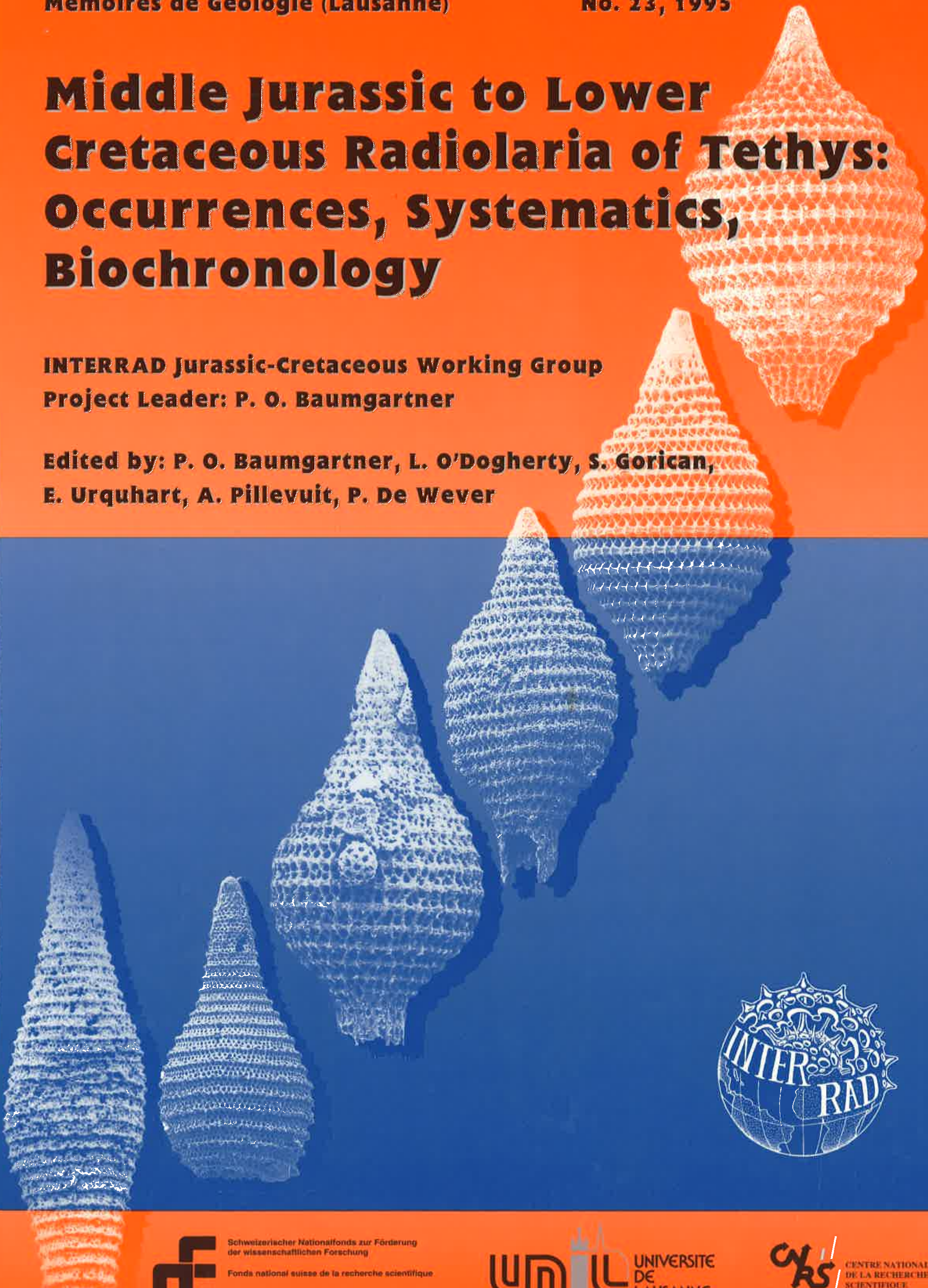
Mémoires de Géologie (Lausanne) No. 23, 1995

Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology

INTERRAD Jurassic-Cretaceous Working Group
Project Leader: P. O. Baumgartner

Edited by: P. O. Baumgartner, L. O'Dogherty, S. Gorican, E. Urquhart, A. Pillevuit, P. De Wever



INTER RAD

Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung
Fonds national suisse de la recherche scientifique
Swiss National Science Foundation

UNIVERSITE DE LAUSANNE

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Mémoires de Géologie
(Lausanne)

Section des Sciences de la Terre
Université de Lausanne
BFSH-2, 1015 Lausanne, Suisse

23

Mémoires de Géologie (Lausanne)

Mémoires de Géologie (Lausanne)
Section des Sciences de la Terre
Institut de Géologie et Paléontologie
Université de Lausanne
BFSH-2, CH-1015 Lausanne

ISSN: 1015-3578

Volume No. 23
Imprimé en Suisse
Dépôt légal: 4ème trimestre 1995

Imprimeur: Chabloz S.A., CH-1131 Tolochenaz, Suisse.
Relieur: Buchbinderei Schumacher AG, CH-3185 Schmitten, Suisse

INTERNATIONAL
ASSOCIATION OF
RADIOLARIAN
PALEONTOLOGISTS

Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology

INTERRAD Jurassic-Cretaceous Working Group
Project Leader: Peter O. Baumgartner

Edited by

**Peter O. Baumgartner, Luis O'Dogherty, Spela Gorican,
Elspeth Urquhart, Alain Pillevuit and Patrick De Wever**

Edited and printed under the auspices of the

INTERNATIONAL ASSOCIATION OF RADIOLARIAN PALEONTOLOGISTS

Volume financed by

Swiss National Science Foundation
Fondation Herbette and Fonds Lugeon, University of Lausanne, Switzerland.
Centre National de la Recherche Scientifique, France.

Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung
Fonds national suisse de la recherche scientifique
Swiss National Science Foundation

UNIVERSITE DE LAUSANNE

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

Contents

Section 3: Biostratigraphy of radiolarian bearing sections and regional radiolarian biochronology

General Papers

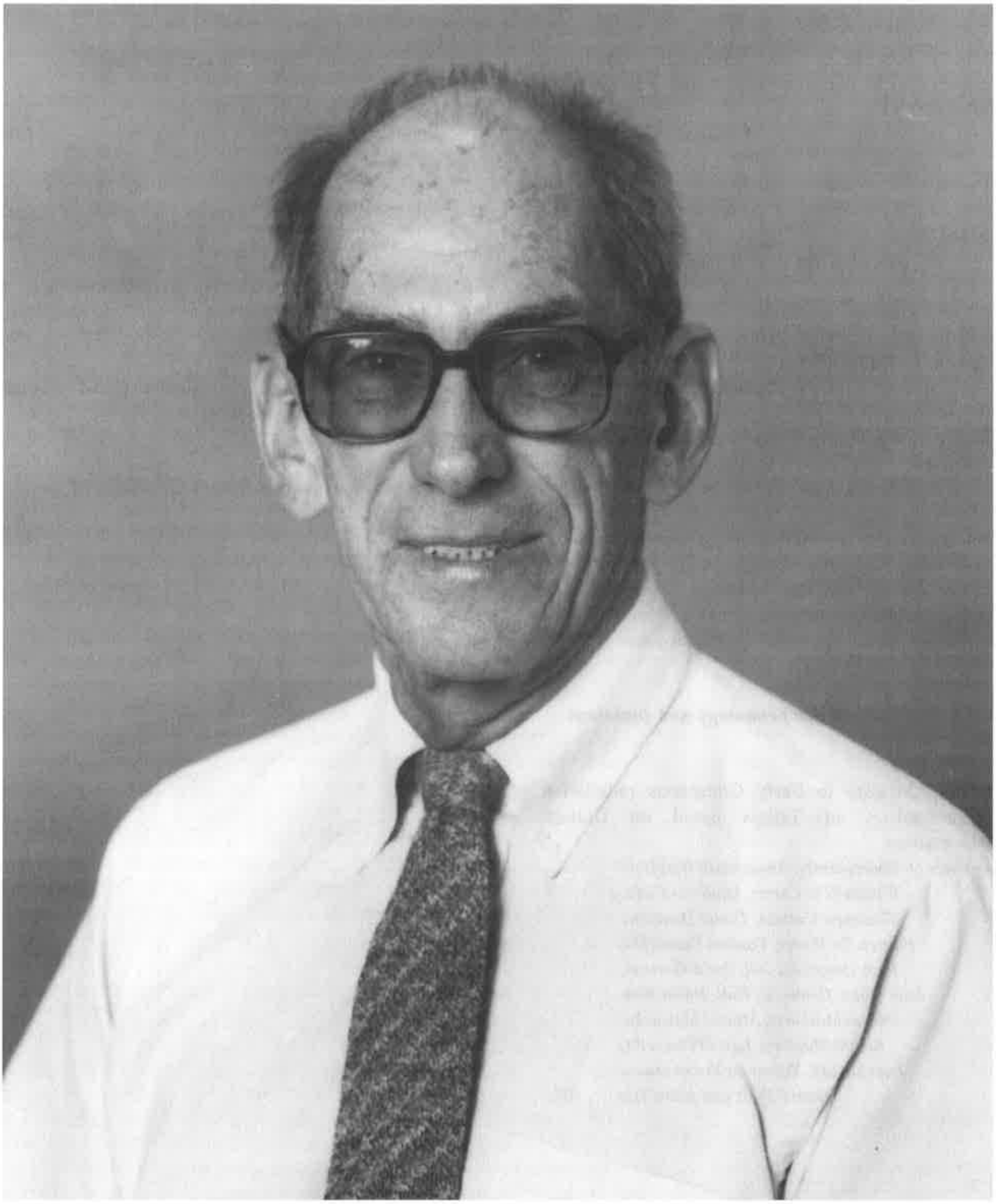
Atlantic

Tethys

Japan, Pacific and Circumpacific Terranes

Section 4: Radiolarian biochronology and zonations of Tethys

Section 5: Glossary, data files and listings.



Bill R.

This work is dedicated to William R. RIEDEL, who originated modern studies of radiolarians

William Rex Riedel was born in Tanunda, in the wine-growing Barossa Valley of South Australia, the 5th of September 1927. After his early education in country schools, he completed his secondary schooling at the Adelaide Technical High School, and then entered the University of Adelaide. His studies there concentrated on geology, zoology and botany- paleontology was not taught as a separate subject until the arrival of Martin Glaessner a few years later. On completion of his Bachelor of Science in 1947, Riedel approached his Professor of Geology and mentor Sir Douglas Mawson with a dilemma - he liked soft-rock geology and biology equally well, and could not decide which to pursue. Mawson unhesitatingly suggested paleontology, and Riedel therefore spent the next year reading in that field. He then returned to Mawson with the observation that paleontology was too broad a subject, and he would need to focus on a single fossil group. Again Sir Douglas had an answer. J.D.H. Wiseman of the British Museum (Natural History) had told him that radiolarians were a neglected group. Riedel readily accepted the suggestion, and spent the next year or so accumulating copies of radiolarian literature - using a wet photography method, and dictating English translations of the predominantly German literature to a typist. He taught himself just enough Italian and French to handle the literature in those languages, and Dutch for the important Tan paper of 1927.

From 1947 to early 1950 he was employed as paleontologist at the South Australian Museum, where he saw his first radiolarians in sediments collected by the British, Australian and New Zealand Antarctic Research Expedition (eventually researched in more detail and published as Riedel, 1958).

During these years, he realized that he would have to go to Europe to further a career based on radiolarians. Minimizing living expenses through an appointment as resident tutor in geology and zoology at St. Mark's College in Adelaide, and accumulating enough for a sea passage to Europe by gardening at weekends, he made a successful application for use of a 'table' at the Zoological Station at Naples, sponsored by the Royal Society. As those arrangements were progressing, he became aware of the deep-sea sediment cores that had been collected by the Swedish Deep-Sea Expedition of 1947-48, which would be a more direct route into radiolarian paleontology than Mediterranean plankton. Therefore he went in 1950 to the Oceanographic Institute in Göteborg, Sweden, instead of to Naples.

With support and encouragement from the director of that Institute, Hans Pettersson, and the inventor of the piston corer, Borje Kullenberg, he was enabled to accomplish some significant research on the radiolarian stratigraphy of Western Pacific cores (Riedel, 1952, 1957). To quote from Sanfilippo, Westberg-Smith and Riedel (1985) "... radiolarians were regarded as having little promise for stratigraphic application ..." In 1950, the reasons for pessimism regarding the utility of radiolarians as a stratigraphic tool seemed incontrovertible. The literature of the previous hundred years provided abundant evidence that the families and genera of radiolarians in Paleozoic rocks are the same as those in the present-day plankton (Campbell, 1954). Even at the level of species, many forms in Recent sediments collected from the ocean floor by HMS Challenger are the same as those occurring in early Tertiary sediments on Barbados (Haeckel, 1887). A chalk from the island of Rotti, near Timor, contained a radiolarian assemblage showing greater similarities to Mesozoic faunas of Europe than to late Tertiary assemblages and present-day plankton (Tan, 1927, 1931). The cores collected by the Swedish Deep-Sea Expedition provided the key that released radiolarian stratigraphy from its hopeless situation. The lower parts of several piston cores from the tropical Pacific were found to contain radiolarian assemblages similar to those that had been described from the early Tertiary of Barbados, or the late Tertiary of Italy and California. The radiolarian assemblages of the upper parts of all of the cores in the region contained a constant component, comprising species described from present-day plankton, and many contained as well a component that varied from core to core, but could be matched with one or more of the Tertiary assemblages that had been encountered a few metres below the sediment surface. Evidently, the rates of accumulation of pelagic sediments were sufficiently low, and physical disturbances of bottom sediments were sufficiently common and intense, to cause widespread admixture of Tertiary radiolarians with Recent ones at the sediment surface (Riedel, 1952, 1957a). Therein lay the explanation for the large number of species in common between the assemblages in sediments collected by the *Challenger* Expedition, and those in Tertiary rocks. The radiolarians of the various levels in the Tertiary proved sufficiently different to permit their application in biostratigraphic interpretations.

"Under these circumstances, the "Mesozoic aspect" of the "Pliocene" assemblage from Rotti became increasingly anomalous, and re-examination of the samples involved led to the explanation that the Dutch exploring expedition had collected samples of lithologically similar pelagic chalks of two very different ages. The samples containing the rich radiolarian assemblages can be dated as Cretaceous on the basis of their calcareous nannofossils, and the samples containing Pliocene nannofossils have a sparse radiolarian fauna that was not noticed until the early 1950s (Riedel, 1953)."

"Those early advances in radiolarian stratigraphy were based mostly on comparisons at the level of species, and did not contradict the firmly entrenched belief that most genera and higher taxa had persisted from the Paleozoic, or at least the Mesozoic, to Recent. However, as increasing numbers of stratigraphic ranges of radiolarian species became known, and as ancestor-descendant relations were elucidated, it became apparent that the long stratigraphic ranges of the higher taxa were an artefact of an unnatural taxonomic system that does not reflect phyletic relationships" (Sanfilippo *et al.*, 1985).

Adopting the piston coring technology developed by Kullenberg, oceanographic institutions soon accumulated large collections of deep-sea sediment cores. Supported by a John Murray Travelling Studentship and a grant from the Geological Society of America, Riedel moved in 1951 to Scripps Institution of Oceanography (California). He was able to explore the radiolarian stratigraphy of Scripps' growing collection of sediment cores, and he led numerous coring expeditions to those parts of the tropical Pacific where slowly accumulating radiolarian clays presented the best opportunities for increasing knowledge of the stratigraphy of these microfossils.

In 1952-1953, M.N. Bramlette began to develop an understanding of the stratigraphic value of calcareous nannofossils, and Riedel collaborated with him in the work that led to a key paper in the initiation of this field (Bramlette & Riedel, 1954). He admired the professional thoroughness and integrity that characterized Bramlette's research, and thereafter regarded him as a mentor.

In 1954-55 Riedel returned to his old position as paleontologist at the South Australian Museum, with the hope of persuading the organization that operated Australia's Antarctic bases to collect Southern Ocean sediments along the tracks of their supply runs. In this he was unsuccessful, and therefore he returned to Scripps Institution in 1955 where he was appointed Curator of Geological Collections. This appointment provided a stable base on which to pursue research into the stratigraphy and taxonomy of radiolarians.

Probably as a result of an interest in the Antarctic instilled a decade earlier by Mawson, Riedel accompanied the new Argentinian supply-and-research vessel *General San Martin* to the Bellingshausen Sea and Weddell Sea in the mid-1950s. The goal of the collaboration was to jump-start the operation of the oceanographic laboratory and facilities on this ship.

Untangling the complexities of radiolarian taxonomy and of disturbed pelagic sequences proved to be time-consuming, and significant results came slowly (Riedel, 1959 ; Riedel, Bramlette & Parker, 1963; Riedel & Funnell, 1964, Friend & Riedel, 1967; Riedel, 1967). However, by piecing together evidence from short Tertiary sections collected by oceanographic coring expeditions, and factoring out the effects of reworking of older fossils into younger deposits, a Cenozoic radiolarian stratigraphy was gradually built up (Riedel & Sanfilippo, 1971). Later legs of DSDP provided sequences that permitted refinement of radiolarian stratigraphy, and vastly improved understanding of evolutionary lineages (e.g., Riedel & Sanfilippo, 1971; Sanfilippo, Westberg-Smith & Riedel, 1985).

Following his service as chief scientist of the Experimental Mohole drilling (Riedel *et al.*, 1961), Riedel played an active role in the planning and implementation of the Deep Sea Drilling Project (1968-1983), for which he acted also as curator. His involvement in its successor, the Ocean Drilling Program, has been mainly through the JOIDES Information Handling Panel.

During the late 1960s and early 1970s, Riedel collaborated with Helen P. Foreman of Oberlin College on a catalog of radiolarians, similar in nature to Ellis and Messina's Catalog of Foraminifera, but differing from the latter in including all references to every radiolarian species, not only the first or nomenclaturally important ones. Only the first two parts of this catalog, covering publications from 1834 to 1862, were published (Foreman & Riedel, 1972) but the entire catalog is now available on microfiches from the U.S. National Technical Information Service (Foreman & Riedel, 1978)

In 1963, he made the first of a series of collecting trips to European Cenozoic and Mesozoic radiolarian localities, which continued throughout the 1970s and early 1980s with the collaboration of Annika Sanfilippo. He spent a year in Lille in 1977-78, which enabled him to participate in the foundation of EURORAD (De Wever, Riedel *et al.*, 1979), which later metamorphosed into INTERRAD, the international community of radiolarian workers.

Around 1970, he became interested in the potential utility of microscopic teeth and scales of fishes for the determination of the ages of otherwise unfossiliferous clays. The results of the first attempt (Helms & Riedel, 1971) were not encouraging, but several years later the development of a procedure for naming these 'ichthyoliths' by a string of coded character-states permitted the development of a useful stratigraphy (e.g. Doyle *et al.*, 1974 ; Tway *et al.*, 1985).

Early in the 1980s, Riedel explored the potential of personal computers for assisting in the objective description of radiolarian shapes. A large investment of effort yielded little in the way of useful results, and this approach was therefore abandoned. However, he continues to believe that emphasis on objectively defined character-states is a promising route toward reducing the subjectivity (and therefore inconsistency) of microfossil identifications, and pursues that goal (Riedel, 1978; 1981, pp. 258-259).

By the mid-1980s, Riedel came to the conclusion that he did not wish to devote the remainder of his active career to radiolarians. His interest in the application of personal computers to paleontologic and biostratigraphic problems intensified, and he found a compatible collaborator in Linda Tway, who had come to Scripps originally to pursue her research on ichthyoliths. They explore the application of newly developing technologies (artificial intelligence, expert systems, and multimedia tools) to paleontology and biostratigraphy, with the general goal of providing tools for improved objectivity and reproductibility in data gathering, and convenience in data retrieval and manipulation (Riedel, 1989; Riedel & Tway, 1990; Tway & Riedel, 1991). Riedel regards the development of practically useful software as a satisfying counterbalance to the academic research which occupied the earlier part of his career.

Now partially retired, he spends a minor part of his time preparing pieces of land in South Australia and Queensland for retirement living.

Annika Sanfilippo
Scripps Institution of Oceanography
La Jolla, California

References

CAMPBELL, A.S. (1954). Radiolaria. *In* Moore, R.C. Ed. *Treatise on Invertebrate Paleontology* - Geological Society of America and University of Kansas Press, Lawrence/Kansas. Part. D, Protista **3**, 11-195.

HAECKEL, E. (1887). Report on the Radiolaria collected by H.M.S. Challenger during the years 1873-1876. *Report on the Scientific Results of the Voyage of the H.M.S. Challenger, Zoology*, **18**, clxxxviii + 1803.

TAN, S.H. (1927). Over de samenstelling en het onstaan van krijt- en mergel-gesteenten van de Molukken. *Jaarboek van het mijnwezen in Nederlandsch Oost-Indie, jaargang 55, 1926, verhandelingen, 3rd gedeelte*, 5-165.

TAN, S.H. (1931). Discoasteridae, Coccolithinae and Radiolaria. *Leidsche geologische mededeelingen, part 5*, 92-114.

Publications by William R. Riedel

1951a RIEDEL, W.R. Number of Radiolaria in sediments. *Nature*, **167**, p. 75.

1951b RIEDEL, W.R. Sedimentation in the tropical Indian Ocean. *Nature*, **168**, 737-738.

1952 RIEDEL, W.R. Tertiary Radiolaria in western Pacific sediments. *Göteborgs Kungliga Vetenskaps- och Vitterhets-Samhälles Handlingar Sjatte Foljden, Series B*, **6** (3), 1-18.

1952 RIEDEL, W.R. & CAMPBELL, A.S. A new Eocene radiolarian genus. *Journal of Paleontology*, **26** (4), 667-669.

1953 RIEDEL, W.R. Mesozoic and late Tertiary Radiolaria of Rotti. *Journal of Paleontology*, **27** (6), 805-813.

1954 BRAMLETTE, M.N. & RIEDEL, W.R. Stratigraphic value of discoasters and some other microfossils related to recent coccolithophores. *Journal of Paleontology*, **28** (4), 385-403.

1954 RIEDEL, W.R. The age of the sediment collected at Challenger (1875) Station 225 and the distribution of Ethmodiscus rex (Rattray). *Deep-Sea Research Part A, Oceanographic Research Papers*, **1**, 170-175.

1956 RIEDEL, W.R. & SCHLOCKER, J. Radiolaria from the Franciscan Group, Belmont, California. *Micropaleontology*, **2** (4), 357-360.

1957a RIEDEL, W.R. Geology of Saipan, Mariana Islands. Part 3. Paleontology. Eocene Radiolaria. *U. S. Geological Survey Professional Paper* **280-G**, 257-263.

1957b RIEDEL, W.R. Radiolaria: a preliminary stratigraphy. *In* Petterson, H. Ed. *Reports of the Swedish Deep-Sea Expedition, 1947-1948* - Elanders Boktryckeri Aktiebolag, Goteborg, Sweden. **6**, 59-96.

1957 RIEDEL, W.R. & HOLM, E.A. Radiolaria. *Geological Society of America, Memoir*, **67**, 1069-1072.

1958 RIEDEL, W.R. Radiolaria in Antarctic sediments. *Reports of the B.A.N.Z. Antarctic Research Expedition, Series B*, **6** (10), 217-255.

1958 RIEDEL, W.R. & NORRIS, R.M. Sediment cores. *In* Fisher, R.L. Ed. *Preliminary Report on Expedition Downwind, University of California, Scripps Institution of Oceanography, IGY Cruise to the Southeast Pacific. IGY General Report Series* - IGY World Data Center A, National Academy of Sciences. **2**, 25-28.

1959a RIEDEL, W.R. Oligocene and Lower Miocene Radiolaria in tropical Pacific sediments. *Micropaleontology*, **5** (3), 285-302.

1959b RIEDEL, W.R. Siliceous organic remains in pelagic sediments. *In* Silica in Sediments - *Special Publication of the Society of Economic Paleontologists and Mineralogists*. **7**, 80-91.

1960 WISEMAN, J.D.H. & RIEDEL, W.R. Tertiary sediments from the floor of the Indian Ocean. *Deep-Sea Research Part A, Oceanographic Research Papers*, **7**, 215-217.

1961 FOREMAN, H.P. & RIEDEL, W.R. Type specimens of North American Paleozoic Radiolaria. *Journal of Paleontology*, **35**, 628-631.

1961 RIEDEL, W.R. & FOREMAN, H.P. Type specimens of North American Paleozoic Radiolaria. *Journal of Paleontology*, **35** (3), 628-632.

1961 RIEDEL, W.R., LADD, H.S., TRACEY, J.I.J. & BRAMLETTE, M.N. Preliminary drilling phase of Mohole Project: Summary of coring operations (Guadalupe Side). *Bulletin of the American Association of Petroleum Geologists*, **45** (11), 1793-1798.

1963a RIEDEL, W.R. Experimental phase of the Mohole Project. *EOS, American Geophysical Union, Transactions*, **44** (2), 358-359.

1963b RIEDEL, W.R. Paleontology of pelagic sediments. *In* Hill, M.N. Ed. *The Sea* - Interscience, New York/London. **3**, 866-887.

1963 RIEDEL, W.R., BRAMLETTE, M.N. & PARKER, F.L. "Pliocene-Pleistocene" boundary in deep-sea sediments. *Science*, **140** (3572), 1238-1240.

1964 RIEDEL, W.R. Microfossils in Indian Ocean sediments. In Preliminary results of SIO investigation in the Indian Ocean during Expeditions MONSOON and LUSIAD, 1960-1963, University of California, San Diego.

1964 RIEDEL, W.R. & FUNNELL, B.M. Tertiary sediment cores and microfossils from the Pacific Ocean floor. *Quarterly Journal of the Geological Society of London*, **120**, 305-368.

1967 FRIEND, J.K. & RIEDEL, W.R. Cenozoic orosphaerid radiolarians from tropical Pacific sediments. *Micropaleontology*, **13** (2), 217-232.

1967a RIEDEL, W.R. Radiolarian evidence consistent with spreading of the Pacific floor. *Science*, **157** (3788), 540-542.

1967b RIEDEL, W.R. Some new families of Radiolaria. *Proceedings of the Geological Society of London*, **1640**, 148-149.

1967c RIEDEL, W.R. Subclass Radiolaria. *In* Harland, W.B., Holland, C.H., House, M.R., Hughes, N.F., Reynolds, A.B., Rudwick, M.J.S., Satterthwaite, G.E., Tarlo, L.B.H. & Willey, E.C. Eds. *The Fossil Record. A symposium with documentation* - Geological Society of London, London, 291-298.

1967 ROSS, D.A. & RIEDEL, W.R. Comparison of upper parts of some piston cores with simultaneously collected open-barrel cores. *Deep-Sea Research Part A, Oceanographic Research Papers*, **14**, 285-294.

1969 RIEDEL, W.R. & HAYS, J.D. Cenozoic Radiolaria from Leg 1. *In* Ewing, M., Worzel, J.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **1**, 400-402.

1969 WINTERER, E.L., RIEDEL, W.R. *et al.* Deep Sea Drilling Project: Leg 7. *Geotimes*, **14** (10), 12-14.

1970 RIEDEL, W.R. & SANFILIPPO, A. Radiolaria, Leg 4, Deep Sea Drilling Project. *In* Bader, R.G. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **4**, 503-575.

1970 SANFILIPPO, A. & RIEDEL, W.R. Post-Eocene "closed" theoperid radiolarians. *Micropaleontology*, **16** (4), 446-462.

1970 SHIPBOARD SCIENTIFIC PARTY. Introduction. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 3-15.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 23. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 17-35.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 24. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 37-57.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 25. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 59-76.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 26. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 77-91.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 27. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 93-123.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 28. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 125-143.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 29. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 145-213.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 30. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 215-241.

1970 SHIPBOARD SCIENTIFIC PARTY. Site 31. *In* Bader, R.G., *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **4**, 243-263.

1971 BRAMLETTE, M.N. & RIEDEL, W.R. Observations of the biostratigraphy of pelagic sediments. *In* Funnell, B.M. & Riedel, W.R. Eds. *The Micropalaeontology of Oceans* - Cambridge University Press, Cambridge, UK., 665-668.

1971 BRÖNNIMANN, P., MARTINI, E., RESIG, J., RIEDEL, W.R., SANFILIPPO, A. & WORSLEY, T. Biostratigraphic synthesis: Late Oligocene and Neogene of the western tropical Pacific. *In* Winterer, E.L., Riedel, W.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7**, 1723-1745.

1971 FUNNELL, B.M. & RIEDEL, W.R. *The Micropalaeontology of Oceans*-Cambridge University Press, Cambridge, UK, 828 p.

1971 HELMS, P.B. & RIEDEL, W.R. Skeletal debris of fishes. *In* Winterer, E.L., Riedel, W.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **7**, 1709-1720

1971a RIEDEL, W.R. The occurrence of pre-Quaternary Radiolaria in deep-sea sediments. *In* Funnell, B.M. & Riedel, W.R. Eds. *The Micropalaeontology of Oceans* - Cambridge University Press, Cambridge, UK., 567-594.

1971b RIEDEL, W.R. Radiolarians from Atlantic Deep-Sea Drilling. *In* Farinacci, A. Ed. *Proceedings of the II Planktonic Conference, Roma, 1970* - Edizioni Tecnoscienza, Roma, Italy, **2**, 1057-1068.

1971c RIEDEL, W.R. Systematic classification of polycystine Radiolaria. *In* Funnell, B.M. & Riedel, W.R. Eds. *The Micropalaeontology of Oceans* - Cambridge University Press, Cambridge, UK., 649-660.

1971 RIEDEL, W.R. & SANFILIPPO, A. Cenozoic Radiolaria from the western tropical Pacific, Leg 7. *In* Winterer, E.L., Riedel, W.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7**, 1529-1672.

1971a WINTERER, E.L., RIEDEL, W.R., *et al.*. Initial reports of the Deep Sea Drilling Project covering Leg 7 of the cruises of the drilling vessel Glomar Challenger, Apra, Guam to Honolulu, Hawaii, August-September 1969. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 1-841.

1971b WINTERER, E.L., RIEDEL, W.R.,*et al.*. Initial Reports of the Deep Sea Drilling Project, covering Leg 7 of the cruises of the drilling vessel ''Glomar Challenger''; Apra, Guam to Honolulu, Hawaii, August-September 1969. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (2), 1-912.

1971 WINTERER, E.L., RIEDEL, W.R. Introduction. *In* Winterer, E.L. *et al.*, Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 3-8.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 61. *In* Winterer, E.L. Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 27-47.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 62. *In* Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 49-322.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 63. *In* Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 323-471.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 64. In Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 473-606.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 65. In Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 607-723.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 66. In Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 725-819.

1971 SHIPBOARD SCIENTIFIC PARTY. Site 67. In Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7** (1), 821-841.

1972 FOREMAN, H.P. & RIEDEL, W.R. *Catalogue of Polycystine Radiolaria, Series 1 (1834-1900).* (Meyen 1834-Bury 1862), Part 1 (Acanthodesmia-Haliomma) & Part 2 (Haliphormis-Gen. et sp. indet.) - American Museum of Natural History, Special Publication, New York, USA.

1973 EDGAR, N.T., SAUNDERS, J.B., *et al.*. Initial Reports of the Deep Sea Drilling Project, covering Leg 15 of the cruises of the drilling vessel Glomar Challenger, San Juan, Puerto Rico to Cristobal, Panama; December 1970-February 1971. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **15**, 1-1137.

1973 RIEDEL, W.R. Cenozoic planktonic micropaleontology and biostratigraphy. *Annual Review of Earth and Planetary Sciences*, **1**, 241-268.

1973 RIEDEL, W.R. & SANFILIPPO, A. Cenozoic Radiolaria from the Caribbean, Deep Sea Drilling Project, Leg 15. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **15**, 705-751.

1973 SANFILIPPO, A., BURCKLE, L.H., MARTINI, E. & RIEDEL, W.R. Radiolarians, diatoms, silicoflagellates and calcareous nannofossils in the Mediterranean Neogene. *Micropaleontology*, **19** (2), 209-234.

1973 SANFILIPPO, A. & RIEDEL, W.R. Cenozoic Radiolaria (exclusive of theoperids, artostrobiids and amphipyndacids) from the Gulf of Mexico, DSDP Leg 10. *In* Worzel, J.L., Bryant, W. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **10**, 475-611.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 146/149. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 17-168.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 147. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 169-215.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 148. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 217-275.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 150. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 277-299.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 151. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 301-329.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 152. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 331-365.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 153. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 367-406.

1973 SHIPBOARD SCIENTIFIC PARTY. Site 154. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 407-471.

1973 SAUNDERS, J.B., BEAUDRY, F.M., BOLLI, H.M, RIEDEL, W.R., SANFILIPPO, A. & PREMOLI-SILVA, I. Paleocene to recent microfossil distribution in the marine and land areas of the Caribbean. *In* Edgar, N.T., Saunders, J.B. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **15**, 769-771.

1974 DOYLE, P.S., KENNEDY, G.G. & RIEDEL, W.R. Stratignathy. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **26**, 825-905.

1974 RIEDEL, W.R. & SANFILIPPO, A. Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

1974 RIEDEL, W.R., SANFILIPPO, A. & CITA, M.B. Radiolarians from the stratotype Zanclean (Lower Pliocene, Sicily). *Rivista Italiana di Paleontologia*, **80** (4), 699-733.

1974a SANFILIPPO, A. & RIEDEL, W.R. Radiolaria from the west-central Indian Ocean and Gulf of Aden, DSDP Leg 24. *In* Fisher, R.L., Bunce, E.T. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **24**, 997-1035.

1974b SANFILIPPO, A. & RIEDEL, W.R. Some radiolarian samples from the western Indian Ocean, DSDP, Leg 25. *In* Simpson, E.S.W., Schlich, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **25**, 657-662.

1975 CARO, Y., LUTERBACHER, H., PERCH-NIELSEN, K., PREMOLI-SILVA, I., RIEDEL, W.R. & SANFILIPPO, A. Zonations à l'aide de microfossiles pélagiques du Paléocéne supérieur et de l'Eocéne inférieur. *Bulletin de la Société Géologique de France, Série VII*, **2**, 125-147.

1975 DENGLER, A.T., DOYLE, P.S. & RIEDEL, W.R. Ichthyoliths in some samples from the Phhilippine Sea, DSDP Leg 31. *In* Karig, D.E., Ingle, J.C.J. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **31**, 821-833.

1975 DUNSWORTH, M.J., DOYLE, P.S. & RIEDEL, W.R. Ichthyoliths from some NW Pacific sediments, DSDP Leg 32. *In* Larson, R.L., Moberly, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **32**, 853-863.

1975 SANFILIPPO, A. & RIEDEL, W.R. Late Tertiary radiolarians from Crete. *Proceedings, VIth Congress Regional Committee on Mediterranean Neogene Stratigraphy, Bratislava*, 61-74.

1976 BERGGREN, W.A., BENSON, R.H., HAQ, B.U., RIEDEL, W.R., SANFILIPPO, A., SCHRADER, H.-J. & TJALSMA, R.C. The El Cuervo section (Andalusia, Spain): micropaleontologic anatomy of an early late Miocene lower bathyal deposit. *Marine Micropaleontology*, **1** (3), 195-247.

1976 PREMOLI-SILVA, I., RIEDEL, W.R., CEPEK, P., DAVIES, T.A., SCHRADER, H.J., THIERSTEIN, H.R. & WORSLEY, T.R. The Results of the Deep Sea Drilling Project: A Preliminary Atlas. *Preliminary Analysis of Deep Sea Drilling Project Data* - Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida, **1**. (unpaginated).

1976 RAMSEY, C.A., DOYLE, P.S. & RIEDEL, W.R. Ichthyoliths in Late Mesozoic pelagic sediments, mainly from Italy. *Micropaleontology*, **22**, 129-142.

1976 Sanfilippo, A. & Riedel, W.R. Radiolarian occurrences in the Caribbean Region. *Publication de la VII conférence géologique des Caraïbes du 30 juin au 12 juillet 1974 (VII Conference Geologique des Caraïbes, Cayenne, Département Français de la Guyane)*, 145-168.

1977 Doyle, P.S., Dunsworth, M.J. & Riedel, W.R. Reworking of ichthyoliths in eastern tropical Pacific sediments. *Deep-Sea Research Part A, Oceanographic Research Papers*, **24**, 181-198.

1977 Edgerton, C.C., Doyle, P.S. & Riedel, W.R. Ichtyolith age determinations of otherwise unfossiliferous Deep Sea Drilling Project cores. *Micropaleontology*, **23** (2), 194-205.

1977 Riedel, W.R. & Sanfilippo, A. Cainozoic Radiolaria. *In* Ramsay, A.T.S. Ed. *Oceanic Micropalaeontology* - Academic Press, London/New York/San Francisco, **2**, 847-912.

1978 Doyle, P.S., Dunsworth, M.J. & Riedel, W.R. Ichthyoliths from some southeast Atlantic sediments, DSDP Leg 40. *In* Bolli, H.M., Ryan, W.B.F. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **40**, 743-759.

1978 Foreman, H.P. & Riedel, W.R. Catalog of Polycycstine Radiolarian Literature, 1834-1930. 35 vols on 246 microfiches. National Technichal Information Service, Springfield, Virginia.

1978 Riedel, W.R. Systems of morphologic descriptors in paleontology. *Journal of Paleontology*, **52** (1), 1-7.

1978a Riedel, W.R. & Sanfilippo, A. Radiolaria. *Utrecht Micropaleontological Bulletins*, **17**, 81-128.

1978b Riedel, W.R. & Sanfilippo, A. Stratigraphy and evolution of tropical Cenozoic radiolarians. *Micropaleontology*, **24** (1), 61-96.

1978 Sanfilippo, A., Caulet, J.P. & Riedel, W.R. Radiolaria from Mediterranean sediments, DSDP Leg 42A. *In* Hsu, K.J., Montadert, L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **44**, 753-760.

1978 Westberg, M.J. & Riedel, W.R. Accuracy of radiolarian correlations in the Pacific Miocene. *Micropaleontology*, **24** (1), 1-23.

1979 De Wever, P., Riedel, W.R., Baumgartner, P., Dumitrica, P., Bjørklund, K.R., Caulet, J.P., Drobne, K., Granlund, A. & Kocher, A.R. Recherches actuelles sur les Radiolaires en Europe. *Annales de la Société Géologique du Nord, Lille*, **96**, 205-222.

1979 De Wever, P., Sanfilippo, A., Riedel, W.R. & Gruber, B. Triassic radiolarians from Greece, Sicily and Turkey. *Micropaleontology*, **25** (1), 75-110.

1979a Doyle, P.S. & Riedel, W.R. Cretaceous to Neogene ichthyoliths in a giant piston core from the central North Pacific. *Micropaleontology*, **25** (4), 337-364.

1979b Doyle, P.S. & Riedel, W.R. Ichthyoliths: Present status of taxonomy and stratigraphy of microscopic fish skeletal debris. *Scripps Institution of Oceanography, Reference Series*, **79** (16), 1-231.

1979 Riedel, W.R. & Saito, T. Marine plankton and sediments. *Micropaleontology Special Publication*, **3**, 1-159 p.

1979 Sanfilippo, A. & Riedel, W.R. Radiolaria from the northeastern Atlantic Ocean, DSDP Leg 48. *In* Montadert, L., Roberts, D.G. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **48**, 493-511.

1980 Boltovskoy, D. & Riedel, W.R. Polycystine Radiolaria from the southwestern Atlantic ocean plankton. *Revista Española de Micropaleontología*, **12** (1), 99-146.

1980 Budai, A., Riedel, W.R. & Westberg, M.J. A general-purpose paleontologic information device. *Journal of Geology*, **54** (1), 259-262.

1980 Doyle, P.S. & Riedel, W.R. Ichthyoliths from Site 436, Northwest Pacific, Leg 56, Deep Sea Drilling Project. *In* Lee, M., Stout, L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **56** (2), 887-893.

1980 Sanfilippo, A. & Riedel, W.R. A revised generic and suprageneric classification of the Artiscins (Radiolaria). *Journal of Paleontology*, **54** (5), 1008-1011.

1980 Westberg, M.J., Sanfilippo, A. & Riedel, W.R. Radiolarians from the Moroccan Basin, Deep Sea Drilling Project Leg 50. *In* Lancelot, Y., Winterer, E.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **50**, 429-437.

1981 DOYLE, P.S. & RIEDEL, W.R. Ichthyoliths at Site 464 in the Northwest Pacific, Deep Sea Drilling Project Leg 62. *In* Stout, L.N., Thiede, J. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **62**, 491-494.

1981 KANEPS, A.G., DOYLE, P.S. & RIEDEL, W.R. Further ichthyolith age determinations of otherwise unfossiliferous deep sea cores. *Micropaleontology*, **27** (3), 317-329.

1981 RIEDEL, W.R. DSDP biostratigraphy in retrospect and prospect. *In* Warme, J.E. *et al.* Eds. *The Deep Sea Drilling Project: A Decade of Progress* - Special Publication of the Society of Economic Paleontologists and Mineralogists, **32**, 253-315.

1981 RIEDEL, W.R. & SANFILIPPO, A. Evolution and diversity of form in Radiolaria. *In* Simpson, T.L. & Volcani, B.E. Eds. *Silicon and Siliceous Structures in Biological Systems* - Springler-Verlag, New York/Heidelberg/Berlin, 323-346.

1981 SANFILIPPO, A., WESTBERG, M.J. & RIEDEL, W.R. Cenozoic radiolarians at Site 462, Deep Sea Drilling Project Leg 61, western tropical Pacific. *In* Larson, R.L., Schlanger, S.O. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **61**, 495-505.

1981 WESTBERG, M.J., SANFILIPPO, A. & RIEDEL, W.R. Potential stratotype sections in Italy and Greece; biostratigraphic results of the Italian sections; Radiolaria. *In* Search of the Palaeogene/Neogene boundary stratotype. Part 1. Potential boundary stratotype sections in Italy and Greece and a comparison with results from the deep-sea. - *Giornale di Geologia*, **44**, 155-165.

1982 PRELL, W.L., GARDNER, J.V., *et al.* Initial reports of the Deep Sea Drilling Project; covering Leg 68 of the cruises of the drilling vessel Glomar Challenger; Willemstad, Curacao to Guayaquil, Ecuador. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **68**, 1-495.

1982 RIEDEL, W.R. & SANFILIPPO, A. Evolutionary history of Cenozoic cyrtoid radiolarian genera. *Third North American Paleontological Convention, Proceedings*, **2**, 429-434.

1982 RIEDEL, W.R. & WESTBERG, M.J. Neogene radiolarians from the eastern tropical Pacific and Caribbean, Deep Sea Drilling Project Leg 68. *In* Gardner, J.V., Prell, W. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **68**, 289-300.

1982 SANFILIPPO, A. & RIEDEL, W.R. Revision of the radiolarian genera *Theocotyle*, *Theocotylissa* and *Thyrsocyrtis*. *Micropaleontology*, **28** (2), 170-188.

1982 WESTBERG, M.J. & RIEDEL, W.R. Radiolarians from the Middle-America Trench off Guatemala, Deep Sea Drilling Project Leg 67. *In* Aubouin, J., Von Huene, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **67**, 401-424.

1982 SHIPBOARD SCIENTIFIC PARTY. Site 502: Colombia Basin, Western Caribbean Sea. *In* Prell, W.L., Gardner, J.V. *et al.*, Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **68**, 15-162.

1982 SHIPBOARD SCIENTIFIC PARTY. Site 503: Eastern Equatorial Pacific. *In* Prell, W.L., Gardner, J.V. *et al.*, Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **68**, 163-242.

1984a GOTTFRIED, M.D., DOYLE, P.S. & RIEDEL, W.R. Advances in ichthyolith stratigraphy of the Pacific Neogene and Oligocene. *Micropaleontology*, **30** (1), 71-85.

1984b GOTTFRIED, M.D., DOYLE, P.S. & RIEDEL, W.R. Stratigraphic interpretations of pelagic sequences revised on the basis of ichthyoliths. *Micropaleontology*, **30** (4), 426-444.

1984 SAUNDERS, J.B., BERNOULLI, D., MULLER-MERZ, E., OBERHANSLI, H., PERCH-NIELSEN, K., RIEDEL, W.R., SANFILIPPO, A. & TORRINI, J., R. Stratigraphy of the late middle Eocene to early Oligocene in theBath Cliff Section, Barbados, West Indies. *Micropaleontology*, **30** (4), 390-425.

1985a DOYLE, P.S. & RIEDEL, W.R. Cenozoic and Late Cretaceous ichthyoliths. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne/Sidney, 965-995.

1985b DOYLE, P.S. & RIEDEL, W.R. Ichthyolith biostratigraphy of western North Pacific pelagic clays, Deep Sea Drilling Project Leg 86. *In* Heath, G.H., D'Agostino, A.E. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **86**, 349-366.

1985 RIEDEL, W.R., WESTBERG-SMITH, M.J. & BUDAI, A. Late Neogene Radiolaria and Mediterranean paleoenvironments. *In* Stanley, D.J. & Wezel, F.C. Eds. *Geological Evolution of the Mediterranean Basin* - Springer-Verlag, New York, USA, 487-523.

1985 Sanfilippo, A. & Riedel, W.R. Cretaceous Radiolaria. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne/Sidney, 573-630.

1985 Sanfilippo, A., Riedel, W.R., Glass, B.P. & Kyte, F.T. Late Eocene microtektites and radiolarian extinctions on Barbados. *Nature*, **314** (6012), 613-615.

1985 Sanfilippo, A., Westberg-Smith, M.J. & Riedel, W.R. Cenozoic Radiolaria. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton stratigraphy* - Cambridge University Press, Cambridge/ New York, 631-712.

1985 Tway, L.E., Doyle, P.S. & Riedel, W.R. Correlation of dated and undated Pacific samples based on ichthyoliths and clustering techniques. *Micropaleontology*, **31** (4), 295-319.

1985 Westberg-Smith, M.J. & Riedel, W.R. Radiolarians from the western margin of the Rockall Plateau: Deep Sea Drilling Project Leg 81. *In* Roberts, D.G., Schnitker, D. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **81**, 479-501.

1986 Briskin, M., Robins, J., Riedel, W.R. & Booker, R. Magnetic resonance imaging analyses of varved marine sedimentary records of the Gulf of California. *Geophysical Research Letters*, **13** (8), 753-756.

1986a Riedel, W.R. & Sanfilippo, A. Morphological characters for a natural classification of Cenozoic Radiolaria, reflecting phylogenies. *Marine Micropaleontology*, **11**, 151-170.

1986b Riedel, W.R. & Sanfilippo, A. Radiolarian events and the Eocene-Oligocene boundary. *In* Pomerol, C. & Premoli-Silva, I. Eds. *Terminal Eocene Events* - Elsevier, Amsterdam, The Netherlands, 253-257.

1986 Westberg-Smith, M.J., Tway, L.E. & Riedel, W.R. Radiolarians from the North Atlantic Ocean, Deep Sea Drilling Project Leg 94. *In* Ruddiman, W.F., Kidd, R.B., Thomas, E. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **94**, 763-777.

1987 Boltovskoy, D. & Riedel, W.R. Polycystine Radiolaria of the California current region: Seasonal and geographic patterns. *Marine Micropaleontology*, **12** (1), 65-104.

1987 Riedel, W.R., Lau, K.Y., Somerville, R.S. & Tway, L.E. Measuring the surface topography of microfossils. *Micropaleontology*, **33** (2), 189-192.

1987 Winfrey, E.C., Doyle, P.S. & Riedel, W.R. Preliminary ichthyolith biostratigraphy, Southwest Pacific, Deep Sea Drilling Project Leg 91. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **91**, 447-468.

1989 Riedel, W.R. IDENTIFY; a Prolog program to help identify fossils. *Computers and Geosciences*, **15** (5), 809-823.

1990 Riedel, W.R. Quantitative description of pore patterns in radiolaria. *Micropaleontology*, **36** (2), 177-181.

1990 Riedel, W.R. & Tway, L.E. Artificial intelligence applications in paleontology and stratigraphy. *In* Agterberg, F. & Banham-Carter, G. Eds. *Statistical applications in earth sciences*. Geological Survey of Canada, Paper **89-90**, 383-388.

1990 Riedel, W.R. & Tway, L.E. The GeoProlog System. Manual distributed, with diskette, on request. 49 p.

1991 Collot, J.Y., Greene, H.G. *et al.* Résultats préliminaires du Leg 134 de l'Océan Drilling Program dans la zone de collision entre l'arc insulaire des Nouvelles-Hébrides et la Zone d'Entrecasteaux. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **313** (5), 539-546.

1991 Greene, G., Collot, J.Y. *et al.* Material transfer in an arc-ridge collision zone. *EOS, American Geophysical Union, Transactions*, **72** (40), 425, 430-431.

1991 Riedel, W.R. & Tway, L.E. Programming in Prolog for paleontologic, stratigraphic and paleoenvironmental applications. *Geobyte*, **6** (2), 31-36.

1991 Tway, L.E. & Riedel, W.R. An intelligent entry and retrieval system for geological databases. *Geobyte*, **6** (4), 11-17.

1992 Collot, J.Y., Greene, H.G. *et al.* Proceedings of the Ocean Drilling Program, Vanuatu (New Hebrides), covering Leg 134 of the cruises of the drilling vessel JOIDES Resolution, Port of Townsville, Queensland, Australia, to Suva, Republic of Fiji, sites 827-833, 11 October 1990-17 December 1990. *Proceedings of the Ocean Drilling Program, Initial Reports*. College Station, TX (Ocean Drilling Program), **134**, 1-1136.

1992 Sanfilippo, A. & Riedel, W.R. The origin and evolution of Pterocorythidae (Radiolaria): A Cenozoic phylogenetic study. *Micropaleontology*, **38** (1), 1-36.

1992 TWAY, L.E. & RIEDEL, W.R. Expert system software: features to consider. PCAI, Jul/Aug, 52-61.

1992 SHIPBOARD SCIENTIFIC PARTY. Introduction. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 5-18.

1992 SHIPBOARD SCIENTIFIC PARTY. Explanatory Notes. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 65-91.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 827. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 95-137.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 828. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 139-177.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 829. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 179-260.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 830. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 261-315.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 831. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 317-386.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 832. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 387-477.

1992 SHIPBOARD SCIENTIFIC PARTY. Site 833. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 479-557.

1992 SHIPBOARD SCIENTIFIC PARTY. Summary and Conclusions. *In* Collot, J.-Y., Greene, H.G., Stokking, L.B. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Initial Reports.* College Station, TX (Ocean Drilling Program), **134**, 561-577.

1994 RIEDEL, W.R. & TWAY, L.E. Intelligent front and back ends to a geological database. Proceedings of the 4th International Conference on Geoscience Information. *Geological Survey of Canada, Open File,* **2315**, 400-408.

1994 RIEDEL, W.R., TWAY, L.E. & SANFILIPPO, A. Rad Notes. Software to assist non-experts to identify radiolarians. Computer software.

1994 WEINHEIMER, A.L., SANFILIPPO, A. & RIEDEL, W.R. Radiolarians from Leg 134, Vanuatu Region, Southwestern Tropical Pacific. *In* Greene, H.G., Collot, J.-Y., Stokking, L.B. *et al.* Eds. Proceedings of the Ocean Drilling Program, Scientific Results, College Station, TX (Ocean Drilling Program), **134**, 309-317.

Objectives and organisation of this book

Introduction

This book is the result of over 15 years of collaborative research on Jurassic and Early Cretaceous Radiolaria. During this time span, radiolarian literature has at least doubled and for the Mesozoic, the number of modern publications grew from a handful in 1978 to over one thousand. This book is a synthesis of our knowledge on Middle Jurassic - Early Cretaceous radiolarians, that has been created in collaboration with all the colleagues that appear in the list of contributors. However, many decisions concerning the final systematic choices, the weighting of prime data for biochronology, and the final presentation were taken by the Lausanne group in the last two years prior to publication. The aim of this foreword is to briefly state the objectives and the limitations of our work. When we started out in 1989, we were perhaps much less aware of these limitations. It was during the countless calculations that led to the zonation presented in this book that we learned most about these limitations. The second part of this foreword talks about the organisation of this book, which is governed much more by practical than by theoretical aspects.

The objectives and the limitations of this book

Objectives

The objectives of this book have remained unchanged over the whole period of production. However, during the first two years we were perhaps overly optimistic both about the amount of time needed to realise the work and about the coherence of the final result. The prime objectives were: Create a database on Middle Jurassic to Lower Cretaceous Radiolaria common to a number of radiolarian specialists, in order to obtain a biostratigraphic correlation and a well-calibrated radiolarian zonation for this time interval.

During three meetings we have tried to come to a consensus concerning over 450 taxa to be used for biostratigraphy. The objective of our discussions was to agree on the "semantics" of each taxon, to achieve a homogeneity of the data. We have limited our work to typical "Tethyan" assemblages. By "Tethyan" we understand assemblages extracted from predominantly biogenic sediments deposited at low to intermediate paleolatitudes under the influence of broadly defined tropical - subtropical current systems.

If all authors could count on similar preservation and sample quality and if all species were equally recorded by all authors then correlation between American, European and Japanese data sets would be no problem. It would just be limited by paleobiogeographic variations from one area to the other, which we tried to avoid by staying in one, broadly defined facies belt.

Limitations

1. There is no easy way to define the "semantics", i.e. the limits of variability of each taxon. The better we know our radiolarians the more transitional forms we observe. There will be always that form that will be included with a given species by one author and not included by another. To escape semantic problems, we grouped in many cases several closely related morphotypes under a species *sensu lato* (s.l.) and defined subspecies to be recorded in case of good preservation. (see *Chapter 2. Concepts*).

2. Problems of selective preservation. Large radiolarian species are preferentially preserved in certain assemblages extracted from cherty limestones, while small forms are sometimes indeterminable in the same samples due to coarse recrystallisation of quartz. Small forms, on the other hand are more resistent to HF-treatment and occur abundantly in residues from ribbon-bedded cherts or siliceous mudstones. Even the best observer will not be able to produce the same species list of coeval samples in two different lithologies.

3. Selective observation. We all have our "pets", i. e. species that we know better than others, for which we are better observers and produce a better record than for others. As a consequence, the species list produced by two independent observers of the same sample.

In the attempt to calculate Unitary Associations of data sets combined from several authors we realised how incoherent our work must be.

Obviously, the zonation created can not be better that the data used to produce it. Our prime objective, correlation, has governed our way of making the zonation. To achieve "global" correlation, we had to sacrifice vertical resolution and to produce broadly defined Zones.

The organisation of this book

General organisation

The organisation of this book was inspired by the *Initial Reports of the Deep Sea Drilling Project.* Each of these volumes was composed of the "Site Chapters", a collection of data and preliminary results on each drilled site, co-authored by the entire scientific shipboard party, and the "Special Chapters" produced by individual members of the shipboard party or invited, shore based contributors.

During the three meetings held by the INTERRAD JURASSIC-CRETACEOUS WORKING GROUP the main effort was put into the selection and discussion of the species and subspecies to be used for biostratigraphy (see *Chapter 1*). Therefore, the systematic part of this book is, like the Site Chapters a result of the meetings held by the whole group, although most of the actual writing, compiling and illustrating was done by the Lausanne group. This systematic part is placed after the introductory chapters in *Section 2* as *Chapter 4. Radiolarian Catalogue and Systematic of Middle Jurassic to Early Cretaceous Tethyan Genera and Species.* We have invited all participants of the meetings, as well as a number of other radiolarian workers to produce individual chapters that report on new radiolarian data or review radiolarian occurrences published elsewhere for the purposes of this atlas. We urged our contributors to give preference to data sets that included stratigraphic sections of a certain length, as well as sections where radiolarian occurrences can be related to occurrences of other fossils, such as ammonites, to calibrate the radiolarian biostratigraphy. These chapters are presented under *Section 3. Biostratigraphy of radiolarian bearing sections and regional radiolarian biochronology* (*Chapters 5-31*).

While each chapter has its own interpretation of the presented data, there are two synthesis chapters that deal with radiolarian biochronology based on a combination of data sets presented in *Section 4: Radiolarian biochronology and zonations of Tethys* (*Chapters 32-33*). The reader will find certain discrepancies between the results presented in *Section 4* and those given by the individual papers. These discrepancies will be discussed where possible in the synthesis chapters.

In the last section: *Section 5: Glossary, data files and listings,* we have put all the materials that are in alphabetical or numerical order and can be expressed as listings

Section 2: Catalogue and systematic of Middle Jurassic to Lower Cretaceous Radiolaria. (Chapters 3-4)

Paulian Dumitrica has produced *Chapter 3.* that intends to give the suprageneric classification of the taxa presented in the catalogue in alphabetical order. It has to be stated that suprageneric classification was not a concern of the Working Group. As a consequence, this chapter has been reviewed only by a few members of the group. It represents Paulian's concept of the classification and other members of the group may not necessarily agree with all that is stated in this chapter.

Chapter 4 includes the bulk of this book the *Radiolarian Catalogue and Systematic of Middle Jurassic to Early Cretaceous Tethyan Genera and Species.* The selection and the morphologic delimitations of most of the species were decided during the three meetings held by the Working Group. The concepts that guided these decisions will be discussed in *Chapter 3.* We have tried to include as many synonymies as possible up to 1994. However, we know that synonymies are incomplete, especially for the last few years. It has to be said once more, that most of the compilation of original descriptions, translations, scanning of holotypes, etc. etc. was done by the Lausanne group. Also most of the illustrations were produced by the Lausanne group. This had the convenience of producing a coherent piece of work. Not all members, however, may necessarily approve all the illustrations given or all the synonymies included. In the course of making the zonation, we realized that the lowermost Middle Jurassic was poorly represented in the selection of taxa made at the meetings. Consequently, we added a number of species representative of the Aalenian-Bajocian interval. We completed our own data and the data of some other contributors based on illustrations in their recent publications. Further details on how this catalogue was made and how it should be used will be given in the introductory remarks of *Chapter 4.*

Section 3: Biostratigraphy of radiolarian bearing sections and regional radiolarian biochronology (Chapters 5-31)

Each chapter in this section contains data, statements, and illustrations for which the author(s) are solely responsible and that do not necessarily reflect a consensus of the Working Group or concur with the ideas of the editors of this book. The quality of the printing figures is determined by the quality of the original artwork submitted by the authors. During the meetings we agreed on a certain format of these data papers that has been followed more or less closely by the contributors. In principle, these chapters should include the geographical and geological setting of each studied section as well as data on the superposition of the samples and on associated fossils other than radiolarians. The calibration of the zonation presented in *Chapter 32* is based on the calibration provided in the data papers. Many papers include a discussion of the age of each sample based on earlier radiolarian zonations and/or other fossils, such as ammonites, nannofossils, aptychi, calpionellids, etc. Paleomagnetic work has been integrated in the calibration of the Lower Cretaceous in *Chapter 12* by Jud. Stable carbon isotope stratigraphy has been used to confirm Aalenian to Oxfordian ages in *Chapter 15* by Bartolini *et al.*

Each Chapter is followed by an appendix that includes the data that has been submitted for the calculations of Unitary Associations. The reader will realise slight differences between the data given in each chapter and the data listed in *Chapter 37.* Minor modifications were made in the following cases 1. Suppression of MRD (Mesozoic Radiolarian Database)-codes not existing in the catalogue (result of typing errors). 2. Suppression of obvious misidentifications of species that created extreme perturbations during calculations (see Chapter 32 for examples) 3. Suppression of MRD-codes representing genera, because we did not use genera in the zonation. 4. Introduction of MRD-codes for each species of which a subspecies is present. In agreement with the decisions made during the meetings, we considered the species as placed hierarchically above the subspecies. Therefore, if a subspecies is determined in a particular sample, automatically the corresponding species has been determined also. Some contributors omitted to include the MRD-codes of the species, each time one of its subspecies was recorded. We have tried to complete the data. 5. Introduction of some MRD-codes of species illustrated in recent publications on the same samples by the same author, where this proved useful for correlation.

Section 4: Radiolarian biochronology and zonations of Tethys (Chapters 32-33)

Chapter 32 describes in detail how we made the zonation (UAZones95 1-22) presented in this book. Based on the concepts stated in this chapter we went through several hundred trials of combinations of data to find an optimal zonation. We give the explanations of why finally some data were not included in the process of construction of the range chart. A second part of this chapter is dedicated to the calibration of the radiolarian zonation. This calibration is based on the data given in all the individual chapters of Section 3. It takes into account all fossils co-existing with radiolarians in the same sections, as well as magnetic and stable isotope stratigraphy. It does not take into account earlier radiolarian zonations or ranges of radiolarian taxa stated by other authors. We discuss the resulting zonation (UAZones95 1-22) and its correlation to earlier zonations. We try to solve the major discrepancies that exist with respect to other zonations.

Chapter 33 by Matsuoka compares the zonation presented in this book to radiolarian zonations used in Japan, based on his sections that were used for the construction of both types of zonations.

Section 5: Glossary, data files and listings.

In this section the reader will find a collection of data sets that serve as tools to use this book.

Chapter 34 includes a glossary of morphological terms used in the systematic chapters of this book.

Chapter 35 gives an alphabetical listing of all genera, species, and subspecies that figure in the catalogue with the respective MRD-codes and the range, expressed as UAZones and as standard stages.

Chapter 36 contains the same information as *Chapter 35*, but ordered numerically after the MRD-codes.

Chapter 37 contains the total data set exactly in the form used for the calculation of the zonation.

Chapter 38 contains a listing of all samples, their zonal assignment and age range, as well as the ages used for calibration, indicated by associated other fossils, magnetic or stable isotope stratigraphy.

Notes on the production of this book

The Radiolarian bibiography RADREFLIB (Sanfilippo *et al.*, Scripps Institution of Oceanography, La Jolla, CA92093-0220) was consulted in compiling bibliographies. The final version of this book was entirely done on Power Macintosh™ computers. Text data from databases, PC-files, and other sources were transferred to text files using Microsoft Word™, modified, and then page set with QuarkXPress™. Art work was either mounted into the text on paper (when originals were submitted on paper) or scanned, recreated in Canvas™ and then imported into QarkXPress™ for page setting.

All photographic illustrations were digitised with a resolution of 8 bits of grey and 300 pixels per inch at the size of the printed image. Digitising was done either by scanning original prints produced for draft versions of the radiolarian catalogue, or by using Kodak™ CD-ROMs produced from SEM-negatives. SEM-negatives were also photographed with a digital camera (Kodak™ DCS 200, a CCD camera with a resolution of 1524 x 1012 pixels). Some, more recent images were digitally acquired from the SEM at 1012 x 1012 pixels. All SEM illustrations were prepared for the plates in Adobe Photoshop™. Preparation included resizing, cropping, rotation, creating black background, and adjustments of brightness and contrast levels. Images were then imported into QuarkXPress™, where the plates were created. The total time for digitising, creation of plates and page setting of this book is estimated as one man year. Metal plates for offset printing were made from films flashed directly from computer files.

The Editors

Acknowledgements

We gratefully acknowledge the Swiss National Science Foundation which has funded most of the research of the Lausanne group that led to the production of this book: P.O. Baumgartner was granted a part time salary from 1985-1994 (Projects No. 82.183.0.84, No. 21-30308.90 and No. 20-36047.92). The doctoral thesis of Ruth Jud and Luis O'Dogherty were financed in the frame of the Projects No. 2.332-0.86, No. 20-27633.89 and No. 20-36040.92. Luis O'Dogherty and Taniel Danelian occupied a postdoctoral position funded for several months by the Projects No. 20-27633.89 and No. 20-36040.92. Field work of the aformentioned and of Spela Gorican was partially funded by the same projects. Finally, the preparation of artwork for this publication was partially funded through salaries provided by the above projects. The research of R. Jud was partially financed by the Société Académique Vaudoise.

Torsten Steiger and the INTERRAD Jurassic-Cretaceous Working Group are thankful to the Deutsche Forschungsgemeinschaft who funded the second meeting 1990 in Grafrath (near Munich).

The doctoral thesis of Spela Gorican was financially supported by the Scientific Research Centre of the Slovenian Academy of Sciences and Arts and aided by grants from the Ministry of Science and Technology of Slovenia, University of Lausanne and the Société

Académique Vaudoise. The research of L. O'Dogherty was partially supported by grants from Fondation du 450ème Anniversaire (Université de Lausanne) and from the *EMMI* Research Group of the Junta de Andalucía, Spain.

Patrick De Wever and the INTERRAD Jurassic-Cretaceous Working Group owe thanks to Centre National de la Recherche Scientifique (CNRS) and to URA 1315 of CNRS-UPMC for providing funds for the meeting in Bierville, near Etampes in 1991.

Page setting and printing of this book are financed by the Fondation Herbette of the Faculty of Sciences, Lausanne University, the Fondation Marguerite Lugeon of the Earth Sciences Department, Lausanne University and by the Centre National de la Recherche Scientifique (France).

Many illustrations of holotypes have been reproduced from original publications. These are acknowledged in the plate captions by reference to the author(s), year, plate, and figure numbers of the original publication. We are deeply thankful for the permission granted.

We are indebted to a number of colleagues and collaborators who constantly encouraged this project during the years of its existence: Henri Masson, Johannes Hunziker and Anne-Marie Magnenat.

Lausanne, August 1995

Contributors

ANNACHIARA BARTOLINI
Dipartimento di Scienze della Terra
Università di Perugia
Piazza dell' Universitá
06100 Perugia
Italy

PETER O. BAUMGARTNER
Institut de Géologie et Paléontologie
Université de Lausanne, BFSH 2
1015 Lausanne
Switzerland

KRZYSZTOF BIRKENMAJER
Institute of Geological Sciences
Polish Academy of Sciences
Senacka 1
31002 Krakow
Poland

ELISABETH S. CARTER
Department of Geology
Portland State University
Portland, Oregon 97207-0751
USA
Mailing address:
58335 Timber Road
Vernonia, Oregon 97064
USA

FABRICE CORDEY
311-1080 Pacific St.
Vancouver B.C., V6E 4C2
Canada

MAURIZIO CONTI
Ecosystems s.a.s.
Via G.F. Mariti, 10
50127 Firenze
Italy

GIUSEPPE CORTESE
Dipartimento di Scienze della Terra
Università di Firenze
Via La Pira, 4
50121 Firenze
Italy

TANIEL DANELIAN
Department of Geology and Geophysics
University of Edinburgh
Grant Institute, West Mains Road
Edinburgh EH9 3JW
UK

PATRICK DE WEVER
CNRS-Université Pierre et Marie Curie
Laboratoire de Stratigraphie T15-16 E4
4 Place Jussieu
75252 Paris Cedex 05
France

PAULIAN DUMITRICA
Institut de Géologie et Paléontologie
Université de Lausanne, BFSH 2
1015 Lausanne
Switzerland
Mailing address:
Könizstrasse 39
3008 Bern
Switzerland

RUTH DUMITRICA-JUD
Institut de Géologie et Paléontologie
Université de Lausanne, BFSH 2
1015 Lausanne
Switzerland
Mailing address:
Könizstrasse 39
3008 Bern
Switzerland

ELISABETTA ERBA
Dipartimento di Scienze della Terra
Università di Milano
Via Mangiagalli 34
20133 Milano
Italy

SPELA GORICAN
Paleontoloski Institut Ivana Rakovca ZRC Sazu
Gosposka 13
61000 Ljubljana
Slovenia

JEAN GUEX
Institut de Géologie et Paléontologie
Université de Lausanne, BFSH 2
1015 Lausanne
Switzerland

DONNA M. HULL
Programs in Geosciences
University of Texas at Dallas
P.O.Box 830688
Richardson, Texas 75083-0688
U.S.A.

NORIO KITO
Institute of Earth Sciences
College of General Education
Hokkaido University of Education
1-2 Hachiman-cho
040 Hakodate
Japan

MARTA MARCUCCI
Dipartimento di Scienze della Terra
Università di Firenze
Via La Pira, 4
50121 Firenze
Italy

Augustín Martín-Algarra
Departamento de Estratigrafía y Paleontología
Universidad de Granada
Av. de Fuentenueva s/n
18002 Granada
Spain

Luca Martire
Dipartimento di Scienze della Terra
Università di Torino
Via Accademie delle Scienze 5
10123 Torino
Italy

Emanuela Mattioli
Dipartimento di Scienze della Terra
Università di Perugia
Piazza dell' Universitá
06100 Perugia
Italy

Atsushi Matsuoka
Department of Geology
Faculty of Science
Niigata University
950-21 Niigata
Japan

Benita Murchey
U.S. Geological Survey
Paleontology Branch, MS 915
Middlefield Road 345
Menlo Park, California 94025
USA

Luis O'Dogherty
Departamento de Geología Marina
Facultad de Ciencias del Mar
Universidad de Cádiz
11510, Puerto Real
Spain

Emile A. Pessagno
Programs in Geosciences
University of Texas at Dallas
P.O.Box 830688
Richardson, Texas 75083-0688
U.S.A.

Alain Pillevuit
Institut de Géologie et Paléontologie
Université de Lausanne, BFSH 2
1015 Lausanne
Switzerland

José Sandoval
Departamento de Estratigrafía y Paleontología
Universidad de Granada
Av. de Fuentenueva s/n
18002 Granada
Spain

Jean Savary
Prarainson
CP 627
1965 Savièse
Switzerland

Torsten Steiger
Institut für Paläontologie
Universität Erlangen-Nürnberg
Loewenichstrasse 28
8520 Erlangen
Germany

Elspeth Urquhart
Department of Geological Sciences
University College London
Gower Street
London WC1E 6BT
UK

Valentina Vishnevskaya
Institute of Litosphaera
Staromonethyiper. 22
Moskova, 109017
Russia

Daniel Widz
Institute of Geological Sciences
Polish Academy of Sciences
Senacka 1
31002 Krakow
Poland

Akira Yao
Department of Geoscience
Faculty of Sciences
Osaka City University
Sugimoto 3-3-138; Sumiyoshi-ku
558 Osaka
Japan

1

Introduction

1. Background and activities of the INTERRAD Jurassic-Cretaceous Working Group

by Peter O. Baumgartner

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

ABSTRACT

This chapter summarises the background that led to the of the activities of the Jurassic-Cretaceous Working Group and to the conception of this book. It gives information of the personal background of the author through the years 1973-1989. It traces the activity of the INTERRAD Jurassic-Cretaceous Working Group through the years 1989 to 1995.

1. Introduction

The aim of this chapter is to inform the user of this book on how and why we made certain decisions and choices. Part of this information resides in my scientific experience during the past 20 years during which I tried to gather an overview on Mesozoic radiolaria. In this chapter I will try to summarise my scientific background and honour the teachers and colleagues I met, that helped me along my way. The activities of the INTERRAD JURASSIC-CRETACEOUS WORKING GROUP, founded in 1989 in Lausanne with the objective to create the database presented herein, will be traced in detail.

2. Personal background 1973 -1989

It was during my first student job, when I had to wash to extract volcanic sanidine for radiometric dating that I discovered radiolarians in a residue from Late Jurassic benthonites of the Southern Alps (see *Chapter* 11). I was fascinated.

In 1973 my professors Daniel Bernoulli and Hanspeter Laubscher offered me to join a field trip to eastern Greece as assistant. Daniel Bernoulli was aware of the fact that only radiolarians could help in dating the Middle Jurassic to Lower Cretaceous pelagic sequences related to the formation and emplacement of the ophiolites in Eastern Greece. We collected many radiolarian samples and soon after the trip I learned how to work with Hydrofluoridric acid (HF) techniques needed to extract radiolarians from siliceous rocks. My diploma work (Baumgartner, 1974) and our first publication on radiolarians and sedimentology (Baumgartner & Bernoulli, 1976) grew out of this field trip to Greece. I still remember the day when Danny got a preprint of the paper by Riedel & Sanfilippo (1974). It was the first attempt to distinguish Upper Jurassic from Lower Cretaceous radiolarians. Are our samples in the Upper Jurassic or the lowermost Cretaceous? We realized that we had to learn much more about radiolarians to be able to tell.

In 1976 I started the field work for my PhD thesis in the Argolis Peninsula. Danny Bernoulli, my supervisor, encouraged me to put much effort into the search for radiolarian samples. I developed a field technique to select good radiolarian samples in using HF on the outcrop (described by myself in De Wever *et al.*, 1979. Today I consider this technique as highly dangerous!) Etching siliceous rocks in the field, besides being very risky, taught me how to collect the best radiolarian samples in each lithology. When Pessagno's first biostratigraphic publications on the Upper Jurassic and the Lower Cretaceous appeared (Pessagno, 1977a and 1977b), I had already produced several hundred SEM-pictures from many samples of the Argolis Peninsula. Despite the fact that many of Pessagno's species looked very familiar to me, I realised that his zonation was not applicable to my Greek material. In one of my best samples (POB 28), collected during my first field days in Greece, contained many species of Pessagno's Zones 1 to 3 occured together. Was it reworking? Were Pessagno's ranges incomplete? Once again, we realised that much more work was needed to understand.

In 1977, Patrick De Wever and Bill Riedel, invited me to a meeting in Lille (France): EURORAD I. The meeting consisted of a group of 10 people and there was much time for informal discussion over the sets of pictures that each of us brought along. The seed for collaboration on Mesozoic radiolarian biostratigraphy between Patrick De Wever and myself was planted during this meeting. It became clear that we had to develop our own zonations based on data from the Tethyan realm. In addition, we felt that only the correlation of radiolarian events to Tethyan ammonite zones could bring us further in developing radiolarians as a tool for dating Tethyan siliceous rocks (De Wever *et al.* 1979).

In 1979, I had the chance to visit Costa Rica and the United States and to meet a number of people who greatly enriched my experience with radiolarians and radiolarites. In Costa Rica I met Eric Kuipers who introduced me to the Nicoya Complex and its radiolarites. In Oberlin, Ohio I had the pleasure to work with Helen Foreman for three weeks. She showed me all her lowermost Cretaceous Upper Jurassic material. In these days I learned more about radiolarians than in years before. When I left Helen, she knew that we would not see each other again. She passed away in early 1980. Two months at Scripps Institution of Oceanography acquainted me with Bill Riedel's and Annika Sanfilippo's work both on DSDP samples and land sections in Europe.

Bill Riedel, help me to reviese with great patience, my first major manuscript on radiolaria: The hagiastrids and patulibracchiids (Baumgartner, 1980). He helped me to sharpen my scientific style and morphological discernment.

At the USGS, Menlo Park, I met Clark Blake, David Jones and Benita Murchey, who introduced me to the Franciscan complex.

I was invited to meet Emile Pessagno in Dallas. I remember holding up a sketch of a *Pantanellium* to identify myself to Emile at the airport. I did not know that he was preparing his pantanellid paper (Pessagno & Blome 1980) at that time. Emile Pessagno was very generous in letting me look at all his beautiful residues from Oregon and from the Queen Charlotte Islands. I became familiar with a particular type of Middle Jurassic radiolarian assemblage. He even gave me a whole collection of residues, with the suggestion to look at the hagiastrids in them. This material gave first insights into the Jurassic evolution of the hagiastrids (Baumgartner, 1980, fig. 7). He invited me to join a field trip to eastern Oregon. During these days I realised the fundamental differences between Pessagno's radiolarian work and my own. Emile was primordially concerned with getting well preserved radiolarian samples from localities dated by ammonites, Buchias or other fossils. In fact, the superposition of his samples in Oregon entirely relied on Imlay's (1964, 1968, 1973) ammonite dating. I also realised that radiolarians occur in Oregon in a sedimentary setting very different from Tethyan radiolarites: many 100 m thick, sand-silt dominated sequences contain occasional concretions with well-preserved radiolarians. It dawned on me that the faunal differences that we had already established were, at least in part, due to differences in sedimentary and paleoceanographic environments.

In late 1979 I was struggling to produce a zonation based on radiolarian associations observed in Greece and the localities studied during my visit to the U.S., when Jean Guex came to Basel and presented a talk on his recently developed concept of Unitary Associations (Guex, 1977, 1979). I suddenly realised that his method was the ideal way of coping with the major problems of Mesozoic radiolarian biostratigraphy. The following text is cited (with minor abbreviations) from Baumgartner *et al.* (1980, p. 25). It clearly summarises the problems and the method to solve them. This text was strongly inspired by Jean Guex' work, it has lost nothing of its actuality and can still be considered as the base line of our way of thinking about radiolarian biostratigraphy:

Problems:

"-high diversity of morphotypes in well preserved samples;

- "documentary gaps" due to selective dissolution, winnowing and selective preservation during diagenesis and sample preparation (HF!);

- limited vertical extent of lithologies favourable to the preservation of radiolarians.

Due to the above factors, differences in faunal composition observed in vertical sequences are more likely to be the result of an incomplete record than of time-related changes...."

"Conventional methods of microfossils biostratigraphy were applied with success to Cenozoic radiolarians (e.g. Riedel & Sanfilippo, 1978) usually by establishing a succession of "events" (first and/or final appearances of morphospecies) in one section and correlating to other sections. However, this method is not effective with Mesozoic material because the succession of "radiolarian events" is almost never the same in two lithologically different sections...."

"Zones defined by the first or final appearance of a single species will necessarily turn invalid as new data will complete the stratigraphic ranges. In contrast, we search for biostratigraphic intervals defined by the co-occurrence of one, or better several pairs of species. In the future, such intervals can be subdivided and their extension may increase as new data become available, however at present, it is possible to establish their chronological sequence with certainty on the basis on radiolarian data alone and completely independent of biostratigraphic correlations with the help of other co-occurring index fossils."

In 1980 we presented a first "Late Jurassic-Early Cretaceous" radiolarian zonation at the 26th International Geological Congress (Baumgartner *et al.*, 1980). Rudi Kocher brought in his data from the Southern Alps and Patrick De Wever added data from Greece to my own database, with included samples provided by Paulian Dumitrica from the Romanian Carpathians, samples from

Santa Anna, Sicily, Site 367, Cap Verde Basin, the Pindos Zone etc. We applied Unitary Associations (Guex, 1977, 1991) for the first time to radiolarians to produce a biozonation. The foundations of this and all following zonations, including the one presented in this book lie in zonation based on superpositional data of radiolarians only. The age calibration is a second step which is independent of the construction of radiolarian biochronozones (See *Chapters 2* and *31* of this book). Conflicts with Pessagno's (1977a, 1977b) zonation were unavoidable: An overlap of Pessagno's Zone 4 with his Zones 2A, 2B, 3 and 5 resulted from the application of our ranges to the Pessagno's zonal marker species. It is a fact that Zones 3 and 4 were not physically superposed in Pessagno's reports, instead, their relative age was inferred from biostratigraphic ages of co-occurring *Buchias.*

In the 1980 paper we could not establish the diachronism of the base of the Tethyan radiolarites. Although we observed different U.A. at the base of the radiolarites in the Lombardy Basin and on the submarine highs of the Pelagonian Zone of Greece, we had to group these U.A. into one zone, since we had no reproducible successions. Another problem was that we had no calibration for the rocks immediately below the radiolarites.

In 1980 I organized EURORAD II in Basel. Again, we were a small group of people. For the first time, Kojiro Nakaseko, Akiko Nishimura and Akira Yao represented the growing Japanese community of radiolarian specialists. The results of this meeting were presented in Baumgartner *et al.* (1981).

In 1981, shortly after obtaining my Ph.D., I was involved in the Deep Sea Drilling Project. I was invited to work on the radiolarians of Site 534 in the Blake Bahamas Basin. The radiolarian preservation was excellent and the discussion about the age of the oldest sediment at this site are still going on. Our statement on the age is made in chapters 7 and 31 of this book.

I sailed with Jerry Winterer in Leg 79 to drill the Mazagan Escarpment. Although no significant Mesozoic radiolarian record was found in this area, I learned how to compare the material from the Mesozoic Atlantic and the Western Tethys. Jerry Winterer was approaching the Tethyan radiolarites as an oceanographer and applied actualistic concepts to the Mesozoic Tethys (Bosellini & Winterer 1975, Winterer & Bosellini 1981). The months at sea and the field work in 1983 in Tuscany and on Elba with Jerry added another dimension to my experience as a geologist. I began to think in terms of the water column that once existed over the sediments and its paleoceanographic conditions.

At Scripps, DSDP was in its best years and I had the chance to meet many interesting people that work with siliceous sediments in the oceans and on land, such as Yves Lancelot, and one of Jerry's students, Mirjam Baltuck.

Later in 1981 I moved to San Jose, Costa Rica to assume a teaching position. I started an intense program of collection of the radiolarites of the Nicoya Complex. During winter months I continued to work as a staff scientist for DSDP, which allowed me to keep in touch with the scientific community.

In 1982 and 1983 the IGCP Project No. 148, dealing with quantitative stratigraphy, led by Fritz Agterberg and Felix Gradstein was very active. Jean Guex invited me to an international meeting of this project in Geneva (1982). The result of this collaboration was a paper that compared Unitary Associations and probabilistic methods of ranking an scaling, applied to the same data set of Jurassic-Cretaceous radiolarians (Baumgartner, 1984a). Eric Davaud calculated Unitary Associations using his program (Davaud *in* Davaud & Guex, 1978). The base for the 1984 zonation was laid during this time, through a painful communication via telexes and phone calls between Costa Rica and Switzerland.

In 1983 I started to notice the difficulties in maintaining and scientific contacts, which later influenced my decision to return to Switzerland: Communications with Costa Rica were difficult and travel funds were very limited. I was able to assist to the AAPG/SEPM radiolarian workshop at Dallas thanks to funds provided by the Basel University through Lukas Hottinger. For the first time, the ideas of a radiolarian zonation based on Unitary Associations was presented to a large group of radiolarian workers.

1983 and 1984 were characterized by the preparation of two syntheses: One on the Mesozoic-Cenozoic stratigraphy of Costa Rica (Baumgartner *et al.,* 1984) and the other on the age and genesis of Tethyan radiolarites, including the 1984 Zonation (Baumgartner, 1984b) The conception and writing of both papers was carried out on a microcomputer for the first time. It was an 8-bit KAYPRO machine based on diskettes with 64 Kilobytes of RAM. The 1984 zonation once published in late 1984 met two kinds of reactions. Scientists working in the Mediterranean Tethys acknowledged the work and applied it to new data with success, while radiolarian palaeontologists in the U.S. led by Emile Pessagno stated severe criticism (Pessagno *et al.,* 1987 a, b)

The idea to produce a Mesozoic Radiolarian Database back to the year 1985. When I visited Patrick De Wever in Paris we started working together on Middle Jurassic radiolarians. We found that many species were undescribed but very characteristic promising an important potential for detailed biostratigraphy. At that time we were much concerned about the data formats owing to the limitations of microcomputers. We tried to figure out how to get all the information on taxonomy and biostratigraphy into computer files. Over the years we have been concerned less about the data format than about the meaning of the data.

In 1985, after the publication of my Ph.D. (Baumgartner, 1985) I continued field work with Jerry Winterer in the Alps. We wanted to find datable radiolarians in a number of tectonic units of Switzerland, Austria, Northern Italy and France. Unfortunately, none of the samples from the South Pennine Ophiolite Zone nor from the Schistes Lustrés was useful for dating. However, in collaboration with R. Polino and Patrick De Wever we could determine a Callovian age of the basal radiolarites covering the ophiolites in the Traversiera area (De Wever *et al.*, 1987). For an update on this sample see *Chapter 9* in this book.

In 1986 I spent 3 months in California working with Jerry Winterer and Bill Riedel at Scripps and with Bon Murchey and Clark Blake at USGS in Menlo Park. This time period was essential for my understanding of the Circum-Pacific terranes stranded in Californian and Oregon. Fundamental lithological differences, such as the absence of Lower Cretaceous pelagic limestones shaped my ideas on the paleoceanography of Western Tethys (see Baumgartner, 1987). In working on samples from the Franscican Terrane, the Jolla Bolly Terrane and the sediments covering the Coast Range Ophiolite, we discovered a fundamental problem in Pessagno's zonation (Pessagno *et al.,* 1987b), that we exposed in an abstract (Baumgartner & Murchey, 1987) and in the revision of the calibration of the 1984 zonation (Baumgartner, 1987). Several samples of the mentioned terranes were dated by Pessagno and Jones as Late Jurassic because they contained *Mirifusus* sp. However, we found, as in Tethyan radiolarites, a number of species typical of Pessagno's Middle Jurassic Zones 1B to 1G co-occurring with *Mirifusus*. We concluded on an overlap of Pessagno's Zones 1B to 1G with the bottom of his Zone 2, defined by the first occurrence of *Mirifusus*, sp. (Fig. 1). For further discussion of this problem I refer to *Chapters 30* and *31*.

The years 1987 - 1988 were characterised by radiolarian work in Corsica, Umbria and the Southern Alps with my doctoral student Ruth Jud, and by a continuing commitment to the geology of Costa Rica and Greece. In these years Ruth did nearly all my radiolarian preparations and helped a great deal in the organisation of the new facilities at Dorigny (University of Lausanne). In 1988 I participated in ODP-Leg 123 off Northwest Australia and started to work on southern hemisphere radiolarians (Baumgartner, 1992, 1993, Baumgartner *et al.*, 1992)

In 1989, when we organised the first meeting of what was to become the Jurassic-Cretaceous Working Group, It was clear that Spela Gorican would come to Lausanne to work on her Ph.D. and Luis O'Dogherty decided to do the

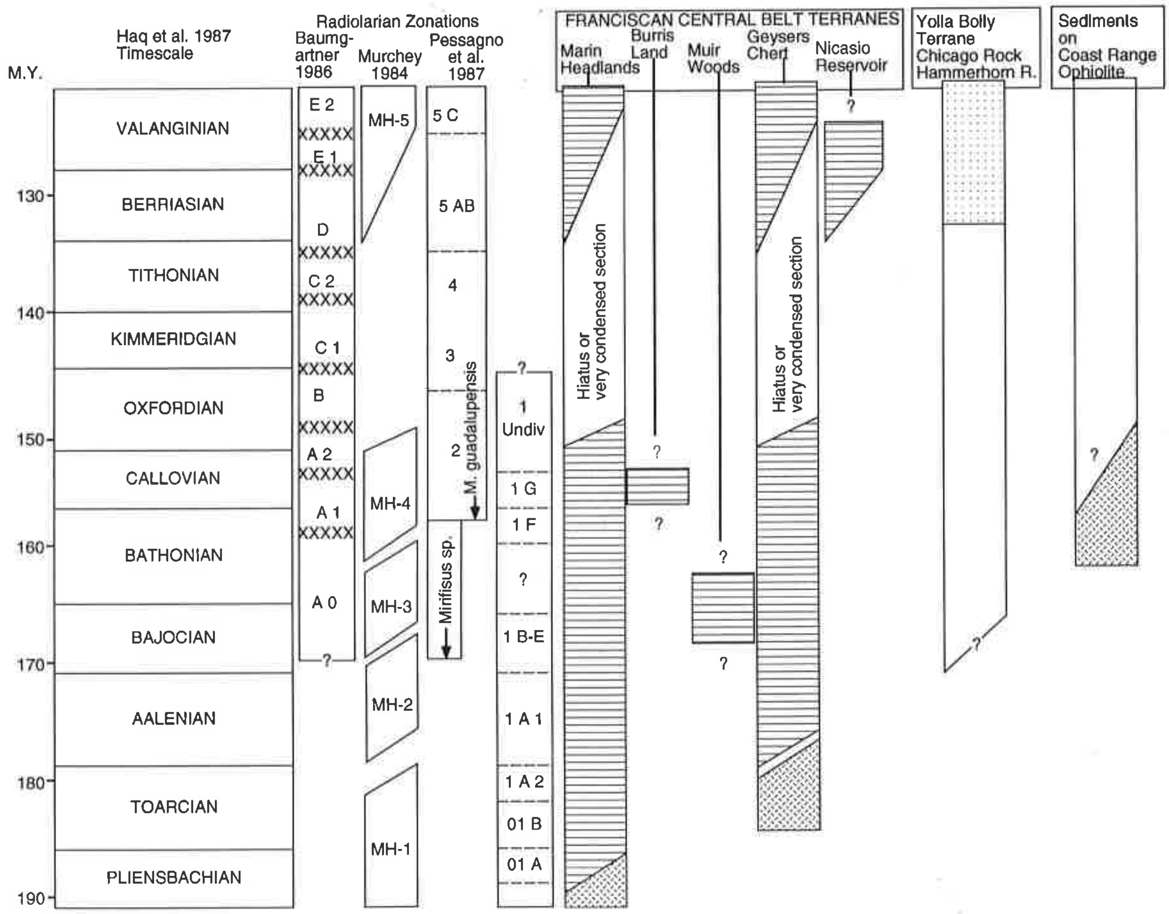


Figure 1. Correlation of Tethyan and W-North American Jurassic radiolarian zonations and the age of the Franciscan and other terranes. North American Zonations after Murchey (1984), Pessagno et al (1984, 1987b). Tethyan zonation of Baumgartner (1987). From Baumgartner (1987), see also comments in Baumgartner and Murchey (1987).

same shortly after the meeting. Thanks to my students and collaborators the group has functioned during the last 5 years and the realisation and completion of this book was possible.

3. INTERRAD JURASSIC - CRETACEOUS WORKING GROUP 1989-1994.

3.1. The first meeting: Lausanne (Switzerland) January, 1989

At the INTERRAD meeting in Marburg in 1988 it became clear that an informal meeting on Tethyan Middle (and Upper) Jurassic radiolarians as well as on preparation methods would be welcomed by several people from Europe. I sent out an invitation to about ten peoples. The meeting was held in January 1989 and was attended by Maurizio Conti, Taniel Danelian, Patrick De Wever, Spela Gorican, Jean Guex, Ruth Jud, Norio Kito, Consalvo Marri, Marta Marcucci, Luis O'Dogherty, Jean Savary, Torsten Steiger, and Elspeth Urquhart (Fig. 2) It was decided to invite Atsushi Matsuoka as a collaborator. Two days were dedicated to an introductory course on radiolarian preparation that turned into an interesting exchange of tricks and hints to get the most out of the rocks. Two day were dedicated to Tethyan Middle and Upper Jurassic radiolarians. We discussed the way of making a joint effort to create a new zonation and to reach a common understanding of a number of Jurassic taxa. The results of this meeting are best summarised by the minutes of the meeting sent out to the participants of the workshop in February 1989:

«Occurrences, Systematic, Biochronology: Guidelines for Contributors

These guidelines represent basically the consensus of our discussions during the meeting. In some instances I may add my own ideas and state them as such. Please, feel free to comment on them and propose additions and/or alternatives.

Figure 2. Attendees of the first meeting of the INTERRAD Jurassic - Cretaceous Working Group. Lausanne 1989. From left to right: P. O. Baumgartner, Claudia Baumgartner-Mora, Luis O'Dogherty, Jean Savary, Maurizio Conti, Elspeth Urquhart, Jean Guex, Ruth Jud, Patrick DeWever, Marta Marcucci, Taniel Danelian, Spela Gorican and Norio Kito hidden behind the camera. We all looked younger than today...

General Concept of the Volume

Radiolarian Occurrences

The first part will contain individual papers authored by the contributors describing radiolarian bearing sections principally covering the Tethyan realm. Each paper should contain the following information:

- Geographic and geologic location of sections, regional and local geology (one or two map figures)

- Lithostratigraphy of the studied sections: Description of the rocks, discussion of sedimentology, environment of deposition (at least one figure showing a lithostratigraphic column representing a measured section with all sample levels indicated).

- Biostratigraphy: Description of the fossil assemblages found in the studied sections. Make special reference to other fossils than rads which are important to the calibration of the rad assemblages (ammonites, nannos, calpionellids, etc.). You should Include an occurrence chart showing rad taxa (defined in common systematic chapter, see below) of each sample and a list of encountered taxa.

- Biochronology: Discussion and comparison of old and new zonation schemes applied to your data. As your data will be used in a compilation for Unitary Associations you may refer to these in your sections.

Systematic part

We agreed on producing a common systematic part (co-authored by all of us) in which a consensus of all contributors will be expressed. This part will probably be worked out by using GESPAL. The details of the format will have to be discussed by correspondence during this year and decided upon at the next meeting. One possibility would also be to produce an atlas (like Schaaf 1985) with one double page per species (one page text, one page figures) with all species in alphabetical order. This, of course, implies a lot of plates, since we are talking of several hundred taxa included for biostratigraphy.

Biochronology

We agreed on putting all the data together in order to produce a data set to calculate Unitary Associations. We will produce a common chapter (co-authored by all of us) discussing the results of the calculation and the steps leading from U.A. to a standard radiolarian zonation.

Taxonomy, Variability and Systematic

Our discussions during the meeting have shown that we can come to an agreement on the definition of a morphotype in well-preserved material. However, most such narrowly defined forms are selected out of a continuum of variability which we deliberately ignore. This procedure is certainly justified for biostratigraphic purposes, if we all agree exactly on the same selection. As soon as we study less well-preserved material, this selection becomes much more difficult; we would rather tend to define groups of morphotypes in order to be able to identify something in poorly preserved samples. Since we are aimed towards a generally applicable biozonation we should not exclude poorly preserved samples from our data, otherwise we limit the use of the resulting zonation to well-preserved material.

As a consequence, we must include both narrowly defined morphotypes and larger defined groups as separate entities in our data. The groups may be defined as species sensu lato or as species groups, whereas the narrowly defined morphotypes (picked out of field of variabilities) may be defined as subspecies or forms. In any case, our taxonomy should fit the biostratigraphic use and not vice versa. In our data subspecies or forms would be elements of the species, i.e. whenever we record a subspecies, we also record the species. In that way subspecies will allow us to subdivide the range of species.

Many authors have made efforts to express evolutionary relationships in their systematic. In this work, we will be mainly concerned with defining forms for biostratigraphy and our systematic treatment will not go much further than the generic level at this stage of the work. Once biostratigraphic relationships and biogeographic distribution of all these forms will be better known, higher level evolutionary relationships will become apparent and may lead to more "natural" suprageneric systematic.

Definition of Presence/Absence: We agreed on not spending an enormous effort on quantitative work, but rather stating presence/absence. This, of course is a minimal requirement and does not exclude that you present abundances if you like!»

This text shows that the ideas were clear and the project was launched in early 1989. The time interval we planned to work within was enlarged to include Ruth Jud's work on the Lower Cretaceous.

In late 1989 Ruth had already a complete inventory of Lower Cretaceous forms and Spela, Luis and myself prepared two volumes of images for discussion at the second meeting: One on Jurassic and one on Early Cretaceous taxa. These volumes were sent out in January 1990 with detailed instructions to all potential contributors, including besides the participants of the first meeting: Yoshiaki Aita, Paulian Dumitrica, Atsushi Matsuoka and Valentina Vishnevskaya.

3.2. The second meeting: Grafrath near Munich (Germany) February, 1990

Torsten Steiger, with founding from the Deutsche Forschungsgemeinschaft invited us to a nice village near Munich, where we discussed over 500 radiolarian taxa one by one, besides having excellent beers. After the meeting we had a clear idea what was going to be the amount of work needed to compile the volume. We counted on the collaboration of everyone, in the first place for the systematic part and after that for the submission of biostratigraphic data. Detailed instructions with deadlines were sent out in March 1990. By June 1990 we realised for the first time that many people had difficulties in making the deadlines and that we had to slow down the whole thing. For the third meeting we worked hard to prepare a second draft of the catalogue that included all taxa selected in Munich. Most of the actual text that had to go into the book was still lacking mainly because the contributions from outside Lausanne, were incomplete or never arrived.

3.3. The third meeting: Bierville near Etampes (France) March 1991

Patrick De Wever invited us to Bierville, near Etampes, close to his home. Here we had a very intense week of work. Besides the usual participants we welcomed Annachiara Bartolini, Giuseppe Cortese, Paulian Dumitrica, Atsushi Matsuoka and his family and Daniel Widz. Once again we discussed many of the species in the catalogue. A first version of the data was submitted by most contributors.

We made a conscientious effort to have a zonation ready for INTERRAD VI, held in October 1991 near Florence, but too many problems appeared in the database. The situation at that time is best summarised by the following parts of a letter sent out in January 1992, some months after the INTERRAD meeting:

«Biostratigraphic Data

Until August 1991, we received form nearly everyone a diskette with biostratigraphic data. We then proceeded to work on this data and to combine it into one database. However, we quickly realised that there were major problems in integrating all the data. These problems arose from typing errors. As a result the data contains numbers that are not in the catalogue, or shows species which should not be at the level, where they are listed. The latter creates an incredible number of contradictions and an artificial lengthening of ranges. We even received a dataset in which one section was overturned ! It took us two days of work to find out and make the corrections. We have learned a lot from this work and I will formulate some recommendations (see below) that will guide you for the submission of your corrected dataset.

We tried hard to get a preliminary zonation ready for the Jurassic meeting in Poitiers and for the INTERRAD meeting in Florence. However, there are too many problems in the data right now and we decided to present Ruths zonation for the Lower Cretaceous (she finished her thesis in June 1991) and a preliminary Jurassic zonation based on our data only (Spela, Luis, POB, which makes together with Ruths data about 80% of the entire database).

We are currently working very hard to totally revise my BG84 database by re-examining critical samples and by including new samples collected since 1987. Right now, we have in our sections excellent calibration with ammonites for the entire Bajocian, the Lower Bathonian, the Middle Callovian, the entire Oxfordian, the entire Kimmeridgian, and Tithonian.

What you should do immediately: We expect you to totally revise your data on the enclosed printouts and on a diskette, using the following instructions:

1. It is now possible to run a "SAMPLE" file with BioGraph. The format is given as enclosure with comments. Please, resubmit your data in this format. It contains the detailed information of each sample and not only generalised local ranges as the DATUM file. It is much easier to spot errors in a sample file, because you have the spectrum of each sample. We have converted your data into a sample file (see enclosure) that you can edit. It is essential, that you include the original sample number, as published or as shown in your biostratigraphic chapter with the sample data. This number and any other comment must appear in parentheses { }, so that BioGraph will ignore this text when compiling the data. Each section can have a title of any length, but in one word. Please, put down the Geographic name of the section as published and as submitted in your special chapter. Produce a name composed of a sequential number, your initials and the section name like: SECTION 45_pob_lo_SIERRA_DE_RICOTE (see enclosures).

2. We have noticed, that some of you simply took their earlier publications and typed the MRD-numbers into the computer. This is not what we want. You have to check for each taxon you enter, whether your earlier taxonomic concept corresponds to the taxa defined in the catalogue. If this is not the case, then you have to re-examine your sample and compare with the illustrations in the catalogue. I know, this takes a lot of time, but that is what we have been doing for our data for the last 4 months. However, we cannot do it for your data. Only you can do it !

3. We expect your corrected data no later than 1st. of March 1992, in order to keep on schedule for the production of the volume. If you do not submit corrected data, we will eliminate your data from the database.

Biostratigraphic chapters

To this date, Daniel Widz is the only one, who has submitted a biostratigraphic chapter. Thank you Daniel! The deadline was the INTERRAD meeting 1st of October 1991. We must have your biostratigraphic chapter by the 1st of April 1991, in order to review it, get it back to you and receive the revised version by the end of June.

Let me recapitulate what your chapter should contain:

- Geographic and geologic location of sections, regional and local geology (one or two map figures).

- Lithostratigraphy of the studied sections: Description of the rocks, discussion of sedimentology, environment of deposition (at least one figure showing a lithostratigraphic column representing a measured section with all sample levels, and original sample numbers indicated).

- Biostratigraphy. Description of the fossil assemblages found in the studied sections. Make special reference to other fossils than rads which are important to the calibration of the rad assemblages (ammonites, nannos, calpionellids, etc.). If possible, relate the other fossils to standard ammonite zones (do not just write "upper Kimmeridgian ammonites" but give the taxa and mention the ammonite zone, with reference to the specialised literature). You should include an occurrence chart showing rad taxa (defined in the catalogue) of each sample and a list of encountered taxa, or simply include the SAMPLE file with annotations.

- Biochronology: Discussion and comparison of old and new zonation schemes applied to your data. We will run your data (or you can run it if you have BioGraph) and you can include the results of BioGraph for your data in your chapter.

The Atlas

We are making an effort to complete the atlas as soon as possible. Currently, we have Paulian Dumitrica with us. He will take care of a systematic chapter to be included with the radiolarian atlas. He will also be responsible for some new generic assignments of taxa. Taniel Danelian will also spend three months with us in Lausanne and help us.

Elspeth Urquhart has promised to do proof-reading and final editing for English style.... We expect to have a final version ready by the end of March 1991. You will receive a copy of this version and you will have to proof-read a part of it. After you have signed off your part, no more changes or updates will be made. Corrections will be introduced by us into the files and then the atlas goes into press.

We hope to finish the whole thing before August 1992, to have a chance to get it published until the end of this year. I enclose a tentative budget with information about funding, printing and distribution of the planned volume. Patrick De Wever and Marta Marcucci have submitted requests for financial contributions to their Science Foundations.

I hope you will get the message through this letter and start to finish your work for this atlas. We are serious about the deadlines, because we will be ready with our material, and we will not modify the publication schedule, if you are late.»

Once again, the ideas were clear and everybody was informed what to do. However, it was not until late 1992 when we received first copies of the biostratigraphic chapters.

Almost no progress with this project was made in 1993 for several reasons. For one, several other projects needed attention. Spela and Luis were occupied finishing their theses and could not spare time, for this project. We waited also for the final version of Ruth's Thesis, published in 1994.

In early 1994 we reactivated the work. We started with the production of the catalogue by scanning all the illustrations and mounting the plates. We completed the text introduced all the holotypes etc. A graphics technician was working for several months on the project. Meanwhile, Patrick collected the biostratigraphic chapters, which were then edited for English by Elspeth Urquhart. In August we still thought we could complete the volume for the INTERRAD VII meeting in Osaka but, however, too many things were still not finished. Between May 1994 and August 1995 we have calculated and discussed at least twenty different versions of zonations. One of these versions was presented at the Osaka meeting. The zonation finally presented in this book is one of several possible solutions to the problems that will be discussed in detail in *Chapter 32*.

Between October 1994 and April 1995 nothing advanced because of my new teaching duties: three new courses. This book was finally completed during the summer months of 1995 thanks to a special effort of Luis O'Dogherty and Alain Pillevuit who took care of the whole page setting and the final corrections of the catalogue. Elspeth Urquhart, Spela Gorican and Beth Carter spent also their time making corrections and proof-reading.

References

BAUMGARTNER, P.O., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1974). *Stratigraphie, Sedimentologie und Radiolarienfaunen einiger jurassisch-kretazischer Serien in Ostgriechenland.* MSc. Universität Basel (unpublished), Basel.

BAUMGARTNER, P.O. (1980). Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peleponnesus, Greece). *Micropaleontology*, **26** (3), 274-322.

BAUMGARTNER, P.O. (1984a). Comparison of unitary associations and probabilistic ranking and scaling as applied to Mesozoic radiolarians. *Computers and Geosciences*, **10** (1), 167-183.

BAUMGARTNER, P.O. (1984b). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1985). Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). *Mémoires de la Société Helvétique des Sciences Naturelles*, **99**, 1-111.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BAUMGARTNER, P.O. (1992). Lower Cretaceous radiolarian biostratigraphy and biogeography off northwestern Australian (ODP sites 765 and 766 and DSDP site 261), Argo abyssal plain and lower Exmouth Plateau. *In* Gradstein, F.M., Ludden, J.N. & et, a. Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program), **123**, 299-342.

BAUMGARTNER, P.O. (1993). Early Createaceous radiolarians of the Northeast Indian Ocean (Leg 123: Sites 765, 766 and DSDP Sites 261): The Antarctic-Tethys connection. *In* Lazarus, D.B. & De Wever, P. Eds. *Interrad VI* - Special Issue: Marine Micropaleontology, Elsevier. **21**, 329-352.

BAUMGARTNER, P.O. & BERNOULLI, D. (1976). Stratigraphy and radiolarian fauna in a Late Jurassic-Early Cretaceous section near Achladi (Evvoia, Eastern Greece). *Eclogae Geologicae Helvetiae*, **69** (3), 601-626.

BAUMGARTNER, P.O., BJØRKLUND, K.R., CAULET, J.-P., DE WEVER, P., KELLOGG, D., LABRACHERIE, M., NAKASEKO,

K., NISHIMURA, A., SCHAAF, A., SCHMIDT-EFFING, R. & YAO, A. (1981). Eurorad II, 1980 - Second European meeting of radiolarian paleontologists: current research on Cenozoic and Mesozoic radiolarians. *Eclogae Geologicae Helvetiae*, **74** (3), 1027-1061.

BAUMGARTNER, P.O., BOWN, P., MARCOUX, J., MUTTERLOSE, J., KAMINSKI, M., HAIG, D. & MCMINN, A. (1992). Early Cretaceous biogeographic and oceanographic synthesis of Leg 123 (off northern Australia). *In* Gradstein, F.M., Ludden, J.N. & et, a. Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program), **126**, 739-758.

BAUMGARTNER, P.O., MORA, C.M., BUTTERLIN, J., SIGAL, J., GLAÇON, G., AZÉMA, J. & BOURGOIS, J. (1984). Sedimentación y paleogeografía del Cretácico y Cenozóico del litoral pacífico de Costa Rica. *Revista de Geología de América Central*, **1** (1), 57-136.

BAUMGARTNER, P.O. & MURCHEY, B. (1987). Correlation of Tethyan and W-North American Jurassic radiolarian zonations and age of Franciscan terranes. *Terra Cognita*, **7** (2-3), 210.

BOSELLINI, A. & WINTERER, E.L. (1975). Pelagic limestone and radiolarite of Tethyan Mesozoic: A genetic model. *Geology*, **3** (5), 279-282.

DAVAUD, E. & GUEX, J. (1978). Traitement analytique "manuel" et algorithmique de problèmes complexes de corrélations biochronologiques. *Eclogae Geologicae Helvetiae*, **71** (3), 598-610.

DE WEVER, P., BAUMGARTNER, P.O. & POLINO, R. (1987). Précision sur les datations de la base des Schistes Lustrés postophiolitiques dans les Alpes Cottiennes. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **305**, 487-491.

DE WEVER, P., RIEDEL, W.R., BAUMGARTNER, P., DUMITRICA, P., BJØRKLUND, K.R., CAULET, J.P., DROBNE, K., GRANLUND, A. & KOCHER, A.R. (1979). Recherches actuelles sur les Radiolaires en Europe. *Annales de la Société Géologique du Nord, Lille*, **96**, 205-222.

GUEX, J. (1977). Une nouvelle méthode d'analyse biochronologique. *Bulletin de la Société Vaudoise des Science Naturelles*, **73**, 309-322.

GUEX, J. (1979). Terminologie et méthodes de la biostratigraphie moderne: commentaires critiques et propositions. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **74**, 170-216.

GUEX, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

IMLAY , R.W. (1964). Upper Jurassic molluscs from eastern Oregon and western Idaho. *United States Geological Survey, Professional Paper, Report*, **483**, 1-21.

IMLAY, R.W. (1968). Lower Jurassic (Pliensbachian and Toarcian) ammonites from eastern Oregon and California. *United States Geological Survey, Professional Paper, Report*, **593**, 1-51.

IMLAY, R.W. (1973). Middle Jurassic (Bajocian) ammonites from eastern Oregon. *United States Geological Survey, Professional Paper, Report*, **756**, 1-99.

MURCHEY, B. (1984). Biostratigraphy and lithostratigraphy of cherts in the Franciscan Complex, Marin Headlands, California. *In* Blake, M. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles, **43**, 51-70.

PESSAGNO, E.A. (1977a). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. (1977b). Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. *Contribution Cushman Foundation for Foraminiferal Research, Special Publication*, **15**, 1-87.

PESSAGNO, E.A. & BLOME, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26** (3), 225-273.

PESSAGNO, E.A., BLOME, C., CARTER, E.S., MACLEOD, N., WHALEN, P. & YEH, K.Y. (1987b). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-18.

PESSAGNO, E.A., LONGORIA, J., MACLEOD, N. & SIX, W. (1987a). Studies of North American Jurassic Radiolaria; Part I, Upper Jurassic (Kimmeridgian-upper Tithonian) Pantanelliidae from the Taman Formation, east-central Mexico; tectonostratigraphic, chronostratigraphic, and phylogenetic implications. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-51.

RIEDEL, W.R. & SANFILIPPO, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. & et, a. Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

RIEDEL, W.R. & SANFILIPPO, A. (1978). Stratigraphy and evolution of tropical Cenozoic radiolarians. *Micropaleontology*, **24** (1), 61-96.

SCHAAF, A. (1985). Un nouveau canevas biochronologique du Crétacé inférieur et moyen: les biozones à radiolaires. *Sciences géologique (Strasbourg), Bulletin*, **38** (3), 227-269.

WINTERER, E.L. & BOSELLINI, A. (1981). Subsidence and sedimetation on Jurassic passive continental margin, Southern Alps, Italy. *Bulletin of the American Association of Petroleum Geologists*, **65**, 394-421.

2. Concepts of the systematic and biostratigraphic work

by Peter O. Baumgartner[1], Jean Guex[1] and Paulian Dumitrica[1, 2]

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Mailing address: Könizstrasse 39, 3008 Bern, Switzerland

ABSTRACT

This chapter addresses the concepts and the methodology that formed the basis of the systematic and the biochrologic chapters of this book. The prime objective of this collaboration was to prepare a database common to a group of researchers to achieve biochrolologic correlation around the world in the Tethyan belt, i. e. the low to intermediate latitude warm water area. In our taxonomy, we use many species *sensu lato* (s.l.) to incorporate several morphotypes. Single morphotypes are rather treated at subspecific level. For biochronology both species and subspecies are recorded.

For biochronology we constructed a discrete biochronologic scale whose subdivisions are characterised by unique and mutually exclusive assemblages of taxa. These subdivisions are non contiguous and isolated from each other by intervals of separation. They are similar to "Concurrent Range Zones" and "Oppel Zones" .

We use the concept of Unitary Associations to establish a set of initial associations for correlation. Unitary Associations are grouped into UAZones (UAZ.) that are reproducible throughout the studied sections. Finally the UAZones are correlated (calibrated) to the stages by means of ammonites, caloinellids, nannofossils etc. co-occurring with the studied radiolarians.

1. Concepts of the systematics used in this book

As discussed in *Chapter 1*, the concepts behind the systematics presented in this book were developed out of a consensus achieved during the three meetings held by the INTERRAD Jurassic-Cretaceous Working Group. Our primary objective was to establish biochronologic correlations and not to work on evolutionary relationships between the taxa selected for biostratigraphy. To use a comparison, we were trying to put a stamp collection into a chronological order, based on the relative order of appearance and disappearance of the stamps in many collections. No relationship between different types of stamps is taken into account *a priori* for the superposition of samples or associations. This does not mean that evolutionary lineages have been ignored in defining taxa.

In order to construct a discrete biochronological scale (see below) we had to produce a binary, i.e. a present/absent information. The definition of the presence of a taxon is based on the recognition of one or several morphotypes delimited by descriptions, illustrations and differential diagnoses from other, excluded morphotypes.

Our discussions during the meetings resulted easily in an agreement on the definition of morphotypes in well-preserved material. However, most such narrowly defined forms were selected out of a continuum of variabilities that we deliberately ignored. This procedure is certainly justified for biostratigraphic purposes, if we all agreed exactly on the same selection criteria. As soon as we discussed less well-preserved material, this selection became much more difficult. We tended to define groups of morphotypes, to be able to identify something in poorly-preserved samples. Since we aimed at a generally applicable biozonation we did not want to exclude poorly-preserved samples from our database as this would have limited the use of the resulting zonation to well-preserved material.

As a consequence, we had to include both narrowly defined morphotypes and larger defined groups as separate entities in our data. The groups were defined as species *sensu lato* or as species groups, whereas the narrowly defined morphotypes (picked out of a field of variabilities) were defined as subspecies. In our data subspecies are elements of the species, i.e. whenever we recorded a subspecies, we also recorded the species. In that way subspecies allow subdivision of the ranges of species.

In the course of searching for the biostratigraphic data we realised that in making groups of morphotypes, we must have left unexploited a considerable potential for refinement of vertical resolution. In fact most of our species *s.l.* ranges are rather long. In the cases where we have defined subspecies the species *s.l.* range is generally broken up into largely overlapping segments of subspecies ranges.

The rather coarse framework produced for this book can be refined in the future by breaking up species *s.l.* into subspecies or narrower defined species according to observed evolutionary relationships.

2. Concepts of biostratigraphic work

Since the first zonation constructed for the Tethyan Late Jurassic by Baumgartner *et al.* (1980) we have continued to apply the biochronologic concepts developed by Guex (1977-1991), Guex & Davaud (1982, 1984), Savary & Guex (1990, 1991). This implies a number of concepts exposed by Guex (1991):

1. We construct discrete biochronologic scales whose subdivisions are characterised by unique and mutually exclusive assemblages of taxa. These subdivisions are non contiguous and isolated from each other by intervals of separation. (Figure 1). They are similar to "Concurrent Range Zones" and "Oppel Zones"

This type of biochronologic scale contrasts with continuous biochronologic scales based on relative abundance (such as "Acme Zones", Figure 1) or based on intervals separating first and/or last appearances of taxa, such as the commonly used interval zones (Figure 1).

Discrete biochronologic scales best cope with the highly discontinuous nature of the radiolarian fossil record. (Baumgartner *et al.* 1981, Baumgartner, 1984a, b).

2. The construction of a discrete biochronologic scale implies two steps:

- The compilation of an optimal synthesis of the raw data representing all coexistences, mutual exclusions and superpositional relationships, called the protoreferential (Guex, 1991, p. 6-11).

- Evaluation of the lateral traceability of each association of the protoreferential and the union of subdivisions to create reproducible biochronozones.

3. The biochronozones created are based on radiolarian data alone. Their superposition defines intervals of relative time that need to be tied to the standard stages by means of other fossils, in our case preferentially ammonites, coexisting with radiolarians in the same sections. This procedure is called calibration (Guex, 1991, p. 203-204).

For definitions and details of the procedure we refer to Guex (1991). The actual procedures followed for the construction of the zonation presented in this book we refer to Chapter 32.

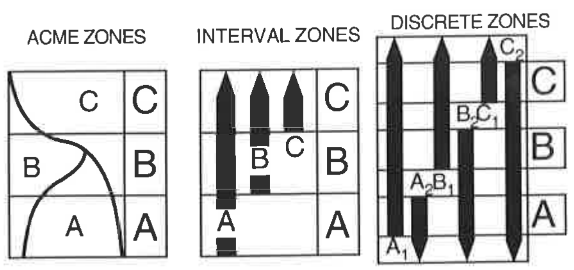


Figure 1. Principal types of zones (from Guex, 1991)

3. Unitary Associations - definition and example

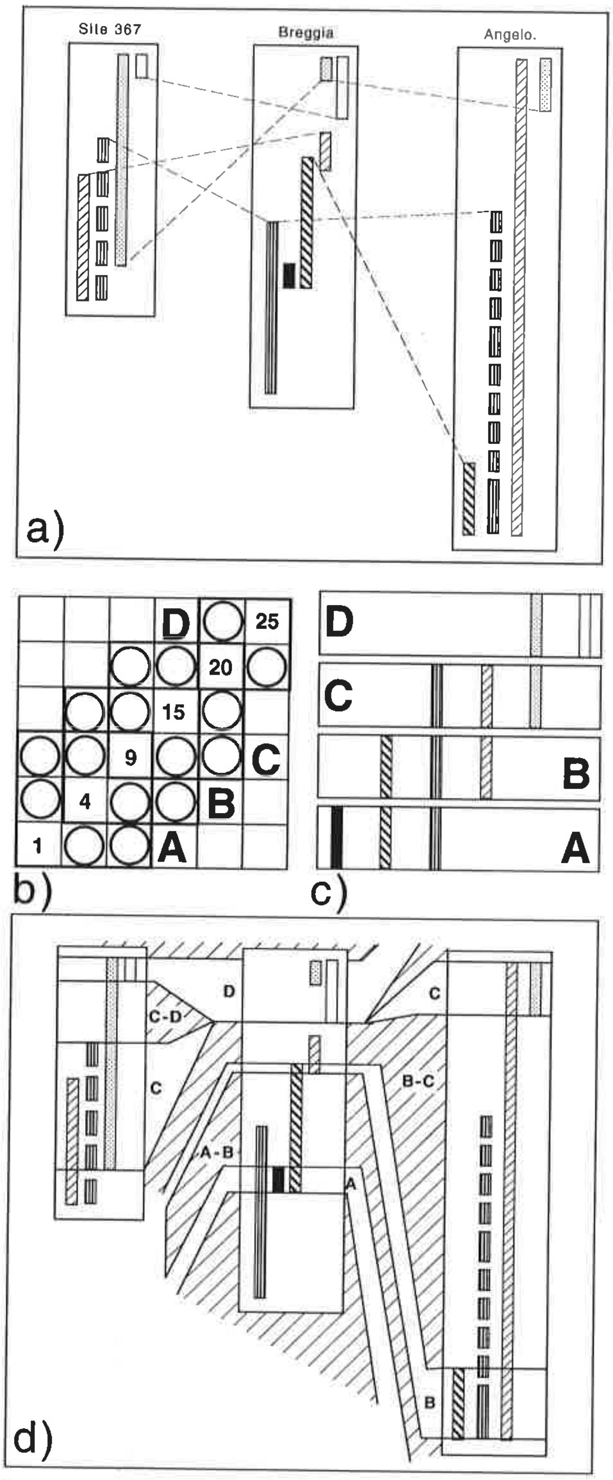
Definition

A Unitary Association (U.A.) is a maximal set of mutually compatible taxa (Guex, 1991, p. 15). This means that the co-occurrences expressed in the set is not contained in any larger set. In general, Unitary Associations are constructed by stacking the co-occurrence information of the whole data set and searching for maximal sets of really or virtually coexisting taxa, in applying the law of transitivity.

Explanatory review of the concept based on a real example (from Baumgartner *et al.*, 1981)

The high susceptibility of radiolarians to dissolution results in a large variation of the number of identifiable morphotypes from one sample to another. This is especially the case in land-based samples which underwent deep burial diagenesis. Well-preserved samples may contain easily over 100 morphotypes, whereas poorly-preserved samples contain as few as 10 or less. This demonstrates that the absence of certain morphotypes in part of a section does not necessarily have a chronological significance. To some extent, the list of morphotypes of a certain level can be extended by searching through more material. However, documentary gaps are unavoidable as certain morphotypes are affected more easily than others by diagenetic processes and selectively disappear from an assemblage. The result of the documentary gaps is that the order of first and final appearances of taxa is generally not the same in two compared sections. Thus, the events themselves are not useful for correlation.

Figure 2a shows the vertical distribution of six radiolarian species in three sections (a simple but real example extracted from Baumgartner *et al.*, 1980). The dotted lines connecting first and final appearances cross everywhere illustrating the usefulness of such a correlation. Nevertheless, the three sections contain valuable information on the mutual coexistence and exclusion, as



well as on the superposition of the species. The method of Unitary Associations (Guex, 1977, 1991) adequately treats this information and results in a chronologically significant correlation. For the detailed theoretical background as well as for the procedures, we refer to Guex's papers (1977-1991). The focus of this review is to elucidate the fundamental differences between the "event thinking" and the "association thinking" and the differences in the resulting zonation.

The information on co-occurrence and mutual exclusion from all species and all sections is reported to a species/species matrix showing the mutual association spectra of every species (Fig. 2b). This matrix has to be permutated to show a maximum of submatrices in which all species are compatible, that equal Unitary Associations. In our example, the lines of thinking for organising the association matrix are relatively simple. For instance, species No. 1 is found below species No. 15, 20 and 25. Thus the association containing species 1 must be the lowest in the matrix. A further step would be: species 4 is co-occurring with species 15 but never with 20 or 25, which are found above 4. Thus, the Unitary Association containing both species 4 and 15 must be above the one containing species 1 (as 1 and 15 do not co-occur, but are superposed) and below the ones containing species 20 and 25... and so on. For a large number of data this process must, of course, be formalised.

Figure 2b gives the permutated matrix for our example, with the indicated Unitary Associations A to D. It is the nature of these associations to represent maximal sets of compatible species (based on the given data). Figure 2b also gives their stratigraphic superposition. This information is easily transferred to the chart in Figure 2c. This chart looks like a range chart but has some fundamental differences: 1. The vertical axis represents neither time nor thickness, but simply superposes intervals of real (or virtual) coexistence of species resulting from a synthesis of all considered data. 2. The "range" of each species is not given with respect to a

Figure 2. Example of correlation of three sections with the help of Unitary Associations based on radiolarian occurrence data (from Baumgartner *et al.*, 1981)

a) Radiolarian occurrence data of six species in three sections extracted from Baumgartner *et al.*, 1980. Site 367: Deep Sea Drilling Project Site 367, Cap Verde Basin, Eastern Atlantic. Breggia: Lower Breggia Gorge, Mendrisiotto, Southern Switzerland. Angelo: Section near Angelokastron, Prov. Korinthos, Argolis Peninsula (Peloponnesus, Greece). Species numbers are taken from Baumgartner *et al.* (1980): *1: Stylocapsa oblongula* Kocher, 4: *Parvicingula procera* Pessagno, 9: *Mirifusus guadalupensis* Pessagno, 15: *Emiluvia orea* Baumgartner , 20: *Podocapsa amphitreptera* Foreman, 25: *Acanthocircus dicranacanthos* Squinabol. Dotted lines connect first and final appearances of species; crossed lines show the uselessness of this operation.

b) Permutaded species/species association matrix showing co-occurrence of pairs of species (squares filled with circles) and mutual exclusions (void squares) based on the data of a) The number in the main diagonal serves as label both for the line and the column. The heavy lined squares A-D indicate complete submatrices = Unitary Associations.

c) Chart of Unitary Associations A-D obtained for the 6 species from matrix b. The range of each species is given with respect to the other species. The double line between Unitary Associations symbolises the interval of separation. No vertical scale is implied.

d) Correlation of the three sections of a) based on the recognition of Unitary Associations A-D. Hatched fields designate intervals of separation assignable to either one of the two bracketing Unitary Associations.

vertical scale, but only with respect to all other considered species. This implies that there is an interval of separation (Guex, 1991) between each two adjacent Unitary Associations which is of unknown duration. The first and final appearances of the species characterising each of the adjacent Unitary Associations may lie anywhere within this interval. Such a zonation is in theory indefinitely perfectible (Guex, 1991). The consideration of more species in more sections with closer spaced sampling will both allow a further subdivision of the established Unitary Associations and eventually permit the insertion of new ones between the established ones to reduce the intervals of separation.

Figure 2d shows the correlation of the three sections based on the recognized Unitary Assemblages. As the number of considered species is small and their occurrence patchy, only thin, discrete parts of the sections can be safely correlated. The hatched fields show the large intervals of separation that may be part of either one of the adjacent Unitary Associations. It is interesting to know that the inclusion of more species considerably reduces the intervals of separation but does not alter the superposition of Unitary Associations. Crossed lines of correlation are excluded by this way of data integration.

Another step in the process of finding a chronologically significant biozonation is the evaluation of the reproducibility of each Unitary Association. In our example, U.A. A. is only found in the Breggia section. Thus, it is not useful for correlation to the other sections. More data are needed to demonstrate its reproducibility elsewhere.

4. UAZones, Definition and Explanation

Definition

An UAZone (abbreviated for Unitary Association Zone) is a biochronozone that results from the union of two or more Unitary Associations that exist in the protoreferential. The procedure follows Guex (1991, p. 15-16). The union of initial Unitary Associations is necessary to increase the reproducibility of the resulting UAZones. All characteristsic elements of the united Unitary Associations are considered as virtually coexisting. The UAZones are characterised by:

1. The set of species and species pairs characteristic of each of the U.A: that were united.

2. By a set of new elements consisting of the species and species pairs exclusively found in this union.

Explanation

As will be shown in Chapter 32, the reproducibility of the Unitary Associations created by the raw data is very poor. Many U.A. exist only in one or two of the sections and their potential for correlation is therefore minimal. However, in grouping U.A.s into UAZones, we reach a good reproducibility (see Chapter 32) that allows to attribute a chronostratigraphic singificance to each UAZone. The process of calibration has confirmed this significance in that each UAZone can be correlated with a time slice of variable duration and expressed with variable precision.

By definition, the ranges of characteristic species and species pairs start at the base or end at the top of a UAZone. Since we do not know the chronostratigraphic significance of the initial U.A. that constitute the UAZone, we cannot define ranges that start or end anywhere within a UAZone. This procedure has the inconvenience, that we assume certain virtual coexistences within UAZones, which result in longer ranges of species than can be observed in the data.

References

BAUMGARTNER, P., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1984a). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1984b). Comparison of unitary associations and probabilistic ranking and scaling as applied to Mesozoic radiolarians. *Computers and Geosciences*, **10** (1), 167-183.

BAUMGARTNER, P.O., BJØRKLUND, K.R., CAULET, J.-P., DE WEVER, P., KELLOGG, D., LABRACHERIE, M., NAKASEKO, K., NISHIMURA, A., SCHAAF, A., SCHMIDT-EFFING, R. & YAO, A. (1981). Eurorad II, 1980 - Second European meeting of radiolarian paleontologists: current research on Cenozoic and Mesozoic radiolarians. *Eclogae Geologicae Helvetiae*, **74** (3), 1027-1061.

GUEX, J. (1977). Une nouvelle méthode d'analyse biochronologique. *Bulletin de la Société Vaudoise des Science Naturelles*, **73**, 309-322.

GUEX, J. (1979). Terminologie et méthodes de la biostratigraphie moderne: commentaires critiques et propositions. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **74**, 170-216.

GUEX, J. (1980). Calcul, caractérisation et identification des associations unitaires en biochronologie. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **75**, 111-126.

GUEX, J. (1981). Associations virtuelles et discontinuités dans la distribution des espèces fossiles: un exemple intéressant. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **75**, 179-197.

GUEX, J. (1984). Estimations numériques de la qualité de l'enregistrement fossile des espèces. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **77**, 79-89.

GUEX, J. (1987). *Corrélations biochronologiques et associations unitaires* - Presses Polytechniques Romandes, Lausanne. 244 p.

GUEX, J. (1988). Utilisation des horizons maximaux résiduels en biochronologie. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **79** (2), 135-142.

GUEX, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

GUEX, J. & DAVAUD, E. (1982). Recherche automatique des associations unitaires: option nouvelle et exemple d'application. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **78** (2), 195-205.

GUEX, J. & DAVAUD, E. (1984). Unitary Associations Method: use of graph theory and computer algorithnm. *Computers & Geosciences*, **10** (1), 69-96.

SAVARY, J. & GUEX, J. (1990). BioGraph, version 2.02. *Institute of Geology and Paleontology, University of Lausanne*.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

2

Catalogue and systematics of Middle Jurassic to Lower Cretaceous Radiolaria

3. Systematic framework of Jurassic and Cretaceous Radiolaria

by Paulian Dumitrica

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
Mailing address: Könizstrasse 39, 3008 Bern, Switzerland

ABSTRACT

A systematic framework for the Jurassic and Cretaceous radiolarian genera included in the catalogue is proposed. It partly follows the present-day systematics. One new family and one subfamily are erected and the definitions of three other families were emended. The systematics proposed reflects the present state of knowledge of post-Triassic Mesozoic Radiolaria

Introduction

The researcher who attempts at present to build up a taxonomical system of Jurassic and Cretaceous radiolarians at various levels is usually confronted with numerous problems the solutions of which are difficult, if not impossible, to find at the present state of knowledge. These problems are caused by the fact that in spite of the immense variety and the steadily increasing number of taxa discovered during the last 2-3 decades our knowledge regarding most of them is very fragmentary. Many of these taxa have been described from poorly-preserved faunas or, even if well preserved, on external characters. In addition, the importance of various internal structures is not well-known. Since homoeomorphy is common among radiolarians it follows that a great deal of fundamental research is needed to improve our understanding of the value of all morphological characters and to find the appropriate place of each taxon in a natural taxonomical system. This research is essential as well-defined taxa represent the basis for any stratigraphic, palaeoecologic and palaeoceanographic work.

Recent papers (Baumgartner, 1980; Pessagno & Whalen, 1982; Dumitrica, 1988, 1989, to cite only very few of them) have proven that a «natural» taxonomy should be based on a better knowledge of the mode of test growth, structure of initial shells or skeletal elements and relationships between them. As a result of such fundamental works a series of remarkable contributions regarding the systematic of the Pantanelliidae (Pessagno & Blome, 1980; Pessagno et al, 1987; Pessagno and Yang, in Pessagno *et al.* 1989), Hagiastridae (Baumgartner, 1980, De Wever, 1981b), Saturnalidae (Kozur & Mostler, 1972, 1983, 1990; De Wever, 1981c, 1984; Dumitrica, 1985), several families of Nassellaria (Pessagno, 1977a, 1977b; Pessagno & Whalen, 1982; Pessagno *et al.* 1986; De Wever, 1982b) and of other groups of Radiolaria have been published in the latter years.

Besides the problems mentioned above, which are in need of solution for a more natural systematic classification of Radiolaria, there are also many irritating nomenclatorial problems. Most of them are due to Campbell (1954) who applied the International Code of Zoological Nomenclature (I.C.Z.N.) rather rigidly. He designated Upper Jurassic and Lower Cretaceous species described by Rüst (1885, 1898) as type species of some Cenozoic genera briefly defined by Haeckel (1881). Riedel (1958), Deflandre (1960), Petrushevskaya (1971), Merinfeld (1980), Lombari & Lazarus (1988) and many others criticised these major defects in Campbell's work and even tried, without success, to have it placed in the Official Index of Rejected Works in Zoology (Merinfeld, 1980).

Although many authors have followed Campbell's innovations our opinion is that Campbell's subsequent designations cannot be considered valid because in doing so he completely altered the original concept of many genera and even families. In defining his new genera Haeckel (1881) had been working on Cenozoic faunas collected especially during the famous Challenger expedition. In addition, Rüst (1885) working with thin section in much older material incorrectly assigned his species to Haeckel's genera. His generic determinations must therefore be considered erroneous and treated as such as in any synonymy.

One of the best example of such misinterpretation is the genus *Hagiastrum.* This genus was originally defined as "four-rayed, cross-shaped porodiscids without patagium and having unbranched chambered rays lying in the equatorial plane". Or *Hagiastrum plenum* RÜST 1885, considered by Campbell (1954) as type species of this genus does not show any chambered rays. Consequently this species was erroneously included in the genus *Hagiastrum.* The Family Hagiastridae erected by Riedel (1967) should therefore refer exclusively to Cenozoic forms, and the type species of the genus *Hagiastrum* should be *Hagiastrum mosis* HAECKEL 1887 or *H. buddhae* HAECKEL, the only species illustrated by Haeckel (1887).

Xiphostylus HAECKEL 1881, type of the family *Xiphostylidae* HAECKEL, is another example. Pessagno *et al.* (1989) discussed the embarrassing problems resulted from Campbell's designation of *X. attenuatus* RÜST 1885 as type species of this genus.

Similar problems have arisen by the designation of *Staurolonche robusta* RÜST 1885 as type species of *Staurolonche* HAECKEL 1881, which in turn is the type genus of the family Staurolonchidae. This genus was originally defined as having two concentric shells. The type species designated by Campbell is practically unrecognisable because it does not show the morphology of the cortical shell. Moreover, the internal radial beams corresponding to spines appear to pass inside the single medullary shell according to Rüst's drawing, suggesting the presence of at least one more shell inside this medullary shell. This species should therefore be considered a *nomen dubium* as well as many other species erected both by Rüst, and by other authors, from thin sections. Its use in the recent literature (Pessagno, 1977a) for Upper Jurassic forms with double medullary shell does not seem to be a god choice because it will always create confusions.

An other example of misinterpretation is illustrated by the genus *Sethocapsa* HAECKEL 1881, reinterpreted by Campbell as an objective synonym of *Adelocyrtis* PANTANELLI 1880, and by Foreman (1973) as an independent genus having as type species *Sethocapsa cometa* (PANTANELLI) in Rüst (1885). The genus was originally defined as "dicyrtida eradiata clausa" (spineless closed dicyrtids) (Haeckel, 1881). Or *Sethocapsa cometa* illustrated by Rüst has an indefinite number of segments, and is practically non-identifiable, whereas all species described by Foreman (1973) under this genus have 3-5 segments. *Sethocapsa pyriformis* HAECKEL 1887 is the species that should be considered as type species of this genus because it was the first described and illustrated by Haeckel and because it answers adequately the generic diagnosis.

Examples like the ones mentioned above may continue but here is not the place to discuss all of them.

The use of Rüst's species as type species of Haeckel's genera also raises another problem. Many of these species described from thin sections are unrecognisable. Since any genus is considered on the basis of its type species it follows that their use will always have a considerable degree of uncertainty which may create endless confusion. One method of avoiding such confusion, while at the same time observing the I.C.Z.N. guidelines, is to treat all these taxa as *nomina dubia.*

Having briefly discussed some of the difficult problems confronting any researcher of Jurassic and Cretaceous Radiolaria in his taxonomic work we shall try in the following chapter to present a systematic framework of the genera enclosed in this volume together with a few of the other genera occurring in the Upper Jurassic and Cretaceous. It is normal that such a framework is very unequal in its parts as some family and subfamily groups have been studied more than others. Only the suborders Spumellaria and Nassellaria are discussed here. The suborder Entactinaria, although present throughout the Mesozoic, is or seems to be, less frequent in the Jurassic and Cretaceous in comparison with the Triassic, and is practically not studied thus far.

In most cases the definitions of the families and subfamilies mentioned below follow the original concept. Where they have been emended this is quoted in the relevant text.

Kingdom Protista

Phylum Sarcomastigopora HONIGBERG & BALAMUTH 1963

Subphylum Sarcodina SCHMARDA 1871

Class Actinopoda CALKINS 1909

Subclass Radiolaria MÜLLER 1858

Order Polycystina EHRENBERG 1838, emend. RIEDEL 1967

Suborder Spumellaria EHRENBERG 1875

Superfamily.- Hexastylacea HAECKEL 1862

Family.- Hexastylidae HAECKEL 1881

***Type Genus*.-** *Hexastylus* HAECKEL 1881

***Definition*.-** Single shelled sphaerellarians with fibrilar initial spicule, the spines of the spicule prolonged usually outside into spines.

***Remarks*.-** As Hollande & Enjumet (1960) proved, the genus *Hexastylus* has a fibrilar initial spicule. Due to its tenuity it is to be supposed that this spicule can only exceptionally be preserved in fossil state.

***Range*.-** Palaeozoic ? to Recent.

***Included Taxa*.-**
Hexastylus HAECKEL 1881
Stigmostylus HOLLANDE & ENJUMET 1960

Family.- Quinquecapsulariidae n. fam.

***Type Genus*.-** *Quinquecapsularia* PESSAGNO 1971b

***Definition*.-** Globular spumellarians having as initial skeleton a system of bars forming a pentagonal prism in the 10 corners of which are originated 10 primary rays interconnected at one or more levels by a system of arches or bars which repeat at a larger scale the initial pentagonal prism. Initial prism formed of two pentagons united by 3 or 5 bars.

***Remarks*.-** Known so far only by a Cenomanian species from the California Coast Ranges (Pessagno, 1971b) this new family is common in the Lower and Middle Jurassic and is represented by many non-described taxa (genera and species), and also by some rare species throughout the whole Cenozoic.

The type of microsphere and system of arches suggest that this family was probably derived from a Triassic group with a cubic microsphere, of which a single taxon (*Arcicubulus constrictus* DUMITRICA) was hitherto described (Dumitrica, 1983). The type of microsphere having the 2 initial pentagons connected by only 3 bars, and the type of connection of one of these bars (which unites the corners of the pentagons, whereas the others 2 bars unites the middle of 2 sides of the pentagons) would suggest the presence of an initial spicule with 6 rays similar to the rays of the spicule of the Centrocubidae Hollande & Enjumet 1960.

***Range*.-** Lower Jurassic to Recent.

***Included Taxa*.-**
Quinquecapsularia PESSAGNO 1971b

Superfamily.- Actinommacea HAECKEL 1862

Family.- Pantanelliidae PESSAGNO 1977a

***Type Genus*.-** *Pantanellium* PESSAGNO 1977a

***Definition*.-** Test of two concentric shells: a latticed, commonly delicate, spherical medullary shell, and a rather robust cortical shell. Cortical shell spherical, ellipsoidal, pyramidal, comprised of pentagonal and hexagonal, usually very symmetrical pore frames, and connected to medullary shell by primary radial beams and secondary radial beams. Primary radial beams, 2-4 in number, prolonged outside into primary spines which may be solid and bladed or smooth and hollow.

***Range*.-** Upper Triassic (Carnian) to Cretaceous (Albian).

Subfamily.- Pantanelliinae PESSAGNO 1977a

***Type Genus*.-** *Pantanellium* PESSAGNO 1977a

***Definition*.-** Test with 2-4 solid bladed primary spines. Primary spines basically triradiate in axial section.

***Range*.-** Upper Triassic (Carnian) to Lower Cretaceous (Albian).

***Included Taxa*.-**
Betraccium PESSAGNO, in Pessagno *et al.* 1979
Cantalum PESSAGNO, in Pessagno *et al.* 1979
Cecrops PESSAGNO 1977a
Gorgansium PESSAGNO & BLOME 1980
Pachyoncus PESSAGNO & BLOME 1980
Pantanellium PESSAGNO 1977a
Pseudopantanellium YEH 1987
Trillus PESSAGNO & BLOME 1980
Zartus PESSAGNO & BLOME 1980

***Subfamily*.-** Vallupinae
PESSAGNO & MACLEOD 1987

***Type Genus*.-** *Vallupus* PESSAGNO & BLOME, in Pessagno *et al.* 1984

***Definition*.-** Pantanelliidae with one or more cortical collars, with or without primary spines. Cortical collar(s) imperforate, usually tubular. Secondary radial beams extending from vertices of pore frames of medullary shell and sutured to inner margin of cortical collar. Primary spines, where present, solid and triradiate in axial section.

***Range*.-** Oxfordian to upper Tithonian.

***Included Taxa*.-**
Bivallupus PESSAGNO & MACLEOD 1987
Mesovallupus PESSAGNO & MACLEOD 1987
Neovallupus YANG & PESSAGNO, in Pessagno *et al.* 1989
Protovallupus PESSAGNO & MACLEOD 1987
Supervallupus YANG & PESSAGNO, in Pessagno *et al.* 1989
Vallupus PESSAGNO & BLOME, in Pessagno *et al.* 1984

***Subfamily*.-** Capnodocinae PESSAGNO,
in Pessagno *et al.* 1979, emend. BLOME 1983

***Type Genus*.-** *Capnodoce* DE WEVER, in De Wever *et al.*, 1979

***Definition*.-** Pantanelliidae with hollow spines. Proximal and medial portions of spines smooth, circular in axial section; distal portions triradiate in axial section with three prominent pores, each pore situated in grooves between internal partition of triradiate structure.

***Range*.-** Upper Triassic (upper Carnian to upper middle Norian).

***Included Taxa*.-**
Capnodoce DE WEVER, in De Wever *et al.*, 1979
Justium BLOME 1983
Loffa PESSAGNO, in Pessagno *et al.* 1979
Renzium BLOME 1983

***Subfamily*.-** Parvivaccinae
PESSAGNO & YANG, in Pessagno *et al.* 1989

***Type Genus*.-** *Parvivacca* PESSAGNO & YANG, in Pessagno *et al.* 1989

***Definition*.-** Pantanelliidae with two main spines lying at an angle smaller than 180°.

***Remarks*.-** Pessagno & Yang (in Pessagno *et al.* 1989) considered this group to be representative of an independent family derived from the Pantanelliidae through the acquisition of a two-layered cortical shell. As this character does not seem to be of family value the family is included as a subfamily of the Pantanelliidae.

***Range*.-** Aalenian to Barremian.

***Included Taxa*.-**
Lanubus PESSAGNO & YANG, in Pessagno *et al.* 1989
Parvivacca PESSAGNO & YANG, in Pessagno *et al.* 1989

***Family*.-** Xiphostylidae HAECKEL 1881,
emend. PESSAGNO & YANG, in Pessagno *et al.* 1989

***Type Genus*.-** *Xiphostylus* HAECKEL 1881, emend. PESSAGNO & YANG, in Pessagno *et al.* 1989

***Definition*.-** Test with cortical shell only, lacking primary radial beams or internal spicule. Cortical shell latticed of two layers, a thin inner layer and a thick to very thick outer layer. Shell with or without two or more three-bladed spines.

***Remarks*.-** According the problems we mentioned in the introduction the assignation of *X. attenuatus* RÜST to the genus *Xiphostylus* HAECKEL should be considered erroneous (generic misinterpretation) in which case the subsequent designation of this species as type species of this genus is void. Therefore the Jurassic and Cretaceous genera are tentatively included in this family which first of all should comprise Cenozoic taxa. The emended diagnosis of the family should be considered just as a provisional solution.

***Range*.-** Triassic to Cretaceous.

***Included Taxa*.-**
Archaeocenosphaera PESSAGNO & YANG, in Pessagno *et al.* 1989
Suna WU 1986 (= *Neotripocyclia* PESSAGNO & YANG 1989)
? *Triactoma* RÜST 1885
Tripocyclia HAECKEL 1881
Xiphostylus HAECKEL 1881
Zanola PESSAGNO & YANG, in Pessagno *et al.* 1989

***Family*.-** Actinommidae
HAECKEL 1862, emend RIEDEL 1967

***Type Genus*.-** *Actinomma* HAECKEL 1862

***Definition*.-** Solitary spumellarians with shells spherical or ellipsoidal (or modifications of those shapes), not discoidal, generally without internal spicule.

***Remarks*.-** The family is probably polyphyletical. Assignation of many genera to it is a provosional solution.

***Range*.-** Mesozoic? to Recent.

***Included Taxa*.-**

Hexapyramis SQUINABOL 1903

Family.- Leugeonidae
YANG & WANG 1990, emend.

Type Genus.- *Leugeo* YANG & WANG 1990, emend.

Definition.- Actinommacea with a latticed spherical medullary shell and a latticed cortical shell, both interconnected by a variable number of rays. External spines, when present, are three-bladed and as a rule are not in line with internal rays. Cortical wall simple or with nodes or tubercles.

Remarks.- The family was originally erected (by methods unacceptably simplistic for a modern standard) on the basis of forms described by Baumgartner (1984) as *Praeconocaryomma* (?) *hexacubica*. These forms have in the centre a spherical latticed microsphere connected to the cortical shell by 6 rays, external spines when present being secondary as they do not represent prolongations of internal beams. Similar situations are known in *Acaeniotyle diaphorogona* FOREMAN, *Triactoma jonesi* PESSAGNO and *Dicroa* FOREMAN. As the medullary shell and its relationships with the cortical shell seem to be or are as a rule much more important than the structure of cortical shell all these genera are herein included in a single family. The Family Acaeniotylidae YANG 1993 is provisionally considered as a junior synonym of the Family Leugeonidae.

Range.- Middle Jurassic or older to Middle Cretaceous.

Included Taxa.-
Acaeniotyle FOREMAN 1973
Acaeniotylopsis KITO & DE WEVER 1994
Dicroa FOREMAN 1975
Leugeo YANG & WANG 1990 (= *Laevileugeo* YANG & WANG 1990)

Family.- Stylosphaeridae
HAECKEL 1881

Type Genus.- *Stylosphaera* EHRENBERG 1847

Definition.- Lattice shell single or concentrically multiple, with two prominent polar spines.

Range.- Cretaceous? to Recent.

Included Taxa.-
Lithatractus HAECKEL 1887
Stylosphaera EHRENBERG 1847

Superfamily.- Saturnaliacea DEFLANDRE 1953

Family.- Saturnalidae
DEFLANDRE 1953

Type Genus.- *Saturnalis* HAECKEL 1881

Definition.- Saturnaliacea with a spherical, subspherical, cylindrical or irregular central shell surrounded by a simple, double or multiple ring armed or not with spines. Ring connected to shell by two polar rays originated in a heteropolar microsphere and eventually also by auxiliary or subsidiary rays originated in various levels of the many-layered shell.

Remarks.- The Families Pseudacanthocircidae KOZUR & MOSTLER 1990, Saturnalideidae KOZUR & MOSTLER 1990, Parasaturnalidae KOZUR & MOSTLER 1972 are also included within the Saturnalidae. Many genera are in need of better definitions based on morphology of central shell and ring, many of the present-day definitions being either too narrow or too wide.

In agreement with De Wever (1984) and Dumitrica (1985) in the post-Triassic Mesozoic and in the Cenozoic we recognize only two ring-bearing subfamilies of the many families or subfamilies proposed by Kozur and Mostler (1990): Saturnalinae and Parasaturnalinae.

Range.- Upper Triassic to Recent.

Subfamily.- Saturnalinae DEFLANDRE 1953,
emend DE WEVER 1984

Type Genus.- *Saturnalis* HAECKEL 1881

Definition.- Saturnalids with peripolar spines. Ring simple of multiple, flat or bladed.

Range.- Upper Triassic to Recent.

Included Taxa.-
Acanthocircus SQUINABOL 1903, emend. DONOFRIO & MOSTLER 1978
Hexasaturnalis KOZUR & MOSTLER 1983
Parasaturnalis KOZUR & MOSTLER 1972

Subfamily.- Heliosaturnalinae
KOZUR & MOSTLER 1972

Type Genus.- *Heliosaturnalis* KOZUR & MOSTLER 1972

Definition.- Saturnalids with polar spines. Ring simple or multiple, with or without auxiliary rays.

Range.- Upper Triassic to Lias.

***Included Taxa*.-**
Heliosaturnalis KOZUR & MOSTLER 1972
Pseudoheliodiscus KOZUR & MOSTLER 1972.

Superfamily.- Pyloniacea HAECKEL 1881, emend. DUMITRICA 1989

Family.- Orbiculiformidae PESSAGNO 1973, emend.

***Type Genus*.-** *Orbiculiforma* PESSAGNO 1973, emend.

***Definition*.-** Four- or two-rayed, disc-shaped or lenticular spumellarians having as medullary shell a system of 3 successively perpendicular girdles forming in polar view a characteristic cross-shaped structure, the arms of the cross aligned with the 4 equatorial primary beams. Primary beams originated in the corners of a square primary ring and bearing a system of branches of which the innermost 4 form constantly 2 successive pairs of opposite branches disposed in the vertical and equatorial plane respectively. Following branches, where existing, may preserve the same disposition in successively perpendicular planes, may be reduced to the vertical plane only, may be disposed in 3 planes at 120°, or may be quite irregularly disposed. This results in four, two, or three primary canals along rays, where existing, or in the absence of canals, respectively.

***Remarks*.-** According to the discussion developed in the first chapter concerning some of Campbell's subsequent designations of type species of a series of genera defined by Haeckel (1881), *Hagiastrum plenum* RUST 1885 should be considered as originally erroneously included in the genus *Hagiastrum* HAECKEL 1881. This genus was defined as having chambered arms (Haeckel, 1881, p. 460) whereas Rüst's species has no such a character. *Hagiastrum plenum* should be considered as a generic misinterpretation. *Hagiastrum* should therefore have another type species, a Cenozoic one anyway, chosen among the species described and illustrated by Haeckel (1887). Consequently the family Hagiastridae RIEDEL 1971 should refer to Cenozoic radiolarians. By its contents this family, as emended by Baumgartner (1980), is a junior synonym of the family Orbiculiformidae PESSAGNO 1973. Personal study of internal structures and mode of growth has proven that *Orbiculiforma* PESSAGNO 1973 is a higumastrin with a thick patagium.

The inclusion of this family within the Pyloniacea is based on the mode of growth of the central part of skeleton which is of pyloniacean type, with girdles disposed in successively perpendicular planes. Moreover, fossil record proves that this family gave birth, probably in the Middle Cretaceous, to the families Larnacillidae and Miropylidae.

On the basis of general shape of shell and structure of first system of girdles (medullary shell) the Orbiculiformidae can be divided into several subfamilies among which: Orbiculiforminae PESSAGNO 1973, Tetraditryminae BAUMGARTNER 1980, Emiluviinae n. subfam.

Subfamily.- Orbiculiforminae PESSAGNO 1973

***Type Genus*.-** *Orbiculiforma* PESSAGNO 1973

***Definition*.-** Orbiculiformidae with 4, exceptionally 2 rays, with or without patagium, with 2 canals as a result of disposition of branches of primary beams exclusively in vertical plane.

***Range*.-** Lower Jurassic to Upper Cretaceous.

***Included Taxa*.-**
Higumastra BAUMGARTNER 1980
Orbiculiforma PESSAGNO 1973
? *Pseudocrucella* BAUMGARTNER 1980

Subfamily.- Emiluviinae n. subfam.

***Type Genus*.-** *Emiluvia* FOREMAN 1973

***Definition*.-** Orbiculiformidae with 2 medullary shells, representing the first system, separated by a relatively large space from a double or single layered cortical shell to which it is connected by the 4 primary beams prolonged into spines outside cortical shell and by a variable number of internal beams.

***Range*.-** Middle Jurassic or older to Upper Cretaceous.

***Included Taxa*.-**
Emiluvia FOREMAN 1973
Kreutzstella EMPSON-MORIN 1981
Staurolonche HAECKEL, emend. PESSAGNO 1977
? *Tympaneides* CARTER, in Carter 1988

Subfamily.- Tetraditryminae BAUMGARTNER 1980

***Type Genus*.-** *Tetraditryma* BAUMGARTNER 1980

***Definition*.-** Orbiculiformidae with 4, rarely 2 rays, each ray with 3 or 4 primary canals and a variable number of cortical beams.

***Range*.-** Middle to Upper Jurassic.

Included Taxa.-
Archaeohagiastrum BAUMGARTNER 1984
Crucella PESSAGNO 1971a
Tetraditryma BAUMGARTNER 1980
Tetratrabs BAUMGARTNER 1980
? *Didactylum* BAUMGARTNER 1980
? *Monotrabs* BAUMGARTNER 1984

Family.- Tritrabidae
BAUMGARTNER 1980

Type Genus.- *Tritrabs* BAUMGARTNER 1980

Definition.- Test composed of three, exceptionally two, rays. Initial skeleton composed of three bars in the equatorial plane forming a triangle in the corners of which three primary beams are originated. On both faces of this initial triangle a pyramidal structure arises formed by three bars originated approximately in the middle of each side. Primary beams with a system of branches disposed in cross or at 120° forming with cortical shell three or four primary canals. Cortical shell of rays composed of 6 or more strongly developed external beams interconnected by bars which forms a system of longitudinally arranged pores. Rays interconnected or not by a well developed patagium with a morphology characteristic of species.

Remarks.- Internal structure (structure of microsphere) and mode of growth of *Tritrabs* and other genera with 3 rays have proven that despite the similarity in ray structure these genera are not closely related to the Tetraditryminae. Consequently the Tritrabinae BAUMGARTNER 1980 are raised to family rank.

Range.- Middle Jurassic or older to Late Cretaceous.

Included Taxa.-
Archaeotritrabs STEIGER 1992
Cyclastrum RÜST 1898
Ditrabs BAUMGARTNER 1980
Deviatus LI, 1986 (=*Foremanella* MUZAVOR, 1977; *Noviforemanella* PESSAGNO, BLOME & HULL, 1993)
? *Halesium* PESSAGNO 1971a, emend. BAUMGARTNER 1980
Homoeoparonaella BAUMGARTNER 1980
Tritrabs BAUMGARTNER 1980

Family.- Catenopylidae
DUMITRICA 1989

Type Genus.- *Catenopyle* DUMITRICA 1989

Definition.- Microsphere with two pairs of opposite gates alternating with two pairs of opposite pores, each pair symmetrical to each other relative to an equatorial plane after a rotation of 90°. Perimicrospheric skeleton formed of single-girdled systems, each girdle of two opposite two-pillared caps rotated 90° to one another around polar axis.

Range.- Upper Jurassic to Upper Cretaceous (Maastrichtian).

Included Taxa.-
Catenopyle DUMITRICA 1989
Praecatenopyle DUMITRICA 1989

Family.- Miropylidae
DUMITRICA 1988

Type Genus.- *Miropyle* DUMITRICA 1988

Definition.- Microsphere eccentric, heteropolar, with 4 gates disposed crosswise at one pole. First system four-girdled, with a combination of two-pillared and four-pillared caps.

Range.- Upper Cretaceous (Cenomanian to Maastrichtian).

Included Taxa.-
Miropyle DUMITRICA 1988

Family.- Larnacillidae
HAECKEL 1887

Type Genus.- *Larnacilla* HAECKEL 1877

Definition.- Microsphere commonly heteropolar, with two symmetrical, opposite pairs of gates. Whole skeleton or only its early ontogenetic stages formed of systems of 3 successively larger elliptical girdles in 3 mutually perpendicular planes.

Range.- Cenomanian or older to Recent Cretaceous.

Included Taxa.-
Larnacopylomma DUMITRICA 1989.

Superfamily.- Spongodiscacea HAECKEL 1862

Family.- Patulibracchiidae PESSAGNO 1971a, emend. BAUMGARTNER 1980

Type Species.- *Patulibracchium* PESSAGNO 1971a, emend.

Definition.- Spongodiscacea with 2-5 rays composed of uniform spongy meshwork. Meshwork of central area irregular or with faint radial bars, in rays arranged in rows parallel to equatorial plane of the test. Individual layers composed of linearly to sublinearly arranged meshes. External pore frames sometimes composed of external beams and bars, sometimes more irregular spongy with weak linearity. Bracchiopyle may be developed.

Range.- Upper Triassic to Upper Cretaceous.

Included Taxa.-
Angulobracchia BAUMGARTNER 1980
Bistarkum YEH 1987
Halesium PESSAGNO 1971a, emend. BAUMGARTNER 1980
Paronaella PESSAGNO 1971a, emend. BAUMGARTNER 1980
Patulibracchium PESSAGNO 1971a
Savaryella JUD 1994

Family.- Pseudoaulophacidae RIEDEL 1967

Type Genus.- *Pseudoaulophacus* PESSAGNO 1963

Definition.- Test disc-shaped to lenticular in lateral view, triangular to polygonal or circular in axial view, with or without tholi. Three to 12 primary spines present equatorially; when not re-absorbed extended to centre of test. Meshwork consisting entirely of equilateral triangular frames composed of bars connected to massive nodes at vertices; triangular frames combining to form hexagonal areas. Meshwork arranged in markedly concentric layers.

Range.- Upper Jurassic to Upper Cretaceous or younger (Eocene).

Included Taxa.-
Alievium PESSAGNO 1972
Pseudoaulophacus PESSAGNO 1963

Family.- Sponguridae HAECKEL 1862

Type Genus.- *Spongurus* HAECKEL 1862

Definition.- Test ellipsoidal, cylindrical or some variation of these forms, with solid spongy meshwork arranged in concentric layers, with or without axial spines and constrictions.

Range.- Triassic to Recent.

Included Taxa.-
Archaeospongoprunum PESSAGNO 1973

Family.- Cavaspongiidae PESSAGNO 1973

Type Genus.- *Cavaspongia* PESSAGNO 1973

Definition.- Test of variable shape having a latticed medullary shell and a cortical shell comprised of polygonal pore frames arranged in an indeterminate number of concentric layers. Cortical shell connected by radial beams to medullary shell.

Range.- Upper Jurassic to Upper Cretaceous.

Included Taxa.-
Cavaspongia PESSAGNO 1973
Pyramispongia PESSAGNO 1973

Family.- Spongodiscidae HAECKEL 1862

Type Genus.- *Spongodiscus* EHRENBERG 1845

Definition.- Shell flat, disc-shaped or lenticular, spongy having in the centre a latticed microsphere. Spongy meshwork massive or in concentric layers.

Range.- Middle Triassic to Recent.

Included Taxa.-
Bernoullius BAUMGARTNER 1984
Godia WU 1986
Haliodictya HOJNOS 1916
Spongotripus HAECKEL 1881
Stylospongia HAECKEL 1862

Family.- Phaseliformidae PESSAGNO 1972

Type Genus.- *Phaseliforma* PESSAGNO 1972

Definition.- Test sub-ellipsoidal, thicker on anterior end than posterior end. Internal meshwork weakly concentric.

Range.- Upper Jurassic to Upper Cretaceous.

Included Taxa.-
Parvicuspis PESSAGNO 1972
Phaseliforma PESSAGNO 1972

Suborder Nassellaria EHRENBERG 1875

Family.- Eptingiidae DUMITRICA 1978

Type Genus.- *Eptingium* DUMITRICA 1978

Definition.- Nassellarians(?) the skeleton of which consist of a sub-globular, disc-shaped or subtriangular "cephalis" with sagittal ring and with spines A, Lr and Ll, or exceptionally one L and one l extended into 3 stout co-planar spines. No thorax or other cephalic apophyses present but pericephalic shell possibly present.

Remarks.- Takemura (1986) included the Jurassic genus *Perispyridium* in a new subfamily, Perispyridinae TAKEMURA 1986, as a member of the family Acanthodesmiidae HAECKEL 1881. Despite its sagittal ring this genus as well as all the Eptingiidae has no relationships with the Acanthodesmiidae which comprise exclusively Cenozoic nassellarians.

Range.- Middle Triassic to Upper Jurassic. (Tithonian).

Included Taxa.-
Eptingium DUMITRICA 1978
Perispyridium DUMITRICA 1978
Protoperispyridium YEH 1987

Family.- Foremanellinidae DUMITRICA 1982

Type Genus.- *Foremanellina* DUMITRICA 1982

Definition.- Test commonly dicyrtid, a third segment when present is a velum-like prolongation of the thorax. Cephalis relatively large with MB, A, V, L and l. Spine D absent. L and l prolonged outside into 4 feet or horns which may extend laterally or along thorax. A and, in many cases, V prolonged also into solid horns.

Remarks.- In spite of different external morphology and structure of thorax nassellarians included in this family have a common type of spicule. It must be mentioned however that an initial spicule characterized by the absence of D is present in other families as well. By comparison with Jurassic forms the Middle Triassic taxa are much more primitive, with larger cephalis, thorax incompletely formed and spines L and l laterally rather than downwardly directed.

Range.- Middle Triassic to Middle Jurassic.

Included Taxa.-
Diceratigalea TAKEMURA & NAKASEKO 1982
Farcus PESSAGNO, WHALEN & YEH 1986
Foremanellina DUMITRICA 1982
Hilarisirex TAKEMURA & NAKASEKO 1982
Recoaroella DUMITRICA 1982
Riedelius DE WEVER 1982a
Rolumbus PESSAGNO, WHALEN & YEH 1986

Family.- Poulpidae DE WEVER 1981a

Type Genus.- *Poulpus* DE WEVER, in De Wever 1979

Definition.- Nassellaria formed exclusively of a cephalis with three feet representing prolongation of L and D. Cephalic skeleton with MB, A, V, L, D, l connected by arches AV, AL, VL, Ll and lD.

Range.- Middle Triassic to Lower Cretaceous.

Included Taxa.-
Eonapora KOZUR & MOSTLER 1981
Hozmadia DUMITRICA, KOZUR & MOSTLER 1980.
Poulpus DE WEVER, in De Wever 1979
Saitoum PESSAGNO 1977a

Family.- Tripedurnulidae DUMITRICA 1991

Type Genus.- *Tripedurnula* DUMITRICA 1991

Definition.- Shell composed exclusively of a relatively large cephalis provided usually with an eccentric apical horn and at least three feet, exceptionally one representing external prolongations of D and L. Initial spicule with MB, A, V, D, L and l, connected by arches Al, Dl, Ll and LV. Arch AV absent. Ax very short. Cephalis with two distinct lobes: a large eucephalic lobe and a small dorsal lobe.

Range.- Middle Triassic to Middle Cretaceous (Albian).

Included Taxa.-
Baratuna KOZUR & MOSTLER 1981
Pseudopoulpus TAKEMURA 1986
Tripedocassis DUMITRICA 1991
Tripedocorbis DUMITRICA 1991
Tripedurnula DUMITRICA 1991
Turanta PESSAGNO & BLOME 1982
? *Takoum* TAKEMURA 1986

Family.- Ultranaporidae
PESSAGNO 1977b

Type Genus.- *Ultranapora* PESSAGNO 1977b

Definition.- Dicyrtid nassellarians with a small hemispherical cephalis and a large, opened, hemispherical thorax bearing 3 feet as prolongations of D and L. Initial cephalic spicule consisting of MB, A, V, D, L and l. A prolonged into a solid apical horn. V prolonged into a spine with or without a cephalocone. Thoracic aperture with or without a velum.

Range.- Middle Triassic to Upper Cretaceous.

Included Taxa.-
Napora PESSAGNO 1977a (= *Ultranapora* PESSAGNO 1977b)
Jacus DE WEVER 1982a
Silicarmiger DUMITRICA, KOZUR & MOSTLER 1980

Family.- Lophophaenidae HAECKEL 1881,
sensu PETRUSHEVSKAYA 1971

Type Genus.- *Lophophaena* EHRENBERG 1847

Definition.- Plagiacanthidae with cephalic wall prolonged downwards forming an incomplete thorax. Aperture wide open.

Range.- Jurassic? - Recent.

Included Taxa.-
Lophophaena EHRENBERG 1847
Thetis DE WEVER 1982a

Family.- Williriedellidae
DUMITRICA 1970

Type Genus.- *Williriedellum* DUMITRICA 1970

Definition.- Three- or four-segmented nassellarians with cephalothorax partly or completely depressed into the abdominal cavity. Abdomen with or without aperture, with or without sutural pore. Cephalis simple, with 4 collar pores in its base.

Range.- Upper Triassic (?) to Upper Cretaceous. The Triassic occurrences are questionable. De Wever *et al.* (1979) are the only authors who illustrated members of this family from a sample from Greece considered Carnian or early Norian in age. Illustrations published in that paper prove that this sample in fact represents a mixture of Upper Triassic and Middle or Upper Jurassic radiolarians.

Included Taxa.-
? *Arcanicapsa* TAKEMURA 1986
Cryptamphorella DUMITRICA 1970
Excentropylomma DUMITRICA 1970
Hemicryptocapsa TAN 1927
Holocryptocanium DUMITRICA 1970
Holocryptocapsa TAN 1927
Immersothorax DUMITRICA 1970
Kozurium PESSAGNO 1977b
? *Tricolocapsa* HAECKEL 1887 (as used for Mesozoic species)
Williriedellum DUMITRICA 1970
Zhamoidellum DUMITRICA 1970

Family.- Sethocapsidae
HAECKEL 1881

Type Genus.- *Sethocapsa* HAECKEL 1881

Definition.- Dicyrtids with last segment inflated, closed or with a narrow aperture. Without apophyses. Cephalis simple, small.

Remarks.- The Jurassic and Cretaceous genera listed below are questionably included in this family. As mentioned in the Introduction the type species of *Sethocapsa* should be *S. pyriformis* HAECKEL 1881 or another Cenozoic species mentioned by him under this genus.

Range.- Jurassic? to Recent.

Included Taxa.-
Archicapsa HAECKEL 1881
Dicolocapsa HAECKEL 1881
Gongylothorax FOREMAN 1968
Sethocapsa HAECKEL 1881
Stylocapsa PRINCIPI 1909

Family.- Xitidae
PESSAGNO 1977b

Type Genus.- *Xitus* PESSAGNO 1977b

Definition.- Test multicyrtid, elongate, conical. Cephalis conical, imperforate with or without an apical horn. Thorax trapezoidal in outline, single-layered. Post-thoracic or post-abdominal chambers trapezoidal in outline, with inner layer of meshwork consisting of symmetrical, uniform sized polygonal pore frames and outer layer comprised of tubercles interconnected by numerous bars which tend to outline irregular polygonal areas. Tubercles and bars often are dense, obscuring the meshwork of inner layer except on final chamber. Post-thoracic chambers separated by imperforate, planiform partitions, each having central aperture bordered by a circumferential rim.

Range.- Upper Jurassic to Upper Cretaceous.

Included Taxa.-
Crolanium PESSAGNO 1977b
Novixitus PESSAGNO 1977b
Xitus PESSAGNO 1977b

Family.- Pseudodictyomitridae PESSAGNO 1977b

Type Genus.- *Pseudodictyomitra* PESSAGNO 1977b

Definition.- Test elongate, conical, lobate, multicyrtid. Cephalis and thorax imperforate, smooth or with weakly developed costae. Cephalis usually conical outside, lacking horn. Thorax trapezoidal in outline. Remaining chambers subcylindrical in shape, expanding moderately rapidly in width and less rapidly in height as added. Abdomen separated from thorax either by single or double rows of pores. Abdomen and all but final post-abdominal chambers separated from each other by two rows of alternate pores situated in strictures at joints; the upper row consists of open primary pores whereas the lower row consists commonly of infilled, relict pores and may be lacking. Final post-abdominal chambers with one row of primary pores occurring in strictures. Abdomen and postabdominal chambers costate; costae discontinuous, not crossing strictures between chambers. Rows of larger relict pores occurring between costae. Final post-abdominal chamber with cylindrical neck.

Range.- Upper Jurassic to Upper Cretaceous.

Included Taxa.-
Pseudodictyomitra PESSAGNO 1977b (= *Shana* WU & PESSAGNO, in Wu 1993)

Family.- Archaeodictyomitridae PESSAGNO 1976

Type Genus.- *Archaeodictyomitra* PESSAGNO 1976

Definition.- Test elongate, conical to spindle-shaped, with well-developed longitudinally aligned pores. Pores on all chambers except cephalis developed between costae either as relict pores or as primary pores. Costae continuous or discontinuous. All chambers except cephalis, thorax and final chamber separated by planiform "septal partitions with large circular aperture in centre. Cephalic structure simple, with MB, A, V, D, L and l.

Remarks.- Three families (Archaeodictyomitridae PESSAGNO 1976, Hsuidae PESSAGNO & WHALEN 1982, and Crubidae YEH 1987) are herein included because all of them show longitudinally aligned pores. Many of the genera listed below are probably synonyms.

Range.- Triassic (?) or Lower Jurassic to Upper Cretaceous.

Included Taxa.-
Archaeodictyomitra PESSAGNO 1976
Combusta YEH 1987
Dictyomitra ZITTEL 1876, emend. PESSAGNO 1976
Diplostrobus SQUINABOL 1903
Drulanta YEH 1987
Fantus YEH 1987
Hsuum PESSAGNO 1977a, emend. TAKEMURA 1986
Linaresia EL KADIRI 1992
Mita PESSAGNO 1977b
Parahsuum YAO 1982
Semihsum PESSAGNO, BLOME & HULL 1993
Thanarla PESSAGNO 1977b
Transhsuum TAKEMURA 1986
Zifondium PESSAGNO 1977

Family.- Theoperidae HAECKEL 1881, emend. RIEDEL 1967, emend TAKEMURA 1986

Type Genus.- *Theopera* HAECKEL 1881

Definition.- Cephalis relatively small, approximately spherical and often poreless or sparsely perforated. MB, A, V, D, L and l as cephalic elements, without distinct arches within the cephalic wall but at collar portion. All elements free from cephalic wall but two l often contacting to or buried in the wall. V always lying obliquely within the cephalic cavity.

Remarks.- Family very large and quite probably polyphyletic, its use for many Mesozoic forms representing a temporary solution.

Range.- Middle Triassic to Recent.

Included Taxa.-
Ares DE WEVER 1982a
Artocapsa HAECKEL 1881
Cyrtocapsa HAECKEL 1881
Diacanthocapsa SQUINABOL 1903
Dictyomitrella HAECKEL 1887
Eucyrtis HAECKEL 1881
Guexella BAUMGARTNER 1984
Milax BLOME 1984b
Protunuma ICHIKAWA & YAO 1976
Pseudoeucyrtis PESSAGNO 1977b
Solenotryma FOREMAN 1968
Stichocapsa HAECKEL 1881
Stichomitra CAYEUX 1897
Theocapsomma HAECKEL 1877, emend. FOREMAN 1977

***Family*.-** Eucyrtidiellidae
TAKEMURA 1986

***Type Genus*.-** *Eucyrtidiellum* BAUMGARTNER 1984

***Definition*.-** Nassellaria of several segments. Initial cephalic skeleton with primary lateral spines reduced, the collar plate having only two pores outlined externally by arches LV and separated from one another by a bar representing MB and V. Spines l included in the cephalic wall.

***Remarks*.-** Because of the absence of a four-pored collar plate Takemura and Nakaseko (1986) and Takemura (1986) regarded the genus *Eucyrtidiellum* a problematic nassellarian. Electron microscope images published by the authors show that this genus is a theoperid in the sense of Riedel (1967), with spines L completely reduced. Remains of them can be observed in some of their illustrations. The genus probably descends from a nondescript Middle Triassic genus of rather similar morphology but with the two L fibrilar, not connected to the collar plate but descending from MB and touching with their distal ends the middle or lower part of thorax.

***Range*.-** Early Middle Triassic ?, Early to Late Jurassic.

***Included Taxa*.-**
Eucyrtidiellum BAUMGARTNER 1984.

***Family*.-** Parvicingulidae
PESSAGNO 1977a, emend.

***Type Genus*.-** *Parvicingula* PESSAGNO 1977a, emend.

***Definition*.-** Test multisegmented, conical, cylindrical or spindle-shaped. Cephalis imperforate, with or without apical horn. Post-thoracic or post-abdominal chambers separated externally by closely spaced concentric circumferential ridges which are continuous internally with planiform imperforate partitions. Partitions circular in outline, having a centrally placed aperture. Circumferential ridges with or without rows of nodes giving way to nodose or non-nodose circumferential ridges. Nodes sometimes interconnected by bars with medially situated constrictions between ridges. Test consisting of one or more layers.

***Remarks*.-** The family is emended to include also the Family Canoptidae. Both the Parvicingulidae and the Canoptidae, considered herein as two subfamilies have many structural elements in common to form a unique family. What differentiates them externally is the disposition of pores: regular in two, three or more transverse rows of alternate pores, in the former, irregular or aligned in transverse rows around sutures, in the latter. The Canoptidae have also a median imperforate belt in each post-abdominal chamber. However, in many species of *Wrangellium* one can see on this belt a row of infilled pores that foreshadows the median row of pores of *Parvicingula*. A similar character shows also *Canoptum* (?) sp. A of Pessagno & Whalen (1982). The H-like structure at sutures is also known in the true *Parvicingula*.

***Range*.-** Upper Triassic (Norian) to Upper Cretaceous (Maastrichtian).

***Subfamily*.-** Canoptinae PESSAGNO,
in Pessagno *et al.* 1979, emend. YEH 1987

***Type Genus*.-** *Canoptum* PESSAGNO, in Pessagno *et al.* 1979

***Definition*.-** Test wall consisting of an inner layer of polygonal pore frames and an outer layer with or without discrete pore frames. Primary pores often penetrating outer layer along circumferential ridges at joints between chambers.

***Range*.-** Upper Triassic (Norian) to Lower Cretaceous (Valanginian).

***Included Taxa*.-**
Canoptum PESSAGNO, in Pessagno *et al.* 1979
Cinguloturris DUMITRICA 1982
Paracanoptum YEH 1987
Relanus PESSAGNO & WHALEN 1982

***Subfamily*.-** Parvicingulinae
PESSAGNO 1977a

***Type Genus*.-** Parvicingula PESSAGNO 1977a

***Definition*.-** Post-abdominal chambers with two or more transverse rows of alternate pores. Test consisting of one or more latticed layers.

***Range*.-** Middle Jurassic (Bajocian) to Upper Cretaceous (Maastrichtian).

***Included Taxa*.-**
Elodium CARTER, in Carter 1988
Mirifusus PESSAGNO 1977a
Parvicingula PESSAGNO 1977a
Pseudocrolanium JUD 1994
Pseudoristola YEH 1987
Ristola PESSAGNO & WHALEN 1982
Wrangellium PESSAGNO & WHALEN 1982

***Family*.-** Amphipyndacidae
RIEDEL 1967

***Definition*.-** Multisegmented Nassellaria with cephalis divided into two chambers by a transverse internal ledge.

***Subfamily*.- Amphipyndacinae**
RIEDEL 1967

***Type Genus*.-** *Amphipyndax* FOREMAN.

***Definition*.-** Amphipyndacidae without a globular last segment.

***Remarks*.-** The diagnosis is rather general, and probably not all genera herein included in this subfamily are closely related. In an excellent study Takemura (1986) explained the difficulties in recognising the differences between the Jurassic members of this subfamily and other nassellarians.

***Range*.-** Lower Jurassic to Paleogene.

***Included Taxa*.-**
Amphipyndax FOREMAN 1966
Palinandromeda PESSAGNO, BLOME & HULL 1993
Parvifavus TAKEMURA 1986
Quarticella TAKEMURA 1986
Triversus TAKEMURA 1986
Unuma ICHIKAWA & YAO 1976
Yamatoum TAKEMURA 1986

***Subfamily*.- Syringocapsinae**
FOREMAN 1973

***Type Genus*.-** *Syringocapsa* NEVIANI 1900

***Definition*.-** Cyrtoidea with the multiple segments of the proximal part very small and the single segment of the distalmost part very large and expanded. A terminal tube may or may not be present. None of the proximal segments are hidden.

***Remarks*.-** The subfamily is included under the Amphipyndacidae because the type genus seems to have a cephalic structure of amphipyndacid type.

***Range*.-** Lower Jurassic to Upper Cretaceous.

***Included Taxa*.-**
Dibolachras FOREMAN 1973
Katroma PESSAGNO & POISSON 1979, emend. DE WEVER 1982a
Parapodocapsa STEIGER 1992
Podobursa WISNIOWSKI 1889, emend. FOREMAN 1973
Podocapsa RÜST 1885
Squinabollum DUMITRICA 1970
Syringocapsa NEVIANI 1900
Trisyringium VINASSA 1901
Urocyrtis PANTANELLI 1880

***Family*.- Spongocapsulidae**
PESSAGNO 1976

***Type Species*.-** *Spongocapsula* PESSAGNO 1977a

***Definition*.-** Test multisegmented, conical with more or less inflate last chambers. Test wall of cephalis and thorax solid, imperforate. Test wall of post-thoracic chambers thick, porous and spongy. Septal platforms between segments solid, not spongy, imperforate, with centrally placed, circular apertures.

***Range*.-** Middle Jurassic or older to Late Cretaceous (Campanian).

***Included Taxa*.-**
Spongocapsula PESSAGNO 1977a
Obesacapsula PESSAGNO 1977a
Maudia CARTER, in Carter 1988
Schaafella VISHNEVSKAYA, in Basov & Vishnevskaya 1991

References

BASOV, V.A. & VISHNEVSKAYA, V.S. (1991). Upper Mesozoic stratigraphy of the Pacific Ocean. *Circum-Pacific Council for Energy and Mineral Resources* - Nauka, Moscow, 200 p. *(in Russian)*

BAUMGARTNER, P.O. (1980). Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peleponnesus, Greece). *Micropaleontology*, **26** (3), 274-322.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BLOME, C. (1983). Upper Triassic Capnuchosphaeridae and Capnodocinae (Radiolaria) from east-central Oregon. *Micropaleontology*, **29** (1), 11-49.

BLOME, C. (1984a). Upper Triassic Radiolaria and radiolarian zonation from western North America. *Bulletins of American Paleontology*, **85** (318), 1-88.

BLOME, C. (1984b). Middle Jurassic (Callovian) radiolarians from carbonate concretions, Alaska and Oregon. *Micropaleontology*, **30** (4), 343-389.

CALKINS, G.N. (1909). *Protozoology* - Lea & Febiger, New York.

CAMPBELL, A.S. (1954). Radiolaria. *In* Moore, R.C. Ed. *Treatise on Invertebrate Paleontology* - Geological Society of America and University of Kansas Press, Lawrence/Kansas. Part. D, Protista **3**, 11-195.

CARTER, E.S., CAMERON, B.E.B. & SMITH, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

CAYEUX, L. (1897). Contribution à l'étude micrographique des terrains sédimentaires. 1. Etude de quelques dépôts siliceux secondaires et tertiaires du Basin de Paris et de la Belgique. 2. Craie du Basin de Paris. *Mémoires de la Société Géologique du Nord, Lille*, **4** (2), 1-591.

DE WEVER, P. (1981a). Une nouvelle sous-famille, les Poulpinae, et quatre nouvelles espèces de Saitoum radiolaires Mésozoïques Tethysiens. *Geobios*, **14** (1), 5-15.

DE WEVER, P. (1981b). Hagiastridae, Patulibracchiidae et Spongodiscidae (Radiolaires polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (1), 27-50.

DE WEVER, P. (1981c). Parasaturnalidae, Pantanellidae et Sponguridae (Radiolaires polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (3), 138-156.

DE WEVER, P. (1982a). Nassellaria (Radiolaires Polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (4), 189-232.

DE WEVER, P. (1982b). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

DE WEVER, P. (1984). Revision des radiolaires Mésozoïque de type Saturnalide, proposition d'une nouvelle classification. *Revue de Micropaléontologie*, **27** (1), 10-19.

DE WEVER, P., SANFILIPPO, A., RIEDEL, W.R. & GRUBER, B. (1979). Triassic radiolarians from Greece, Sicily and Turkey. *Micropaleontology*, **25** (1), 75-110.

DEFLANDRE, G. (1953). Radiolaires fossiles. *In* Grassé, P.P. Ed. *Traite de Zoologie* - Masson, Paris. **1** (2), 389-436.

DEFLANDRE, G. (1960). A propos du developpment des recherches sur les Radiolaires fossiles (Remarks about the expansion of radiolarian research). *Revue de Micropaléontologie*, **2** (4), 212-218.

DONOFRIO, D. & MOSTLER, H. (1978). Zur Verbreitung der Saturnalidae (Radiolaria) im Mesozoikum der Nordlichen Kalkalpan und Sudalpen. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **7** (5), 1-55.

DUMITRICA, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14** (1), 45-124.

DUMITRICA, P. (1978). Badenian Radiolaria from central Paratethys. *In* Brestenska, E. Ed. *Chronostratigraphie und Neostratotypen; Miozaen der Zentralen Paratethys* - VEDA, Verlag der Slowakischen Akademie der Wissenschaften, Bratislava, Czechoslovakia. **6**, 231-261.

DUMITRICA, P. (1982). Foremanellinidae, a new family of Triassic Radiolaria. *Dari de Seama Sedint. Institutul de Geologie si Geofizica*, **67**, 75-82.

DUMITRICA, P. (1983). Evolution of Mesozoic and Cenozoic Centrocubidae (Radiolaria). *Revue de Micropaléontologie*, **25** (4), 221-230.

DUMITRICA, P. (1985). Internal morphology of the Saturnalidae (Radiolaria); systematic and phylogenetic consequences. *Revue de Micropaléontologie*, **28** (3), 181-196.

DUMITRICA, P. (1988). New families and subfamilies of Pyloniacea (Radiolaria). *Revue de Micropaléontologie*, **31** (3), 178-195.

DUMITRICA, P. (1989). Internal skeletal structures of the superfamily Pyloniacea (Radiolaria), a basis of a new systematics. *Revista Española de Micropaleontología*, **21** (2), 207-264.

DUMITRICA, P. (1991). Middle Triassic Tripedurnulidae, n. fam. (Radiolaria) from the eastern Carpathians (Romania) and Vicentinian Alps (Italy). *Revue de Micropaléontologie*, **34** (4), 261-278.

DUMITRICA, P., KOZUR, H. & MOSTLER, H. (1980). Contribution to the radiolarian fauna of the Middle Triassic of the Southern Alps. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **10** (1), 1-46.

EHRENBERG, C.G. (1838). Uber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen. *Abhandlungen der Konigliche Preussichen Akademie der Wissenschaften zu Berlin*, 59-147.

EHRENBERG, C.G. (1845). Neue Untersuchungen uber das kleinste Leben als geologisches Moment. *Bericht der Konigliche Preussichen Akademie der Wissenschaften zu Berlin*, 53-88.

EHRENBERG, C.G. (1847). Uber eine halibiolithische, von Herrn R. Schomburgk entdeckte, vorherrschend aus mikroskopischen Polycystinen gebildete, Gebirgsmasse von Barbados. *Bericht der Konigliche Preussichen Akademie der Wissenschaften zu Berlin*, 382-385.

EHRENBERG, C.G. (1875). Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersichtder mikroskopischen Palaontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rucksicht auf den

Polycystinen-Mergel von Barbados. *Abhandlungen der Konigliche Preussichen Akademie der Wissenschaften zu Berlin*, 1-225.

El Kadiri, K. (1992). Description de nouvelles espèces de radiolaires jurassiques de la Dorsale calcaire externe (Rif, Maroc). *Revista Española de Paleontología*, **Núm. Extra.**, 37-48.

Empson-Morin, K. (1981). Campanian Radiolaria from DSDP Site 313, Mid-Pacific Mountains. *Micropaleontology*, **27** (3), 249-292.

Foreman, H.P. (1966). Two Cretaceous radiolarian genera. *Micropaleontology*, **12** (3), 355-359.

Foreman, H.P. (1968). Upper Maestrichtian Radiolaria of California. *Special Papers in Palaeontology*, **3**, 1-82.

Foreman, H.P. (1973). Radiolaria from DSDP Leg 20. *In* Heezen, B.C., MacGregor, J.D. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **20**, 249-305.

Foreman, H.P. (1975). Radiolaria from the North Pacific, Deep Sea Drilling Project, Leg 32. *In* Larson, R.L., Moberly, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **32**, 579-676.

Foreman, H.P. (1977). Mesozoic Radiolaria from the Atlantic Basin and its borderlands. *In* Swain, F.M. Ed. *Stratigraphic Micropaleontology of Atlantic Basin and Borderlands* - Elsevier, Amsterdam, The Netherlands, 305-320.

Haeckel, E. (1862). *Die Radiolarien (Rhizopoda Radiaria). Eine monographie* - Reimer, Berlin. 572 p.

Haeckel, E. (1881). Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien (Basis for a radiolarian classification from the study of Radiolaria of the Challenger collection). *Jenaische Zeitschrift fur Naturwissenschaft*, **15**, 418-472.

Haeckel, E. (1887). Report on the Radiolaria collected by H.M.S. Challenger during the years 1873-1876. *Report on the Scientific Results of the Voyage of the H.M.S. Challenger, Zoology*, **18**, clxxxviii + 1803.

Hojnos, R. (1916). Beitrage zur Kenntnis der ungarischen fossilen Radiolarien. *Földtany Közlöny*, **46**, 340-364.

Hollande, A. & Enjumet, M. (1960). Cytologie, évolution et systématique des Sphaeroides (Radiolaires). *Archives du Museum National d'Histoire Naturelle, Paris*, **7**, 134.

Ichikawa, K. & Yao, A. (1976). Two new genera of Mesozoic cyrtoid radiolarians from Japan. *In* Takayanagi, Y. & Saito, T. Eds. *Progress in Micropaleontology, Special Publication* - Micropaleontology Press, The American Museum of Natural History, New York, 110-117.

Jud, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

Kito, N. & De Wever, P. (1994). New species of Middle Jurassic Actinommidae (Radiolaria) from Sicily (Italy). *Revue de Micropaléontologie*, **37** (2), 123-134.

Kozur, H. & Mostler, H. (1972). Beitrage zur Erforschung der mesozoischen Radiolarien. Teil I: Revision der Oberfamilie Coccodiscacea Haeckel 1862 emend. und Beschreibung ihrer triassischen Vertreter. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **2**, 60.

Kozur, H. & Mostler, H. (1981). Beitrage zur Erforschung der mesozoischen Radiolarien. Teil IV: Thalassosphaeracea Haeckel, 1862, Hexastylacea Haeckel, 1862 emend. Petrushevskaya, 1979, Sponguracea Haeckel, 1862 emend. und weitere triassische Lithocycliacea, Trematodiscacea, Actinommacea und Nassellaria. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **1**, 1-208.

Kozur, H. & Mostler, H. (1983). The polyphyletic origin and the classification of the Mesozoic saturnalids (Radiolaria). *Geologisch Paläontlogische Mitteilungen Innsbruck*, **13** (1), 1-47.

Kozur, H. & Mostler, H. (1990). Saturnaliacea Deflandre and some other stratigraphically important radiolaria from the Hettangian of Lenggries/Isar (Bavaria, Northern Calcareous Alps). *Geologisch Paläontlogische Mitteilungen Innsbruck*, **17**, 179-248.

Lombari, G. & Lazarus, D.B. (1988). Neogene cycladophorid radiolarians from the North Atlantic, Antarctic, and North Pacific deep-sea sediments. *Micropaleontology*, **34** (2), 97-135.

Merinfeld, E.G. (1980). Proposal to place part of Campbell's (1954) chapter Radiolaria in the Official Index of Rejected Works in Zoology. *Eurorad News*, **3**, 38-39.

Müller, J. (1858). Uber die Thalassicollen, Polycystinen und Acanthometren des Mittelmeeres. *Abhandlungen der konigliche preussichen Akademie der Wissenschaften zu Berlin*, 1-62.

Muzavor, S.N.X. (1977). *Die oberjurassische Radiolarienfauna von Oberaudorf am Inn.* Ph.Dissertation, Munich Universität, 163 p.

Neviani, A. (1900). Supplemento alla fauna a Radiolari delle rocce mesozoiche del Bolognese. *Bollettino della*

Societa Geologica Italiana, **19**, 645-671.

PANTANELLI, D. (1880). I diaspri della Toscana e i loro fossili. *Atti della Reale Accademia Nazionale dei Lincei, Memorie della Classe di Scienze Fisiche, Matematiche e Naturali*, **8**, 35-66.

PESSAGNO, E.A. (1963). Upper Cretaceous Radiolaria from Puerto Rico. *Micropaleontology*, **9** (2), 197-214.

PESSAGNO, E.A. (1971a). Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg 1) and the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology*, **60** (264), 5-83.

PESSAGNO, E.A. (1971b). A new radiolarian from the Upper Cretaceous of the California Coast Ranges. *Micropaleontology*, **17** (3), 361-364.

PESSAGNO, E.A. (1972). Cretaceous Radiolaria. Part I: The Phaseliformidae, new family, and other Spongodiscacea from the Upper Cretaceous portion of the Great Valley Sequence, part II; Pseudoaulophacidae Riedel from the Cretaceous of California and the Blake-Bahama Basin (JOIDES leg 1). *Bulletins of American Paleontology*, **61** (270), 269-328.

PESSAGNO, E.A. (1973). Upper Cretaceous Spumellariina from the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology*, **63** (276), 49-102.

PESSAGNO, E.A. (1976). Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley Sequence, California Coast Ranges. *Micropaleontology Special Publication*, **2**, 1-95.

PESSAGNO, E.A. (1977a). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. (1977b). Lower Cretaceous radiolarian biostratigraphy of the Great ValleySequence and Franciscan Complex, California Coast Ranges. *Contribution Cushman Foundation for Foraminiferal Research, Special Publication*, **15**, 1-87.

PESSAGNO, E.A. & BLOME, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26** (3), 225-273.

PESSAGNO, E.A. & BLOME, C. (1982). Bizarre Nassellariina (Radiolaria) from the Middle and Upper Jurassic of North America. *Micropaleontology*, **28** (3), 289-318.

PESSAGNO, E.A., BLOME, C. & LONGORIA, J. (1984). A revised radiolarian zonation from Upper Jurassic of western North America. *Bulletins of American Paleontology*, **87** (320), 1-51.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

PESSAGNO, E.A., FINCH, W. & ABBOTT, P.L. (1979). Upper Triassic Radiolaria from the San Hipolito Formation, Baja California. *Micropaleontology*, **25** (2), 160-197.

PESSAGNO, E.A., LONGORIA, J., MACLEOD, N. & SIX, W. (1987). Studies of North American Jurassic Radiolaria; Part I, Upper Jurassic (Kimmeridgian-upper Tithonian) Pantanelliidae from the Taman Formation, east-central Mexico; tectonostratigraphic, chronostratigraphic, and phylogenetic implications. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-51.

PESSAGNO, E.A. & POISSON, A. (1979). Lower Jurassic Radiolaria from the Gumuslu Allochton of southwest Turkey (Taurides Occidentales). *Bulletin of the Mineral Research and Exploration Institute of Turkey*, **92**, 47-69.

PESSAGNO, E.A., SIX, W.M. & YANG, Q. (1989). The Xiphostylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. *Micropaleontology*, **35** (3), 193-255.

PESSAGNO, E.A. & WHALEN, P. (1982). Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, **28** (2), 111-169.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

PETRUSHEVSKAYA, M.G. (1971). On the natural system of polycystine Radiolaria (Class Sarcodina). *In* Farinacci, A. Ed. *Proceedings of the II Planktonic Conference, Roma, 1970* - Edizioni Tecnoscienza, Roma, Italy, 981-992.

PRINCIPI, P. (1909). Contributo allo studio dei Radiolari Miocenici Italiani. *Bollettino della Società Geologica Italiana*, **28**, 1-22.

RIEDEL, W.R. (1958). Radiolaria in Antarctic sediments. *Reports of the B.A.N.Z. Antarctic Research Expedition, series B*, **6** (10), 217-255.

RIEDEL, W.R. (1967). Subclass Radiolaria. *In* Harland, W.B.*et al.* Eds. *The Fossil Record. A symposium with documentation* - Geological Society of London, 291-298.

RIEDEL, W.R. (1971). Systematic classification of polycystine Radiolaria. *In* Funnell, B.M. & Riedel, W.R. Eds. *The Micropalaeontology of Oceans* - Cambridge University Press, Cambridge, UK, 649-660.

RÜST, D. (1885). Beitrage zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura. *Palaeontographica*, **31**, 269-321.

RÜST, D. (1898). Neue Beitrage zur Kenntniss der Fossilen Radiolarien aus Gesteinen des Jura und der Kreide. *Palaeontographica*, **45**, 1-67.

SCHMARDA, L.K. (1871). *Zoologie* - Wilhelm Braumüller, Vienna.

SQUINABOL, S. (1903). Le Radiolarie dei noduli selciosi nella Scaglia degli Euganei. Contribuzione I. *Rivista Italiana di Paleontologia*, **9**, 105-151.

STEIGER, T. (1992). Systematik, stratigraphie und Palökologie der Radiolarien des Oberjura-Unterkreiden-Grenzbereiches im Osterhorn-Tirolikum (Nördliche Kalkalpen, Salzburg und Bayern. *Zitteliana*, **19**, 3-188.

TAKEMURA, A. (1986). Classification of Jurassic Nassellarians (Radiolaria). *Palaeontographica Abteilung A: Palaozoologie-Stratigraphie*, **195** (1-3), 29-74.

TAKEMURA, A. & NAKASEKO, K. (1982). Two new Jurassic genera of family Palaeoscenidiidae (Radiolaria). *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **128**, 452-464.

TAKEMURA, A. & NAKASEKO, K. (1986). The cephalic skeletal structure of Jurassic "*Eucyrtidium*" (Radiolaria). *Journal of Paleontology*, **60** (5), 1016-1024.

TAN, S.H. (1927). Over de samenstelling en het onstaan van krijt- en mergel-gesteenten van de Molukken. *Jaarboek van het mijnwezen in Nederlandsch Oost-Indie, jaargang 55, 1926, verhandelingen, 3rd gedeelte*, 5-165.

VINASSA DE REGNY, P.E. (1901). Radiolari Cretacei dell'Isola di Karpathos. *Memorie della Reale Accademia delle Scienze dell'Istituto di Bologna*, **9**, 497-512.

VISHNEVSKAYA, V.S. (1991). Radiolarian layers of the USSR late Mesozoic. *Izvestija Akademii Nauk SSSR, Serija Geologiceskaja*, **2**, 57-81. (*in Russian*)

WISNIOWSKI, T. (1888). Beitrag zur Kenntniss der Mikrofauna aus den oberjurassischen Feuersteinknollen der Umgegend von Krakau. *Jahrbuch der Kaiserlich-Koniglichen Geologischen Reichsanstalt*, **38** (4), 657-702.

WU, H. (1986). Some new genera and species of Cenomanian Radiolaria from southern Xizang (Tibet). *Acta Micropalaeontologica Sinica*, **3** (4), 347-360.

WU, H. (1993). Upper Jurassic and Lower Cretaceous radiolarians of Xialu chert, Yarlung Zangbo ophiolite belt, southern Tibet. *In* Blueford, J.R. & Murchey, B.L. Eds. *Micropaleontology, Special Publication*, Radiolaria of giant and subgiant fields in Asia. Nazarov Memorial Volume - Micropaleontology Press, American Museum of Natural History, New York, **6**, 115-136.

YANG, Q., MIZUTANI, S. & NAGAI, H. (1993). Biostratigraphic correlation between the Nadanhada Terrane of NE China and the Mino Terrane of central Japan. *Journal of Earth Sciences Nagoya University*, **40**, 27-43.

YANG, Q. & WANG, Y.J. (1990). A taxonomic study of Upper Jurassic radiolarian from Rutog county, Xizang (Tibet). *Acta Micropalaeontologica Sinica*, **7** (3), 195-218.

YAO, A. (1982). Middle Triassic to Early Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53-70.

YEH, K. (1987). Taxonomic studies of lower Jurassic Radiolaria from east-central Oregon. *National Museum of Natural Science, Special Publication*, **2**, 1-169.

ZITTEL, K.A. (1876). Ueber einige fossile Radiolarien aus der norddeutschen Kreiden. *Zeitschrift der Deutschen Geologischen Gesellschaft*, **28**, 75-87.

4. Radiolarian catalogue and systematics of Middle Jurassic to Early Cretaceous Tethyan genera and species

by Peter O. Baumgartner[1], Luis O'Dogherty[2], Spela Gorican[3], Ruth Dumitrica-Jud[1,4] Paulian Dumitrica[1,4], Alain Pillevuit[1], Elspeth Urquhart[5], Atsushi Matsuoka[6], Taniel Danelian[7], Annachiara Bartolini[1,8], Elisabeth S. Carter[9], Patrick De Wever[10], Norio Kito[11], Marta Marcucci[12], and Torsten Steiger[13]

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Departamento de Geología Marina, Facultad de Ciencias del Mar, Universidad de Cádiz, 11510, Puerto Real, Spain
[3] Paleontoloski Institut Ivana Rakovca ZRC SAZU, Gosposka 13, 61000 Ljubljana, Slovenia
[4] Mailing address: Könizstrasse 39, 3008 Bern, Switzerland
[5] Department of Geological Sciences, University College London, Gower Street, London WC1E 6BT, UK
[6] Department of Geology, Faculty of Science, Niigata University, Niigata 950-21, Japan
[7] Department of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Road, Edinburgh EH9 3JW, UK
[9] Mailing address: 58335 Timber Road, Vernonia, Oregon 97064, USA
[10] CNRS-Université P.M. Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France
[11] Institute of Earth Sciences, College of General Education, Hokkaido University of Education, 040 Hakodate, Japan
[12] Dipartimento di Scienze della Terra, Università di Firenze, Via La Pira, 4, 50121 Firenze, Italy
[13] Institut für Paläontologie, Universität Erlangen-Nürnberg, Loewenichstrasse 28, 8520 Erlangen, Germany

ABSTRACT

This chapter contains a catalogue of 151 genera, 424 species and 41 subspecies treated in alphabetical order. 19 species and 6 subspecies are new formal descriptions. All descriptions include the original definition (translated into English where necessary), original remarks, subsequent emendations. actualised definitions/remarks and remarks by the authors of this catalogue. Each description further contains the original measurements, etymology, type locality and the stratigraphic range established in this book expressed as UAZones. Each species/subspecies is illustrated on a plate that bears the MRD-taxon code, and shows the holotype (H) as well as one to several illustrations of our material, if possible from several localities. Synonymies are nearly complete up until 1992 and include only some major publications of the years 1993-1995.

Introduction

The more we work with Mesozoic radiolarians, the more we realise how complex their phylogenetic relationships must be. When we started the work for this catalogue, we were principally concerned with establishing the biochronologic range of more or less common and characteristic groups of morphotypes. We were much less concerned with the evolutionary relationships within or between these groups, but we tried to define them as clearly as possible, knowing that we were deliberately ignoring transitional forms that will eventually become important in the future for the understanding of evolutionary lineages. We agreed on groups that represented the smallest common denominator. For those who dealt with well preserved material, we devised the subspecies as a way of subdividing our groups into individual morphotypes, where preservation permitted (see *Chapter 2.* Concepts). During the elaboration of this catalogue and during the refinement of our datasets, we realised that in many cases we lost biochronologic resolution in lumping several morphotypes into groups. Therefore, we consider this catalogue as the first attempt to give an overview of Jurassic-Cretaceous Tethyan radiolarian including both holotypes and material from Atlantic, Europe, Japan, the Pacific and Western North America. Further work is needed to understand the evolutionary lineages that compose or divide the selected groups. Much more work in the Triassic and Lower Jurassic is needed to understand the origin and the relationships between the majority of the groups illustrated herein. In the cases, where someone has established or suspected evolutionary ties between the subspecies or species in this catalogue, this is stated in the "Original Remarks" or in the "Remarks" (see below). However, as explained in the preceding chapters, none of these ties have been considered in the process of creating the Biochronology. The zonation (UAZones 95) presented in this book are therefore a test to any established or suspected evolutionary relationships between the included taxa.

This catalogue gives 151 Genera 424 species and 41 subspecies in strictly alphabetical order, i.e. the descriptions of the species of each genus follow the description of the genus, the descriptions of the subspecies of species y (if present) follow the description of the species. Forms given with open nomenclature as *affinis* (aff.) or *confer* (cf.) are inserted in alphabetical order after the formal species/subspecies. Species/subspecies A, B, etc. follow at the end of all formal, aff. and cf. species/subspecies. 19 species and 6 subspecies are newly described in this catalogue.

For suprageneric assignments of the included genera the reader is referred to the previous chapter (Chapter 4.) by P. Dumitrica. An overview of all included taxa is given after these introductory remarks.

Notes for the User

The written information contained in this catalogue was initially entered into a database in which each heading had a clear definition that will be explained in the following text.

TRIACTOMA	**3655**

This heading marks top of a lexicon entry. All names (generic, specific, and subspecific) appear in alphabetical order. It contains what we call the "*LEXICON NAME*" in capitals and the "MRD-Number", or, it sends the reader to the place where the taxon is treated (e.g. *cylindricus* >> *ARES CYLINDRICUS 3001*)

The Lexicon Name was used to order all entries alphanumerically (according to ascending ASCII-values). It contains the genus, species and subspecies names, followed sometimes by aff. or cf.. Letters denominating informal species/subspecies are preceded by a backslash (e.g. \A), which placed these descriptions and the end of all formal ones.

The MRD-Numbers (Mesozoic Radiolarian Database-Numbers) were created to use in numerical data bases for calculations of Unitary Associations (see Chapter 31). These numbers are cited in all data chapters and in the data listings at the end of this book. Each number was strictly defined by a set of illustrations and is independent of nomenclature. During our work we discovered an advantage of these codes: Instead of debating synonymy and nomenclature, we could communicate by using MRD-numbers, which were tied to the set of illustrations distributed to all contributors. Many names, indeed changed during the five years of preparation, because someone had formally described new genera or some or the included species/subspecies before us. Originally, Numbers between 3000 and 4999 were used for taxa who's range started in the Middle - Upper Jurassic. Numbers between 5000 and 6999 we used for species who's range started in the Lower Cretaceous. Lately, we have added a few species to complete the Aalenian-lower Bajocian occurrences that have numbers between 2000 and 2100. Of course, these numbers were not changed, if new data showed a change in the range. In cases of later splitting of a species group into subspecies, these would get new numbers and the group would always keep its number according to the already acquired data.

Genus: *Triactoma* RÜST
***Triactoma tithonianum* RÜST**

These are the titles of the taxonomic descriptions as in any systematic section. The title includes the original author of the taxon. In cases of emendations or important changes to the meaning of a taxon, we make reference to a subsequent author preceded by "emend." or "sensu".

Synonymy.- Under this heading we list all published and illustrated, formal or informal references to taxa that we consider as synonyms with the above taxon. Names appear in chronological order. Under each name citations appear in chronological order. In many cases we have included doubtful synonymy preceded by "?" or taxa explicitly excluded from a particular synonymy preceded by "not". These synonymies are nearly complete up to the year 1992. For 1993-1995 we have included only some major publications that seemed important to the scope of this catalogue.

Type designation.- Under this heading, we give the type species for genera, or the designation of the holotype for species/subspecies.

Original Definition.- This heading is followed by the original diagnosis and/or description of the original authors of the taxon. If the original language was other than English, we have used the translation provided in the microfiche set by W.R. Riedel and A. Sanfilippo, or one or us has translated the text to English, in this case the descriptions are in inverted commas.

Actualized Definition.- Under this heading (where present) we give additional information that completes the original definition from our point of view, or forms the point of view of a modern author (cited in parentheses).

Original Remarks.- This heading cites the original remarks that follow the original description. If the original language was other than English, we have used the translation provided in the microfiche set by W.R. Riedel and A. Sanfilippo, or one or us has translated the text to English, in this case the descriptions are in inverted commas.

Actualized Remarks.- Includes any comments, more recent than the original ones than seemed important to us and are part of our understanding of the taxon.

Remarks.- Contains the remarks of the authors of this catalogue.

Etymology.- Makes reference to the origin of the formal name of the taxon.

Measurements (in µm).- States the original measurements, and/or our own measurements where appropriate.

Type Locality.- States the type locality of the formal taxon (species/subspecies).

Included Taxa.- Gives a list of species/subspecies included in this catalogue with the taxon. Names are preceded by the MRD-Number.

UAZones.- Under this heading we give the range of the taxon in terms of the zonation (UAZones 95) presented in this book (Chapter 31). The range is stated in numerical form and the age range is stated as follows: the hyphen "-" marks the age range of each UAZone, the "to" links the age ranges of the early and the late UAZone. By definition, the total possible age range of a taxon goes from the base of the lowest to the top of the highest UAZone. The actual range of a taxon, however, can be anywhere from within the range of the lower to within the range of the higher UAZone. Example: A range of UAZones 7-9 means that the species makes its first appearance in UAZone 7 and its last in UAZone 9. The age range of UAZ. 7 is late Bathonian - early Callovian. The age range of UAZ. 9 is middle - late Oxfordian. The age range of the taxon is late Bath.-early Call. to middle-late Oxf. The actual range of the taxon could be for instance early Callovian to middle Oxfordian etc. The abbreviations used are as follows: Aal. = Aalenian, Baj. = Bajocian, Bath. = Bathonian, Call. = Callovian, Oxf. = Oxfordian. Kimm. = Kimmeridgian, Tith. = Tithonian, Berr. = Berriasian, Val. = Valanginian, Haut. = Hauterivian, Barr. = Barremian, Apt. = Aptian.

Plates.- Each species/subspecies has its plate that is numbered according to the MRD-Number of the taxon. The plates show the holotype (for formal taxa) and one or several illustrations, if possible from more than one locality. Magnification is indicated in the plate caption. We have also placed a scale bar in the upper right of each plates. It measures 200 µ for a magnification of x100. The figure caption indicates for each figure, the following: the author code and the photo/negative number, the sample number and sometimes the preparation numbers. The following list gives the meaning of the utilised codes of the collections of individual authors. The figure number of the holotypes is followed by (H) on the plates and in the captions. Reference is made to the author, year of publication, plate and figure number(s) of the original illustration of the holotypes. Permissions granted for reproduction of the holotypes are gratefully acknowledged.

List of author codes used on the figure caption:

AB: Annachiara Bartolini
CA: Beth Carter
DU: Paulian Dumitrica
DW: Patrick De Wever
GO: Spela Gorican
KI: Norio Kito
MA: Atsushi Matsuoka
MC: Marta Marcucci
POB: Peter O. Baumgartner
RJ: Ruth Jud
TD: Taniel Danelian
TS: Torsten Steiger

Acknowledgements

All SEM micrographs bearing the codes "POB76/" to "POB81/" were produced in the years 1976-81 on a Cambridge MkII, at the Labor für Raster-Elektronen-Mikroskopie, Geologisch-paläontologisches Institut, University of Basel (Switzerland). We gratefully acknowledge the the use of negatives from their archives.

All SEM micrographs bearing the codes "AB","GO" and "RJ" were produced on a CamScan DV4, at the Institut de Géologie et paléontologie, University of Lausanne (Switzerland). We are thankful to the Fonds Lugeon, who financed the instrument, and to Werner Witte for the excellent technical maintenance.

Overview of the taxa treated in the catalogue

Acaeniotyle **FOREMAN**
Acaeniotyle dentata BAUMGARTNER
Acaeniotyle diaphorogona gr. FOREMAN sensu BAUMGARTNER
Acaeniotyle (?) *florea* OZVOLDOVA
Acaeniotyle (?) *glebulosa* (FOREMAN)
Acaeniotyle umbilicata (RÜST)
Acaeniotyle (?) sp. A

Acaeniotylopsis **KITO & DE WEVER**
Acaeniotylopsis ghostensis (CARTER)
Acaeniotylopsis variatus s.l. (OZVOLDOVA)
Acaeniotylopsis variatus triacanthus KITO & DE WEVER
Acaeniotylopsis variatus variatus (OZVOLDOVA)

Acanthocircus **SQUINABOL, emend. DONOFRIO & MOSTLER**
Acanthocircus carinatus FOREMAN
Acanthocircus furiosus JUD
Acanthocircus protoformis (YAO)
Acanthocircus suboblongus s.l. (YAO)
Acanthocircus suboblongus minor n.ssp. BAUMGARTNER
Acanthocircus suboblongus suboblongus (YAO)
Acanthocircus trizonalis s.l. (RÜST)
Acanthocircus trizonalis angustus n.ssp. BAUMGARTNER
Acanthocircus trizonalis dicranacanthos (SQUINABOL), emend. FOREMAN
Acanthocircus trizonalis trizonalis (RÜST)
Acanthocircus variabilis (SQUINABOL)

Actinomma HAECKEL
Actinomma siciliensis KITO & DE WEVER

Alievium **PESSAGNO, emend. FOREMAN**
Alievium helenae SCHAAF
Alievium sp. A

Amphipyndax **FOREMAN, emend. EMPSON-MORIN**
Amphipyndax durisaeptum AITA
Amphipyndax tsunoensis AITA

Angulobracchia **BAUMGARTNER**
Angulobracchia biordinalis OZVOLDOVA
Angulobracchia digitata BAUMGARTNER
Angulobracchia (?) *portmanni* s.l. BAUMGARTNER
Angulobracchia (?) *portmanni portmanni* BAUMGARTNER
Angulobracchia purisimaensis (PESSAGNO)
Angulobracchia (?) *rugosa* JUD
Angulobracchia sicula KITO & DE WEVER
Angulobracchia sp. B

Archaeodictyomitra **PESSAGNO**
Archaeodictyomitra (?) *amabilis* AITA
Archaeodictyomitra apiarium (RÜST)
Archaeodictyomitra chalilovi (ALIEV)
Archaeodictyomitra excellens (TAN)
Archaeodictyomitra (?) *lacrimula* (FOREMAN)
Archaeodictyomitra minoensis (MIZUTANI)
Archaeodictyomitra (?) *mirabilis* AITA
Archaeodictyomitra (?) sp. A

Archaeohagiastrum **BAUMGARTNER**
Archaeohagiastrum longipes n.sp. BAUMGARTNER
Archaeohagiastrum munitum BAUMGARTNER

Archaeospongoprunum **PESSAGNO**
Archaeospongoprunum patricki JUD

Archaeotritrabs **STEIGER emend. JUD**
Archaeotritrabs gracilis STEIGER

Archicapsa **HAECKEL**
Archicapsa (?) *pachyderma* (TAN)

Ares **DE WEVER**
Ares cylindricus s.l. (TAKEMURA)
Ares cylindricus cylindricus (TAKEMURA)
Ares cylindricus flexuosus (TAKEMURA)
Ares sp. A

Artocapsa **HAECKEL**
Artocapsa (?) *amphorella* JUD

Bernoullius **BAUMGARTNER**
Bernoullius cristatus BAUMGARTNER
Bernoullius dicera (BAUMGARTNER)
Bernoullius furcospinus KITO, DE WEVER, DANELIAN & CORDEY
Bernoullius (?) *manica* JUD
Bernoullius (?) *monoceros* JUD
Bernoullius rectispinus s.l. KITO, DE WEVER, DANELIAN & CORDEY
Bernoullius rectispinus delnortensis PESSAGNO, BLOME & HULL
Bernoullius rectispinus leporinus CONTI & MARCUCCI
Bernoullius rectispinus rectispinus KITO, DE WEVER, DANELIAN & CORDEY
Bernoullius rectispinus ssp. B
Bernoullius spelae JUD

Bistarkum **YEH**
Bistarkum brevilatum JUD
Bistarkum irazuense (AITA)
Bistarkum valdorbiense JUD

Canoptum **PESSAGNO**
Canoptum banale JUD

Cecrops **PESSAGNO**
Cecrops septemporatus (PARONA)
Cecrops (?) *sexaspina* JUD

Cinguloturris **DUMITRICA**
Cinguloturris carpatica DUMITRICA
Cinguloturris cylindra KEMKIN & RUDENKO

***Crolanium* PESSAGNO**
Crolanium pythiae SCHAAF
Crolanium spp.

***Crucella* PESSAGNO**
Crucella bossoensis JUD
Crucella collina JUD
Crucella sp. aff. C. *espartoensis* PESSAGNO
Crucella (?) *inflexa* (RÜST)
Crucella lipmanae JUD
Crucella remanei JUD
Crucella theokaftensis BAUMGARTNER

***Cyclastrum* RÜST**
Cyclastrum infundibuliforme RÜST
Cyclastrum (?) *luminosum* JUD
Cyclastrum (?) *planum* RÜST
Cyclastrum rarum (SQUINABOL)
Cyclastrum (?) *trigonum* (RÜST)

***Cyrtocapsa* HAECKEL**
Cyrtocapsa (?) *grutterinki* TAN
Cyrtocapsa (?) *kisoensis* YAO
Cyrtocapsa mastoidea YAO

***Deviatus* LI**
Deviatus diamphidius s.l. (FOREMAN)
Deviatus diamphidius diamphidius (FOREMAN)
Deviatus diamphidius hipposidericus (FOREMAN)

***Diacanthocapsa* SQUINABOL, emend. DUMITRICA**
Diacanthocapsa normalis YAO
Diacanthocapsa (?) *operculi* YAO

***Dibolachras* FOREMAN**
Dibolachras chandrika KOCHER
Dibolachras tytthopora FOREMAN

***Dicolocapsa* HAECKEL**
Dicolocapsa (?) *conoformis* MATSUOKA

Dicroa FOREMAN
Dicroa periosa FOREMAN

***Dictyomitra* ZITTEL, emend. PESSAGNO**
Dictyomitra pseudoscalaris (TAN) sensu SCHAAF

***Dictyomitrella* HAECKEL**
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO

***Ditrabs* BAUMGARTNER**
Ditrabs (?) *osteosa* JUD
Ditrabs sansalvadorensis (PESSAGNO)

***Elodium* CARTER**
Elodium cameroni CARTER

***Emiluvia* FOREMAN, emend. FOREMAN, emend. PESSAGNO**
Emiluvia bisellea n.sp. DANELIAN
Emiluvia chica s.l. FOREMAN
Emiluvia chica decussata STEIGER
Emiluvia hopsoni PESSAGNO
Emiluvia lombardensis n.sp. BAUMGARTNER
Emiluvia nana n.sp. BAUMGARTNER
Emiluvia ordinaria OZVOLDOVA
Emiluvia orea s.l. BAUMGARTNER
Emiluvia orea orea BAUMGARTNER
Emiluvia orea ultima n.ssp. BAUMGARTNER & DUMITRICA
Emiluvia pessagnoi s.l. FOREMAN
Emiluvia pessagnoi multipora STEIGER
Emiluvia pessagnoi pessagnoi FOREMAN
Emiluvia premyogii BAUMGARTNER
Emiluvia salensis PESSAGNO
Emiluvia sedecimporata (RÜST)
Emiluvia splendida CARTER

***Eucyrtidiellum* BAUMGARTNER**
Eucyrtidiellum nodosum WAKITA
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
Eucyrtidiellum pyramis (AITA)
Eucyrtidiellum (?) *quinatum* TAKEMURA
Eucyrtidiellum semifactum NAGAI & MIZUTANI
Eucyrtidiellum unumaense s.l. (YAO)
*Eucyrtidiellum unumaense dentatum n.*ssp. BAUMGARTNER
Eucyrtidiellum unumaense pustulatum BAUMGARTNER
Eucyrtidiellum unumaense unumaense (YAO)

***Eucyrtis* HAECKEL**
Eucyrtis columbaria RENZ

***Godia* WU**
Godia coronata (TUMANDA)
Godia lenticulata JUD
Godia tecta (TUMANDA)

***Gongylothorax* FOREMAN, emend. DUMITRICA**
Gongylothorax favosus DUMITRICA
Gongylothorax sp. aff. *G. favosus* DUMITRICA
Gongylothorax oblongus YAO
Gongylothorax sakawaensis MATSUOKA
Gongylothorax sp. aff. *G. siphonofer* DUMITRICA

Gorgansium PESSAGNO & BLOME
Gorgansium spp.

***Guexella* BAUMGARTNER**
Guexella nudata (KOCHER)

***Halesium* PESSAGNO, emend. BAUMGARTNER**
Halesium biscutum JUD
Halesium (?) *lineatum* JUD
Halesium medium (STEIGER)

***Haliodictya* HOJNOS**
Haliodictya (?) *antiqua* s.l. (RÜST)
Haliodictya (?) *antiqua antiqua* (RÜST) sensu PESSAGNO
Haliodictya (?) *antiqua* ssp. B.
Haliodictya (?) *hojnosi* RIEDEL & SANFILIPPO

***Hemicryptocapsa* TAN, emend. DUMITRICA**
Hemicryptocapsa capita TAN

***Hexapyramis* SQUINABOL**
Hexapyramis (?) *precedis* JUD

***Hexasaturnalis* KOZUR & MOSTLER**
Hexasaturnalis hexagonus (YAO)
Hexasaturnalis tetraspinus (YAO)

***Hexastylus* HAECKEL**
Hexastylus (?) *tetradactylus* CONTI & MARCUCCI
Hexastylus sp. A

***Higumastra* BAUMGARTNER**
Higumastra coronaria OZVÖLDOVA
*Higumastra gratiosa n.*sp. BAUMGARTNER
Higumastra imbricata (OZVOLDOVA)
Higumastra inflata BAUMGARTNER
Higumastra wintereri n.sp. BAUMGARTNER & KITO

Hilarisirex* TAKEMURA & NAKASEKO, emend. PESSAGNO *et al.
Hilarisirex quadrangularis TAKEMURA & NAKASEKO

***Holocryptocanium* DUMITRICA**
Holocryptocanium barbui DUMITRICA

***Homoeoparonaella* BAUMGARTNER**
Homoeoparonaella argolidensis BAUMGARTNER
Homoeoparonaella sp. aff. *H. argolidensis* BAUMGARTNER
Homoeoparonaella elegans (PESSAGNO)
Homoeoparonaella sp. aff. *H. elegans* (PESSAGNO)
Homoeoparonaella (?) *gigantea* BAUMGARTNER
Homoeoparonaella sp. aff. *H. irregularis* (SQUINABOL)
Homoeoparonaella peteri JUD
Homoeoparonaella (?) *pseudoewingi* n.sp. BAUMGARTNER
Homoeoparonaella speciosa (PARONA)

***Hsuum* PESSAGNO, emend. TAKEMURA**
Hsuum sp. aff. *H. cuestaense* PESSAGNO
Hsuum feliformis JUD
Hsuum matsuokai ISOZAKI & MATSUDA
Hsuum sp. cf. *H. mirabundum* PESSAGNO & WHALEN
Hsuum raricostatum JUD
Hsuum sp. *1*

***Jacus* DE WEVER**
Jacus (?) *italicus* JUD

***Katroma* PESSAGNO and POISSON, emend. DE WEVER**
Katroma milloti SCHAAF

***Laxtorum* BLOME**
Laxtorum (?) *hichisoense* ISOZAKI & MATSUDA
Laxtorum (?) *jurassicum* ISOZAKI & MATSUDA

***Leugeo* YANG & WANG**
Leugeo hexacubicus (BAUMGARTNER)

***Linaresia* EL KADIRI**
Linaresia beniderkoulensis EL KADIRI
Linaresia chrafatensis EL KADIRI
Linaresia rifensis (EL KADIRI)

***Lithatractus* HAECKEL**
Lithatractus sp. aff. *L. pusillus* (CAMPBELL & CLARK)

***Milax* BLOME**
Milax adrianae JUD

***Mirifisus* PESSAGNO, emend. BAUMGARTNER**
Mirifusus apenninicus JUD
Mirifusus chenodes (RENZ)
Mirifusus dianae s.l. (KARRER)
Mirifusus dianae baileyi PESSAGNO
Mirifisus dianae dianae (KARRER)
Mirifusus dianae minor BAUMGARTNER
Mirifusus fragilis s.l. BAUMGARTNER
Mirifusus fragilis praeguadalupensis n.ssp. BAUMGARTNER & BARTOLINI
Mirifusus guadalupensis PESSAGNO
Mirifusus odoghertyi JUD
Mirifusus petzholdti (RÜST)
Mirifusus proavus TONIELLI

***Monotrabs* BAUMGARTNER**
Monotrabs plenoides gr. BAUMGARTNER

***Napora* PESSAGNO**
Napora boneti PESSAGNO, WHALEN & YEH
Napora deweveri BAUMGARTNER
Napora latissima TAKEMURA
Napora lospensis PESSAGNO
Napora nipponica TAKEMURA
Napora pyramidalis BAUMGARTNER
Napora saginata TAKEMURA
Napora sp. A
Napora sp. B

***Novixitus* PESSAGNO**
Novixitus (?) *daneliani* JUD
Novixitus (?) *tuberculatus* WU & LI

***Obesacapsula* PESSAGNO**
Obesacapsula breggiensis JUD
Obesacapsula bullata STEIGER
Obesacapsula cetia (FOREMAN)
Obesacapsula lucifer (BAUMGARTNER)
Obesacapsula morroensis PESSAGNO
Obesacapsula polyedra (STEIGER)
Obesacapsula rusconensis s.l. BAUMGARTNER
Obesacapsula rusconensis rusconensis BAUMGARTNER
Obesacapsula rusconensis umbriensis JUD
Obesacapsula verbana (PARONA)

***Orbiculiforma* PESSAGNO**
Orbiculiforma (?) *heliotropica n.*sp. BAUMGARTNER
Orbiculiforma(?) sp. aff. *O. mclaughlini* PESSAGNO
Orbiculiforma (?) *catenaria* OZVOLDOVA
Orbiculiforma (?) sp. X

***Palinandromeda* PESSAGNO, BLOME & HULL**
Palinandromeda crassa (BAUMGARTNER)
Palinandromeda depressa (DE WEVER & MICONNET)
Palinandromeda sp. aff. *P. depressa* (DE WEVER & MICONNET)
*Palinandromeda murcheyae n.*sp. *BAUMGARTNER*
Palinandromeda podbielensis (OZVOLDOVA)
Palinandromeda praecrassa (BAUMGARTNER)
Palinandromeda praepodbielensis (BAUMGARTNER)
Palinandromeda sognoensis n.sp. BAUMGARTNER

***Pantanellium* PESSAGNO**
Pantanellium berriasianum BAUMGARTNER
Pantanellium sp. aff. *P. cantuchapai* PESSAGNO & MACLEOD
Pantanellium riedeli PESSAGNO
Pantanellium squinaboli (TAN)
Pantanellium sp. *L*

***Parahsuum* YAO**
Parashuum cruciferum TAKEMURA
Parahsuum (?) *grande* HORI & YAO
Parahsuum (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER
Parashuum izeense (PESSAGNO & WHALEN)
Parahsuum (?) *magnum* TAKEMURA
Parahsuum (?) *natorense* (EL KADIRI)
Parashuum officerense (PESSAGNO & WHALEN)
Parahsuum (?) *olorizi* (EL KADIRI)
Parashuum stanleyensis (PESSAGNO)
Parashuum sp. M
Parahsuum sp. S

***Parapodocapsa* STEIGER**
Parapodocapsa furcata STEIGER

***Parasaturnalis* KOZUR & MOSTLER**
Parasaturnalis diplocyclis (YAO)

***Paronaella* PESSAGNO, emend. BAUMGARTNER**
Paronaella (?) *annemariae* JUD
Paronaella bandyi PESSAGNO
Paronaella broennimanni PESSAGNO
Paronaella sp. aff. *P. corpulenta* DE WEVER
Paronaella kotura BAUMGARTNER
Paronaella mulleri PESSAGNO
Paronaella pristidentata BAUMGARTNER
Paronaella pygmaea BAUMGARTNER
Paronaella skowkonaensis CARTER
Paronaella trifoliacea OZVOLDOVA
Paronaella (?) *tubulata* STEIGER

***Parvicingula* PESSAGNO**
Parvicingula boesii gr. (PARONA)
Parvicingula (?) sp. aff. *P. cincta* (HINDE) sensu TAN
Parvicingula cosmoconica (FOREMAN)
Parvicingula dhimenaensis s.l. BAUMGARTNER
Parvicingula dhimenaensis dhimenaensis BAUMGARTNER
Parvicingula dhimenaensis ssp. A
Parvicingula sp. *aff. P. elegans* PESSAGNO & WHALEN
Parvicingula longa JUD
Parvicingula mashitaensis MIZUTANI
Parvicingula schoolhousensis gr. PESSAGNO & WHALEN
Parvicingula sphaerica STEIGER
Parvicingula (?) *spinata* (VINASSA)
Parvicingula usotanensis TUMANDA
Parvicingula (?) sp. A

***Parvivacca* PESSAGNO & YANG**
Parvivacca magna JUD

***Perispyridium* DUMITRICA**
Perispyridium ordinarium gr. (PESSAGNO)

***Phaseliforma* PESSAGNO**
Phaseliforma ovum JUD

***Podobursa* WISNIOWSKI, emend. FOREMAN**
Podobursa helvetica (RÜST)
Podobursa multispina JUD
Podobursa polyacantha (FISCHLI)
Podobursa (?) sp. aff. *P. quadriaculeata* (STEIGER)
Podobursa spinosa (OZVOLDOVA)

***Podocapsa* RÜST, emend. FOREMAN**
Podocapsa amphitreptera FOREMAN
Podocapsa (?) *hexaptera* CONTI & MARCUCCI
Podocapsa (?) *imperialis* JUD

***Poulpus* DE WEVER**
Poulpus sp. aff. *P. oculatus* DE WEVER

***Protunuma* ICHIKAWA & YAO**
Protunuma japonicus MATSUOKA & YAO
Protunuma (?) *ochiensis* MATSUOKA
Protunuma turbo MATSUOKA

***Pseudoaulophacus* PESSAGNO**
Pseudoaulophacus (?) *florealis* JUD
Pseudoaulophacus (?) *pauliani* JUD

***Pseudocrolanium* JUD**
Pseudocrolanium cristatum JUD
Pseudocrolanium fluegeli JUD

***Pseudocrucella* BAUMGARTNER**
Pseudocrucella adriani BAUMGARTNER
Pseudocrucella (?) *elisabethae* (RÜST)
Pseudocrucella sanfilippoae (PESSAGNO)
Pseudocrucella sp. B

***Pseudodictyomitra* PESSAGNO**
Pseudodictyomitra carpatica (LOZYNIAK)
Pseudodictyomitra lanceloti SCHAAF
Pseudodictyomitra sp. aff. *P. lanceloti* SCHAAF
Pseudodictyomitra leptoconica (FOREMAN)
Pseudodictyomitra lilyae (TAN)
Pseudodictyomitra nuda SCHAAF
Pseudodictyomitra primitiva MATSUOKA & YAO

***Pseudoeucyrtis* PESSAGNO**
Pseudoeucyrtis (?) *aspera* JUD
Pseudoeucyrtis acus JUD
Pseudoeucyrtis (?) *fusus* JUD
Pseudoeucyrtis sp. cf. *P. hanni* (TAN)
Pseudoeucyrtis reticularis MATSUOKA & YAO
Pseudoeucyrtis sceptrum JUD
Pseudoeucyrtis sp. J

***Pseudopoulpus* TAKEMURA**
Pseudopoulpus acutipodium TAKEMURA

***Pyramispongia* PESSAGNO**
Pyramispongia barmsteinensis (STEIGER)

***Quarticella* TAKEMURA**
Quarticella ovalis TAKEMURA

***Quinquecapsularia* PESSAGNO**
Quinquecapsularia megasphaerica n.sp. DUMITRICA & BAUMGARTNER

Ristola PESSAGNO & WHALEN sensu BAUMGARTNER
Ristola altissima s.l. (RÜST)
Ristola altissima altissima (RÜST)
Ristola altissima major n.ssp. BAUMGARTNER & DE WEVER
Ristola asparagus JUD
Ristola cretacea (BAUMGARTNER)
Ristola martae JUD
Ristola praemirifusus n.sp. BAUMGARTNER & BARTOLINI
Ristola procera (PESSAGNO)
Ristola (?) *turpicula* PESSAGNO & WHALEN

***Saitoum* PESSAGNO**
Saitoum corniculum DE WEVER
Saitoum elegans DE WEVER
Saitoum levium DE WEVER
Saitoum sp. aff. *S. levium* DE WEVER
Saitoum pagei PESSAGNO
Saitoum sp. aff. *S. pagei* PESSAGNO
Saitoum trichylum DE WEVER

***Savaryella* JUD**
Savaryella guexi JUD

***Sethocapsa* HAECKEL**
Sethocapsa (?) *concentrica* (STEIGER)
Sethocapsa dorysphaeroides NEVIANI sensu SCHAAF
Sethocapsa funatoensis AITA
Sethocapsa sp. aff. *S. kaminogoensis* AITA
Sethocapsa kitoi JUD
Sethocapsa leiostraca FOREMAN
Sethocapsa (?) *orca* FOREMAN
Sethocapsa simplex TAKETANI
Sethocapsa (?) *sphaerica* (OZVOLDOVA)
Sethocapsa trachyostraca FOREMAN
Sethocapsa tricornis JUD
Sethocapsa uterculus (PARONA) sensu FOREMAN
Sethocapsa (?) *zweilii* JUD
Sethocapsa sp. A

***Solenotryma* FOREMAN**
Solenotryma ichikawai MATSUOKA & YAO

***Spongocapsula* PESSAGNO**
Spongocapsula sp. aff. *S. coronata* (SQUINABOL)
Spongocapsula obesa JUD
Spongocapsula palmerae PESSAGNO
Spongocapsula perampla (RÜST)
Spongocapsula (?) *tripes* JUD

***Spongotripus* HAECKEL**
Spongotripus (?) *satoi* (TUMANDA)

***Staurolonche* HAECKEL, emend. PESSAGNO**
Staurolonche robusta RÜST sensu PESSAGNO

***Stichocapsa* HAECKEL**
Stichocapsa altiforamina TUMANDA
Stichocapsa convexa YAO
Stichocapsa decora RÜST
Stichocapsa himedaruma AITA
Stichocapsa japonica YAO
Stichocapsa naradaniensis MATSUOKA
Stichocapsa pulchella (RÜST)
Stichocapsa robusta MATSUOKA
Stichocapsa sp. E

***Stichomitra* CAYEUX**
Stichomitra sp. aff. *S. asymbatos* FOREMAN
Stichomitra (?) sp. aff. *S. euganea* (SQUINABOL)
Stichomitra (?) *takanoensis* gr. AITA
Stichomitra (?) sp. A

***Stylocapsa* PRINCIPI, emend. TAN**
Stylocapsa catenarum MATSUOKA
Stylocapsa (?) *hemicostata* MATSUOKA
Stylocapsa lacrimalis MATSUOKA
Stylocapsa oblongula KOCHER
Stylocapsa (?) *spiralis* gr. MATSUOKA
Stylocapsa tecta MATSUOKA

***Stylosphaera* EHRENBERG**
Stylosphaera (?) *macroxiphus* (RÜST)

***Stylospongia* HAECKEL**
Stylospongia (?) *titirez* JUD

***Suna* WU**
Suna echiodes (FOREMAN)
Suna hybum (FOREMAN)

***Syringocapsa* NEVIANI**
Syringocapsa agolarium FOREMAN
Syringocapsa coronata STEIGER
Syringocapsa sp. aff. *S. coronata* STEIGER
Syringocapsa limatum FOREMAN
Syringocapsa longitubus JUD
Syringocapsa spinellifera n.sp. BAUMGARTNER
Syringocapsa sp. aff. *S. spinosa* (SQUINABOL)
Syringocapsa vicetina (SQUINABOL)
Syringocapsa (?) sp. A

***Tetraditryma* BAUMGARTNER**
Tetraditryma corralitosensis s.l. (PESSAGNO)
Tetraditryma corralitosensis bifida CONTI & MARCUCCI
Tetraditryma corralitosensis corralitosensis (PESSAGNO)
Tetraditryma praeplena BAUMGARTNER
Tetraditryma sp. cf. *T. praeplena* BAUMGARTNER
Tetraditryma pseudoplena BAUMGARTNER

***Tetratrabs* BAUMGARTNER**
Tetratrabs bulbosa BAUMGARTNER
Tetratrabs izeense YEH
Tetratrabs radix JUD
Tetratrabs zealis (OZVOLDOVA)

***Thanarla* PESSAGNO**
Thanarla elegantissima (CITA) sensu SANFILIPPO & RIEDEL
Thanarla gutta JUD
Thanarla pulchra (SQUINABOL) sensu SANFILIPPO & RIEDEL

***Theocapsomma* HAECKEL, emend. FOREMAN**
Theocapsomma bicornis n.sp. BAUMGARTNER
Theocapsomma cordis KOCHER
Theocapsomma cucurbiformis n.sp. BAUMGARTNER
Theocapsomma sp. A.

***Thetis* DE WEVER**
Thetis (?) *bernoullii* n.sp. BAUMGARTNER

***Transhsuum* TAKEMURA**
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum hisuikyoense (ISOZAKI & MATSUDA)
Transhsuum maxwelli gr. (PESSAGNO)
Transhsuum medium TAKEMURA

***Triactoma* RÜST**
Triactoma blakei (PESSAGNO)
Triactoma cornuta BAUMGARTNER
Triactoma foremanae MUZAVOR
Triactoma jacobsae n.sp. CARTER
Triactoma jonesi (PESSAGNO)
Triactoma luciae JUD
Triactoma mexicana PESSAGNO & YANG
Triactoma parablakei YANG & WANG
Triactoma tithonianum RÜST

***Tricolocapsa* HAECKEL**
Tricolocapsa conexa MATSUOKA
Tricolocapsa (?) *fusiformis* YAO
Tricolocapsa (?) sp. aff. *T. fusiformis* YAO sensu MATSUOKA
Tricolocapsa plicarum s.l. YAO
Tricolocapsa plicarum plicarum YAO
Tricolocapsa plicarum ssp. A
Tricolocapsa tetragona MATSUOKA
Tricolocapsa sp. M
Tricolocapsa sp. S

***Trillus* PESSAGNO & BLOME**
Trillus spp.

***Tritrabs* BAUMGARTNER**
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)
Tritrabs ewingi worzeli (PESSAGNO)
Tritrabs exotica (PESSAGNO)
Tritrabs hayi (PESSAGNO)
Tritrabs rhododactylus BAUMGARTNER
Tritrabs simplex KITO & DE WEVER

***Turanta* PESSAGNO & BLOME**
Turanta flexa PESSAGNO & BLOME
Turanta morinae gr. PESSAGNO & BLOME

***Tympaneides* CARTER**
Tympaneides charlottensis CARTER

***Unuma* ICHIKAWA & YAO**
Unuma echinatus ICHIKAWA & YAO
Unuma latusicostatus (AITA)
Unuma typicus YAO
Unuma sp. A

***Williriedellum* DUMITRICA**
Williriedellum carpathicum DUMITRICA
Williriedellum crystallinum DUMITRICA
Williriedellum sp. A sensu MATSUOKA

***Wrangellium* PESSAGNO & WHALEN, emend YEH**
Wrangellium columnum (RÜST)
Wrangellium depressum (BAUMGARTNER)
Wrangellium okamurai (MIZUTANI)
Wrangellium puga (SCHAAF)

***Xiphostylus* HAECKEL, emend PESSAGNO & YANG**
Xiphostylus spp.

***Xitus* PESSAGNO**
Xitus (?) *alievi* (FOREMAN)
Xitus (?) *channelli* JUD
Xitus gifuensis MIZUTANI
Xitus horridus JUD
Xitus magnus n.sp. BAUMGARTNER
Xitus sp. aff. *X. pulcher* PESSAGNO
Xitus sandovali JUD
Xitus sp. aff. *X. spicularius* (ALIEV)
Xitus (?) sp. D

Yamatoum **TAKEMURA**
Yamatoum caudatum TAKEMURA
Yamatoum komamiensis TAKEMURA
Yamatoum spinosum TAKEMURA

Zartus **PESSAGNO & BLOME**
Zartus dickinsoni gr. PESSAGNO & BLOME
Zartus imlayi gr. PESSAGNO & BLOME

Zhamoidellum **DUMITRICA**
Zhamoidellum ovum DUMITRICA
Zhamoidellum testatum JUD
Zhamoidellum ventricosum DUMITRICA

Radiolarian catalogue and systematics of Middle Jurassic to Early Cretaceous Tethyan genera and species

ACAENIOTYLE 3600

Genus: *Acaeniotyle* FOREMAN

Synonymy.-
Acaeniotyle FOREMAN
FOREMAN 1973b, p. 258.

Type Species.- *Xiphosphaera umbilicata* RÜST 1898.

Original Definition.- Spherical or ellipsoidal shell with a surface of large porous nodes from which two or three spines extend.

Etymology.- Greek *akainos* thorny + *tyle* (f.) pillow = *Acaeniotyle* (f.) thorny pillow.

Included Taxa.-
3281 *Acaeniotyle dentata* BAUMGARTNER
3090 *Acaeniotyle diaphorogona* gr. FOREMAN sensu BAUMGARTNER
5032 *Acaeniotyle* (?) *florea* OZVOLDOVA
5033 *Acaeniotyle* (?) *glebulosa* (FOREMAN)
3092 *Acaeniotyle umbilicata* (RÜST)
3091 *Acaeniotyle* (?) sp. A

ACAENIOTYLE DENTATA 3281

Acaeniotyle dentata BAUMGARTNER

Synonymy.-
Acaeniotyle diaphorogona FOREMAN
FOREMAN 1975, p. 607, pl. 2F, fig. 5.
SCHAAF 1981, p. 431, pl. 15, fig. 2.
? NAKASEKO et al. 1979, pl. 4, fig. 9.
? NAKASEKO & NISHIMURA 1981, pl. 1, fig. 12.
Acaeniotyle diaphorogona dentata BAUMGARTNER
BAUMGARTNER 1984, p. 754, pl. 1, figs. 3-4.

Original Definition.- Central spherical nodose shell as with species, spines generally equal or longer than diameter of shell, bearing 3 broad blades with one to several teeth on distal half of spines.

Original Remarks.- This form is separated from the bulk of *A. diaphorogona* on the basis of the teeth present on the spines, a character which occurs in the Cretaceous only.

Remarks.- The specimens in our material show a high variety in their morphology: in the size of the central test and the number of nodes covering the latter, in the shape and length of the spines and in the number of teeth developed on the distal portion of the spines.

Etymology.- *Dentatus, -a, -um,* Latin, equipped with teeth.

Measurements (in µm).-
Based on 12 specimens.

	HT	av.	min.	max.
Diameter of central shel:	187	188	149	238
Average length of 3 spines:	195	188	153	213
Number of teeth on spines:	5-6	4	3	6

Type Locality.- Cava Rusconi, Cittiglio, Prov. Varese, Italy. Locality no. 23 of locality descriptions (Baumgartner, 1984).

UAZones.- 12-20, early-early late Tith. to late Haut.

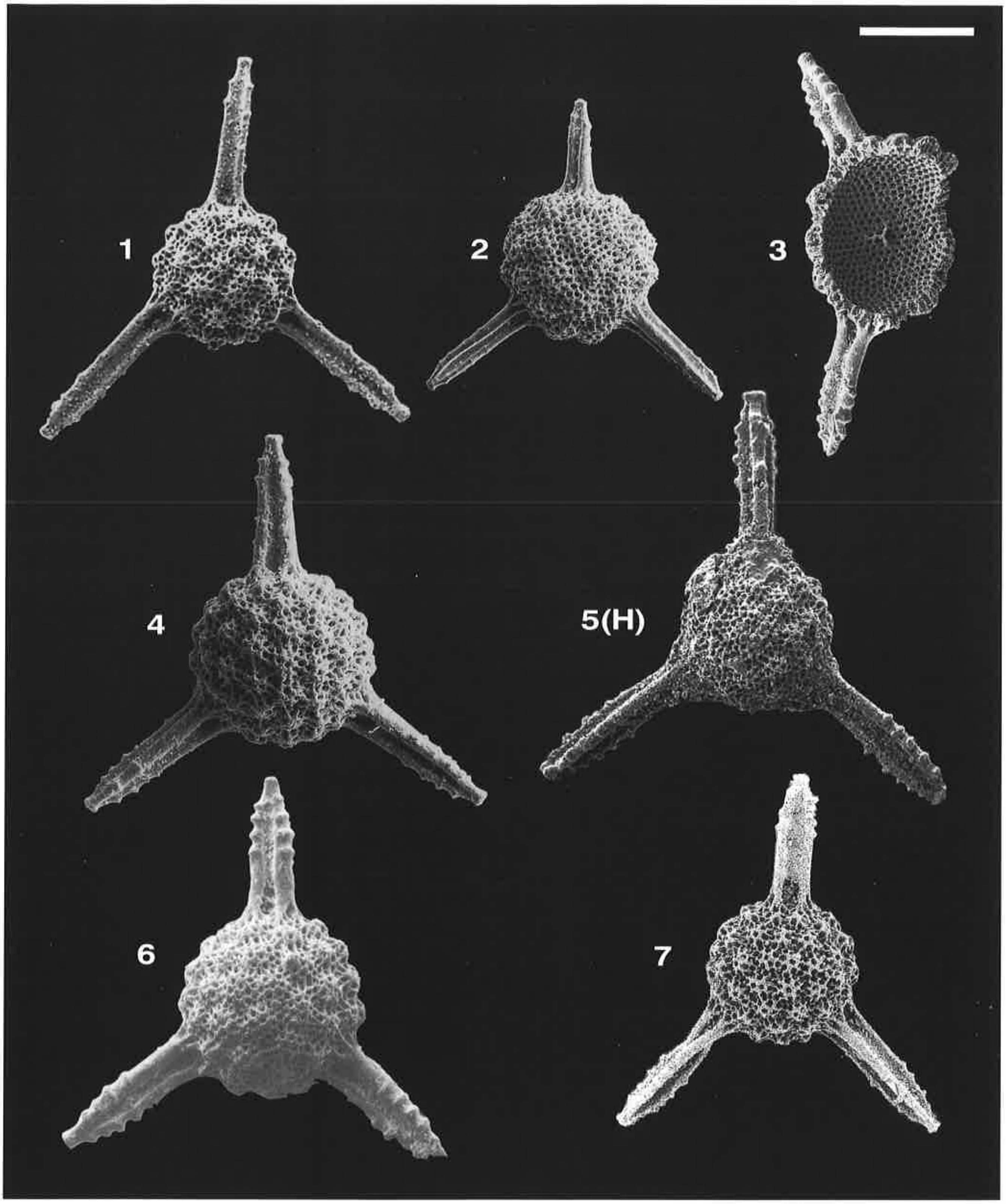


Plate 3281. ***Acaeniotyle dentata*** **BAUMGARTNER.** magnification x 150. **Fig. 1.** POB80/3030, POB 1205. **Fig. 2.** DU1232, V40. **Fig. 3.** POB79/4112, MO2 22. **Fig. 4.** DU3303, MO34. **Fig. 5(H).** POB79/5274, POB1205. **Fig. 6.** DU2183, MO22. **Fig. 7.** RJ48, Br28.85.

ACAENIOTYLE DIAPHOROGONA GR.	*3090*

Acaeniotyle diaphorogona gr. FOREMAN sensu BAUMGARTNER

***Synonymy*.-**
Acaeniotyle diaphorogona FOREMAN
FOREMAN 1973b, p. 258, pl. 2, figs. 2-5.
FOREMAN 1975, pl. 2F, figs. 1-3, not figs. 4-5; pl. 3, figs. 1-2.
MUZAVOR 1977, p. 34, pl. 1, fig. 1.
MIZUTANI 1981, p. 175, pl. 61, figs. 1-2.
DE WEVER & THIEBAULT 1981, p. 582, pl. 2, fig. 7.
KANIE et al. 1981, pl. 1, fig. 1.
AOKI 1982, pl. 1, fig. 1.
ORIGLIA-DEVOS 1983, p. 36, 37, pl. 1, figs. 1, 2.
SCHAAF 1984, p. 104-105, figs. 1-5.
OZVOLDOVA & SYKORA 1984, p. 261, pl. 1, figs. 1-3.
SANFILIPPO & RIEDEL 1985, p. 586, fig. 4.1a-b.
KIMINAMI et al. 1985, pl. 2, fig. 3
LI 1986, pl. 1, fig. 1
DE WEVER et al. 1986, pl. 6, fig. 11.
AITA 1987, p. 63, pl. 12, fig. 12.
OZVOLDOVA & PETERCAKOVA 1987, pl. 31, fig. 1.
OZVOLDOVA 1988, pl. 1, fig. 2.
KAWABATA 1988, pl. 2, fig. 15
DANELIAN 1989, pl. 1, figs. 1-4.
TUMANDA 1989, p. 33, pl. 1, figs. 2, ? 3
BAUMGARTNER 1992, p. 317, pl. 3, fig. 1.
MATSUOKA 1992, pl. 3, fig. 12.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 13, 16.
STEIGER 1992, p. 28, pl. 2, figs. 1-2.
TAKETANI & KANIE 1992, Fig. 3.1.
Acaeniotyle sp. aff. *A. diaphorogona* FOREMAN
FOREMAN 1973b, pl. 2, figs. 6-7; pl. 16, fig. 16.
FOREMAN 1975, p. 607, pl. 1F, fig. 1.
YAO 1984, pl. 3, fig. 24.
Acaeniotyle tribulosa FOREMAN
FOREMAN 1973b, p. 258, pl. 2, fig. 8.
Tripocyclia sp. aff. *T. trigonum* RÜST
PESSAGNO 1977a, p. 80, pl. 7, figs. 8-9.
Acaeniotyle diaphorogona FOREMAN s. l.
BAUMGARTNER 1984, p. 753, pl. 1, figs. 1-2.
WIDZ 1991, p. 243, pl. 1, fig. 1.

***Original Definition*.-** The nodose shell, circular in transverse section and elliptical in vertical section, bears three sturdy three-bladed spines with blunt tips. The spines are approximately equal in length in the older forms and longer, less equal in the younger forms; some show a slight tendency to turn. They are arranged asymmetrically with angles between adjacent spines approximately 90 , 115, and 155 degrees, respectively. Pores are closely spaced, circular to subangular, and moderate in size. The interior of the shell could not be examined and it is not certain if there are any internal structures.

***Original Remarks*.-** Excluded are forms with spines more symmetrically arranged (plate 16, figure 16) and forms with proportionally longer, more slender spines (plate 2, figures 6 and 7). This species is distinguished from the younger *Acaeniotyle tribulosa* by the greater length of the three spines, the asymmetric arrangement, and the general lack of basal pores.

***Actualized Definition*.-** (BAUMGARTNER, 1984) Included are all forms having 3 primary spines and a central spherical, nodose shell with fine pores, typical for *Acaeniotyle*. Jurassic forms may have spines shorter than the diameter of the shell.

***Remarks*.-** *Acaeniotyle diaphorogona* shows a wide variation in size of the central test, in the number of nodes covering the surface of the spherical test and in the arrangement and length of the spines. Some specimens show distinct bilateral symmetric arrangement of the 3 spines, of which the two slightly longer and more or less curved make an angle of only 50- 80 degrees, and the third one, which is mostly shorter, makes with one of the curved spines, a wide angle of about 140-155 degrees.

***Etymology*.-** Greek *diaphoros* different + *gonio* f. angle = *diaphorogonus, -a, -um,* with different angles.

Measurements (in μm).-
Based on 20 specimens. Diameter of shell, 110-195 (majority 125-170); length of spines, 75-185 (majority 95-140).

***Type Locality*.-** DSDP Leg 20, Site 194, northwest Pacific basin.

***UAZones*.-** 4-22, late Baj. to late Barr.-early Apt.

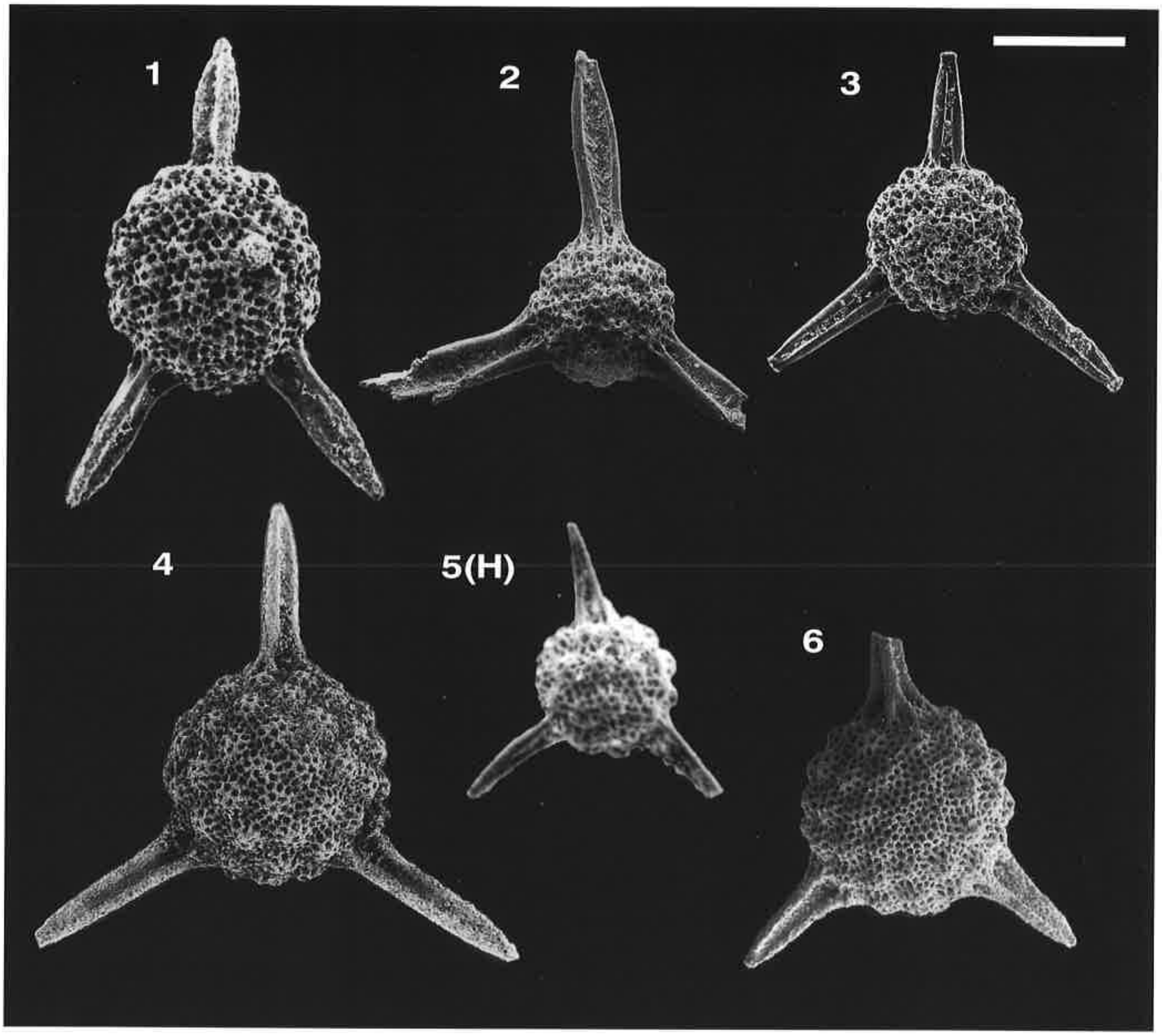


Plate 3090. ***Acaeniotyle diaphorogona*** **gr. FOREMAN sensu BAUMGARTNER.** magnification x 150. **Fig. 1.** POB81/9028, 76-534A-106-1.29. **Fig. 2.** DU1239, MO22. **Fig. 3.** POB80/2803, V34. **Fig. 4.** RJ540, BO566.5. **Fig. 5(H).** FOREMAN 1973b, pl. 2, fig. 3. **Fig. 6.** RJ004,PR225.3.

ACAENIOTYLE (?) FLOREA 5032

Acaeniotyle (?) *florea* OZVOLDOVA

***Synonymy*.-**
? *Acaeniotyle florea* OZVOLDOVA
OZVOLDOVA & PETERCAKOVA 1992, p. 314, pl. 5, figs. 6-8.
JUD 1994, p. 58, pl. 1, figs. 9-12.

***Original Definition*.-** Test is of drumlike shape, with slightly bulged top and bottom and with four massive spines, arranged in the shape of a cross. Spines are composed of three longitudinal ridges separated by deep grooves. On the periphery of the top and bottom sides there are protruding 10-12 subspherical nodes with coarse meshwork arranged like a garland. In the inner part the nodes are smaller and their arrangement is indistinct. Between nodes there is fine meshwork. Pores on the lateral side of the test are of medium to large size.

***Remarks*.-** *Acaeniotyle* (?) *florea* OZVOLDOVA differs from *Acaeniotyle* (?) *glebulosa* (FOREMAN) by the distinct cylindrical, drum-like shape of test and by the arrangement of the tubercles exclusively on the upper and lower faces of the cylindrical body. The internal structure of *Acaeniotyle* (?) *florea* is at present unknown. The test does not consist of a spongy meshwork as it seems by looking at the original description of Ozvoldova ("between nodes there is fine meshwork ..."). The surface of the test has pores of middle size which are regularly quinquncially arranged.

***Etymology*.-** Lat. *floreus,* flower: after the test, resembling the perianth.

Measurements (in μm).-
Diameter of the top and the bottom of the test, HT 156, min. 135, max. 158; maximum thickness of the test, HT 136, min. 131, max. 140; length of spines, HT 125, min. 93, max. 125; diameter of nodes, HT 25, min. 21, max. 25.

***Type Locality*.-** Mt. Butkov, Strazovske vrchy Mts., Central Western Carpathians.

***UAZones*.-** 17-22, late Val. to late Barr.-early Apt.

ACAENIOTYLE (?) GLEBULOSA 5033

Acaeniotyle (?) *glebulosa* (FOREMAN)

***Synonymy*.-**
Staurosphaera glebulosa FOREMAN
FOREMAN 1973b, p. 259, pl. 3, fig. 5; pl. 16, fig. 24.
LI & WU 1985, pl. 1, fig. 9.
Acaeniotyle sp. A
THUROW 1988, p. 396, pl. 6, fig. 2.
Acaeniotyle (?) *glebulosa* FOREMAN
JUD 1994, p. 58, pl. 1, figs. 5-8.

***Original Definition*.-** The shell is small, circular in transverse section, elliptical in vertical section, and bears four relatively sturdy, three-bladed spines. Three of these spines are approximately equal in length and one is longer. The surface of the shell is slightly nodose and has small, rounded, somewhat irregular, closely spaced pores.

***Original Remarks*.-** The older forms in Sample 196-4-1, piece 3 tend to have an only slightly nodose surface with smaller, more irregular pores, while the younger forms in Samples 196-3-1, pieces 3 and 2 have a more nodose surface with larger, more regular pores.

***Actualized Remarks*.-** The specimens found in our samples are similar to those described and illustrated by Foreman, bearing generally one spine a little longer than the three other ones, but in many cases all spines are of equal length. The pores are arranged irregularly or in transverse rows. In vertical section the central body is slightly elliptical or, on some specimens, with a tendency to become subcylindrical, and covered with several tubercles also in the interradial space of the spines. By these characters it differs clearly from *Acaeniotyle* (?) *florea* OZVOLDOVA.

***Etymology*.-** Latin *glebula* f. dim. lump + *-osus* full of = *glebulosus*, *-a*, *-um* full of lumps.

Measurements (in μm).-
Based on 13 specimens. Greatest width of shell, 95-124 (95-115); length of short spines, 80-150; of long spine 115-180.

***Type Locality*.-** DSDP Leg 20, Site 196, northwest Pacific basin.

***UAZones*.-** 17-22, late Val. to late Barr.-early Apt.

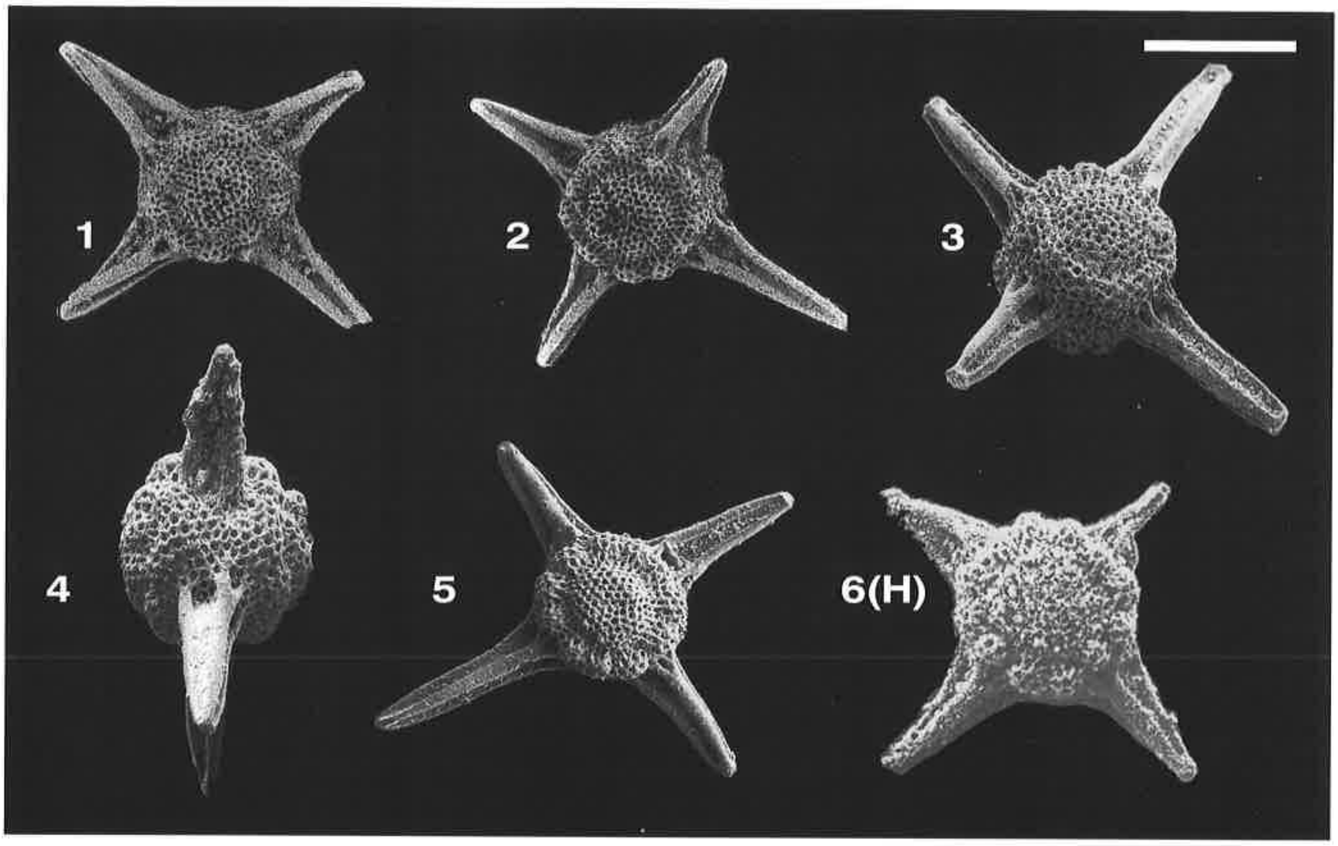


Plate 5032. *Acaeniotyle* (?) *florea* OZVOLDOVA. magnification x 150. **Fig. 1.** RJ 392, BO566.5. **Fig. 2.** RJ546, BO566.5. **Fig. 3.** DU1294, V40. **Fig. 4.** POB79/4271, MO2 46. **Fig. 5.** POB79/4264, MO2 46. **Fig. 6(H).** OZVOLDOVA & PETERCAKOVA 1992, pl. 5, fig. 7.

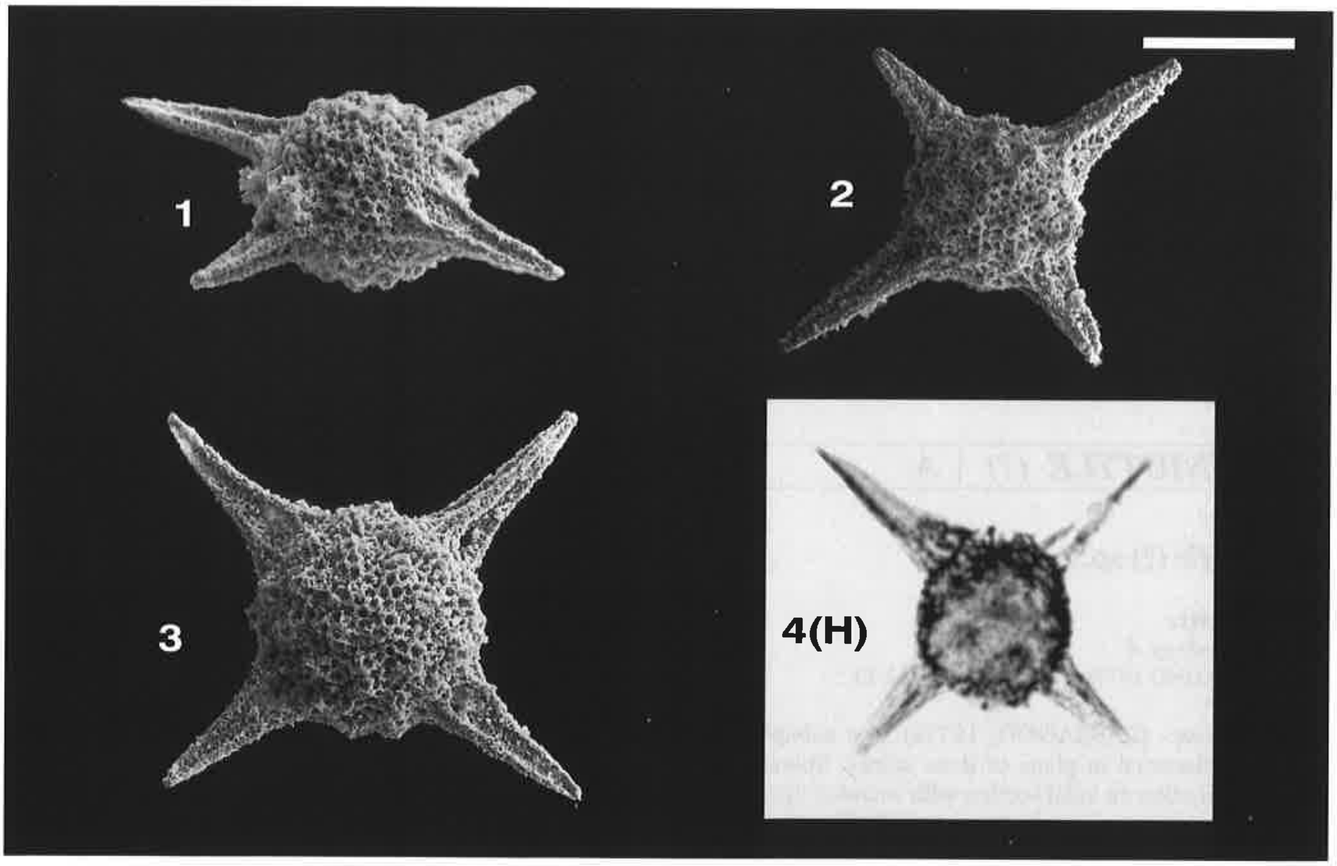


Plate 5033. *Acaeniotyle* (?) *glebulosa* (FOREMAN). Magnification x200. **Fig. 1.** RJ1150, Bo561.5. **Fig. 2.** RJ40, Bo581.65. **Fig. 3.** RJ68, Ru146.5,2. **Fig. 4(H).** FOREMAN 1973b, pl. 3, fig. 5.

ACAENIOTYLE UMBILICATA 3092

Acaeniotyle umbilicata (RÜST)

Synonymy.-

Xiphosphaera umbilicata RÜST
RÜST 1898, p. 7, pl. 1, fig. 9.
DUMITRICA 1972, p. 832, pl. 1, fig. 1.
RENZ 1974, p. 799, pl. 2, figs. 9-11, ? 12; pl. 9, fig. 21.
Spumellariinid
PESSAGNO 1969, p. 610, pl. 4, fig. N.
Acaeniotyle umbilicata (RÜST)
FOREMAN 1973b, p. 258, pl. 1, figs. 12-14, 16.
FOREMAN 1975, p. 607, pl. 2E, figs. 14-17; pl. 3, fig. 3.
MUZAVOR 1977, p. 36, pl. 1, fig. 3.
NAKASEKO et al. 1979, pl. 4, fig. 7.
BAUMGARTNER et al. 1980, pl. 2, fig. 8.
DE WEVER & THIEBAULT 1981, p. 582.
KOCHER 1981, p. 51, pl. 12, figs. 1-2.
SCHAAF 1981, p. 431, pl. 6, fig. 11; pl. 15, figs. 3a-b.
NAKASEKO & NISHIMURA 1981, p. 141, pl. 1, fig. 7; not pl. 14, fig. 2.
KANIE et al. 1981, pl. 1, fig. 2.
ORIGLIA-DEVOS 1983, p. 38-39, pl. 1, figs. 4-5.
BAUMGARTNER 1984, p. 754, pl. 1, fig. 5.
OZVOLDOVA & SYKORA 1984, p. 261, pl. 1, figs. 4-5.
SCHAAF 1984, p. 148-149, figs. 1, 2a-b, 3a-b.
SANFILIPPO & RIEDEL 1985, p. 587, figs. 4.2a-d.
KIMINAMI et al. 1985, pl. 2, fig. 10.
AITA & OKADA 1986, p. 108, pl. 1, fig. 1.
DE WEVER et al. 1986, pl. 6, figs. 8, 12-13.
AITA 1987, p. 63, pl. 12, fig. 2.
IGO et al. 1987, fig. 2.11.
PAVSIC & GORICAN 1987, p. 22, pl. 2, fig. 5.
KITO 1987, pl. 1, fig. 7.
TAKETANI 1987, pl. 1, fig. 1.
OZVOLDOVA 1988, pl. 1, fig. 1
TUMANDA 1989, p. 33, pl. 1, fig. 4
KATO & IWATA 1989, pl. 1, fig. 9.
STEIGER 1992, p. 27, pl. 1, figs. 16-17.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 8, 10.
BAUMGARTNER 1992, p. 317, pl. 3, fig. 2.
TAKETANI & KANIE 1992, fig. 3.2.
JUD 1994, p. 58, pl. 1, figs. 13-16.
Acaeniotyle sp.
OZVOLDOVA 1987, pl. 1, fig. 3
Acaeniotyle tuberosa STEIGER
STEIGER 1992, p. 27, pl. 1, figs. 18-20.

Original Definition.- "Shell of medium size, covered with 17 (one side) rather flat round nodes which have a pore-frame of regularly aligned small pores. The long spines are of a slender pyramidal form ending with sharp tips."

Actualized Remarks.- (JUD, 1994) A high variety of morphotypes exists in our material with regard to the size of the central test, the number and size of nodes covering the surface of the test and the length of the two polar spines. In this species we included also a morphotype with rather long, strong spines and a subspherical to subcylindrical main body, bearing only 3-5 circumferential rows of strong tubercles, with 4-5 tubercles visible on the largest median row. The tubercles of the central row(s) show a tendency to merge and form longitudinally elongated prominent tubercles, which are distinctly stronger, longer and higher than the tubercles disposed towards the poles of shell.

Measurements (in μm).-
Diameter of the shell 204, length of spines 265.

Type Locality.- Cittiglio, Prov. Varese, Italy.

UAZones.- 10-22, late Oxf.-early Kimm. to late Barr.-early Apt.

ACAENIOTYLE (?) | A 3091

Acaeniotyle (?) sp. A

Synonymy.-

Acaeniotyle sp. *A*
PESSAGNO 1977a, p. 78, pl. 6, figs. 12-13.

Definition.- (PESSAGNO, 1977a) Test subspherical; somewhat flattened in plane of three spines. Spines short, massive, triradiate in axial section with rounded tips; spines having length approximately equal to half diameter of test. Test surface and surface of spines nodose; test with circular to elliptical pores.

Remarks.- (PESSAGNO, 1977a) This form differs from *Acaeniotyle diaphorogoa* FOREMAN by having short spines with bluntly rounded tips and numerous small nodes on the test surface and the surface of the spines.

Actualized Remarks.- This species differs from *A. diaphorogona* FOREMAN by having no pores on the raised nodes and by rounded spine-tips, bearing small nodes.

UAZones.- 8-11, mid Call.-early Oxf. to late Kimm.-early Tith.

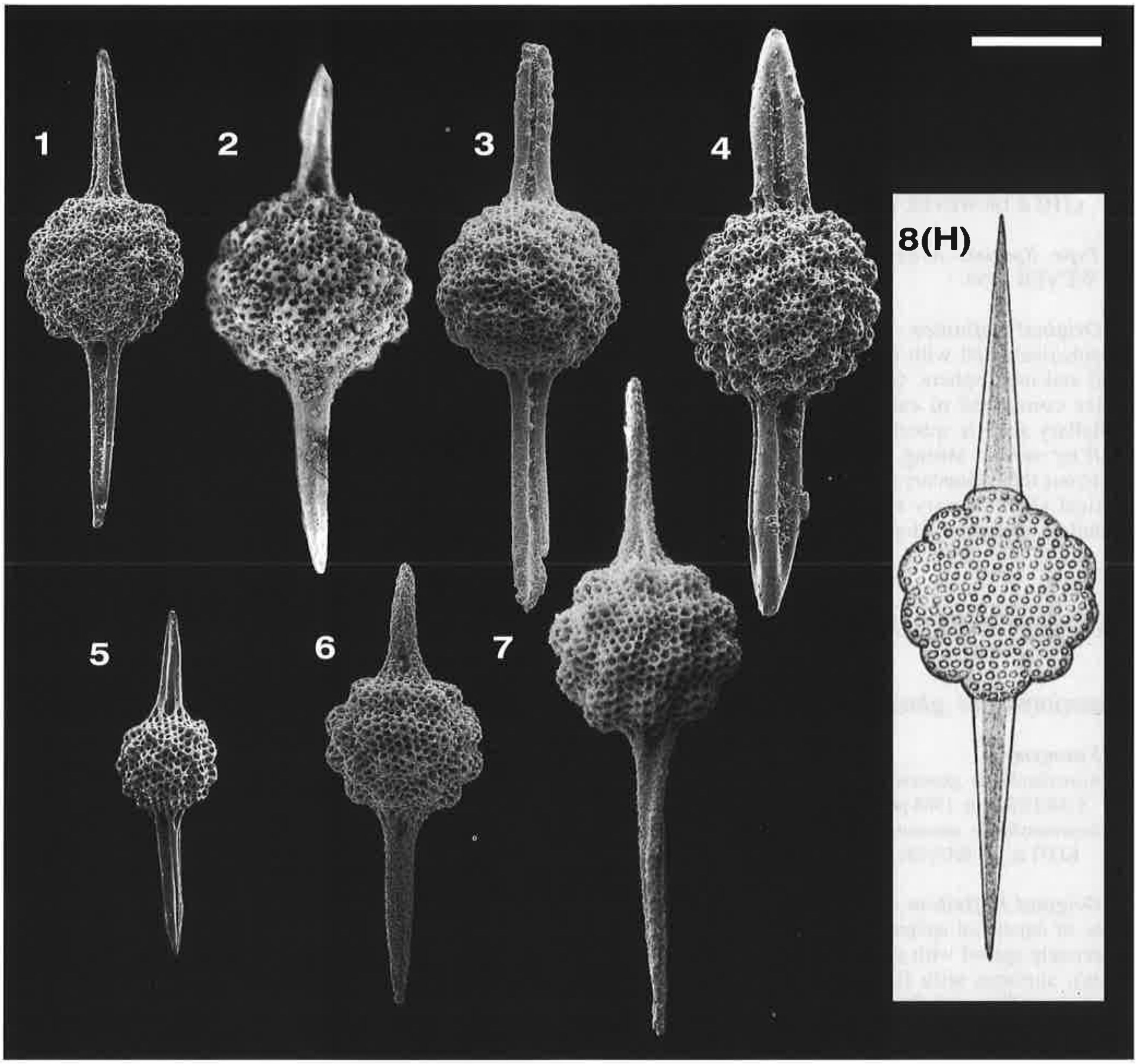


Plate 3092. *Acaeniotyle umbilicata* (RÜST). Magnification x150. **Fig. 1.** POB79/4161, MO2 46. **Fig. 2.** POB79/4160, MO2 46. **Fig. 3.** DU2235, MO22. **Fig. 4.** RJ005, Pr2253,1. **Fig. 5.** RJ204, Pr225.3. **Fig. 6.** POB82/9071, 79-547A-45CC. **Fig. 7.** RJ132, Br141.55. **Fig. 8(H).** RÜST 1898, pl. 1, fig. 9.

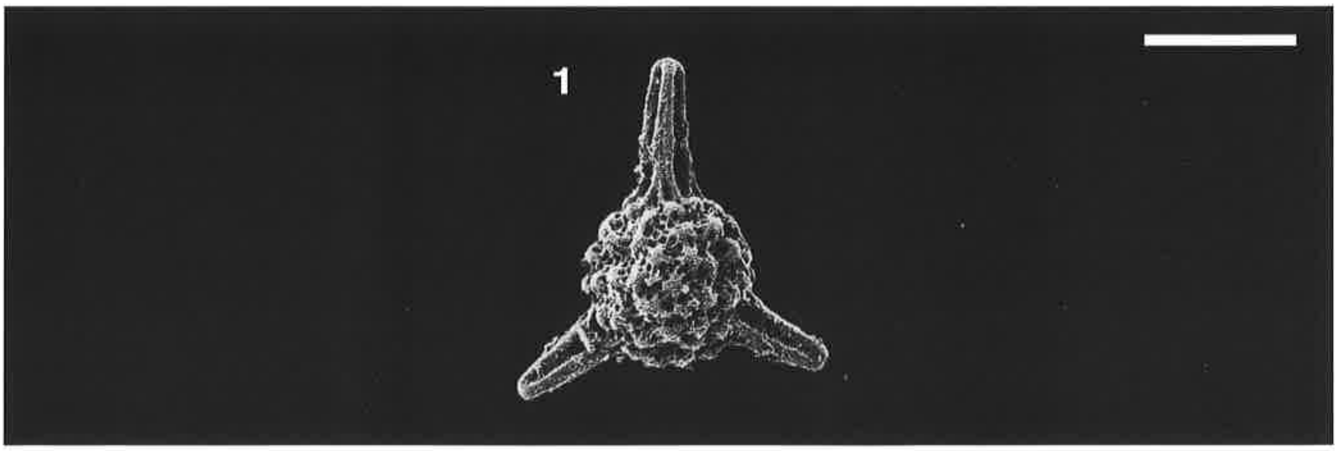


Plate 3091. *Acaeniotyle* (?) sp. A. Magnification x150. **Fig. 1.** POB78/6237, POB899.52.

ACAENIOTYLOPSIS 3701

Genus: *Acaeniotylopsis* KITO & DE WEVER

Synonymy.-
Acaeniotylopsis KITO & DE WEVER
KITO & DE WEVER 1994, p. 130.

Type Species.- *Acaeniotylopsis triacanthus* KITO & DE WEVER 1994.

Original Definition.- Test composed of spherical or subspherical shell with some radial spines, a medullary shell and microsphere. Cortical shell comprises massive nodes connected to each other by short bars. Outer medullary shell is spherical and is connected to cortical shell by several strong triradiate radial beams and by numerous thin secondary radial beams which join nodes on cortical shell. Rimary spines merge into spines. Inner medullary shell polyhedral.

Original Remarks.- The genus differs from *Acaeniotyle* FOREMAN 1973b by the absence of perforated mammae on the cortical shell, by a cortical shell composed of bars with nodes and by the presence of the primary radial beams.

Etymology.- *Acaeniotyle* + *-opsis* (masculine), in reference to a similar morphology to *Acaeniotyle* FOREMAN.

Included Taxa.-
2001 *Acaeniotylopsis ghostensis* (CARTER).
4063 *Acaeniotylopsis variatus* s.l. (OZVOLDOVA)
4066 *Acaeniotylopsis variatus triacanthus* KITO & DE WEVER
3270 *Acaeniotylopsis variatus variatus* (OZVOLDOVA)

ACAENIOTYLOPSIS GHOSTENSIS 2001

Acaeniotylopsis ghostensis (CARTER)

Synonymy.-
Acaeniotylopsis ghostensis (CARTER)
CARTER et al. 1988 pl. 9 fig. 6, p. 33.
Acaeniotylopsis ghostensis (CARTER)
KITO & DE WEVER 1994, p. 132, pl. 1, figs. 7-8.

Original Definition.- Test subspherical, flattened in plane of equatorial spines. Nodes on cortical shell strong, moderately spaced with somewhat flattened distal surfaces (tops); surfaces with fine perforations, some bearing remnants of fine central spines. Nodes connected by strong bars that form circular, elliptical and subtriangular pores. Spines tribladed and long (entire ones greater than 3/4 diameter of test) carrying narrow rounded ridges and wider grooves; complete spines are pointed. First medullary shell has small irregular pore frames connected to cortical shell by radial beams. Radial beams (3) are strong, triradiate and continuous with each primary spine; beams of lesser strength are attached to cortical shell at base of nodes.

Original Remarks.- Genus queried; the form described is doubtfully assigned to this genus because nodes are smaller, knob-like rather than rounded, and have fewer perforations, and all are much older.

Actualized Remarks.- (KITO & DE WEVER, 1994) Our specimens have longer radial spines than the specimens of the original description. The microsphere was not described in the original description, but external features and internal structure of type specimens are completely identical with our material.

Etymology.- Named for Ghost Creek, north of the type locality.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
Diameter of test:	146	145	175	139
Length of longest spine:	121	108	145	82

Type Locality.- GSC locality C-080597. Toarcian of Phantom Creek Formation, Graham Island, Queen Charlotte Islands.

UAZones.- 1-4, early-mid Aal. to late Baj.

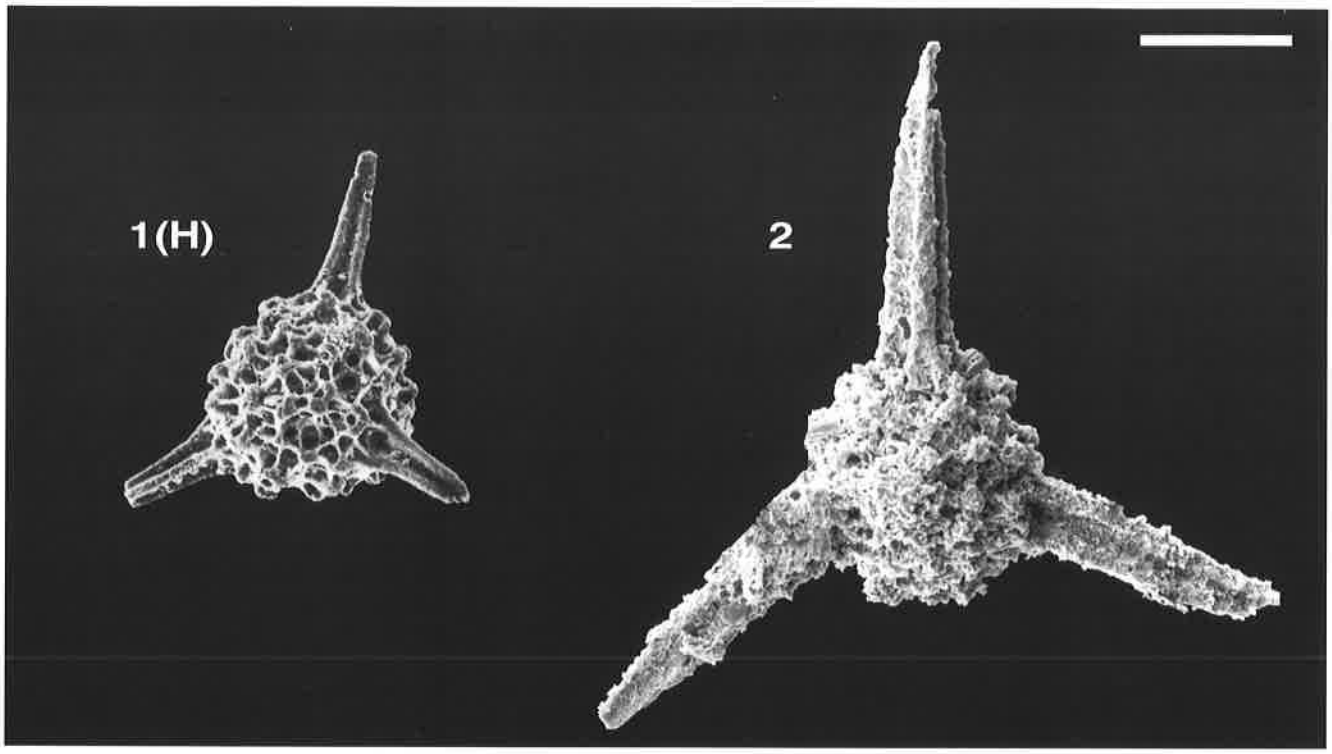


Plate 2001. ***Acaeniotylopsis ghostensis*** **(CARTER).** Magnification x200. **Fig. 1(H).** CARTER et al. 1988, pl. 9, fig. 6. **Fig. 2**. AB288, TM40.15, a4.

ACAENIOTYLOPSIS VARIATUS S.L. 4063

Acaeniotylopsis variatus s.l. (OZVOLDOVA)

Synonymy.-
See subspecies

Remarks.- The type species of *Acaeniotyle diaphorogona* FOREMAN has porous mammae but the specimen illustrated by Ozvoldova (1979) presents non perforated, massive nodes on its surface. Therefore we include the species with the genus *Acaeniotylopsis*.

Included Taxa.-
4066 *Acaeniotylopsis variatus triacanthus* KITO & DE WEVER
3270 *Acaeniotylopsis variatus variatus* (OZVOLDOVA)

UAZones.- 1-8, early-mid Aal. to mid Call.-early Oxf.

ACAENIOTYLOPSIS VARIATUS TRIACANTHUS 4066

Acaeniotylopsis variatus triacanthus KITO & DE WEVER

Synonymy.-
Acaeniotyle (?) sp. 1
KITO 1989, p. 95, pl. 3, figs. 1-5, 8-9.
Acaeniotyle sp. B
TONIELLI 1991, p. 21, pl. 1, fig. 20.
Acaeniotylopsis triacanthus KITO & DE WEVER
KITO & DE WEVER 1994, p. 132, pl. 1, figs. 4-6, 9-11; pl. 3, figs. 5a-b, 6.

Original Definition.- Test composed of a spherical or subspherical cortical shell with three strong radial spines; one outer and one inner medullary shells. Cortical shell constituted of massive nodes connected by short bars. Pores are small, polygonal or circular. Three radial spines are arranged in a plane at about 120 degrees. Radial spines possess three wide grooves (primary grooves) alternating with three narrow grooves (secondary grooves). A short spine on each ridge arises at the end of the radial spine and provides a clove- like tip. Outer medullary shell is spherical and connected to cortical shell by three triradiate primary beams and thin secondary beams. Inner medullary shell is polygonal, composed of pentagonal pore frames.

Original Remarks.- This species differs from *Acaeniotyle diophorogona variata* OZVOLDOVA 1979 in the construction of the cortical shell. The cortical shell lacks perforated mammae. The species also differs from *Acaeniotyle ghostensis* (CARTER) in the aspect of its cortical shell and in having branched spines.

Remarks.- This subspecies seems to be ancestral to *A.* (?) *variatus variatus* (OZVOLDOVA). The latter has less developed but more numerous nodes, and a finer meshwork of pores between nodes, built by fine bars connecting nodes and a somewhat depressed meshwork between bars forming at least 3, small, almost circular pores between adjacent nodes.

Etymology.- From the Greek *tri-* (three) + *acanthus* (spine).

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Diameter of cortical shell:	189	160	128	204
Length of spine A:	206	-	-	-
Length of spine B:	187	159	111	222
Length of spine C:	193	-	-	-

Type locality.- Sample S69, Contrada la Ferta, Sicily, Italy.

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

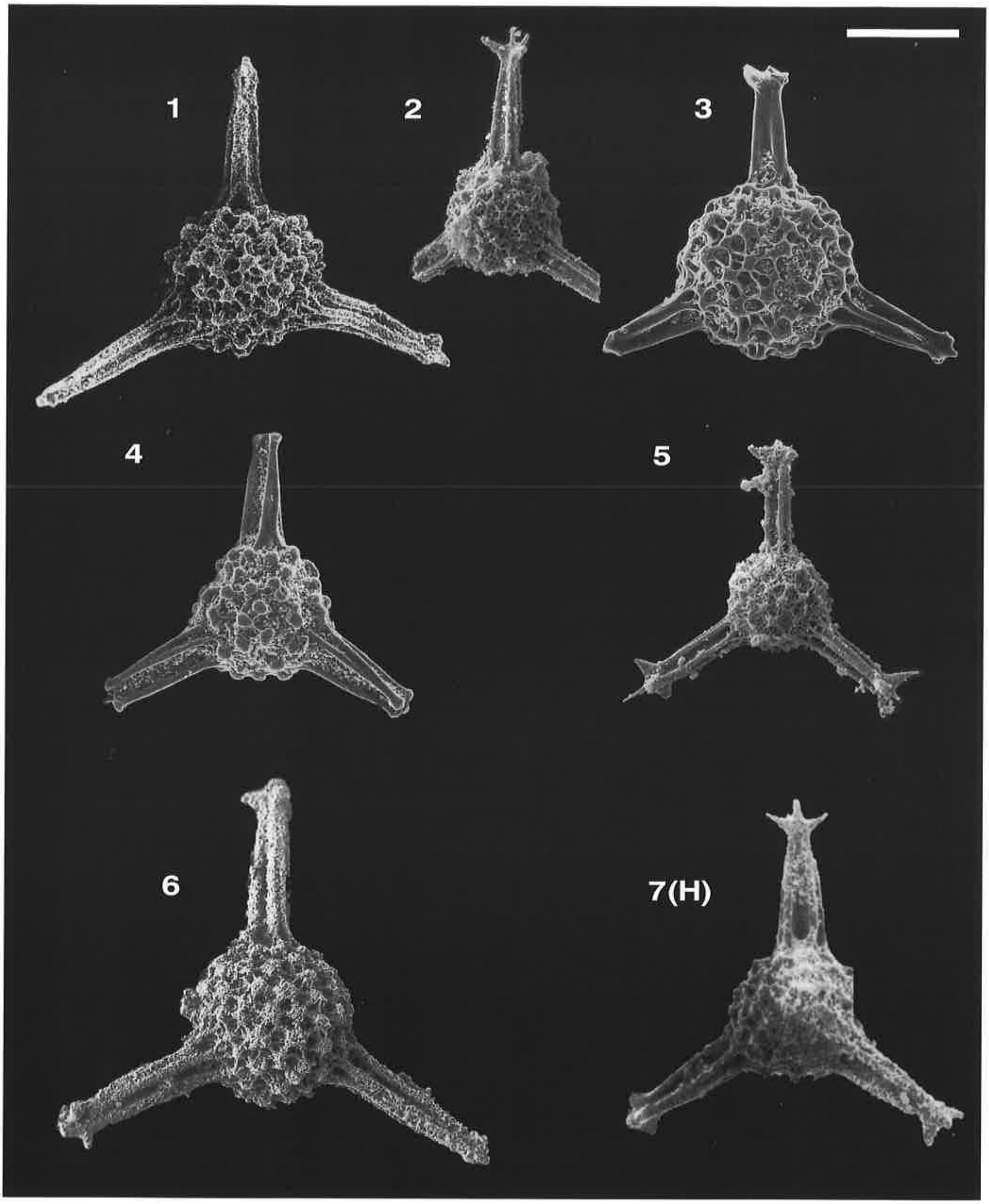


Plate 4066. ***Acaeniotylopsis variatus triancanthus*** **KITO & DE WEVER.** Magnification x150. **Fig. 1.** POB81/2833, POB1341. **Fig. 2.** MA10347, MKM-1. **Fig. 3.** CA47-13. **Fig. 4.** CA47-2. **Fig. 5.** MA 10235, MKM-1. **Fig. 6.** POB81/2913, POB1341. **Fig. 7(H).** KITO & DEWEVER 1994, pl.1, fig. 11.

ACAENIOTYLOPSIS VARIATUS VARIATUS — *3270*

Acaeniotylopsis variatus variatus (OZVOLDOVA)

Synonymy.-
Acaeniotyle diaphorogona variata OZVOLDOVA
OZVOLDOVA 1979, p. 251, pl. 1, fig. 2.
CONTI & MARCUCCI 1991, pl. 1, fig. 2.
MATSUOKA 1992, pl. 5, fig. 10.

Original Definition.- Test with meshwork, with numerous regularly placed protuberances on its surface, is of a round shape, slightly flattened vertically. Pores of test are small, oval, placed close to one another. Three massive spines, composed of three longitudinal ridges separated by deep grooves diverge from test to sides. At their ends, the spines split into three short, lateral little spines formed by diverging of the ridges of spines to sides. The spines are arranged asymmetrically. Angles between spines are about 130, 130, 100 degrees.

Remarks.- This subspecies seems to be descendant from *A. variatus triacanthus* KITO & DE WEVER as it occurs in younger levels.

Etymology.- It expresses the difference from the typical species.

Measurements (in μm).-
Based on 1 specimen.

	HT
Diameter of cortical shell:	120-130
Length of spines:	100-120

Type Locality.- Podbiel, Orava, Slovakia.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

ACANTHOCIRCUS — *3601*

Genus: *Acanthocircus* SQUINABOL emend. DONOFRIO & MOSTLER

Synonymy.-
Acanthocircus SQUINABOL
SQUINABOL 1903, p. 124.
DONOFRIO & MOSTLER 1978, p. 22.

Type Species.- *Acanthocircus irregularis* SQUINABOL 1903, subsequent designation by Campbell 1954, p. D106.

Original Definition.- "Elliptical ring, divided into two parts by two spines arising from the internal part towards each other until they almost touch. External periphery armed with simple or branched spines".

Actualized Definition.- (DONOFRIO & MOSTLER, 1978) Forms consisting of a ring which is distinctly articulated by ridges and not continuously armed with spines. The spines are mostly directed plus or minus perpendicularly to the polar spines, sometimes also thorns are developed in the same position. The presence of thorns in combination with spines can also be the case in the vicinity of the polar bars (i. e. being developed more or less in parallel position to the polar bars). Except of the two polar bars no other auxiliary or supporting bars are developed.

Remarks.- It is difficult to standardize species identification within this genus as recovery of complete specimens is unusual and also there is a high incidence of transitional forms between the end members.

Included Taxa.-
5012 *Acanthocircus carinatus* FOREMAN
5003 *Acanthocircus furiosus* JUD
2021 *Acanthorcircus protoformis* (YAO)
3064 *Acanthocircus suboblongus* s.l. (YAO)
3085 *Acanthocircus suboblongus minor* n.ssp. BAUMGARTNER
3088 *Acanthocircus suboblongus suboblongus* (YAO)
3065 *Acanthocircus trizonalis* s.l. (RÜST)
3082 *Acanthocircus trizonalis angustus* n.ssp. BAUMGARTNER
3087 *Acanthocircus trizonalis dicranacanthos* (SQUINABOL), emend. FOREMAN
3083 *Acanthocircus trizonalis trizonalis* (RÜST)
5011 *Acanthocircus variabilis* (SQUINABOL)

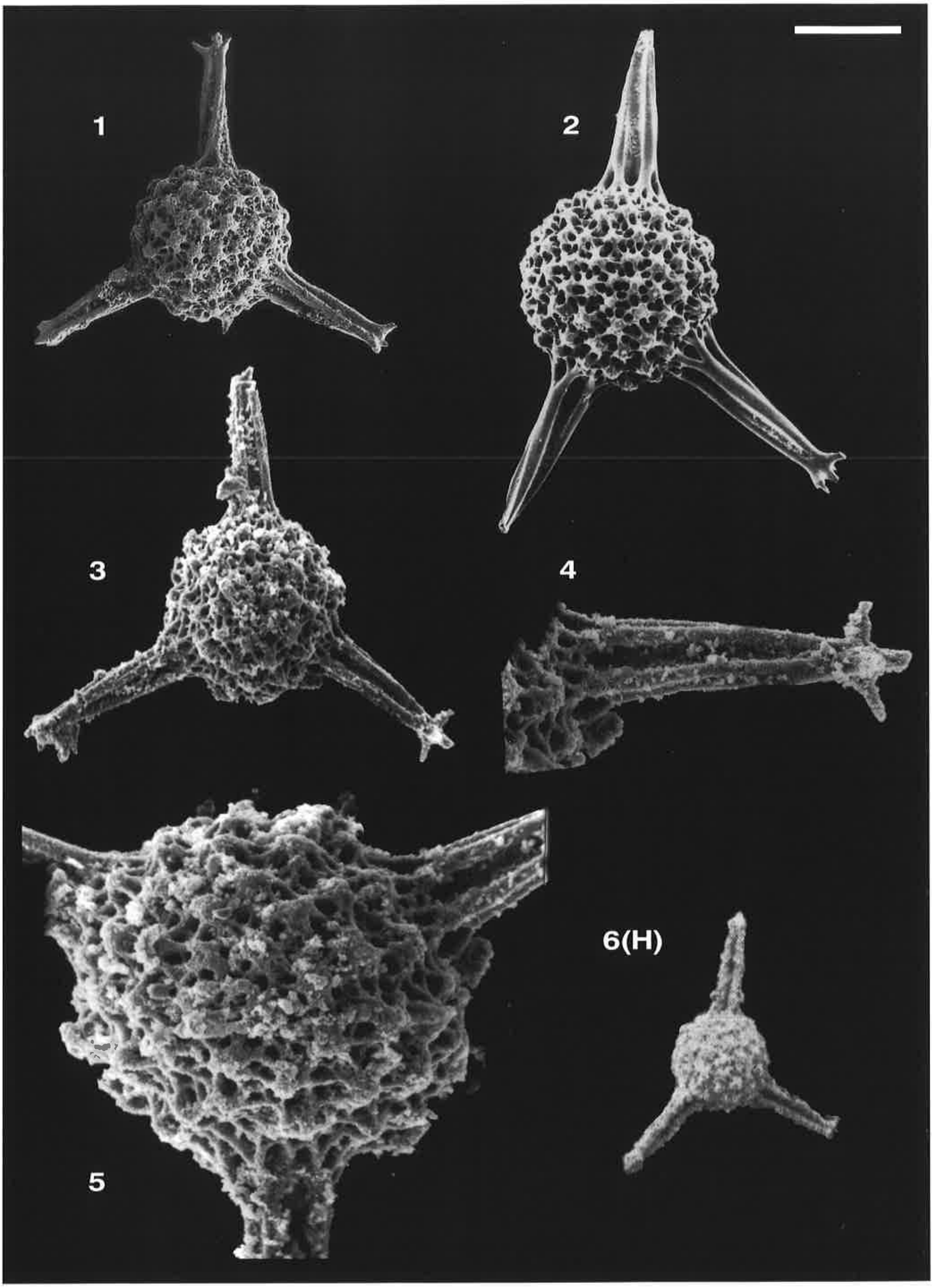


Plate 3270. *Acaeniotylopsis variatus variatus* (OZVOLDOVA). Magnification x150, unless otherwise indicated **Fig. 1.** POB79/1709, NSF907. **Fig. 2.** POB81/9135, 76-534A-126-2-125. **Fig. 3.** MC, GR6. **Fig. 4.** MC, GR6, x300. **Fig. 5.** MC, GR6, x300. **Fig. 6(H).** OZVOLDOVA 1979b, pl. 1, fig. 2.

ACANTHOCIRCUS CARINATUS 5012

Acanthocircus carinatus FOREMAN

Synonymy.-

Acanthocircus carinatus FOREMAN
- FOREMAN 1973b, p. 260, pl. 5, fig. 2, not fig. 1.
- not RIEDEL & SANFILIPPO 1974, p. 775, pl. 2, figs. 1-2.
- FOREMAN 1975, p. 610, pl. 2C, fig. 8; pl. 4, fig. 12.
- SCHAAF 1981, p. 431, pl. 16, fig. 2.
- SCHAAF 1984, p. 159, fig. 7.
- JUD 1994, p. 59, pl. 2, figs. 1-3.

Acanthocircus suboblongus (YAO)
- ORIGLIA-DEVOS 1983, p. 60, pl. 4, fig. 5, not fig. 3

Original Definition.- The size and shape of the shell are not known because all specimens observed are broken and the shell is missing. The internal extension of the polar spine is smooth and suggests a porous rather than a spongy shell. No complete ring has been observed. Fragments indicate that it is elliptical with the ends of ellipse not as broadly rounded as in *Acanthocircus trizonalis* (?) and *Acanthocircus dizonius* (?). It has one blade on the outer margin and two on the inner margin and bears two obliquely outward-directed spines, presumably one set at each end of the ellipse. Two distinct ridges or keels are developed on each side of the ring between the two spines, approximately parallel to the two end spines and perpendicular to the plane of the ring. Each ridge is offset from the other and each appears to be developed as an extension of one of the inner blades.

Original Remarks.- Only the distinctive ends of the ellipse with their two spines and separating ridge or keel are preserved. However, since this fragment is so distinctive and easily recognized and is apparently useful for stratigraphic determinations, the species has been named and described here. Early forms have a greater width between the end spines than late forms: 196-4-1 (90-114 μm); 196-3-1 (65-98 μm). One specimen with a complete ring (plate 5, figure 3) had one end with a ridge between the spines as in this species, and the other end without a ridge as in *Acanthocircus* sp. aff. *Saturnalis variabilis* suggesting that the forms are closely related and this specimen is a transitional form between the two species. The ends of the ellipse of *Acanthocircus carinatus* resemble those of *Acanthocircus* sp. aff. *Saturnalis variabilis* but differ in having a distinctive ridge between the end spines.

Remarks.- Transitional forms having only at one extremity a ridge developed in the space between the 2 spines, as described by Foreman, were found in our material, but not taken into account for biostratigraphic data. Their study as well as a detailed systematic study of this species is in preparation and will be published elsewhere (Dumitrica & Jud, in press).

Etymology.- Latin *carinatus, -a, -um* keeled.

Measurements (in μm).-
Based on 10 specimens, mostly fragmentary. Width of one-half of the ring from polar spines to outer margin, 185-225; estimated greatest width of ring of five specimens, 370-450; distance between outer margins of end spines near their base, 55-114.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

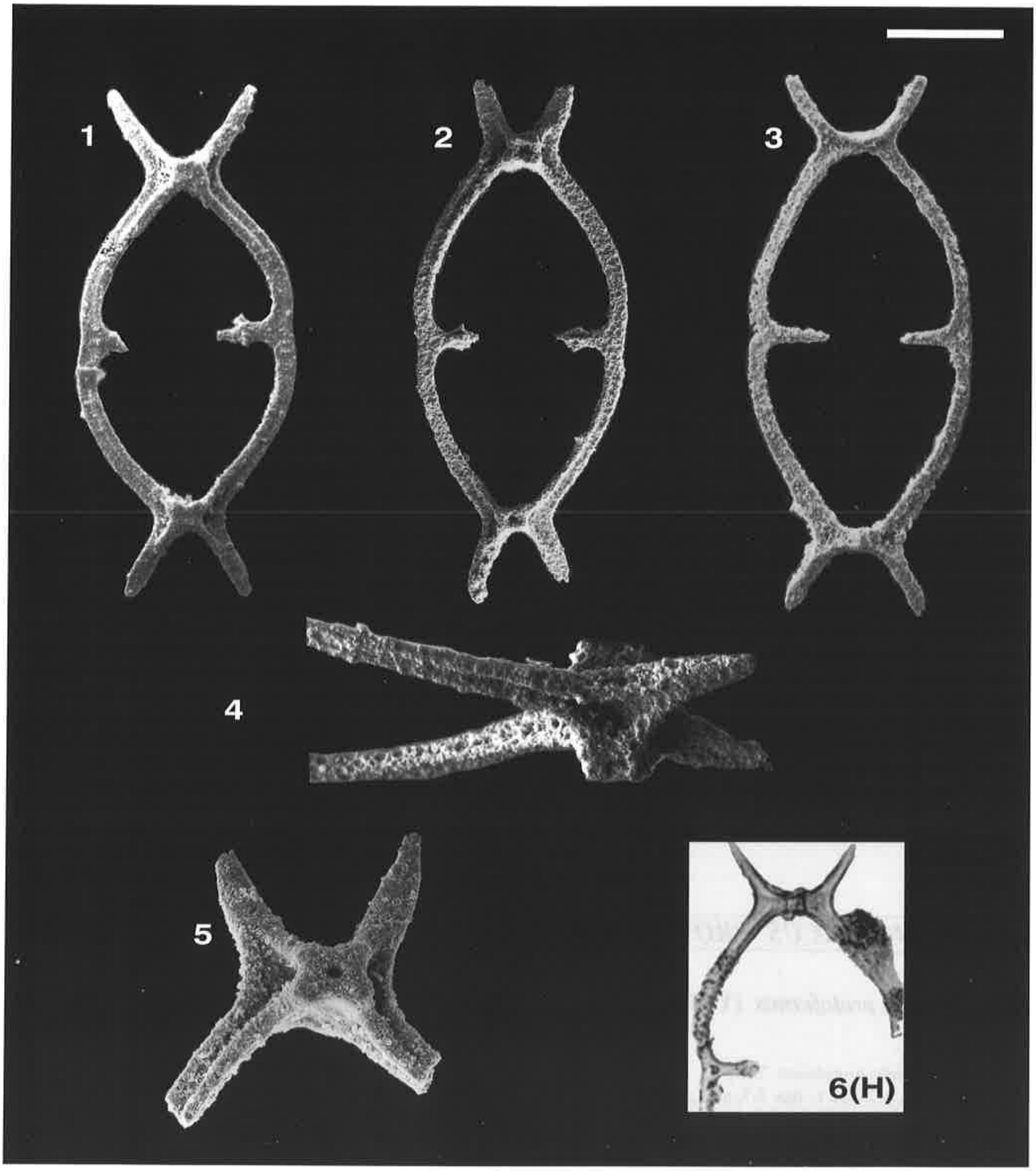


Plate 5012. *Acanthocircus carinatus* FOREMAN. Magnification x150, unless otherwise indicated. **Fig. 1**. RJ1042, Br141.55. **Fig. 2**. RJ2092, GC887.0. **Fig. 3**. RJ1760, GC819.75. **Fig. 4** RJ2093, GC887.0, x300. **Fig. 5.** RJ134, Bo619.9, x300. **Fig. 6(H).** FOREMAN 1973b, pl. 5, fig. 2.

ACANTHOCIRCUS FURIOSUS 5003

Acanthocircus furiosus JUD

Synonymy .-
Acanthocircus furiosus JUD
JUD 1994, p. 59, pl. 2, figs. 4-7

Original Definition.- Flat elliptical ring with bifurcating polar spines. The ridges of each polar spine are alternately formed by an inner and outer edge of the ring turning outwards at the poles, forming two external ridges with a deep central groove. The ridges finally bifurcate into two short, curved tips. The alternate inner and outer rim of the ring either taper into the ring or twist to form part of the ridge on the opposite side of the polar spine. In the central part inside of the elliptical ring two polar rays are disposed opposite to each other in the plane of the ring.

Original Remarks.- *Acanthocircus furiosus* n.sp. differs from *A. dicranacanthos* (SQUINABOL) in that the spines on the extremities of the ring bifurcate distally rather than at their base, by lacking the triangular thickening at the base of the spines and by the different arrangement of the ridges. Complete specimens were only rarely observed.

Etymology.- From the Latin *furiosus* = furious.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Total length test:	630	618	382	720
Length of ring:	430	432	257	510
Width test:	220	243	147	325
Length spine:	100	102	85	120

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 10-20, late Oxf.-early Kimm. to late Haut.

ACANTHOCIRCUS PROTOFORMIS 2021

Acanthocircus protoformis (YAO)

Synonymy.-
Spongosaturnalis protoformis YAO
YAO 1972, p. 27, pl. I , figs. 2-7, pl. X, figs. 1-2.

Original Definition.- *Spongosaturnalis* with simple ring, where no spine is developed. Shell approximately spherical, spongy, composed of irregular meshes which become denser centrally. Polar spines short, smooth, not always distinguished when shell extends completely across ring. Polar spines change to sturdy spines inside shell. When shell is not preserved, numerous fragmentary thorns are observed on sturdy spines and rarely on ring where each of polar spines bifurcates. Ring generally bilaterally symmetrical or ovoidal, simple, with ridges on both edges near polar spines. Ridge on outer edge extends across ends of polar spines, and another one on inner edge disappears at polar spines. Both ridges become obsolete on terminal end of ring. No spine on ring.

Original Remarks.- This species may be similar to *Saturnalis simplex* SQUINABOL (1914, p. 287, pl. 22, fig. 2; Jurassic, Fontanafredda, Euganei, Italy) in the shape of the saturnalin ring, but the generic assignment of *S. simplex* is doubtful because the nature of the shell is not known, namely the shell is not preserved and the fragmentary thorns are not observed on the polar spines. *Spongosaturnalis protoformis* differs from *S. bispinus* (described below) in lacking spine on each terminal end of the ring, and in having ridges on both edges of the ring.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
D. of ring along polar spines:	170	191	170	210
Diameter of ring transversaly:	335	362	330	420
Diameter of shell:	110	153	110	180
Length of polar spine:	20	15	7	20
Breadth of ring:	11-21	12-20	9	29

Type Locality.- Inuyama area, Gifu Prefecture, Japan.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

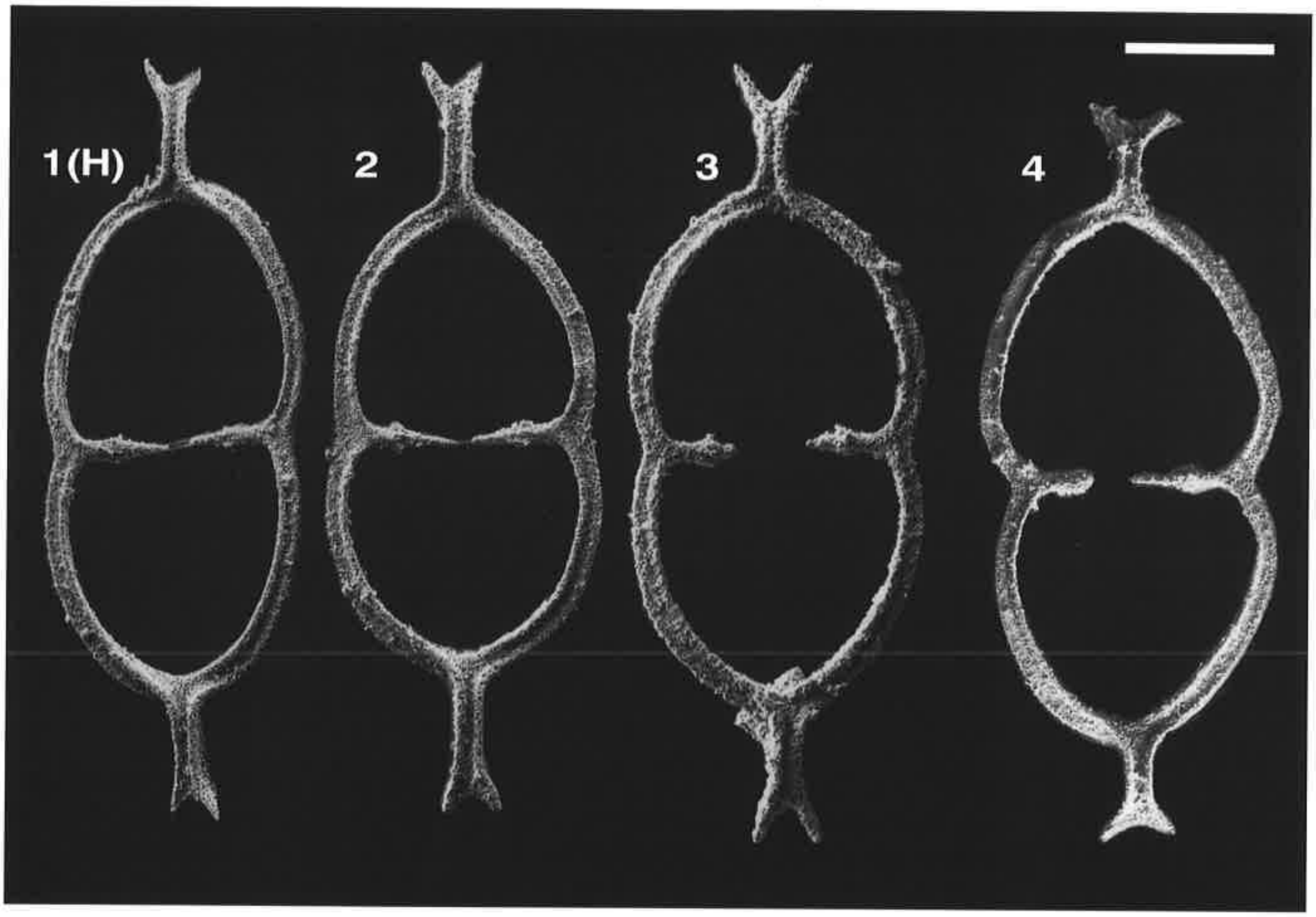


Plate 5003. ***Acanthocircus furiosus*** **JUD.** Magnification x150. **Fig. 1(H).** RJ2433, Ru135.50. **Fig. 2.** RJ2434, Ru135.5. **Fig. 3**. RJ2070, Capr.146.5. **Fig. 4.** RJ2353, Br28.85.

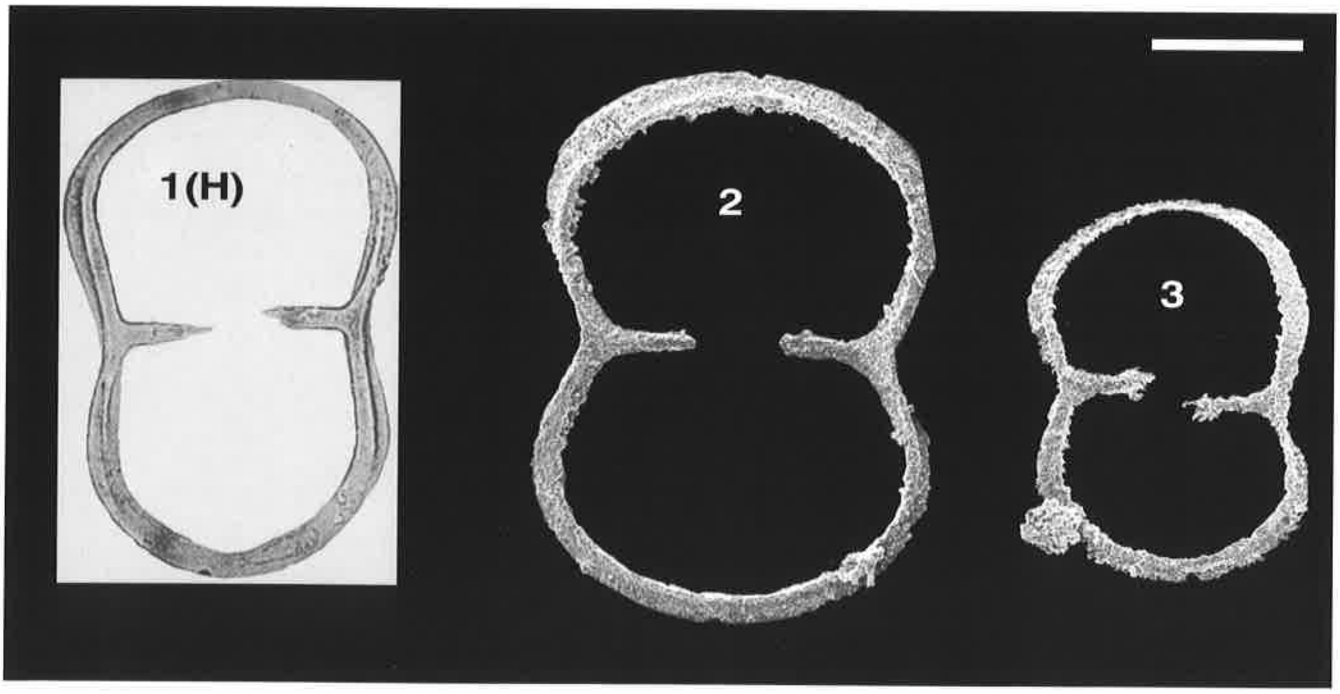


Plate 2021. ***Acanthocircus protoformis*** **(YAO).** Magnification x200. **Fig. 1(H)**. YAO 1972, pl. I , fig. 2-7. **Fig. 2.** AB 4103.TM168.15.b4. **Fig. 3**. AB 2853.TM164.66.f6

ACANTHOCIRCUS SUBOBLONGUS S.L. — *3064*

Acanthocircus suboblongus s.l. (YAO)

Synonymy.-
See also subspecies.

Included Taxa.-
3085 *Acanthocircus suboblongus minor* n.ssp. BAUMGARTNER
3088 *Acanthocircus suboblongus suboblongus* (YAO)

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

ACANTHOCIRCUS SUBOBLONGUS MINOR — *3085*

Acanthocircus suboblongus minor n.ssp. BAUMGARTNER

Synonymy.-
Acanthocircus variabilis (SQUINABOL)
PESSAGNO 1977a, p. 74, pl. 3, fig. 6.
DUMITRICA & MELLO 1982, pl. 3, fig. 18.
Acanthocircus sp. cf. S. (?) *suboblongus* YAO
FOREMAN 1978, p. 744, pl. 1, fig. 8.
Acanthocircus suboblongus (YAO)
KOCHER 1981, p. 52, pl. 12, figs. 4-5.
not ORIGLIA-DEVOS 1983, p. 60, pl. 4, figs. 3, 5.
BAUMGARTNER 1984, p. 755, pl. 1, fig. 6.
MURCHEY 1984, pl. 2, fig. 12.
KISHIDA & HISADA 1986, fig. 2.21.
AITA 1987, p. 63, pl. 8, fig. 9.
OZVOLDOVA & PETERCAKOVA 1987, pl. 31, fig. 3.
DANELIAN 1989, p. 132, pl. 1, figs. 12-13.
KITO 1989, p. 153, pl. 16, fig. 15 only.
WIDZ 1991, p. 243, pl. 1, fig. 3.
CONTI & MARCUCCI 1991, pl. 1, fig. 3.
JUD 1994, p. 59, pl. 2, fig. 8.
Acanthocircus carinatus FOREMAN
DE WEVER & MICONNET 1985, pl. 2, figs. 7-8.

Type Designation.- 78/6123, POB899. 51.

Original Definition.- Form as with species, except for the paired spines that sit on the poles of the ring. These spines are shorter, wider spaced and more outwards-directed than for the holotype of *Acanthocircus suboblongus.*

Remarks.- This new subspecies is erected to include all forms that have much smaller and more diverging spines than the holotype of *Acanthocircus suboblongus.*

Etymology.- *Minor*, Latin: younger, referring to its younger stratigraphic range as compared to *Acanthocircus suboblongus.*

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Width base of spine:	85	114	78	159
Length spine:	75	78	68	92

Type Locality.- POB 899.51, Lower Angelokastron Chert, Didhimi-Trapezona Composite Unit, Prov. Korinthos, Northern Argolis Peninsula, Greece.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

Plate 3085. *Acanthocircus suboblongus minor* n.ssp. BAUMGARTNER. Magnification x150, except Figs. 3,4 x200. **Fig. 1(H).** POB78/6123, POB899.51. **Fig. 2** MC, GR6. **Fig. 3.** POB81/2657, 534.124.1.52. **Fig. 4.** POB81/2226, 534.122.1.43.

ACANTHOCIRCUS SUBOBLONGUS SUBOBLONGUS 3088

Acanthocircus suboblongus suboblongus (YAO)

Synonymy.-
Spongosaturnalis (?) *suboblongus* YAO
YAO 1972, p. 29, pl. 3, figs. 1-6; pl. 10, figs. 3a-c.
WAKITA 1982, pl. 4, fig. 10.
Acanthocircus suboblongus (YAO)
GORICAN 1987, p. 180, pl. 3, figs. 2-3.
KITO 1989, p. 153, pl. 16, fig. 12 only.

Original Definition.- Spongosaturnalid with suboblong ring, and with two strong spines on each narrow end of ring. Shell not preserved, but presence of numerous fragmentary thorns at tip of polar spines and on sturdy spines suggests that shell may be spongy. Polar spines short, a little thick, with no ridge. Ring usually bilaterally symmetrical, suboblong or considerably elliptical, with clear ridge on outer edge. Ridge becomes steep at narrow ends and continues to one on spines. Narrow ends are straight parallel with short axis of ring. Two spines are present on narrow ends of each half ring. Spines strong, somewhat long, beaky, curved slightly and opposite each other, with sharp tip, and with clear ridges.

Original Remarks.- This species appears to resemble *Saturnalis variabilis* SQUINABOL (1914. p. 291-292, pl. 22, fig. 8; Jurassic of Cittiglio, Laveno, Italy) in the shape of the ring. But the nature of the shell in Squinabol's is so indistinct that *Spongosaturnalis* ? *suboblongus* cannot be compared sufficiently with *Saturnalis variabilis*.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
D. ring along polar spines:	173	177	167	193
D. ring transversely:	315	343	303	395
D. of shell:	102	105	95	117
Lenght of polar spine:	15	16	15	18
Lenght of spine:	78	83	70	95
Breath of ring:	14-24	14-30	13	37

Type Locality.- Inuyama area, Gifu Prefecture, Japan.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

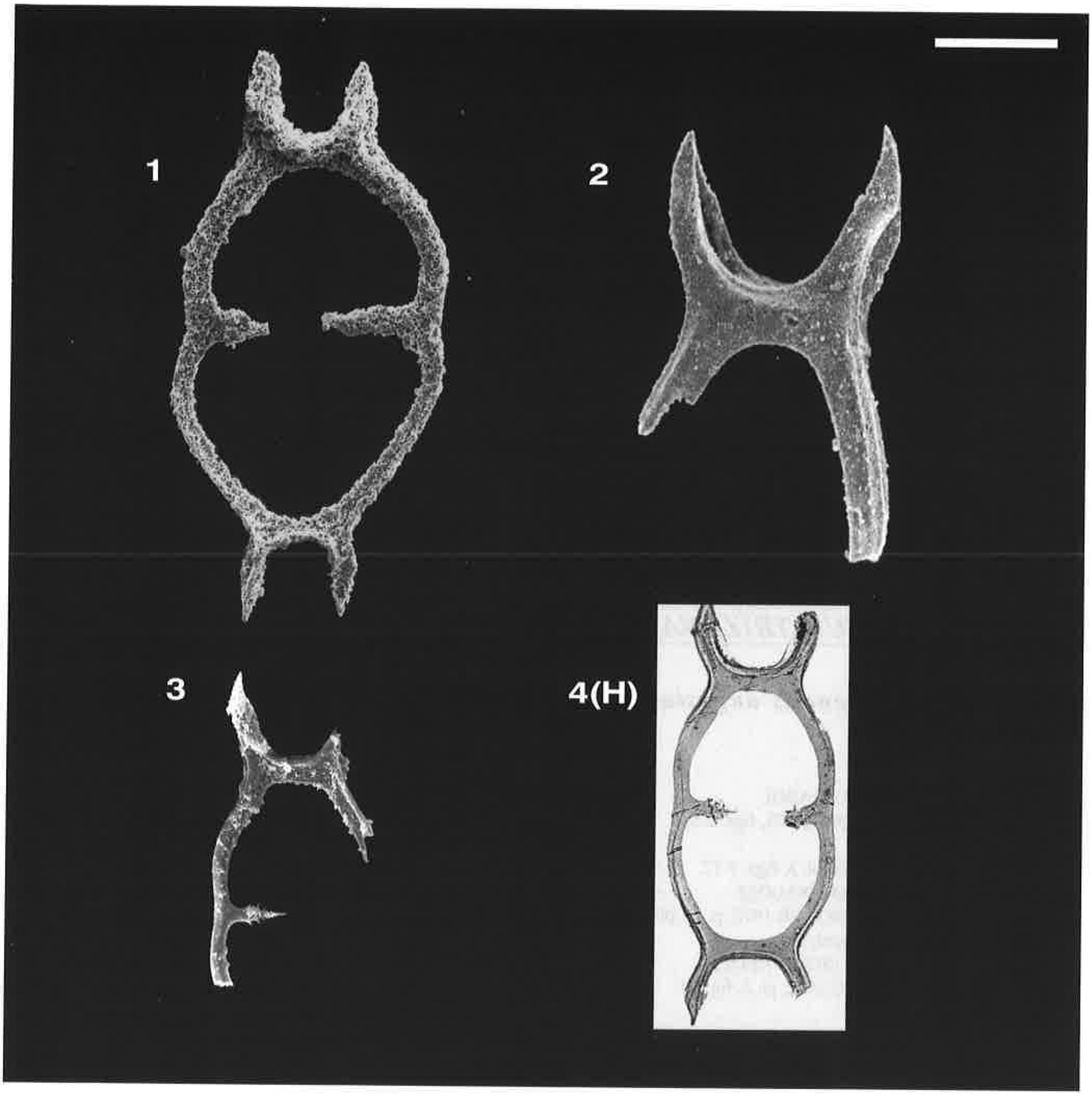


Plate 3088. ***Acanthocircus suboblongus suboblongus*** **(YAO).** Magnification x150, except Fig. 2 x300. **Fig. 1.** DU3733, SV6. **Fig. 2**. GO86/141/1, ZB28. **Fig. 3.** MA9788, MIN-10. **Fig. 4(H).** YAO 1972, pl. 3, fig. 4.

ACANTHOCIRCUS TRIZONALIS S.L. 3065

Acanthocircus trizonalis s.l. (RÜST)

Synonymy.-
Saturnulus dizonius RÜST
RÜST 1898, p. 8, pl. 2, fig. 3.
Saturnulus trizonalis RÜST
RÜST 1898, p. 9, pl. 2, fig. 4.
FISCHLI 1916, p. 47, fig. 52.
Saturnalis dicranacanthos SQUINABOL
SQUINABOL 1914, p. 289, pl. 22, figs. 4-7. pl. 23, fig. 8; text-fig. 1, p. 290.
Acanthocircus trizonalis (RÜST)
JUD 1994, p. 60, pl. 2, figs. 9 11.
Complete synonymy under subspecies.

Remarks.- *Acanthocircus trizonalis* (RÜST) and *Acanthocircus dicranacanthos* (SQUINABOL) are herein synonymized, because together with the two morphotypes representing *A. trizonalis trizonalis* (RÜST) and *A. trizonalis dicranacanthos* (SQUINABOL) in the same samples there are almost always specimens which have on one extremity of the ring a simple spine characteristic of the former species and on the other extremity the bifurcated spine characteristic of the latter species. On the other way, our investigations (e. g. Fiume Bosso section) seem to prove that the two morphotypes have the same stratigraphic range. Besides these morphotypes exists also a high variety of other morphotypes differing from one another in the shape and the size of the distal spines and of the ring.

Included Taxa.-
3082 *Acanthocircus trizonalis angustus* n.ssp. BAUMGARTNER
3087 *Acanthocircus trizonalis dicranacanthos* (SQUINABOL) emend. FOREMAN
3083 *Acanthocircus trizonalis trizonalis* (RÜST)

UAZones.- 6-22, mid Bath. to late Barr.-early Apt.

ACANTHOCIRCUS TRIZONALIS ANGUSTUS 3082

Acanthocircus trizonalis angustus n.ssp. BAUMGARTNER

Synonymy.-
cf. *Saturnalis amissus* SQUINABOL
SQUINABOL 1914, p. 296, pl. 23, figs. 2-5.
Acanthocircus sp. A
PESSAGNO 1977a, p. 74, pl. 3, figs. 7-12.
Acanthocircus amissus (SQUINABOL)
part. DONOFRIO & MOSTLER 1978, p. 23, pl. 5, fig. 2 (only); pl. 6, figs. 8, 11 (only).
Acanthocircus cf. *amissus* (SQUINABOL)
DUMITRICA & MELLO 1982, pl. 3, fig. 20.
Acanthocircus sp. A gr.
ORIGLIA-DEVOS 1983, p. 63, pl. 14, figs. 9-10, ? 8; pl. 15, figs. 2-3, ? 1.
Acanthocircus sp. 1
? ORIGLIA-DEVOS 1983, p. 64, pl. 5, fig. 4.
Acanthocircus amissus (SQUINABOL)
OZVOLDOVA 1988, pl. 3, fig. 8.

Type Designation.- POB 78/6541, POB 899.54.

Original Definition.- Saturnalid ring of symmetrical "eight"-shape bearing two flat polar knobs with a short point. Polar knobs are fattened perpendicular or slightly oblique to the plane of the ring. In lateral view, the base of knobs is less than half their height. The two lateral thickened sides of the knob embrace the ring but have no extensions onto the ring.

Original Remarks.- This subspecies differs from *A. trizonalis trizonalis* by polar knobs that are narrow, instead of regular triangular in lateral view. The polar knobs bear a short point only, no spines have been observed.

Etymology.- *Angustus, a, um*, from Latin: narrow.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Width of rings:	234	236	235	240
Heigth of rings:	405	426	405	439
Width of polar knobs:	48	54	43	61
Height of polar knobs:	50	48	44	65

Type Locality.- Angelokastron, Argolis Peninsula, Greece, Sample POB899.

UAZones.- 6-10, mid Bath. to late Oxf.-early Kimm.

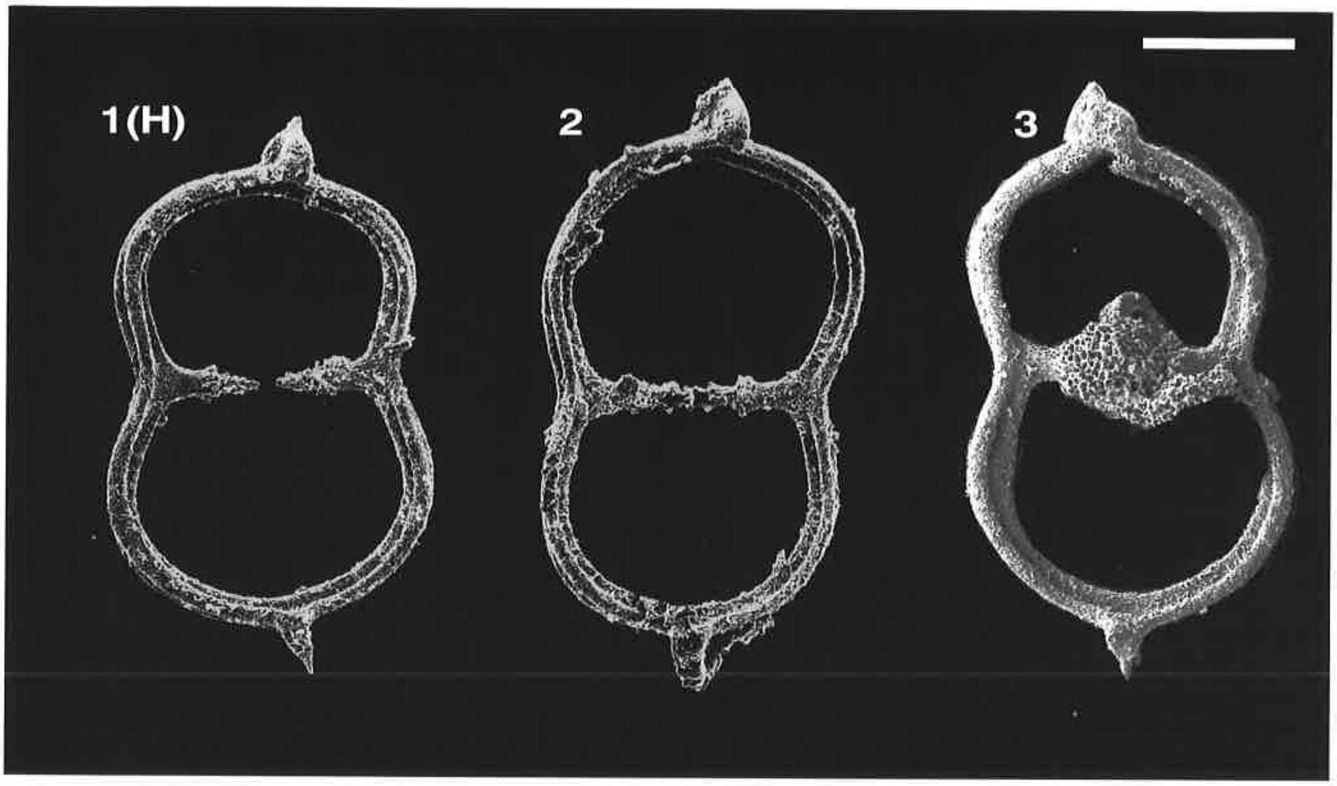


Plate 3082. ***Acanthocircus trizonalis angustus*** **n.ssp. BAUMGARTNER.** Magnification x150. **Fig. 1(H).** POB78/6541, POB899.54. **Fig. 2.** POB78/6538, POB899.54. **Fig. 3.** POB79/1653, POB 899.

ACANTHOCIRCUS TRIZONALIS DICRANACANTHOS 3087

Acanthocircus trizonalis dicranacanthos (SQUINABOL), emend. FOREMAN

Synonymy.-
Saturnalis dicranacanthos SQUINABOL
SQUINABOL 1914, p. 289, pl. 22, figs. 4-7, pl. 23, fig. 8; text-fig. 1, p. 290.
Saturnalis novalensis SQUINABOL
SQUINABOL 1914, p. 268, 297, pl. 20, fig. 1; pl. 23, fig. 7.
Saturnulus sp.
FISCHLI 1916, p. 46, fig. 53.
Spongosaturnalis dicranacanthos (SQUINABOL)
PESSAGNO 1969, p. 610, pl. 4, figs. a-b.
MOORE 1973, p. 824, pl. 3, figs. 1, 3.
Acanthocircus dizonius (RÜST) (?)
FOREMAN 1973b, p. 260, pl. 4, figs. 4-5.
Acanthocircus dizonius (RÜST)
RIEDEL & SANFILIPPO 1974, p. 775, pl. 2, figs. 4-5, not fig. 3.
Acanthocircus dicranacanthos (SQUINABOL)
emend. FOREMAN 1975, p. 610, pl. 2D, figs. 5-6.
MUZAVOR 1977, p. 37, pl. 4, fig. 4.
PESSAGNO 1977a, p. 73, pl. 3, fig. 5.
PESSAGNO 1977b, p. 31, pl. 2, fig. 6.
DONOFRIO & MOSTLER 1978, p. 28, pl. 2, fig. 3; pl. 4, figs. 4, 7-9; pl. 5, figs. 10-11.
NAKASEKO et al. 1979, p. 2, fig. 7.
BAUMGARTNER et al. 1980, p. 49, pl. 1, fig. 11.
HOLZER 1980, p. 156, text-fig. 2, pl. 1, figs. 1-12; pl. 2, fig. 7.
KANIE et al. 1981, pl. 1, fig. 3.
KOCHER 1981, p. 51, pl. 12, fig. 3.
NAKASEKO & NISHIMURA 1981, p. 141, pl. 1, fig. 6.
SCHAAF 1981, p. 431, pl. 7, fig. 1; pl. 16, fig. 3.
AOKI 1982, pl. 1, fig. 3.
ORIGLIA-DEVOS 1983, p. 58, pl. 4, figs. 2-4.
BAUMGARTNER 1984, p. 754, pl. 1, fig. 7.
MURCHEY 1984, pl. 2, fig. 7.
OZVOLDOVA & SYKORA 1984, p. 261, pl. 1, figs. 6-7.
SCHAAF 1984, p. 106-107, figs. 1-5.
SANFILIPPO & RIEDEL 1985, p. 591, figs. 5.2a-e.
SCHAAF 1985, p. 266.
AITA & OKADA 1986, p. 108, pl. 1, fig. 5.
DE WEVER et al. 1986, pl. 6, figs. 3-4.
AITA 1987, p. 63.
PAVSIC & GORICAN 1987, p. 22, pl. 2, fig. 2.
OZVOLDOVA & PETERCAKOVA 1987, pl. 31, fig. 2.
OZVOLDOVA 1988, pl. 3, fig. 7.
DANELIAN 1989, p. 130, pl. 1, figs. 9-11.
TUMANDA 1989, p. 34, pl. 2, fig. 12.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 1-2, 11.
STEIGER 1992, p. 34, pl. 5, figs. 3-6.
Acanthocircus
OZVOLDOVA 1987, pl. 1, fig. 12
Acanthocircus sp. cf. *A. dicranacanthos* (SQUINABOL)
THUROW 1988, p. 396, pl. 10, fig. 4.
Acanthocircus sp. B
OZVOLDOVA & PETERCAKOVA 1992, p. 315, pl. 1, fig. 3.

Original Definition.- "Test composed of a simple sphere, not always preserved, smooth, regularly perforated with rather big circular pores. The sphere is held up by arms terminating with a pointed tip and connected to an elliptical flat ring which is symmetrical with undistorted specimens. The ring sometimes bears a protruding rim on its outer circumference and bears a spine or appendix on both extremities of the larger axis of the elliptical ring.

The spine or appendix is subdivided in two at the tip and shows all gradations, going from a simple lobe to a true and deep bifurcation with long pointed, curved or straight teeth.

There are transitional forms to the species described below where one extremity bears a simple lobate or furcate spine and the other extremity bears two separate and independent spines.

Many specimens have normal furcate spines; a few have a bell-shaped swelling, with two lateral nodes at the spine base. This swelling can be present at one extremity or both. It is possible that this swelling could serve as connection for a part of the test yet to be discovered."

Actualized Remarks.- (FOREMAN, 1975) Included here are all elliptical saturnalin rings with two blades on the outer margin and with a single bifurcated spine at each narrow end, regardless of the nature of the shell. Rare specimens (Squinabol, 1914, pl. 22, fig. 7) with a bifurcated spine at one end only are also included.

Measurements.-
Based on 5 specimens.

	HT	av.	min.	max.
D. ring along polar spines:	445	530	433	746
D. ring transversely:	250	251	220	301
D. of shell:	166	-	-	-
Lenght of spine:	120	98	61	143
Width of polar knobs:	83	-	-	-

Type Locality.- Colli Euganei, southern Venetian Alps, central Italy.

UAZones.- 10-17, late Oxf.-early Kimm. to late Val.

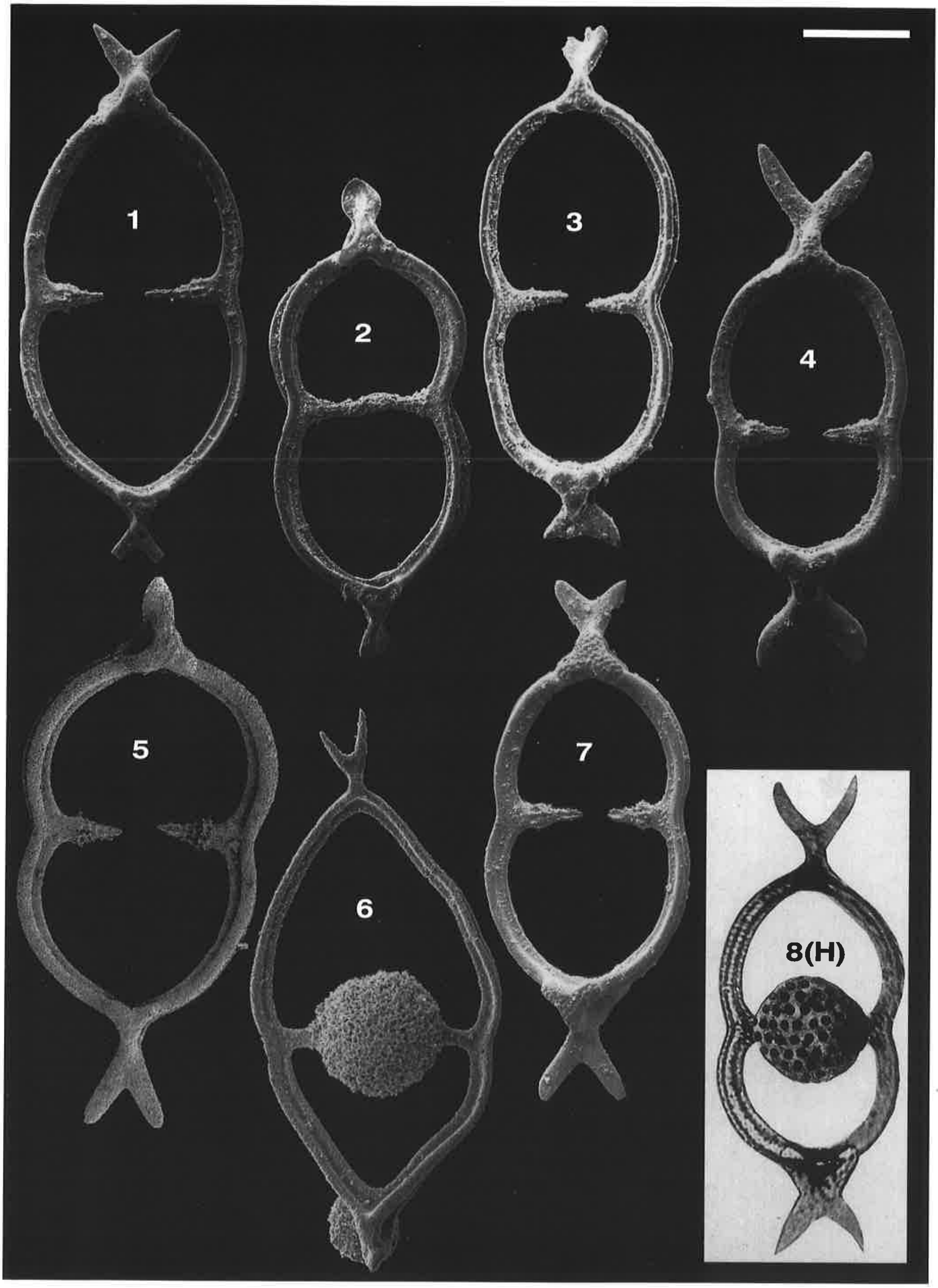


Plate 3087. ***Acanthocircus trizonalis dicranacanthos*** **(SQUINABOL), emend. FOREMAN.** Magnification x150. **Fig. 1.** DU33, Mo46. **Fig. 2.** POB79/3094, MO1 46. **Fig. 3.** POB81/0950 MO46a'. **Fig. 4.** DU11, V40. **Fig. 5.** RJ237, Bo566.5. **Fig. 6.** RJ222, Bo449.5. **Fig. 7.** DU32, Mo46. **Fig. 8(H).** SQUINABOL 1914, pl. 22, fig. 5.

ACANTHOCIRCUS TRIZONALIS TRIZONALIS — *3083*

Acanthocircus trizonalis trizonalis (RÜST)

Synonymy.-

Saturnulus dizonius RÜST
RÜST 1898, p. 8, pl. 2, fig. 3.
Saturnulus trizonalis RÜST
RÜST 1898, p. 9, pl. 2, fig. 4.
FISCHLI 1916, p. 47, fig. 52.
Acanthocircus trizonalis (RÜST) (?)
FOREMAN 1973b, p. 261, pl. 4, figs. 6-8.
emend. FOREMAN 1975, p. 610, pl. 2D, fig. 3 only.
FOREMAN 1978, p. 744, pl. 1, fig. 9.
Spongosaturnalis amissus (SQUINABOL)
? MOORE 1973, p. 824, pl. 3, fig. 2.
Acanthocircus amissus (SQUINABOL)
DONOFRIO & MOSTLER 1978, p. 23, pl. 1, figs. 1, 10; pl. 5, figs. ? 1, 3, 4, ? 6, ? 9, not 2; pl. 6, figs. 4, ? 6, not 8, 11.
STEIGER 1992, p. 34, pl. 5, fig. 7.
Acanthocircus trizonalis (RÜST)
DE WEVER & THIEBAULT 1981, p. 584, pl. 2, fig. 16.
SCHAAF 1981, p. 431, pl. 16, fig. 1.
ORIGLIA-DEVOS 1983, p. 61, pl. 4, figs. 6- 7.
SCHAAF 1984, p. 155, fig. 5.
SANFILIPPO & RIEDEL 1985, p. 592, fig. 1c only.
PAVSIC & GORICAN 1987, p. 23, pl. 2, fig. 3.
THUROW 1988, p. 396, pl. 10, fig. 2.
Acanthocircus sp.
SCHAAF 1981, p. 431, pl. 7, fig. 7.
THUROW 1988, p. 396, pl. 10, fig. 1.

Original Definition.- "The external shell is much less elliptical than that of the species *S. dizonius* but with the same small irregularly arranged pores, which can be seen also on the internal small and very elliptical test. The two bodies connecting the two central shells seem to be rather big and globose, also covered with small pores. The two less strong, very short polar spines divide into three arms, of which two form the long elliptical ring and the third forming a much shorter bow from one to the other polar side. The polar sides of the bow ring bear a three-branched body, on which the protruding branch is slightly inflated, while the other two branches are posed on the ring. This dark coloured, opaque body has a central, three-rayed portion filled with a strongly light-braking, siliceous material."

Remarks.- Only forms with a distinctive triangular thickened knob at the base of spines are here assigned to this morphotype. Pictures taken in transmitted light are excluded from the synonymy if this characteristic feature is not clearly recognizable.

Type Locality.- Siliceous calcareous sediments of Cittiglio, North Italy.

UAZones.- 8-11, mid Call.-early Oxf. to late Kimm.-early Tith.

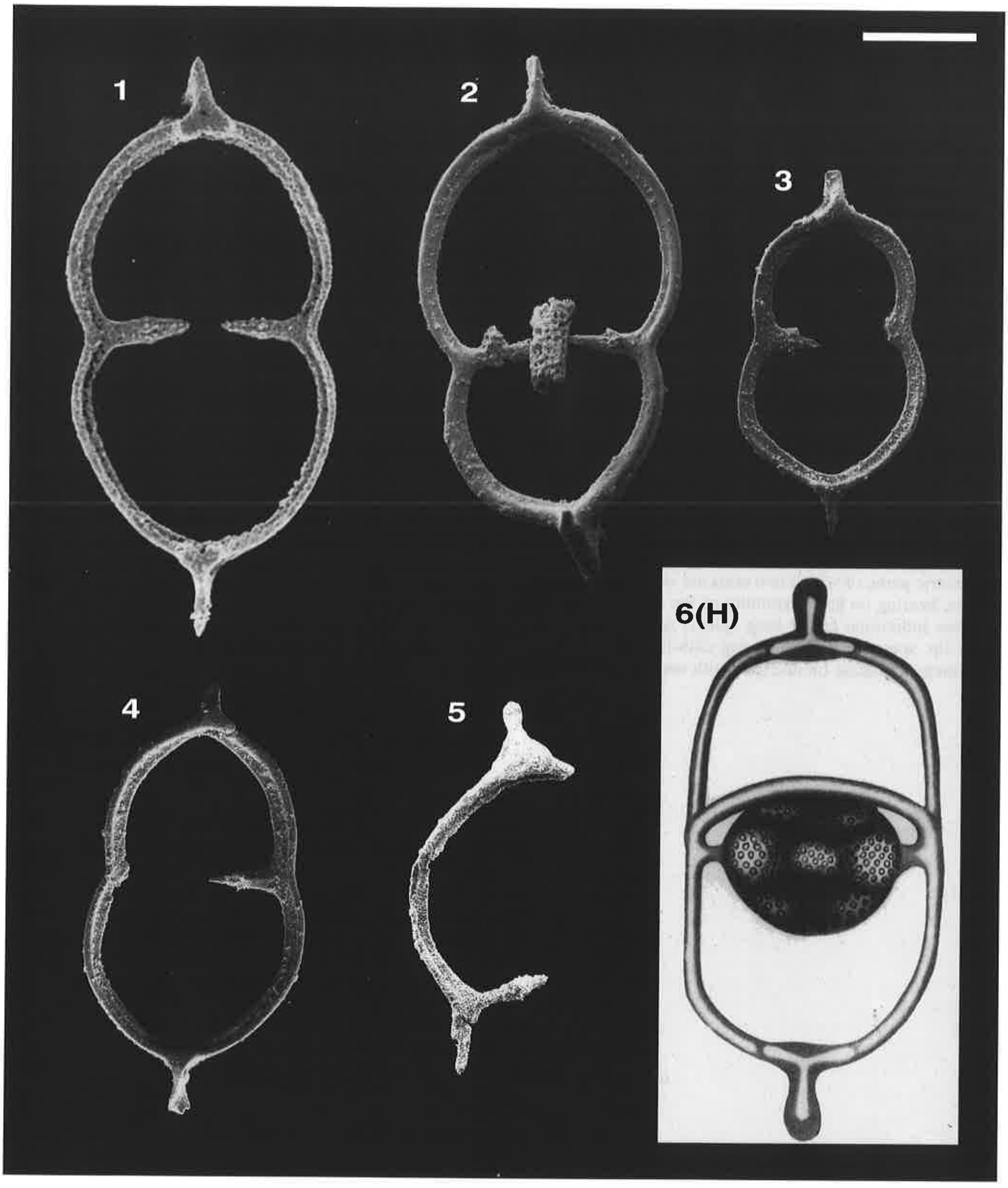


Plate 3083. *Acanthocircus trizonalis trizonalis* (RÜST). Magnification x150. **Fig. 1.** GO86/56/9, VS3. **Fig. 2.** DU73, V40. **Fig. 3.** DU53, Mo46. **Fig. 4.** DU56, Mo46. **Fig. 5.** POB78/8117, POB986.52. **Fig. 6(H),** RÜST 1898, pl. 2, fig. 4.

ACANTHOCIRCUS VARIABILIS 5011

Acanthocircus variabilis (SQUINABOL)

Synonymy.-
Saturnalis variabilis SQUINABOL
SQUINABOL 1914, p. 291, pl. 22, fig. 8, not 9.
Acanthocircus sp. aff. *S. variabilis* SQUINABOL
FOREMAN 1973b, p. 261, pl. 5, figs. 4-5.
Acanthocircus carinatus FOREMAN
MOORE 1973, p. 824, fig. 2, not 1, 3.
FOREMAN 1973b, p. 260, pl. 5, fig. 1, not 2.
RIEDEL & SANFILIPPO 1974, p. 775, pl. 2, fig. 1, not: 2.
FOREMAN 1975, p. 610, pl. 2C, fig. 9, pl. 4, fig. 12; not pl. 2C, fig. 8.
Acanthocircus variabilis (SQUINABOL)
DONOFRIO & MOSTLER 1978, p. 32, pl. 3, figs. 6, 10; pl. 6, figs. 5-7.
JUD 1994, p. 60, pl. 2, figs. 12-13.
Acanthocircus carinatus FOREMAN
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 5.

Original Definition.- "Form rather frequent at Cittiglio, consisting of a flat, regular ring, divided into two symmetric parts, of which two arms are carrying the central sphere, bearing on each extremity of the maximal axis two to three individual rather long spines, terminating with a blunt tip, sometimes even having club-like shapes. Some specimens terminate on one side with two, on the opposite side with three of such club-like spines, which shows that the double- or triple-spine-tips must be considered as simple varieties."

Original Remarks.- "The differences in length of the minor axes of the two specimens (figs. 8-9) are only a consequence of a lateral compression due to fossiliziation, which is also reported not only by the median spine-tips pushed towards each other but also by the position of the spines on a different height-level (compared to the plane ring), which would finally negate the spine's equality."

Remarks.- In agreement with Donofrio & Mostler (1978) we include in this species only forms with two spines at each end of the ring.

Measurements (in μm).-
Holotype (pl 22, fig. 8) length of the maximal axis 555, length of the minimal axis 305, length of the branches 98-110, length of the spines 118-125. Paratype (pl. 22 fig. 9) maximal axis 555, minimal axis 220, branches 91, spines 86-100.

Type Locality.- Colli Euganei, southern Venetian Alps, central Italy.

UAZones.- 17-20, late Val. to late Haut.

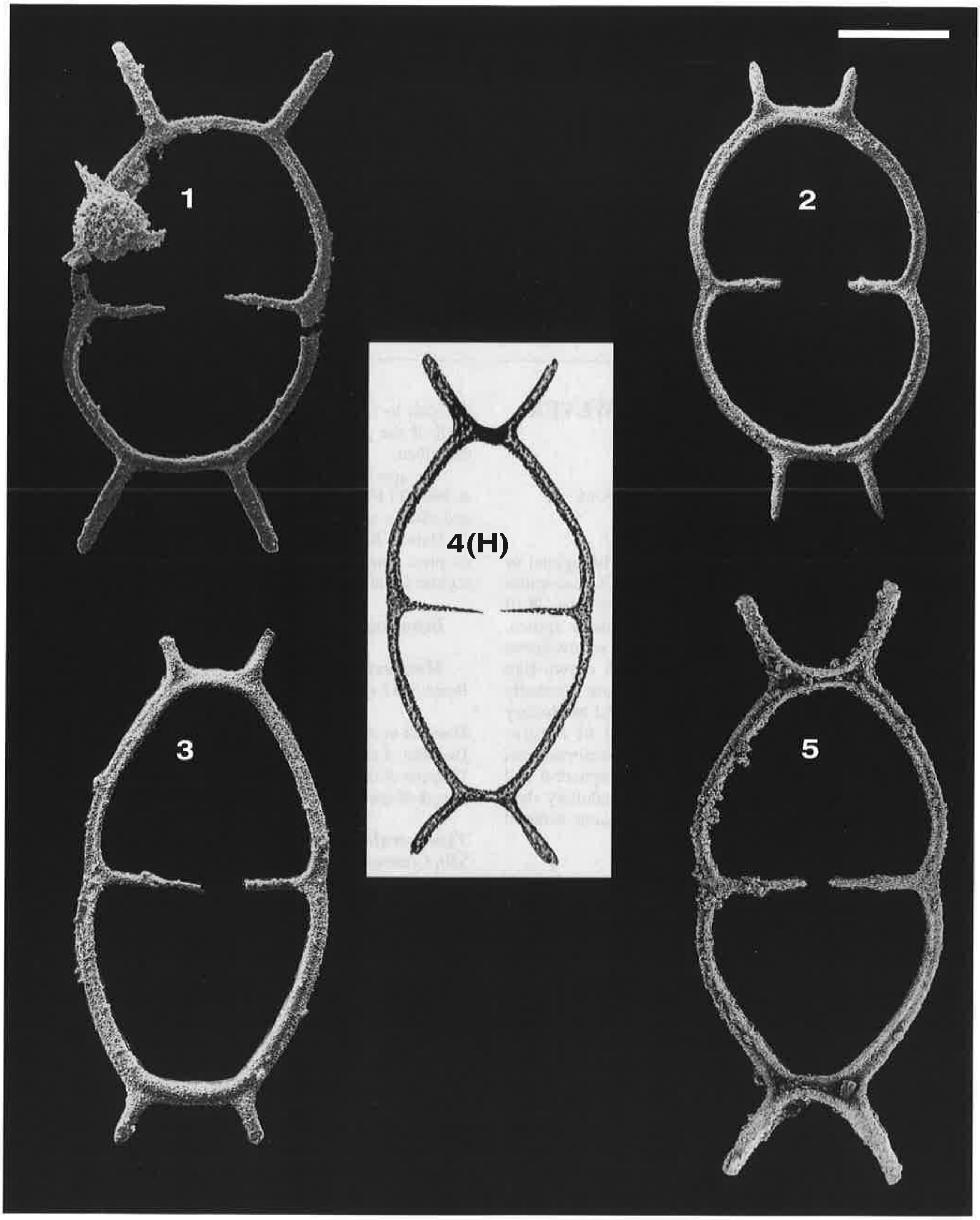


Plate 5011. *Acanthocircus variabilis* (SQUINABOL). Magnification x150, **Fig. 1.** RJ80, Ru146.5. **Fig. 2.** RJ2405, Ru135.5. **Fig. 3.** RJ2427, Ru135.5, **Fig. 4(H).** SQUINABOL 1914, pl. 22, fig. 8 **Fig. 5.** RJ236, Bo566.5.

ACTINOMMA 3820

Genus: *Actinomma* HAECKEL

Synonymy.-
Actinomma HAECKEL 1862
HAECKEL 1862, p. 404.

Type Species.- *Haliomma trinacrium* HAECKEL 1860.

Original Definition.- "Skeleton consisting of three concentric, sphaerical or ellipsoidal, undivided, latticed shells which are connected to each other by radial beams. The two inner (medullary) shells are inside, the outer (cortical) shell is located outside the central capsule."

Etymology.- *Actis* (Greek): beam, *omma* (Greek): eye.

Included Taxa.-
2008 *Actinomma siciliensis* KITO & DE WEVER

ACTINOMMA SICILIENSIS 2008

Actinomma siciliensis KITO & DE WEVER

Synonymy.-
Actinomma siciliensis KITO & DE WEVER
KITO & DE WEVER 1994, p. 128, pl. 2 fig. 8-14; pl. 3 figs. 3a-b, 4.

Original Definition.- Cortical shell with hexagonal or pentagonal pore frames and triradiate spines. Radial spines are variably developed, 15 to 20 on hemisphere. Well preserved specimens present pointed triradiate spines, sometimes circular in section distally. Robust specimens possess relatively long strong spines, with crown-like structure at tip. All spines on cortical shell are internally connected to fine beams joining cortical and medullary shells. Outer medullary shell composed of regular hexagonal or pentagonal pore frames of uniform size, supported by fine beams. Microsphere is polyhedral and composed of pentagonal pore frames. Inner medullary shell is connected to the outer one by thin radial beams, some of which reach the cortical shell.

Original Remarks.- The robust form may be a mature stage. The species might possibly be assigned to *Astrocentrus* KOZUR & MOSTLER (1979); it is, however, difficult to recognize *Astrocentrus* because the medullary shell of the genus was not illustrated when the genus was described.

The species differs from *Astrocentrus pulcher* KOZUR & MOSTLER (1979) by its cortical shell with larger pores and shorter spines. It differs from Gen. sp. indet HATTORI (in Hattori & Sakamoto, 1989, pl. 45, fig. J) by its size and its pore pattern (which is irregular for *A. siciliensis* and regular for Hattori's morphotype).

Etymology.- From the name of the type locality, Sicily.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
Diameter of cortical shell:	153	174	85	247
Diameter of medullary shell:	-	55	47	65
Diameter of microsphere:	-	20	20	20
Length of spine:	151	58	32	105

Type Locality.- Middle Jurassic; samples S66, S68, S69, S70, Contrada La Ferta, Sicily (Italy).

UAZones.- 1-4, early-mid Aal. to late Baj.

acus >> *PSEUDOEUCYRTIS ACUS* 5572

acutipodium >> *PSEUDOPOULPUS ACUTIPODIUM* 2007

adrianae >> *MILAX ADRIANAE* 5453

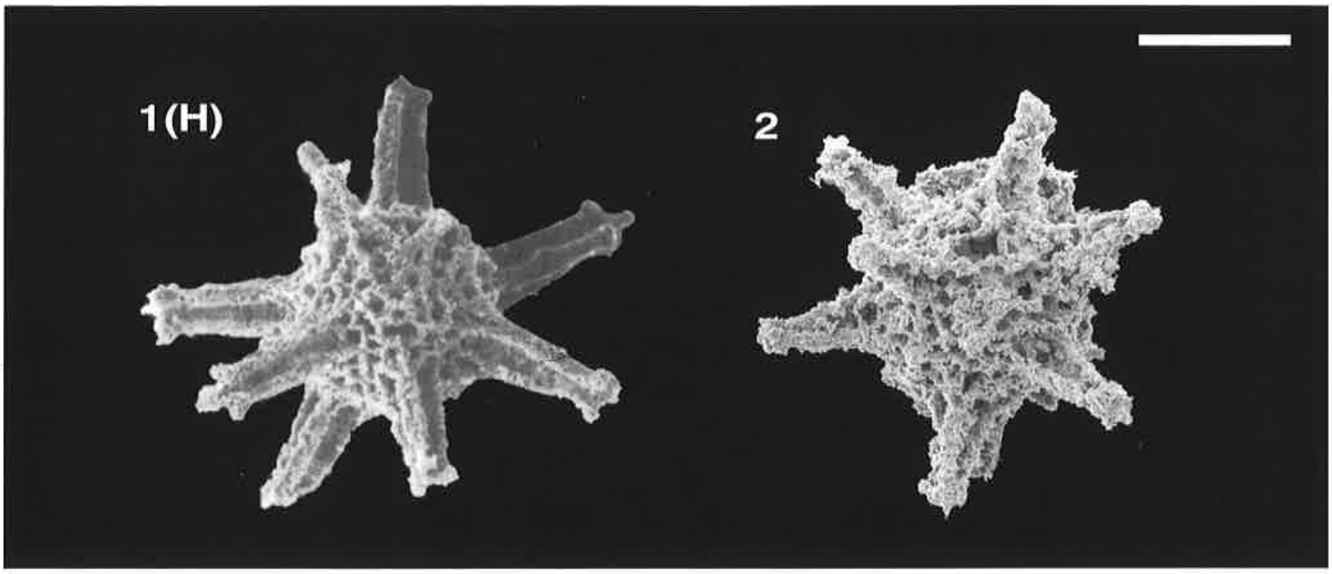


Plate 2008. ***Actinomma siciliensis*** **KITO & DE WEVER.** Magnification x200. **Fig. 1(H).** KITO & DE WEVER 1994, pl. 2, fig.10. **Fig. 2.** AB 0002, TM48.35.1/4.

adriani >> *PSEUDOCRUCELLA ADRIANI* *3129*

agolarium >> *SYRINGOCAPSA AGOLARIUM* *3291*

alievi >> *XITUS (?) ALIEVI* *5674*

ALIEVIUM 3603

Genus: *Alievium* PESSAGNO emend. FOREMAN

Synonymy.-
Alievium PESSAGNO
PESSAGNO 1972, p. 297.
FOREMAN 1973b, p. 262.

Type Species.- *Theodiscus superbus* SQUINABOL 1914.

Original Definition.- Test triangular to subtriangular lacking tholi. Three primary spines occurring in corners of triangular or subtriangular test; variable number of secondary spines occurring peripherally or on sides of test; sometimes extending from nodes. Meshwork generally quite coarse, massive, uniform size throughout.

Original Remarks.- Differs from *Pseudoaulophacus* PESSAGNO by lacking tholi and by possessing meshwork of relatively uniform size. *Alievium* is possibly ancestral to *Pseudoaulophacus* PESSAGNO.

Actualized Definition.- (FOREMAN, 1973b) *Alievium* is here emended to include circular as well as triangular forms.

Remarks.- Species are differentiated by a combination of size range, inflation of test and shape of primary spines in axial section.

Etymology.- *Alievium* is named after K. S. Aliev in honour of his contribution to the study of the Cretaceous Radiolaria of the USSR.

Included Taxa.-
3228 *Alievium helenae* SCHAAF
4004 *Alievium* sp. A

ALIEVIUM HELENAE 3228

Alievium helenae SCHAAF

Synonymy.-
Alievium sp.
FOREMAN 1973b, p. 262, pl. 9, figs. 1-2.
MATSUYAMA et al. 1982, pl. 1, fig. 8.
OZVOLDOVA & SYKORA 1984, p. 261, pl. 1, fig. 8.
AITA & OKADA 1986, p. 1, fig. 9.
OZVOLDOVA 1987, pl. 1, fig. 7.
Alievium spp.
FOREMAN 1975, p. 613, pl. 2D, figs. 7-8; pl. 5, fig. 14.
Alievium sp. A
PESSAGNO 1977b, p. 29, pl. 3, figs. 10, 18.
KANIE et al. 1981, pl. 1, fig. 4.
Alievium helenae SCHAAF
BAUMGARTNER et al. 1980, p. 49, pl. 1, fig. 8.
KOCHER 1981, p. 53, pl. 12, fig. 6.
SCHAAF 1981, p. 431, pl. 7, fig. 9; pl. 10, figs. 2a-b.
AOKI 1982, pl. 2, fig. 3.
ORIGLIA-DEVOS 1983, pl. 13, figs. 6-7, 10.
BAUMGARTNER 1984, p. 755, pl. 1, figs. 8-10.
SCHAAF 1984, p. 112-113, figs. 1-3b.
DE WEVER et al. 1986, pl. 6, fig. 10.
PAVSIC & GORICAN 1987, p. 23, pl. 2, fig. 9.
KITO 1987, pl. 1, fig. 9.
TAKETANI 1987, pl. 1, fig. 2.
IGO et al. 1987, text-fig. 2.13.
TUMANDA 1989, p. 34, pl. 1, fig. 9
OZVOLDOVA & PETERCAKOVA 1992, pl. 2, figs. 2, 7.
JUD 1994, 61, pl. 3, fig. 1.

Original Definition.- Test subspherical with three stout spines which are three-bladed, the three blades becoming much wider at their edges so as to be trefoil in section. Meshwork consisting of large equilateral triangular pore frames. Small secondary spines, circular in transverse section, arise from the nodes of the triangular meshwork.

Original Remarks.- This species differs from *A. superbus* by having a more globular test with fewer triangular pores covering its surface, by being circular in outline and by having three bladed spines trefoil in section.

Etymology.- This species is named in memory of Helen P. Foreman, in honor of her contributions to the study of Mesozoic Radiolaria.

Measurements (in μm).-
Based on 11 specimens. Min. diameter of skeleton 145; its max. diameter (without spines) 195, min. length of spines 105, their max. length 210.

Type Locality.- DSDP Leg 62, Site 463, Mid-Pacific Mountains.

UAZones.- 11-22, late Kimm.-early Tith. to late Barr.-early Apt.

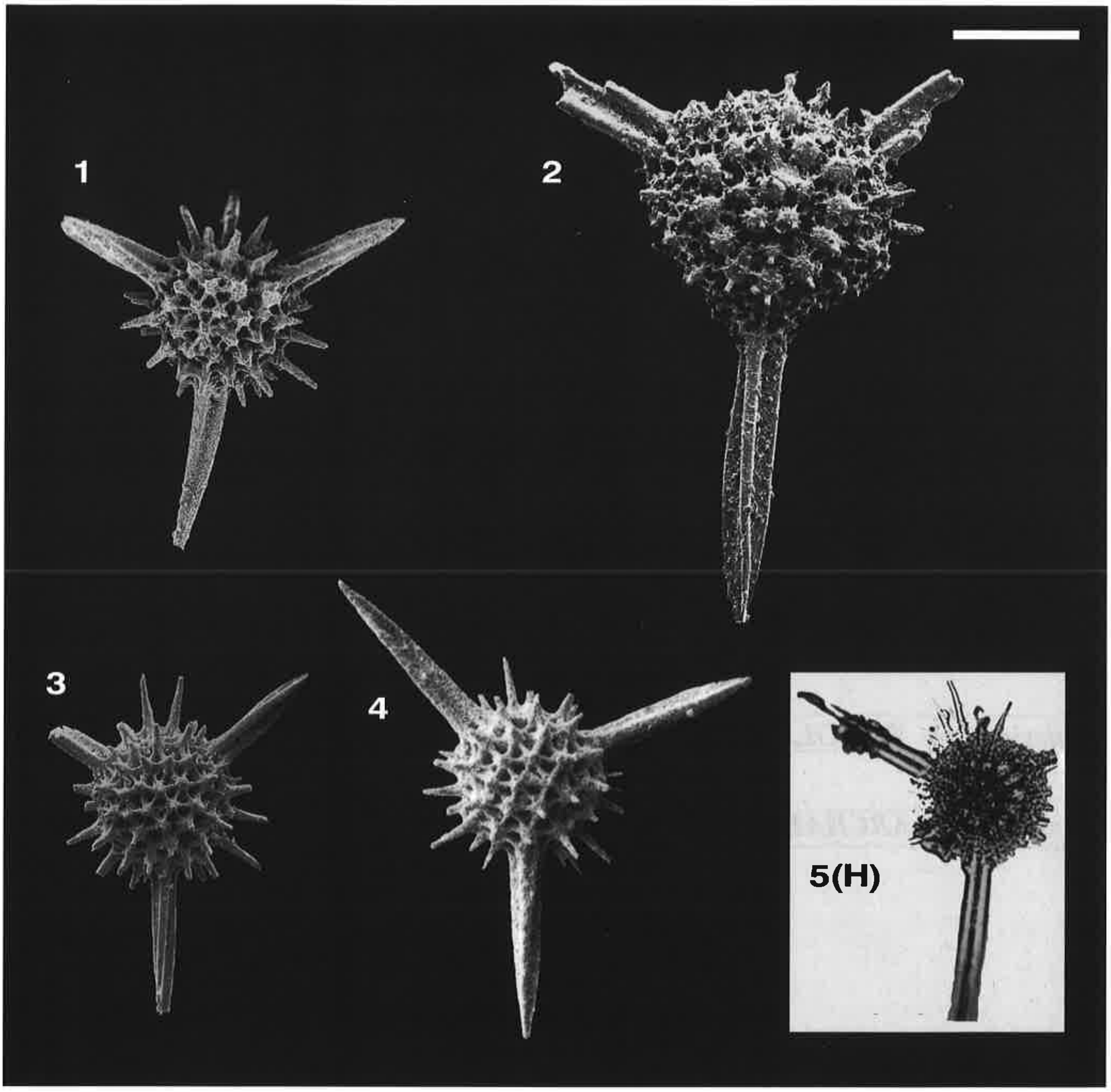


Plate 3228. ***Alievium helenae*** **SCHAAF.** Magnification x200. **Fig. 1.** RJ141, Br141.55. **Fig. 2.** POB79/0158, MO22. **Fig. 3.** DU1148, V40. **Fig. 4.** RJ1827, Ru135.5. **Fig. 5(H).** SCHAAF 1981, pl. 10, fig. 2a.

ALIEVIUM | A 4004

Alievium sp. A

Synonymy.-
Alievium (?) sp. A
CONTI & MARCUCCI 1991, p. 793, pl. 1, fig. 6.

Original Definition.- Flattened sub-triangular shell, with three primary spines. Variable number of secondary spines radiating from nodosities. Meshwork consisting of four rounded pores comprised of bars connected to massive nodes at vertices.

UAZones.- 8-9, mid Call.-early Oxf. to mid-late Oxf.

altiforamina >> STICHOCAPSA ALTIFORAMINA 5761

altissima >> RISTOLA ALTISSIMA ALTISSIMA 3241

altissima >> RISTOLA ALTISSIMA MAJOR 3238

altissima >> RISTOLA ALTISSIMA S.L. 3164

amabilis >> ARCHAEODICTYOMITRA (?) AMABILIS 3237

AMPHIPYNDAX 3605

Genus: *Amphipyndax* FOREMAN emend. EMPSON-MORIN

Synonymy.-
Amphipyndax FOREMAN
FOREMAN 1966, p. 355.
EMPSON-MORIN 1982, p. 508.

Type Species.- *Amphipyndax enesseffi* FOREMAN 1966; junior synonym of *Lithostrobus pseudoconulus* PESSAGNO 1963.

Original Definition.- Lithocampids in which the cephalis is divided into two chambers by a relatively thick, transverse partial septum; the upper of these chambers usually considerably larger than the lower.

Actualized Remarks.- (EMPSON-MORIN, 1982) Test conical, multicyrtid. Cephalis subspherical, small, generally imperforate, without horn. Thorax subtrapezoidal, often smaller than cephalis, imperforate to sparsely perforate. Post-abdominal chambers subtrapezoidal to subelliptical with small subcircular pores arranged into variable number of transverse rows. Most post-abdominal chambers covered with secondary layer of shell material, structurally distinct from underlying layer and forming regularly to irregularly disposed, interconnecting ridges over surface of test which may or may not be locally thickened into nodes.

Remarks.- It is necessary to use transmitted light to determine the cephalic structure of specimens.

Etymology.- Greek. *amphi* = double, *pyndax* = bottom of a vessel (masculine).

Included Taxa.-
4005 *Amphipyndax durisaeptum* AITA
2025 *Amphipyndax tsunoensis* AITA

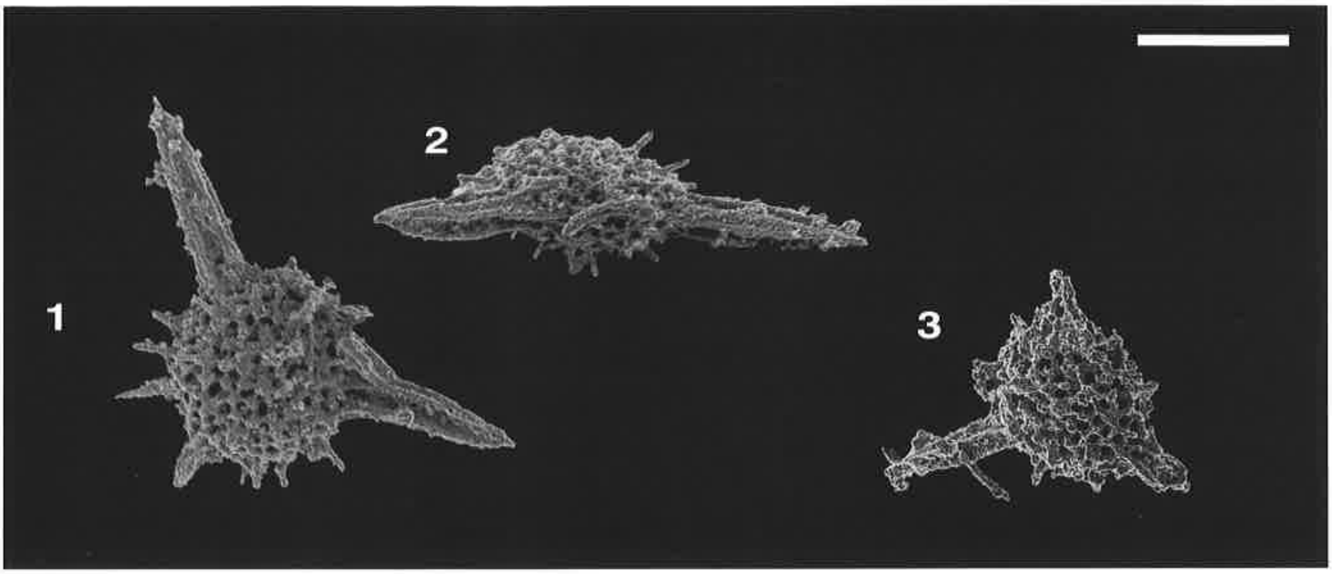


Plate 4004. *Alievium* sp. A. Magnification x150. **Fig. 1.** MC10/02, GR6. **Fig. 2.** MC11/02, GR6. **Fig. 3.** MC07/53, GR6.

AMPHIPYNDAX DURISAEPTUM 4005

Amphipyndax durisaeptum AITA

Synonymy.-
Amphipyndax sp.
ISHIDA 1983, pl. 6, fig. 2.
Amphipyndax durisaeptum AITA
AITA 1987, p. 69, pl. 1, figs. 9-10; pl. 9, figs. 2-3.

Original Definition.- Cylindrical spool-like shell with six to seven segments; Cephalis small, dome-shaped, poreless, smooth surface with an apical horn. Collar stricture distinct. Thorax and abdomen trapezoidal in shape, with horizontally spaced small pores. Post abdominal segments cylindrical with three rows of hexagonal to rarely pentagonal pore frames. Pores small, circular. Closed terminal segments hemispherical. Post-abdominal segments, externally, with weakly developed circumferential ridges, and, internally, thick, stout septa at segments joints.

Original Remarks.- This new species appears to have been included in those morphotypes belonging to the genus *Parvicingula* PESSAGNO because of the possession of circumferential ridges on post-thoracic segments. However, this species should be refered to the genus *Amphipyndax* because it has a distinctive two-chambered cephalis (pl. 1, fig. 9 of Aita, 1987) which is divided by the ring-like septum.

Remarks.- This species differs from many species of *Amphipyndax* by having a closed distal end. This species is distinguished from *Amphipyndax tsunoensis* AITA by having a less inflated last segment and by possessing circumferential ridges.

Etymology.- The specific name is derived from the Latin adjective *durus,* stout hard and noun *saeptum,* wall.

Measurements (in μm).-
Based on 6 specimens.

	HT	max.	min.	av.
Height of last segment:	45	45	38	39
Overall height:	183	183	150	167
Maximum width:	85	85	70	77

Type Locality.- Sample IRZ-50, Irazu Valley section IV, Irazuyama Formation (=Togano Group), Kochi Prefecture, Southwest Japan.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

AMPHIPYNDAX TSUNOENSIS 2025

Amphipyndax tsunoensis AITA

Synonymy.-
Amphipyndax tsunoensis AITA
AITA 1987, p. 69, pl. 1 figs. 11-12; pl. 9, fig. 4-5.

Original Definition.- Shell of six to seven segments, conical, except for terminal segment which closes, rarely has a small aperture, and has a inverted two-thirds spherical shape. Cephalis push-button like, poreless and smooth without an apical horn. Cephalic cavity divided into two chambers by a transverse annular septum, the upper compartment subspherical, the lower cylindrical with four collar pores. Internal collar structures visible in well-preserved specimens; a vertical spine extends upward from median bar to inner wall of thorax. Thorax and post-thoracic segments trapezoidal in outline except for final segment. (collar stricture slightly developed. No distinct strictures between adjoining post-thoracic segments which gradually increase its width except for last one. Thoracic pores small, poorly developed. Pores of post-thoracic segments small, circular, arranged in transverse rows and set in hexagonal pore frames.

Original Remarks.- This new species is distinguished from *Amphipyndax durisaeptum* n.sp. by having an inflated, inverted spherical last segment, and by lacking weakly developed circumferential ridges in external view and having thick, stout septa at adjoining segments in internal view.

Etymology.- This species is named for Higashitsuno Village, Kochi Prefecture, Shikoku, Japan.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Height of last segment:	78	69	68	69
Overall height:	198	202	165	202
Maximum width:	105	104	88	104

Type Locality.- Holotype- pl. 9, fig. 4 (IGPS 99610), sample IRZ-50, Isazuyama Formation, Irazu Valley section IV, Japan.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

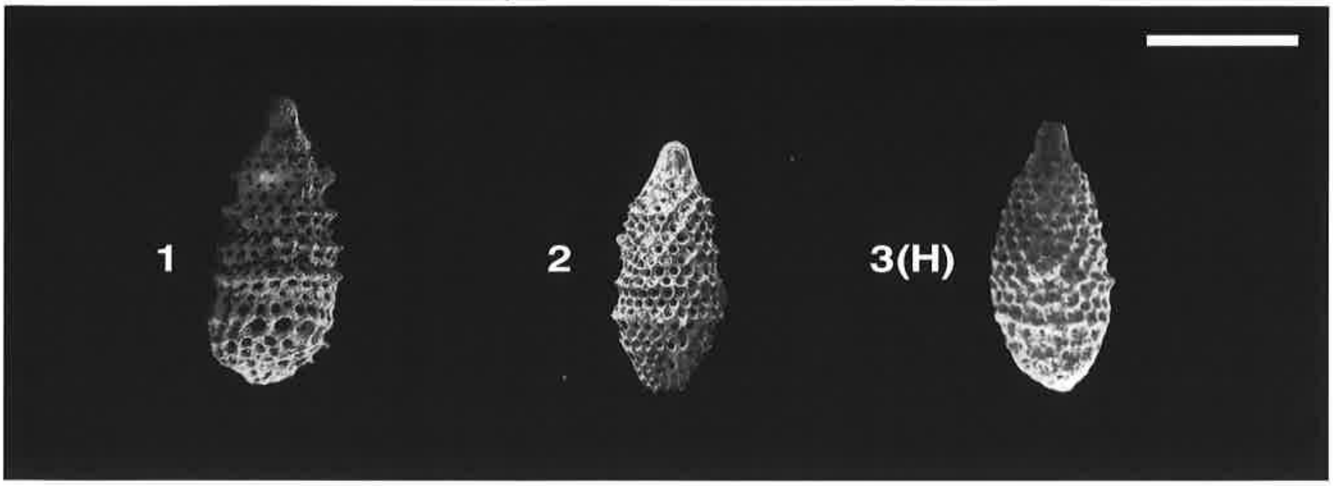


Plate 4005. *Amphipyndax durisaeptum* AITA. Magnification x200. **Fig. 1.** MA1312, S-06. **Fig. 2.** POB81/2802, 534.124.1.52. **Fig. 3(H).** AITA 1987, pl. 9, fig. 2.

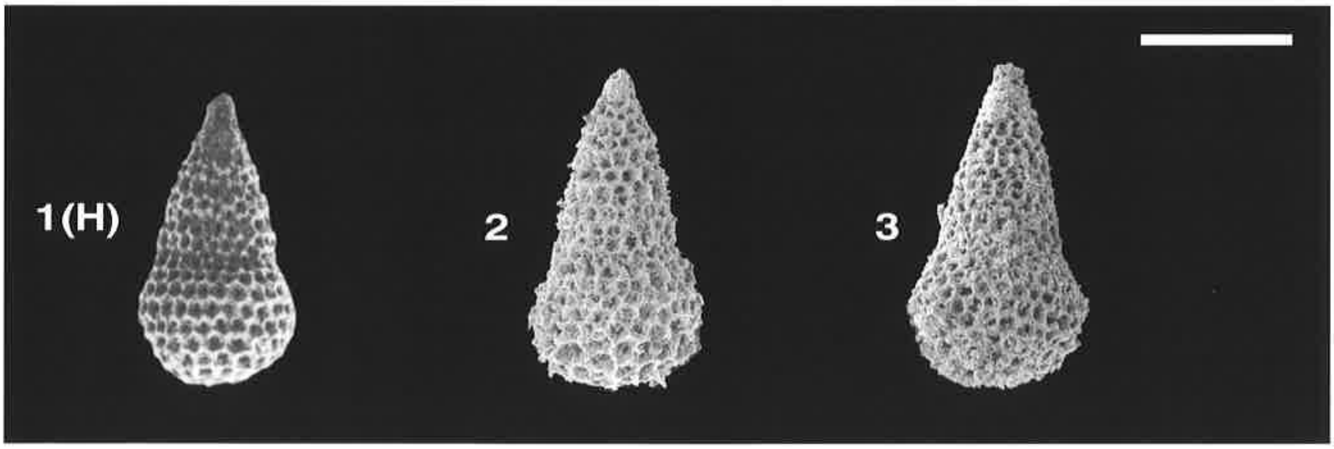


Plate 2025. *Amphipyndax tsunoensis* AITA. Magnification x200. **Fig. 1(H)**. AITA 1987, pl. 9 fig. 4. **Fig. 2.** AB 4344, TM168.15g35. **Fig. 3.** AB 4352, TM168.15g43.

amphitreptera >> *PODOCAPSA AMPHITREPTERA* 3171

amphorella >> *ARTOCAPSA (?) AMPHORELLA* 3924

ANGULOBRACCHIA 3607

Genus: *Angulobracchia* BAUMGARTNER

***Synonymy*.-**
Angulobracchia BAUMGARTNER 1980, p. 310.

***Type Species*.-** *Paronaella* (?) *purisimaensis* PESSAGNO 1977a.

***Original Definition*.-** Test as with subfamily with 3 rays, without bracchiopyle. Lateral external beams of top and bottom sides parallel or distally diverging to form broadening or thickening rays. Ray tips expanded bulbous or wedge-shaped sometimes with tubular bracchiopyle-like extensions, or porous spines on all 3 rays. Central area of equal thickness as ray tips.

***Original Remarks*.-** This genus differs from *Halesium* in the lack of a true hollow bracchiopyle.

***Etymology*.-** Latin: *angulo-*, angular; *bracchium*, arm-form with angular arms.

***Included Taxa*.-**
3145 *Angulobracchia biordinalis* OZVOLDOVA
3147 *Angulobracchia digitata* BAUMGARTNER
6121 *Angulobracchia* (?) *portmanni* gr. BAUMGARTNER
3285 *Angulobracchia* (?) *portmanni portmanni* BAUMGARTNER
3144 *Angulobracchia purisimaensis* (PESSAGNO)
3911 *Angulobracchia* (?) *rugosa* JUD
3301 *Angulobracchia sicula* KITO & DE WEVER
4006 *Angulobracchia* sp. B

ANGULOBRACCHIA BIORDINALIS 3145

Angulobracchia biordinalis OZVOLDOVA

***Synonymy*.-**
Angulobracchia sp. aff. *A. digitata* BAUMGARTNER
BAUMGARTNER 1980, p. 312, pl. 10, fig. 15.
Angulobracchia biordinale OZVOLDOVA
OZVOLDOVA & SYKORA 1984, p. 262, pl. 2, figs. 1-7; pl. 16, figs. 1, 2.
OZVOLDOVA 1988, pl. 1, fig. 10.
DANELIAN 1989, p. 140.
WIDZ 1991, p. 243, pl. 1, fig. 17.
Halesium digitatum (BAUMGARTNER)
DE WEVER et al. 1986, pl. 8, fig. 10.
ORIGLIA-DEVOS 1983, pl. 10, fig. 10 only.
Halesium sp. aff. *Angulobracchia digitata* BAUMGARTNER
DE WEVER & CORDEY 1986, pl. 1, fig. 15.

***Original Definition*.-** Three short rays bulbous at their ends arising from a small central area. The ray tips end in tubular bracchiopyle-like extensions with small spines on their sides. Lateral sides of the rays are concave, the edge of connection is sharp. The meshwork of the top and the bottom ray sides consists of two longitudinal rows of large pores. Three horizontal rows of pores are on their lateral sides. The test consists of three short rays arising from a small central area. The rays distinctly widen to a bulbous shape at their ends and end in tubular bracchiopyle-like extensions. On both sides of the extensions relics of thin, short lateral spines can be observed. The meshwork of the top and bottom side of the rays is composed by three equally prominent beams connected by transverse bars. This way, two longitudinal rows of large pores are formed on each ray. Meshwork nodes are distinctly prominent. The central area meshwork forms smaller, concentrically arranged pores, sometimes with a large pore in the centre. The meshwork on the ray widened ends and on the tubular bracchiopyle-like extensions forms linear rows of smaller pores of a subhexagonal shape. The ray bulbous endings are 2.5 times wider than the rays. The rays lateral sides are concave, with three horizontal rows of smaller circular pores (pl. 2, figs. 3-6).

***Remarks*.-** Specific name is changed from *biordinale* to *biordinalis* according to the feminine generic name.

***Etymology*.-** Latin *ordinalis* - of a row; after the two-rowed pore meshwork on the rays.

Measurements (in μm).-
Based on 5 specimens.

	HT	min.	max.
Length of rays:	200-220	200	240
Width of rays:	45	45	60
Width of ray ends:	110	110	150
Width of extensions:	55	50	65

***Type Locality*.-** The Sipkovky Haj, the Cachticke Karpaty Mountains.

***UAZones*.-** 9-11, mid-late Oxf. to late Kimm.-early Tith.

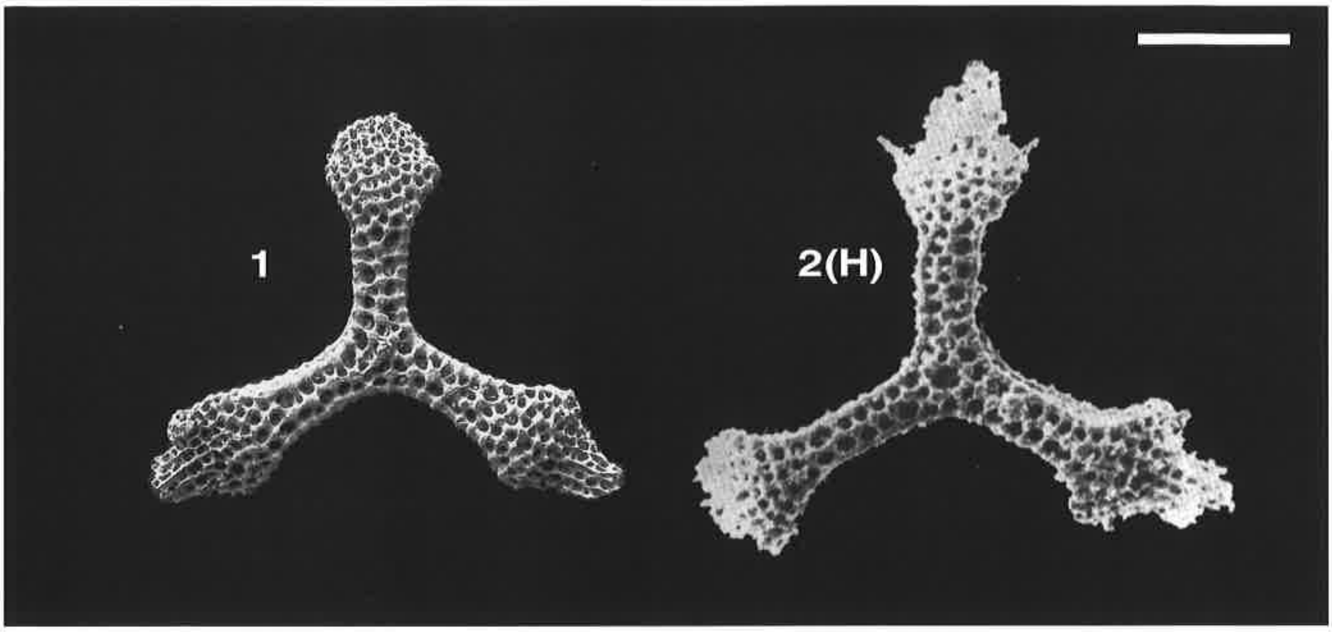


Plate 3145. ***Angulobracchia biordinalis*** **OZVOLDOVA.** Magnification x150. **Fig. 1.** POB78/8216, POB986.51. **Fig. 2(H).** OZVOLDOVA & SYKORA 1984, pl. 2, fig. 3.

ANGULOBRACCHIA DIGITATA 3147

Angulobracchia digitata BAUMGARTNER

Synonymy.-
Angulobracchia digitata BAUMGARTNER
BAUMGARTNER 1980, p. 310, pl. 10, figs. 18-22; pl. 12, fig. 11.
KOCHER 1981, p. 55, pl. 12, fig. 11.
ISHIDA 1985, pl. 2, fig. 3.
DANELIAN 1989, p. 140, pl. 1-2, fig. 12.
WIDZ 1991, p. 243, pl. 1, figs. 8-10.
Halesium digitatum (BAUMGARTNER)
? ORIGLIA-DEVOS 1983, p. 88, pl. 10, fig. 12, not fig. 10.

Original Definition.- Relatively small form with short rays and spherical bulbous tips with long, porous, cylindrical extensions on all 3 rays. Meshwork between lateral beams irregular, usually with 2 irregular pore rows. Some forms have a depressed central area with small irregular pores, some are nodose . Ray tips have equally distributed fine pores. The centrally placed cylindrical extensions are composed of 6 to 12 longitudinal beams connected by bars forming rows of small pores. They reach the width and the length of the rays (when entirely preserved). Inner structure of extensions spongy layered as the whole test.

Original Remarks.- This species differs from the other *Angulobracchia* spp. in its short rays and long, cylindrical extensions.

Etymology.- Latin: *digitatus, a, um*, fingered.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
Length of rays AX:	175	176	140	233
Length of rays BX:	190	-	-	-
Length of rays CX:	170	-	-	-
Width of rays:	40	39	36	47
Width of ray tip:	64	72	47	100
Width of extension:	44	48	36	68
Length of longest ext.:	125	-	125	154

Type Locality.- Locality A of Baumgartner (1980); Argolis Peninsula (Peloponennesus, Greece).

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

ANGULOBRACCHIA (?) PORTMANNI S.L. 6121

Angulobracchia (?) *portmanni* s.l. BAUMGARTNER

Synonymy.-
Angulobracchia (?) *portmanni* BAUMGARTNER
BAUMGARTNER 1984, p. 757, pl. 2, fig. 3.
Angulobracchia sp. C BAUMGARTNER
STEIGER 1992, p. 50, pl. 13, fig. 1.
Angulobracchia (?) *portmanni* gr. BAUMGARTNER
JUD 1994, p. 61, pl. 3, figs. 2-6.

Definition.- Three-rayed test. Rays composed of generally two main marginal beams to which at a certain distance from the central area other beams are added. Beams with strong nodes, connected in the proximal part of rays by a rather irregular network of bars and in the distal part by regularly disposed transverse bars, forming polygonal to subrounded poreframes. Mostly the central area, which is very narrow in face view, has only two nodes. Rays decreasing in height from the center, which is inflated, to distal ends. The latter have several longitudinal beams added around the ends of the main beams. The distal ends of rays bear several small conical spines. Little interradial patagium is sometimes developed.

Remarks.- We have included in *Angulobracchia* (?) *portmanni* gr. specimens lacking the broad central part of test covered with strong nodes, characteristic of the holotype of the species. These specimens resemble *A.* (?) *portmanni portmanni* BAUMGARTNER in lateral view, both having a rather high inflated central area. Our specimens have a maximum length of rays of 303-310 μm. The holotype of the species *Angulobracchia* (?) *heteroporata* STEIGER 1992 resembles some of our specimens with rays terminating abruptly with a stout end, lacking additional beams on ray tips and small spines. Steiger included in his species two rather different morphotypes. According to his description, both are lacking an inflated central part. Unfortunately he illustrated in lateral view only the morphotype with enlarged ray tips. Furthermore he assigned to *Angulobracchia* sp. C a specimen (pl. 13, fig. 1, 2) which seems to us to be very similar to the holotype of *Angulobracchia heteroporata.*

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

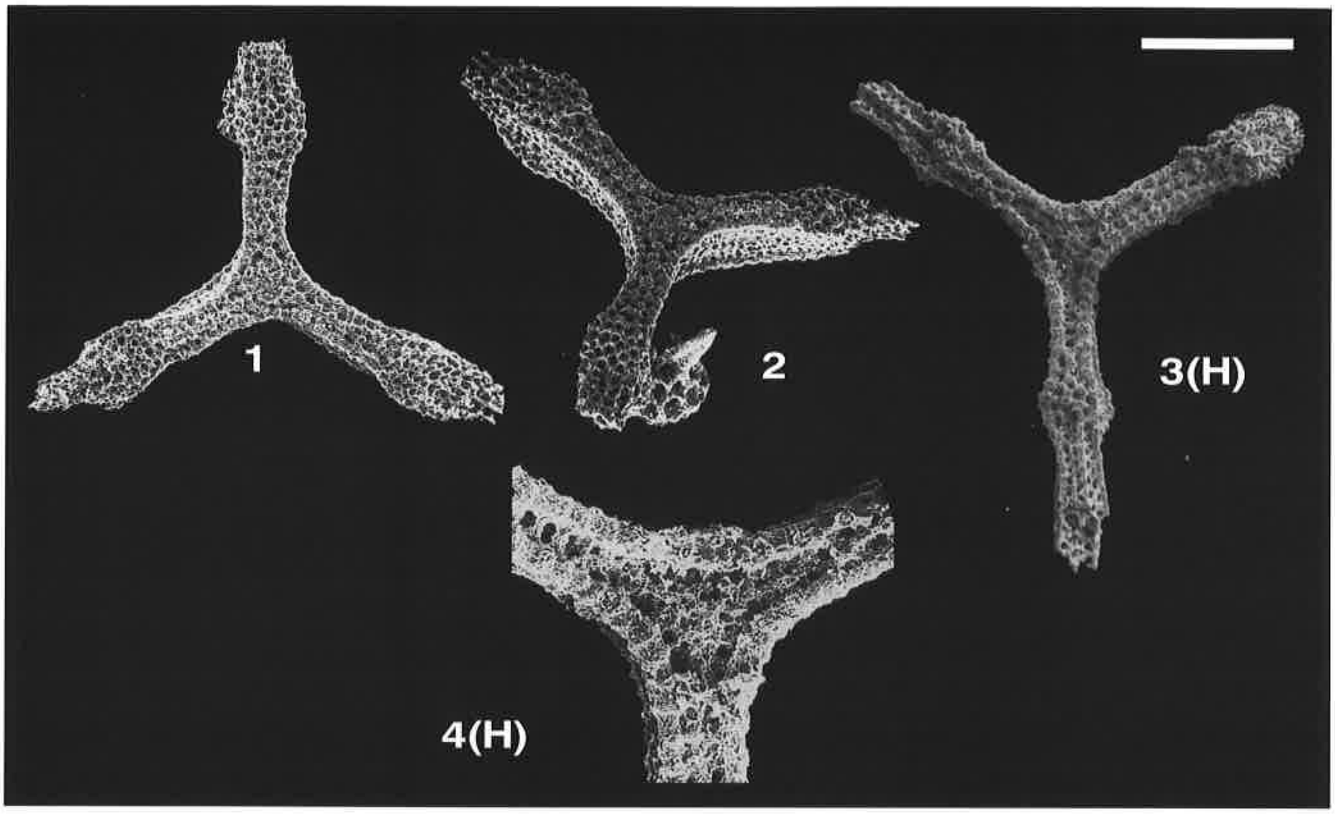


Plate 3147. *Angulobracchia digitata* BAUMGARTNER. Magnification x150, except Fig. 4 x300. **Fig. 1.** POB78/6468, POB899.53. **Fig. 2.** POB78/6467, POB899.53. **Fig. 3(H).** POB78/6504, POB899.54. **Fig. 4(H).** POB78/6502, POB899.54.

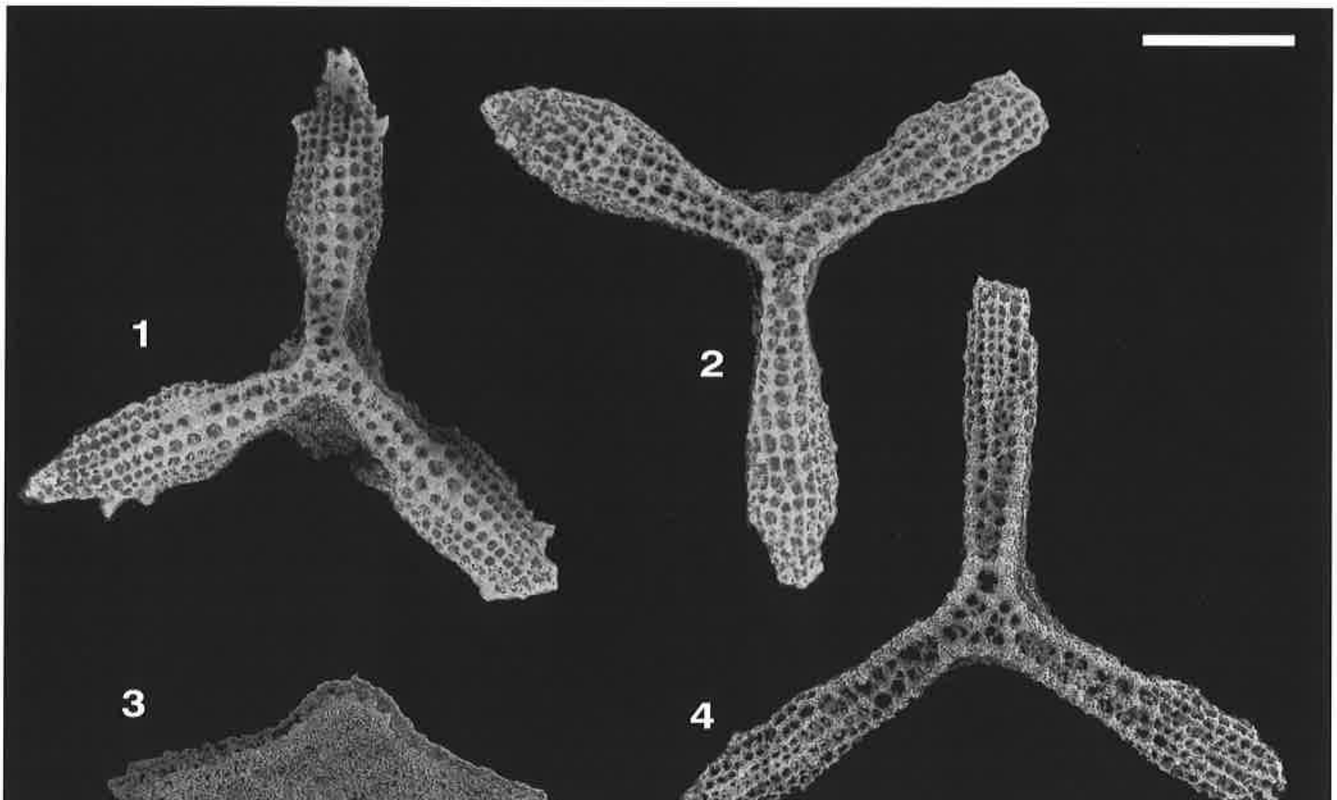


Plate 6121. *Angulobracchia* (?) *portmanni* s.l. BAUMGARTNER. Magnification x150. **Fig. 1.** RJ340, Bo566.5. **Fig. 2.** RJ344, Bo566.5. **Fig. 3.** RJ145, Br1330. **Fig. 4.** RJ456, Br28.85.

ANGULOBRACCHIA (?) PORTMANNI PORTMANNI 3285

Angulobracchia (?) *portmanni portmanni* BAUMGARTNER

Synonymy.-
Hagiastrid gen et sp. indet.
FOREMAN 1973b, pl. 7, figs. 1, 2, 5, not 3, 4, 6-7.
Paronaella sp.
SCHAAF 1981, p. 436, pl. 8, fig. 7.
OZVOLDOVA & PETERCAKOVA 1987, p. 122, pl. 35, fig. 1.
Angulobracchia (?) *portmanni* BAUMGARTNER
BAUMGARTNER 1984, p. 757, pl. 2, figs. 1-3.
PAVSIC & GORICAN 1987, p. 23, pl. 2, fig. 7.
TUMANDA 1989, p. 34, pl. 2, figs. 9, ? 8
STEIGER 1992, p. 50, pl. 12, figs. 10, 12, 13, ? 7, ? 11, not 8.
Angulobracchia cf. *portmanni* BAUMGARTNER
DE WEVER et al. 1986, pl. 8, figs. 16-17.

Original Definition.- Three-rayed patulibracchiid with an axially raised central area. Central area in lateral view almost spherical, with roughly horizontal rows of small pores (corresponding to layers of internal spongy meshwork), in vertical view with convex outlines between rays, equipped with coarse irregular nodes and small pores. Rays in lateral view rapidly wedging out from central area to tip, in vertical view proximally constricted, with club-shaped ray tip. Ray tip may bear cylindrical extensions and some short lateral spines. Nodes on rays sometimes finer than on central area, in roughly parallel rows which lead to beams of the cylindrical extensions. These may be as broad as ray tip or thinner, more fragile.

Original Remarks.- This species differs from *A. digitata* BAUMGARTNER which has similar cylindrical extensions, by a highly raised central area and flattened, club-shaped ray tips. It is questionably assigned to *Angulobracchia* because of the thickened central area and the lack of distinct lateral external beams.

Remarks.- For biostratigraphic data we included with *Angulobracchia* (?) *portmanni portmanni* BAUMGARTNER only specimens with a broad central part of test covered with strong nodes and proximally enlarged rays.

Etymology.- Named in honor of Adolf Portmann (1897-1982), biologist and philosopher from Basel, Switzerland, for his support during my first scientific essays.

Measurements (in μm).-
Based on 8 specimens.

	min.	max.	av.	HT
Length of rays:	135	284	190	-
Width of rays:	35	49	42	41
Width of ray tip:	60	92	78	63
Width of extensions:	36	121	69	36
Max. length of extension:	65	177	121	65

Type Locality.- Locality no. 24 of Baumgartner (1984); Breggia Gorge, Ticino, Switzerland.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

ANGULOBRACCHIA PURISIMAENSIS 3144

Angulobracchia purisimaensis (PESSAGNO)

Synonymy.-
Paronaella (?) *purisimaensis* PESSAGNO
PESSAGNO 1977a, p. 71, pl. 2, figs. 4-6.
Angulobracchia purisimaensis (PESSAGNO)
BAUMGARTNER 1980, p. 312, pl. 1, fig. 14; pl. 10, figs. 11-14; pl. 12, figs. 9-10.
BAUMGARTNER 1984, p. 757, pl. 2, fig. 4.
KOCHER 1981, p. 55, pl. 12, fig. 12.
DANELIAN 1989, p. 141, pl. 2, fig. 16.
KITO 1989, p. 129, pl. 9, figs. 6-7, 9.
Angulobracchia sp. C
BAUMGARTNER 1980, p. 314, pl. 10, figs. 16-17.
Angulobracchia sp.
SATO et al.1982, pl. 3, fig. 9.
Angulobracchia sp. B
WAKITA 1982, pl. 6, fig. 6.
Angulobracchia sp. C of BAUMGARTNER
ISHIDA 1983, pl. 10, fig. 11.
Halesium purisimaensis (PESSAGNO)
ORIGLIA-DEVOS 1983, p. 89.
EL KADIRI 1984, p. 197.
Halesium sp. C
EL KADIRI 1984, p. 199, pl. 7, figs. 1, 9.
Halesium sp.
DE WEVER et al. 1985, pl. 1, fig. 21.

Original Definition.- Test with three rays of moderate length, expanding slightly in width distally; ray tips wedge-shaped in side view; each ray tip with two short spines oriented in plane of test and diverging slightly outward. Margins of rays and central area flanked by nodose ridges. Meshwork fine with irregular polygonal (tetragonal to pentagonal) pore frames.

Original Remarks.- Because of the presence of peculiar ridge structures (tabulae?) on its rays, this species is questionably assigned to *Paronaella*. *Paronaella* (?) *purisimaensis* n.sp. differs from *P.* (?) *casmaliaensis* n.sp. by having (1) only two ridges on the top and bottom surfaces of each ray; and (2) fine irregular meshwork.

Actualized Remarks.- (BAUMGARTNER, 1980) Entirely preserved specimens have a porous, thorny central spine.

Etymology.- This species is named for Point Purisima, south of Point Sal, Santa Barbara County, California.

Measurements (in μm).-
Based on 10 specimens. L. rays: 190 to 300; W. rays: 70 to 100.

Type Locality.- Point Sal, Santa Barbara County.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

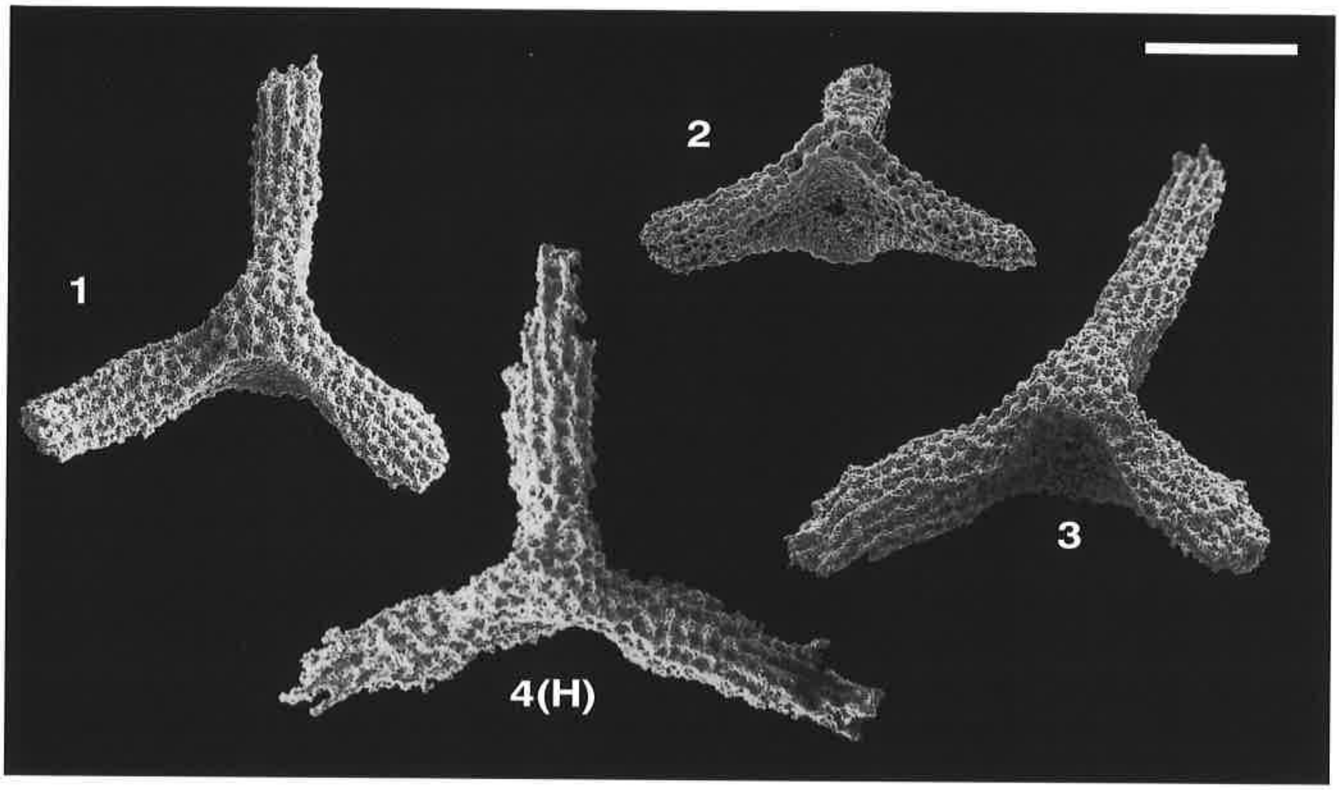


Plate 3285. *Angulobracchia* (?) *portmanni portmanni* BAUMGARTNER. Magnification x150. **Fig. 1.** POB79/5741, POB1205.3. **Fig. 2.** POB79/3121, MO1 46. **Fig. 3.** POB79/5264, POB1205.3. **Fig. 4(H).** POB81/9091, POB1330.

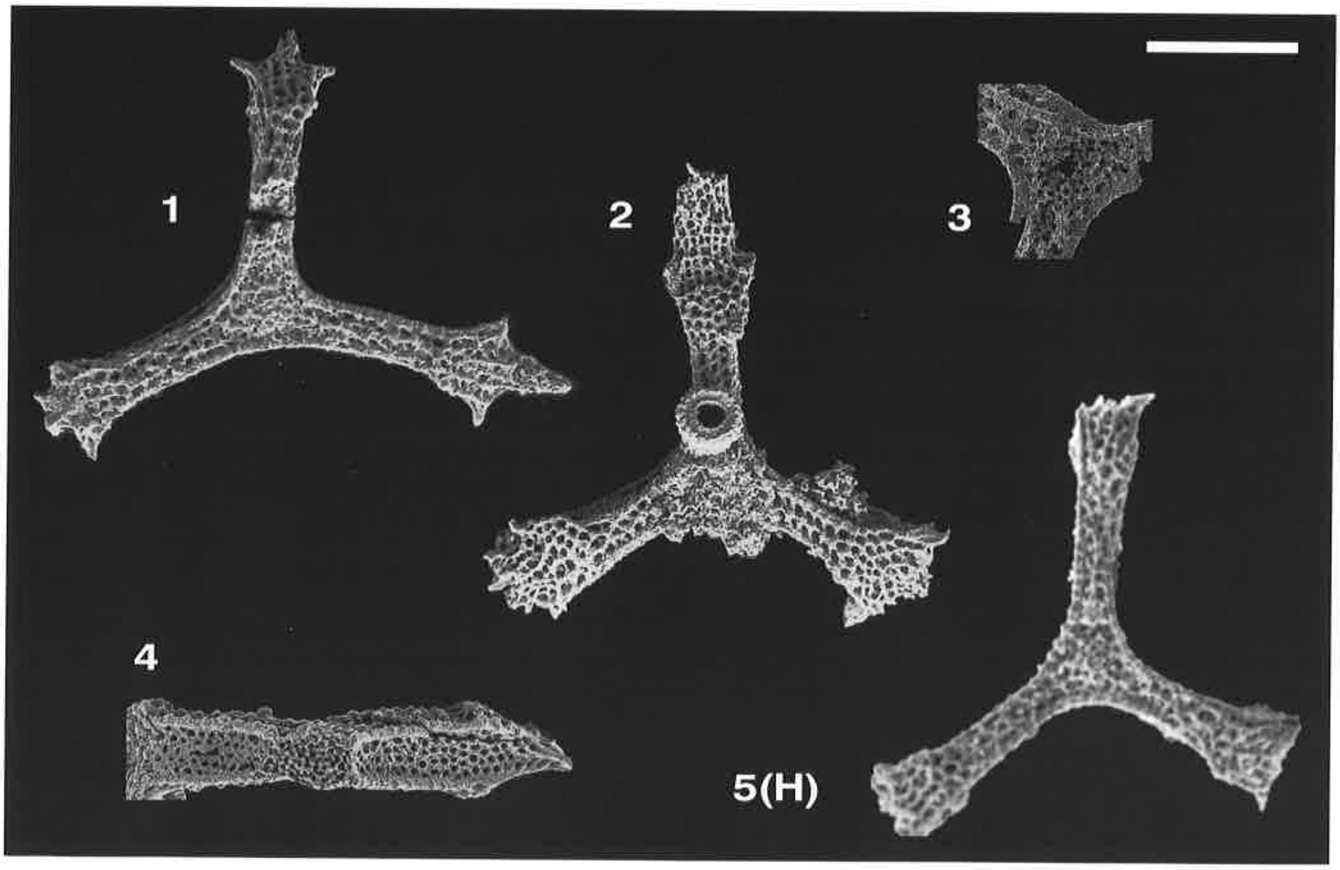


Plate 3144. *Angulobracchia purisimaensis* (PESSAGNO). Magnification x150. **Fig. 1.** POB78/3762, POB28.66. **Fig. 2.** POB79/1527, POB79.49. **Fig. 3.** POB79/1493, POB899.61. **Fig. 4.** POB79/1521, POB79.49. **Fig. 5(H).** PESSAGNO 1977a, pl. 2, fig. 4.

ANGULOBRACCHIA (?) RUGOSA 3911

Angulobracchia (?) *rugosa* JUD

Synonymy.-
Hagiastridae, gen. et sp. indet.
HOLZER 1980, pl. 2, figs. 15-16.
Angulobracchia (?) *portmanni* BAUMGARTNER
STEIGER 1992, p. 50, pl. 12, fig. 8 only.
Angulobracchia (?) *rugosa* JUD
JUD 1994, p. 62, pl. 3, figs. 8-9.

Original Definition.- Three-rayed test. Rays equal in length and regularly arranged at 120 degrees. Central area inflated, slightly thinning distally. Middle portion of rays enlarged and prolonged to a short, small ray-tip. Upper and lower surface of test with prominent nodes connected by small bars forming triangular or irregular pore-frames. Enlarged middle portion of rays with finer, nodose irregular meshwork. Termination of rays consisting of longitudinal beams irregularly connected by bars. Interradial sides in both lateral and vertical view concave,with spongy meshwork.

Original Remarks.- *Angulobracchia* (?) *rugosa* n.sp. was questionably assigned to the genus *Angulobracchia* BAUMGARTNER because although the lateral sides of the test are of angulobracchiin-type, being concave or straight, the test lacks prominent solid lateral external beams characteristic of the group (Baumgartner, 1980). The species could be also assigned to the genus *Paronaella* PESSAGNO if we take into account the resemblance of the external structure on the upper and lower faces of test with *Paronaella mulleri* PESSAGNO. Most specimens found in our material had the distal parts of the beams broken off.

Etymology.- From the Latin *rugosus* = rough, coarse.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Length of rays:	273	170	160	187
Maximum width:	109	113	80	124
Thickening of test:	-	162	-	-

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 12-16, early-early late Tith. to early Val.

ANGULOBRACCHIA SICULA 3301

Angulobracchia sicula KITO & DE WEVER

Synonymy.-
Angulobracchia sp. *A.* cf. *A. digitata* BAUMGARTNER
WAKITA 1982, pl. 6, fig. 5.
Halesium sp.
DE WEVER et al. 1985, pl. 1, fig. 28.
Angulobracchia sp. B
GORICAN 1987, p. 181, pl. 1, fig. 7.
Angulobracchia sp. A
HATTORI 1987, pl. 5, fig. 3.
HATTORI 1988a, pl. 5, fig. A.
Angulobracchia sp. 1
KITO 1989, p.129, pl. 11, figs. 1-10.
Angulobracchia sicula KITO & DE WEVER
KITO & DE WEVER 1992, 136, text-fig. 6; pl. 3, figs. 1-10.

Original Definition.- Test composed of robust 3 rays which have a heart shape ray tip. Upper and lower surface covered by nodular and irregular framework elongated longitudinally. Vertical wall of rays concave, and perforated regularly by 4 or 5 horizontal rows of pores. Lateral beams are nodular. Ray tip, flattened, perforated irregularly, lens form in section, and oriented obliquely. Three ray tips are oriented in the same direction. Ray tip having a small extension like a porous tube or small spine. Internal structure as with genus.

Remarks.- This species differs from *A. digitata* BAUMGARTNER by the form of ray tip and by lack of well developed cylindric extension on ray.

Etymology.- From Latin *siculus* (-a, -*um*; adj.) sicilian, type locality of this species.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Length of ray:	225	288	210	255
Width of ray:	45	49	45	46
Length of ray tip:	100	109	90	120
Width of ray tip:	95	104	92	115

Type Locality.- Contrada La Ferta (Sicily, Italy).

UAZones.- 1-6, early-mid Aal. to mid Bath.

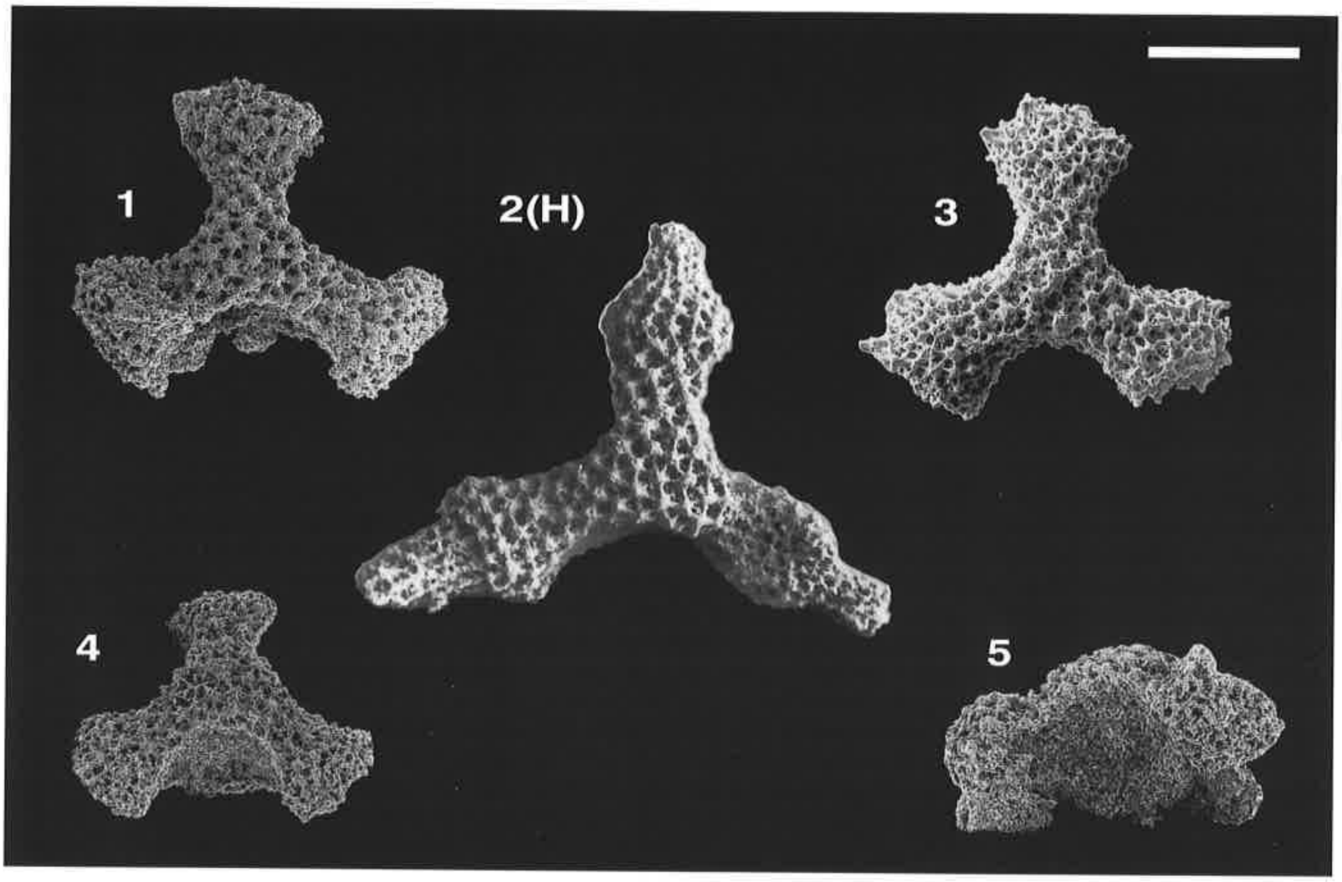


Plate 3911. ***Angulobracchia* (?) *rugosa* JUD.** Magnification x150. **Fig. 1.** RJ181, Br1330. **Fig. 2(H).** RJ1247, V -6.5. **Fig. 3.** DU1281, V40. **Fig. 4.** RJ179, Br1330. **Fig. 5.** RJ180, Br1330.

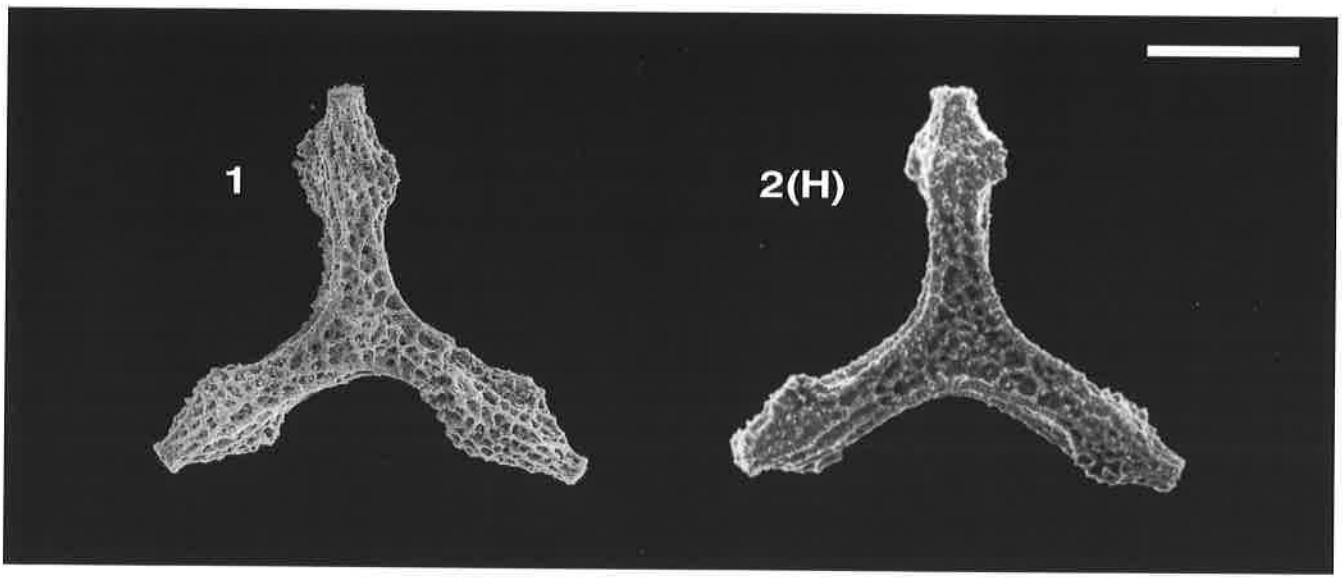


Plate 3301. ***Angulobracchia sicula* KITO & DE WEVER.** Magnification x150. **Fig. 1.** GO86/134/3, ZB28. **Fig 2(H).** KITO & DE WEVER 1992, pl. 3, fig. 1.

ANGULOBRACCHIA | *B* 4006

Angulobracchia sp. B

Synonymy.-
Halesium (?) sp. B
BAUMGARTNER 1980, p. 314, pl. 10, figs. 6-8.

Remarks.- (BAUMGARTNER, 1980) The ray structure is similar to *H. quadratum* PESSAGNO, but only a large, centrally placed aperture may represent the base of the bracchiopyle. Two strong primary spines diverging outwardly.

UAZones.- 7-9, late Bath.-early Call. to mid-late Oxf.

angustus >> *ACANTHOCIRCUS TRIZONALIS ANGUSTUS* 3082

annemariae >> *PARONAELLA (?) ANNEMARIAE* 5314

antiqua >> *HALIODICTYA (?) ANTIQUA ANTIQUA* 3218

antiqua >> *HALIODICTYA (?) ANTIQUA S.L.* 3243

antiqua >> *HALIODICTYA (?) ANTIQUA* | *B* 3217

apenninicus >> *MIRIFUSUS APENNINICUS* 5716

apiarium >> *ARCHAEODICTYOMITRA APIARIUM* 3263

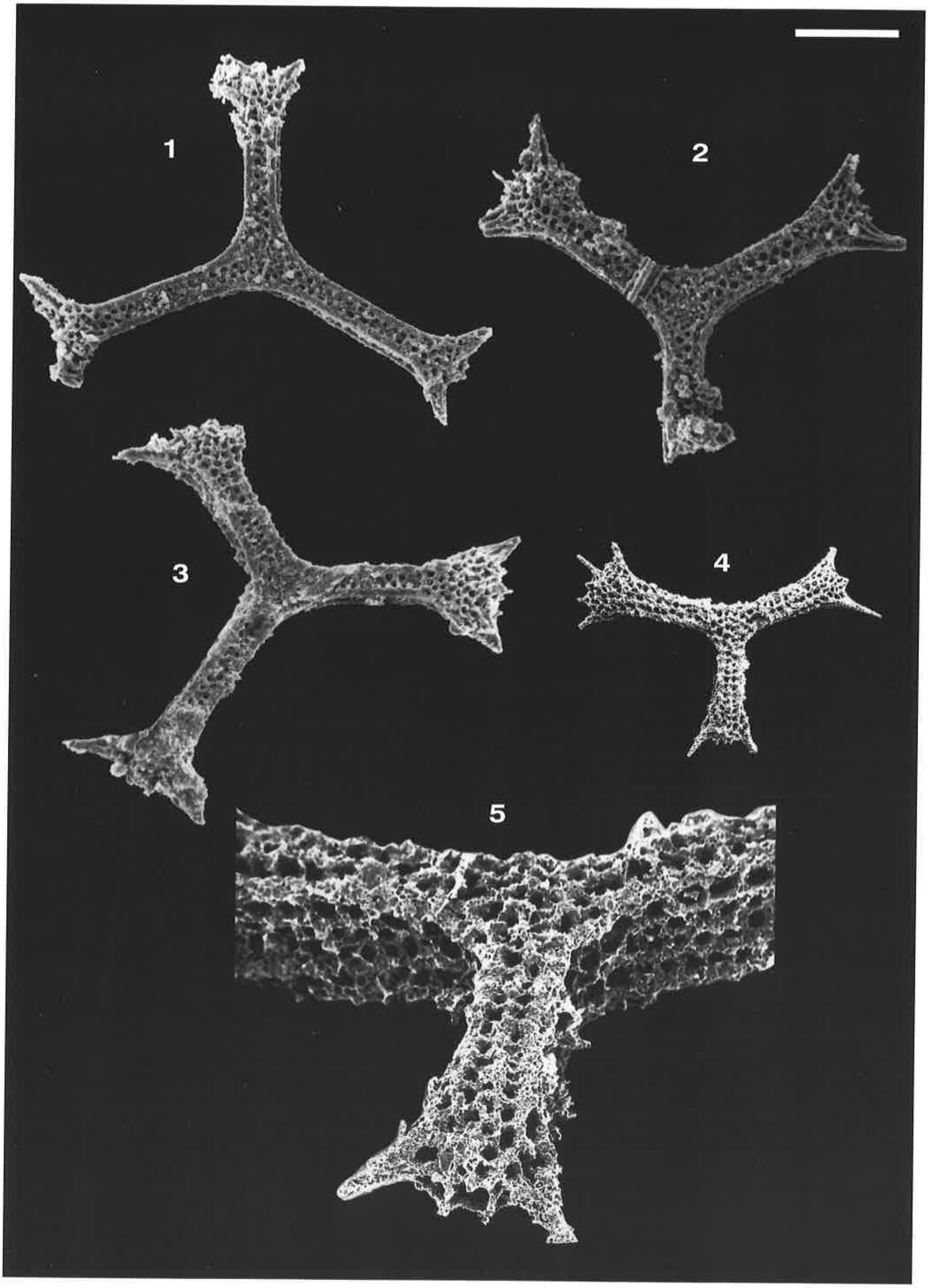


Plate 4006. ***Angulobracchia* sp. B.** Magnification x150, except Fig. 5 x500. **Fig. 1.** MC, GR6. **Fig. 2.** MC, GR6. **Fig. 3.** MC, GR6. **Fig. 4.** POB78/6745, POB899. **Fig. 5.** POB6747, POB899.

ARCHAEODICTYOMITRA 3608

Genus: *Archaeodictyomitra* PESSAGNO

Synonymy.-
Archaeodictyomitra PESSAGNO
PESSAGNO 1976, p. 49.
PESSAGNO 1977b, p. 41.

Type Species.- *Archaeodictyomitra squinaboli* PESSAGNO 1976.

Original Definition.- Test conical, non-lobate, becoming somewhat spindle-shaped in unbroken or mature forms; cephalis, thorax, abdomen, and post-abdominal chambers covered by linearly arranged continuous costae which converge in the area of the cephalis and thorax; pores distributed in single row between costae, entirely relict on earlier chambers and observable only on etched or eroded specimens.

Original Remarks.- *Archaeodictyomitra* n.gen. differs from *Dictyomitra* ZITTEL 1976 by being non-lobate in outline and lacking well-developed strictures; and by possessing relict pores and lacking primary pores. It differs from *Diplostrobus* SQUINABOL for the reasons cited above and by lacking an apical horn. Only a few of the many potential species known to be assignable to this genus have been described from Jurassic and Cretaceous strata. "*Dictyomitra*" *margarita* ALIEV 1961, from the Lower Cretaceous of Russia is definitely assignable to *Archaeodictyomitra.*

Actualized Definition.- (PESSAGNO, 1977b) Emended definition as in Pessagno (1976), but including forms with constrictions; constrictions not occurring at joints.

Remarks.- This genus is distinguished from *Pseudodictyomitra* because the costae in *Archaeodictyomitra* are continuous down the length of the test and the genus is distinguished from *Dictyomitra* by the distribution pattern of the pores. Members of the genus *Dictyomitra* also tend to have a more lobate shape to the post abdominal segments. In distinction between species of *Archaeodictyomitra* the shape of the costae in cross section may be important.

Included Taxa.-
3237 *Archaeodictyomitra* (?) *amabilis* AITA
3263 *Archaeodictyomitra apiarium* (RÜST)
5582 *Archaeodictyomitra chalilovi* (ALIEV)
3287 *Archaeodictyomitra excellens* (TAN)
5595 *Archaeodictyomitra* (?) *lacrimula* (FOREMAN)
3305 *Archaeodictyomitra minoensis* (MIZUTANI)
3236 *Archaeodictyomitra* (?) *mirabilis* AITA
3235 *Archaeodictyomitra* (?) sp. A

ARCHAEODICTYOMITRA (?) AMABILIS 3237

Archaeodictyomitra (?) *amabilis* AITA

Synonymy.-
Thanarla sp. A
AITA 1982, pl. 1, fig. 5.
KISHIDA & HISADA 1986, pl. 2, fig. 9.
Thanarla sp. C
AITA 1982, pl. 1, fig. 16.
Archaeodictyomitra sp. R
MATSUOKA 1982a, pl. 2, figs. 11a-b, 16.
YAO 1984, pl. 2, fig. 14.
Thanarla sp.
KISHIDA & HISADA 1986, fig. 2.9.
Archaeodictyomitra (?) *amabilis* AITA
AITA 1985, fig. 6.6.
AITA 1987, p. 70, pl. 1, figs. 13a-b; pl. 9, fig. 6.
MATSUOKA 1990, pl. 1, fig. 5.
Thanarla ? sp.
KOJIMA & MIZUTANI 1987, fig. 5.9.
KOJIMA 1989, pl. 2, figs. 8a-b.

Original Definition.- Conical shell of five segments; cephalo-thorax forms a small subconical part, and postthoracic segments a large, inflated smooth cone. Cephalis small, spherical, poreless without an apical horn, but rare specimen with single dotted apical horn. Post-cephalic segments with eight to nine costae which separate three longitudinal rows of small circular pores. Collar stricture poorly developed. Thorax, abdomen and fourth segment trapezoidal in outline and gradually enlarge its height and width. Last segment inflated cylindrical, constricted distally. Traces of terminal feet present.

Original Remarks.- This new species is closely related to *Hsuum* (?) *inexploratum* BLOME (1984) in overall configuration. It is distinguished from the latter, however, in possessing a more conical outline. This species differs from *Archaeodictyomitra* (?) *mirabilis* n.sp. in having broad longitudinal costae. *Archaeodictyomitra* (?) *amabilis* is questionably assigned to the genus *Archaeodictyomitra* PESSAGNO because it has three rows of pores between costae.

Measurements (in μm).-
Based on 10 specimens.

	HT	max.	min.	av.
Overall height:	173	178	135	153
Maximum width:	115	120	90	101

Type Locality.- Sample SOG-8, Sogatani section, Irazuyama Formation (Togano Group), Kochi Prefecture, Southwest Japan.

UAZones.- 4-7, late Baj. to late Bath.-early Call.

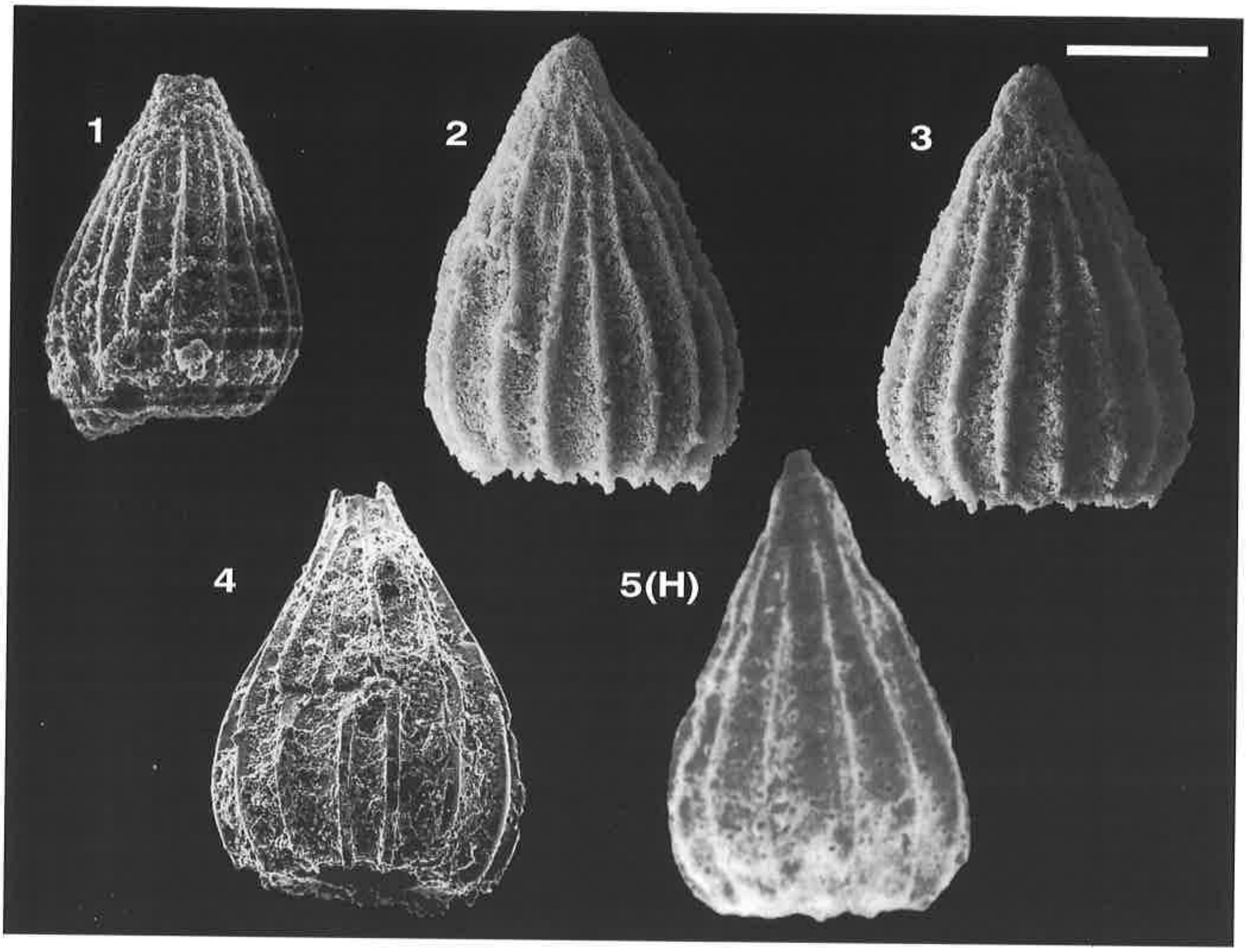


Plate 3237. *Archaeodictyomitra* (?) *amabilis* AITA. Magnification x400. **Fig. 1.** GO891714, ZR683. **Fig. 2.** DU3069, PJ9. **Fig. 3.** DU3085, PJ9. **Fig. 4.** POB81/2292, 534.122.1.43. **Fig. 5(H).** AITA 1987, pl. 9, fig. 6.

ARCHAEODICTYOMITRA APIARIUM 3263

Archaeodictyomitra apiarium (RÜST)

Synonymy.-
Lithocampe apiarium RÜST
RÜST 1885, p. 314, pl. 39 (14), fig. 8.
Dictyomitra apiarium (RÜST)
RÜST 1898, p. 58.
not FOREMAN 1975, p. 613, pl. 2G, figs. 7-8.
Dictyomitra excellens (TAN)
BAUMGARTNER & BERNOULLI 1976, p. 615, fig. 12k.
Archaeodictyomitra apiara (RÜST)
PESSAGNO 1977b, p. 41, pl. 6, figs. 6, 14.
DE WEVER & THIEBAULT 1981, p. 585.
not KANIE et al. 1981, pl. 1, fig. 8.
NAKASEKO & NISHIMURA 1981, p. 145, pl. 6, figs. 2-4; pl. 15, figs. 2, 6, not fig. 7.
not SCHAAF 1981, p. 432, pl. 18, figs. 2a-b.
MATSUYAMA et al. 1982, pl. 1, fig. 1.
AOKI 1982, pl. 2, figs. 11, ? 12.
MATSUOKA & YAO 1985, pl. 2, fig. 4.
TANAKA et al. 1985, pl. 1, figs. 5-6
CONTI & MARCUCCI 1986, pl. 1, fig. 3.
KISHIDA & HISADA 1986, fig. 2.8.
MATSUOKA 1986a, pl. 2, fig. 14; pl. 3, fig. 13.
AITA 1987, p. 64.
KAWABATA 1988, pl. 2, fig. 9.
WAKITA 1988, pl. 4, fig. 1.
TUMANDA 1989, p. 36, pl. 2, fig. 9.
KIESSLING 1922, pl. 1, figs. 4-5.
STEIGER 1992, p. 88, pl. 25, figs. 8-9.
Dictyomitra apiarum (RÜST)
NAKASEKO et al. 1979, pl. 3, fig. 4, not 3.
Archaeodictyomitra apiarium (RÜST)
KOCHER 1981, p. 56, pl. 12, fig. 13.
SCHAAF 1984, p. 92-93, figs. 1, 3a-b, 5a-b; not 2, 4a-b.
ISHIDA 1985, pl. 3, fig. 4.
SUYARI & ISHIDA 1985, pl. 2, figs. 7-10.
AITA & OKADA 1986, p. 108, pl. 1, fig. 11.
IGO et al. 1987, fig. 2.14.
PAVSIC & GORICAN 1987, p. 24, pl. 2, fig. 11.
DANELIAN 1989, p. 142, pl. 3, figs. 1-2.
WIDZ 1991, p. 243, pl. 1, fig. 14.
JUD 1994, p. 62, pl. 3, figs. 10-11.
Archaeodictyomitra apiaria (RÜST)
WU & LI 1982, p. 67, pl. 1, figs. 15- 16.
OZVOLDOVA & SYKORA 1984, p. 263, pl. 3, fig. 6.
BAUMGARTNER 1984, p. 758, pl. 2, figs. 5-6.
OZVOLDOVA 1990, pl. 3, fig. 2; pl. 5, fig. 5.
not MURCHEY 1984, pl. 1, fig. 3.
? *Archaeodictyomitra directiporata* (RÜST)
OZVOLDOVA 1988, pl. 4, fig. 3.
Archaeodictyomitra sp. C
FOLEY et al. 1986, p. 485, fig. 3, not 10, 11, ? 12.

Original Definition.- Shell of 8-10 segments with the shape of a honey-basket. 3 rows of pores in the central and 2 rows in the proximal and distal parts of the shell.

Remarks.- This species differs from the closely related *A. minoensis* by low circumferential ridges placed above segmental divisions, which appear between continuous costae. These have a more important relief than circumferential ridges, which therefore do not appear in silhouette.

Measurements (in μm).-
Maximum length of test 267, maximum width of test 106.

Type Locality.- Aptychus Beds, Kren, Tirol, Australie

UAZones.- 8-22, mid Call.-early Oxf. to late Barr.-early Apt.

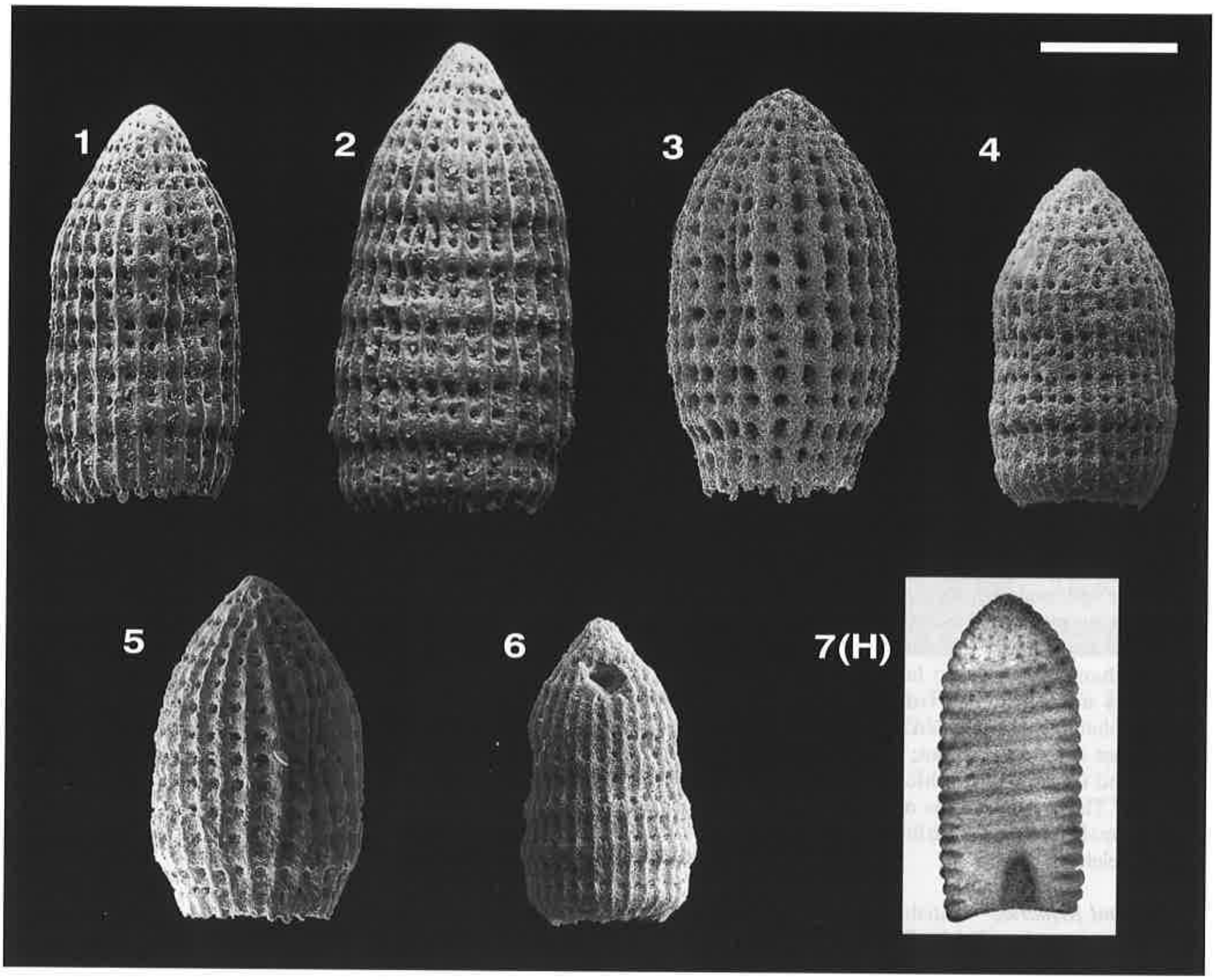


Plate 3263. *Archaeodictyomitra apiarium* (RÜST). Magnification x250. **Fig. 1.** POB79/4101, MO2 22. **Fig. 2.** RJ277, Br28.85. **Fig. 3.** POB79/0184, MO22. **Fig. 4.** DU2631, PJ17. **Fig. 5.** DU2341, MO22. **Fig. 6.** DU2493, PJ25. **Fig. 7(H).** RÜST 1885, pl. 39 (14), fig. 8.

ARCHAEODICTYOMITRA CHALILOVI 5582

Archaeodictyomitra chalilovi (ALIEV)

***Synonymy*.-**
Lithocampe chalilovi ALIEV
ALIEV 1965, p. 67, pl. 12, figs. 10-13.
Dictyomitra pseudoscalaris TAN
DUMITRICA 1975, pl. 2, fig. 15.
? *Mita magnifica* PESSAGNO
? SCHAAF 1981, p. 435, pl. 24, figs. 13a-b; not pl. 6 fig. 10.
Archaeodictyomitra chalilovi (ALIEV)
JUD 1994, p. 63, pl. 3, figs. 12-14.
Mita gracilis (SQUINABOL)
SCHAAF 1984, p. 110-111, figs. 1-3, 4a-b, not 5 a-c.
GORICAN 1987, p. 184, pl. 3, figs. 22-23.

***Original Definition*.-** "The conical skeleton gradually widens to the penultimate chamber and further on tapers toward the apertural end. It consists of 4-5 distinct chambers, the size of which rapidly increases towards the apertural end. The initial conical, tapered chamber is followed by barrel-shaped chambers; the two last ones are very high. The chambers are separated from one another by hardly distinguishable thin septa. In some places, the surface of skeleton has slight constrictions; from the initial to the apertural end extend distinct ribs, which reach the edge of the last chamber. There are 7-8 ribs on each side of the skeleton. Round, small pores are distributed between the ribs. Thin-walled skeleton."

***Original Remarks*.-** "Variability. The height and width of the skeleton vary, but slightly. The variation in the number of ribs and chambers is also slight. In some specimens the undulation of the edges of the skeleton is not noticeable. Sometimes the apertural chamber is elongated. The height of the chambers of this species is rather peculiar. However, it resembles somewhat *Lithocampe strelkovi* ALIEV, described from Valanginian deposits near Khaltan village, northeastern Azerbaidzhan, but differs from it in having very high chambers, a rather elongated skeleton with small pores, and a smaller number of chambers."

***Actualized Remarks*.-** (JUD, 1994) This species was assigned by Schaaf (1984) and Gorican (1987) to the species *Sethoconus gracilis* SQUINABOL and included in the genus *Mita* PESSAGNO. The illustration and description of Squinabol 1903b show however clearly that *Sethoconus gracilis* has a skeletal structure of acropyramidid type. Our specimens seem to correspond rather perfectly to *Lithocampe chalilovi* ALIEV, described from the Albian strata of Azerbaidzhan. They have an average length of 410 μm and a width of 156 μm.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max
Height of skeleton:	385	334	277	339
Width of skeleton:	115	115	108	123
Height of 1st chamber:	31	28	23	31
Height of 2nd chamber:	46	48	46	53
Height of 3rd chamber:	69	69	62	77
Height of 4th chamber:	139	123	108	123
Height of 5th chamber:	92	87	77	92
Diameter of pores:	8	7	5	8

***Type Locality*.-** Northeast Azerbaidzhan.

***UAZones*.-** 20-22, late Haut. to late Barr.-early Apt.

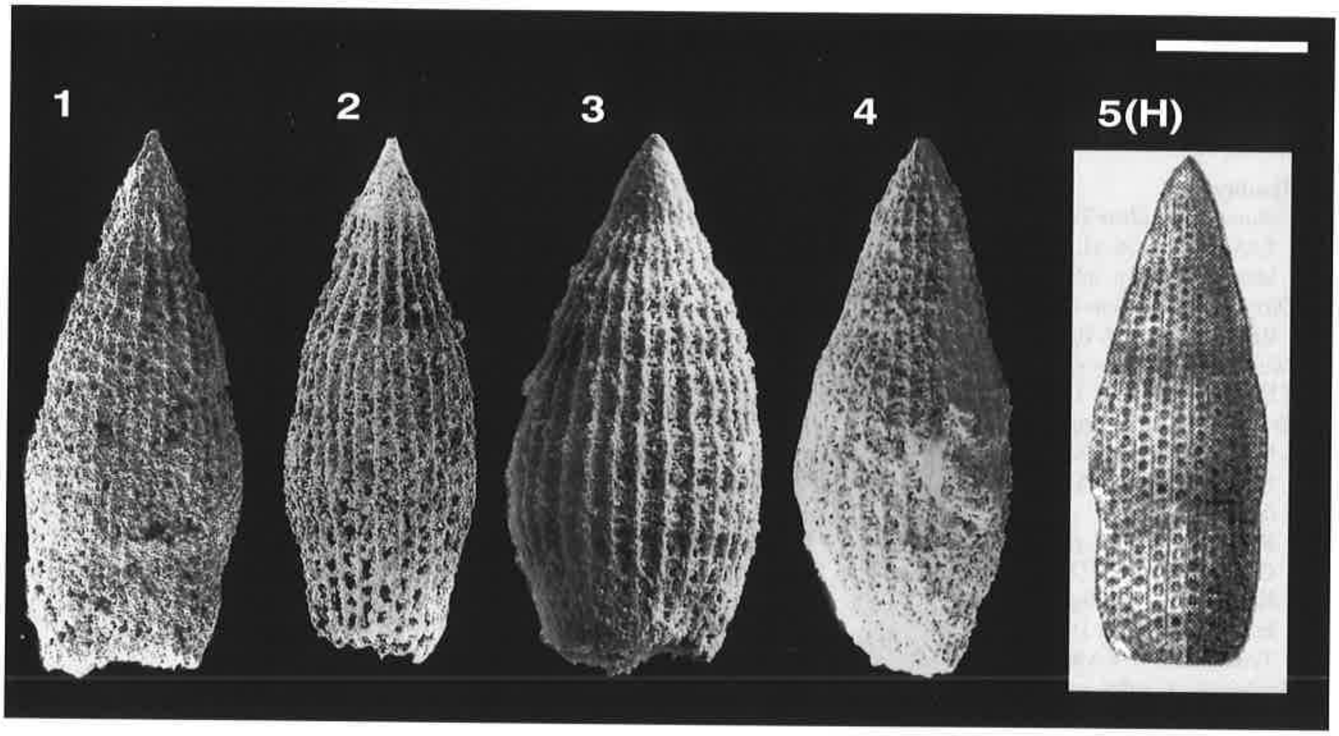


Plate 5582. ***Archaeodictyomitra chalilovi*** **(ALIEV).** Magnification x300. **Fig. 1.** RJ49, Bo569.6. **Fig. 2.** RJ35, Bo566.5. **Fig. 3.** RJ2919, Bo566.5. **Fig. 4.** RJ29, Bo704.2. **Fig. 5(H).** ALIEV 1965, pl. 12, fig. 10.

ARCHAEODICTYOMITRA EXCELLENS 3287

Archaeodictyomitra excellens (TAN)

Synonymy.-
Lithomitra excellens TAN
TAN 1927, p. 56, pl. 11, fig. 85.
MOORE 1973, p. 827, pl. 4, figs. 3-4.
Dictyomitra excellens (TAN)
RENZ 1974, pl. 8, fig. 8, not fig. 7; pl. 11, fig. 35.
Dictyomitra apiarum (RÜST)
NAKASEKO et al. 1979, pl. 3, fig. 3, not 4.
Archaeodictyomitra apiara (RÜST)
SCHAAF 1981, p. 432, pl. 18, figs. 2a-b.
NAKASEKO & NISHIMURA 1981, p. 145, pl. 6, fig. 1, not 3-4.
KANIE et al. 1981, pl. 1, fig. 8.
OKAMURA & UTO 1982, pl. 2, figs. 1-2.
KITO 1987, pl. 3, fig. 2.
KATO & IWATA 1989, pl. 2, fig. 4.
TAKETANI & KANIE 1992, fig. 3.9.
Archaeodictyomitra excellens (TAN)
BAUMGARTNER 1984, p. 758, pl. 2, figs. 7-8.
PAVSIC & GORICAN 1987, p. 24, pl. 2, fig. 10.
TUMANDA 1989, p. 35, pl. 2, fig. 7; pl.10, fig. 3.
AGUADO et al. 1991, fig. 1.4.
MATSUOKA 1992, pl. 1, fig. 7.
STEIGER 1992, p. 88, pl. 25, figs. 10-11.
JUD 1994, p. 63, pl. 3, figs. 15-16.
Archaeodictyomitra apiarium (RÜST)
SCHAAF 1984, 92-93, figs. 2, 4a-b; not figs. 1, 3a-b, 5a-b.

Original Definition.- "External shell of 10 segments, test conical on the upper, and cylindrical on the lower portion, without apical horn. Shell-thickening maximal on two levels. Cephalis and thorax combined to a cephalo thorax. The irregularly disposed ribs on the cephalis may be leftovers of the internal skeleton. The first two and the last segment have one row of pores, which is on the first segments "nodial" placed, all other segments have two rows of pores of which one is placed "nodial". All pores are round. The last segment is less wide than the second last. The shell-ornamentation is represented by longitudinal ribs, starting on the cephalo-thorax. The prolongation of those ribs form a crown around the pylome. The aperture of the last segment is very small."

Original Remarks.- "This form is considered to be a variety of *L. dignus*, pl. 11, fig. 79."

Measurements (in μm).-
Length 238, maximal width 95, maximal thickness of the shell 15.

Type Locality.- Rotti Island, Moluccas Archipielago, East Indian Ocean.

UAZones.- 11-22, late Kimm.-early Tith. to late Barr.-early Apt.

ARCHAEODICTYOMITRA (?) LACRIMULA 5595

Archaeodictyomitra (?) *lacrimula* (FOREMAN)

Synonymy.-
Dictyomitra (?) *lacrimula* FOREMAN
FOREMAN 1973b, p. 263, 264, pl. 10, fig. 11.
FOREMAN 1975, p. 614, pl. 2G, figs. 5, 6.
NAKASEKO et al. 1979, p. 22, pl. 4, fig. 1.
NAKAGAWA et al. 1980, pl. 3, fig. 4.
Archaeodictyomitra lacrimula (FOREMAN)
SCHAAF 1981, p. 432, pl. 22, figs. 3a-b.
NAKASEKO & NISHIMURA 1981, p. 146, pl. 6, figs. 5-6; pl. 15, fig. 10.
OKAMURA & UTO 1982, pl. 7, fig. 4.
SANFILIPPO & RIEDEL 1985, 598, figs. 7.3a-c.
OKAMURA & MATSUGI 1986, p. 123, pl. 1, figs. 1-2.
KITO 1987, pl. 3, fig. 3.
TUMANDA 1989, p. 35, pl. 2, fig. 19.
IWATA et al. 1990, pl. 1, fig. 6, pl. 2, fig. 1.
AGUADO et al. 1991, fig. 7.1.
TAKETANI & KANIE 1992, fig. 3.10.
JUD 1994, p. 63, pl. 3, fig. 17; pl. 4, fig.1.
Thanarla (?) *lacrimula* FOREMAN
VISHNEVSKAYA et al. 1982, pl. 2, fig. P.
Thanarla lacrimula FOREMAN
VISHNEVSKAYA 1984, pl. 12, figs. 1, 4, 8.
Thanarla ex. gr. *lacrimula* FOREMAM
VISHNEVSKAYA et al. 1985, pl. 2, figs. 5-6.

Original Definition.- The shell is spindle-shaped, of six or seven segments. These increase gradually in length and width until the last one or two segments which constrict, terminating in a narrow aperture with a smooth margin. Externally, the segmental divisions can sometimes be distinguished by very slight identations of the shell wall. Longitudinal ribs, approximately 10 per half a circumference, extend from thorax to the aperture. A single vertical row of pores is present between adjacent ribs; these may be rounded or elliptical with the long axis transverse.

Original Remarks.- This species differs from *Cyrtocalpis duodecimradiata* RÜST 1898 in having more segments and a much narrower aperture with a smooth margin.

Remarks.- We included with the species *Archaeodictyomitra lacrimula* (FOREMAN) only specimens with a biconical, distally closed test.

Etymology.- Latin *lacrimula* f. dim. little tear.

Measurements (in μm).-
Based on 10 specimens. Length of shell, 205-255; greatest width of shell, 85-130.

Type Locality.- Leg 20, Site 195, NE Pacific Basin.

UAZones.- 14-22, early-early late Berr. to late Barr.-early Apt.

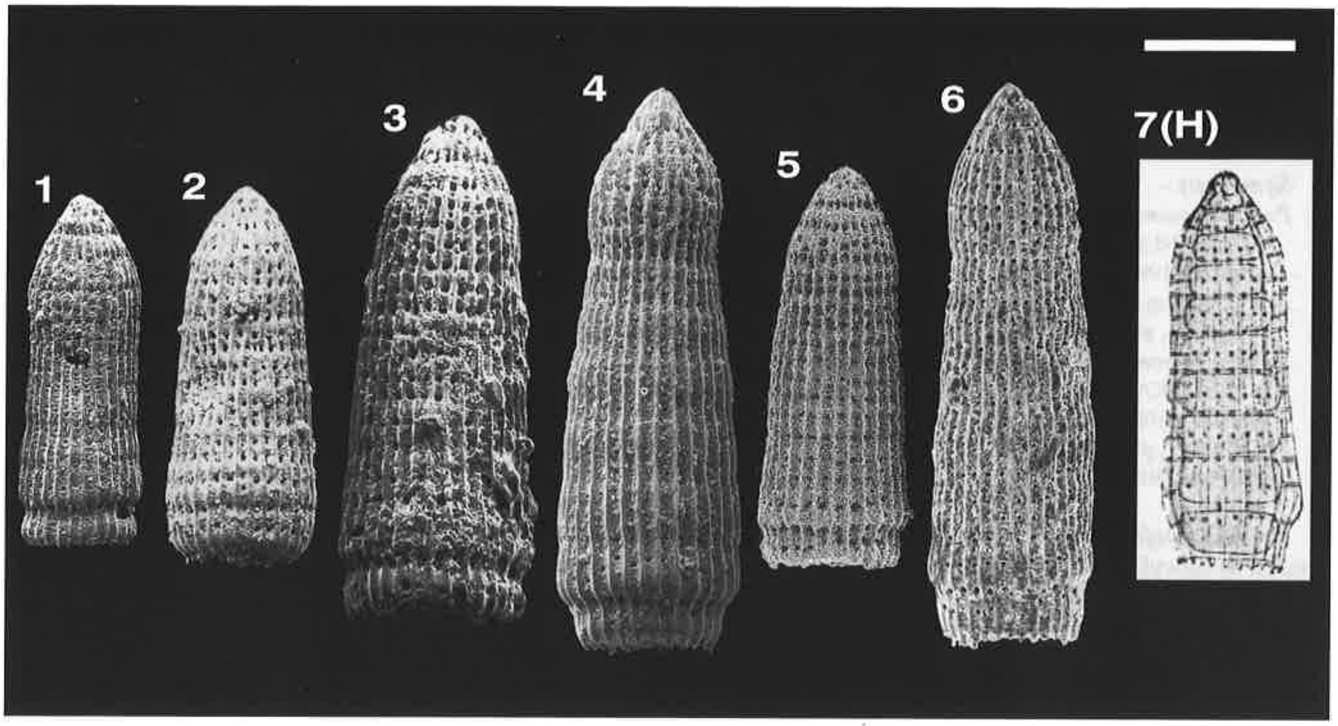


Plate 3287. *Archaeodictyomitra excellens* (TAN). Magnification x200. **Fig. 1.** POB79/4292, MO2 46. **Fig. 2.** POB79/0183, MO22. **Fig. 3.** POB81/9101, 76.534A.81.2.3. **Fig. 4.** DU3399, MO41. **Fig. 5.** RJ307, Br28.85. **Fig. 6.** DU3527, MO46. **Fig. 7(H).** TAN 1927, pl. 11, fig. 85.

Plate 5595. *Archaeodictyomitra* (?) *lacrimula* (FOREMAN). Magnification x300. **Fig. 1.** RJ18, Pr225.3, . **Fig. 2.** RJ14, Br141.55, **Fig. 3.** RJ13, Pr225.3, **Fig.4 (H).** FOREMAN 1973b, pl.10, fig. 11.

ARCHAEODICTYOMITRA MINOENSIS 3305

Archaeodictyomitra minoensis (MIZUTANI)

Synonymy.-
Pseudodictyomitra minoensis MIZUTANI
MIZUTANI 1981, p. 178, pl. 58, fig. 4; pl. 63, figs. 9-10.
ADACHI 1982, pl. 1, figs. 9, 10.
Dictyomitra sp. aff. *D. minoensis* (MIZUTANI)
YAO 1984, pl. 3, fig. 5.
Archaeodictyomitra minoensis (MIZUTANI)
MATSUOKA & YAO 1985, pl. 2, fig. 5.
WAKITA 1988, pl. 5, fig. 2; pl. 6, fig. 10.
YAO 1991, pl. 4, fig. 25.
? KIESSLING 1922, pl. 1, figs. 2-3.

Original Definition.- Shell moderate in size elongated conical or subcylindrical, 225 μm (average of 7 specimens) in height, ranging 215-230 μm. Cephalic part has a solid termination, but longitudinal plication extends much of the length of the shell. Usually, the first three or four are indistinct; stricture becomes clear downward, and circular pores in pair are found in the strictured part. The last two chambers are smaller in size. Strictured girdle is clearly developed, and hence costae are not always continuous.

Original Remarks.- This species differs from *Pseudodictyomitra lodogaensis* PESSAGNO (1977b, p. 50, pl. 8, figs. 4, 21, 28) or *Pseudodictyomitra* sp. D PESSAGNO (1977b, p. 52, pl. 8, fig. 13) in having paired pores lying apart.

Remarks.- *A. minoensis* differs from *A. apiarium* at the middle portion of the test. The segments are more individualized, somewhat trapezoidal in outline.

Etymology.- The specific name is derived from the Mino area, central Japan.

Measurements (in μm).
Based on 4 specimens.

	HT	av.	min.	max
Height of skeleton:	385	334	277	339
Width of skeleton:	115	115	108	123
Height of 1st chamber:	31	28	23	31
Height of 2nd chamber:	46	48	46	53
Height of 3rd chamber:	69	69	62	77
Height of 4th chamber:	139	123	108	123
Height of 5th chamber:	92	87	77	92
Diameter of pores:	8	7	5	8

Type Locality.- Sample 31, Mazegawa Formation, Gifu Prefecture, central Japan.

UAZones.- 9-12, mid-late Oxf. to early-early late Tith.

ARCHAEODICTYOMITRA (?) MIRABILIS 3236

Archaeodictyomitra (?) *mirabilis* AITA

Synonymy.-
Thanarla sp. B
AITA 1982, pl. 3, figs. 1, 2 a-b.
Archaeodictyomitra (?) *mirabilis* AITA
AITA 1985, figs. 6.7-8.
AITA 1987, p. 71, pl. 1, figs. 14a-b; pl. 9, figs. 7-8.

Original Definition.- Conical shell of five segments;: cephalis knob-like, spherical, poreless without an apical horn. Post-cephalic segments with 16-18 wavy costae on lateral side; these costae extend from external collar stricture to distal part of last segment, and separate a single longitudinal row of pores. Pores small, circular and uniform in size. Thorax campanulate to hemispherical, perforated. Abdomen and fourth segment truncated conically to cylindrically. Last segment inflated-annular, constricted distally. Collar stricture well developed, lumbar stricture distinct, and strictures between postabdominal segments slightly developed.

Original Remarks.- This species resembles *Archaeodictyomitra* (?) *amabilis* n.sp. in overall shape. However, it differs from the latter in having a more slender form and in having numerous longitudinal costae on the postcephalic segments.

Measurements (in μm).-
Based on 4 specimens.

	HT	max.	min.	av.
Maximum height:	173	178	135	153
Maximum width:	115	120	90	101

Type Locality.- Sample IRZ-50, Irazu Valley section IV, Irazuyama Formation (=Togano Group), Kochi Prefecture, southwest Japan.

UAZones.- 7-7, late Bath.-early Call. to late Bath.-early Call.

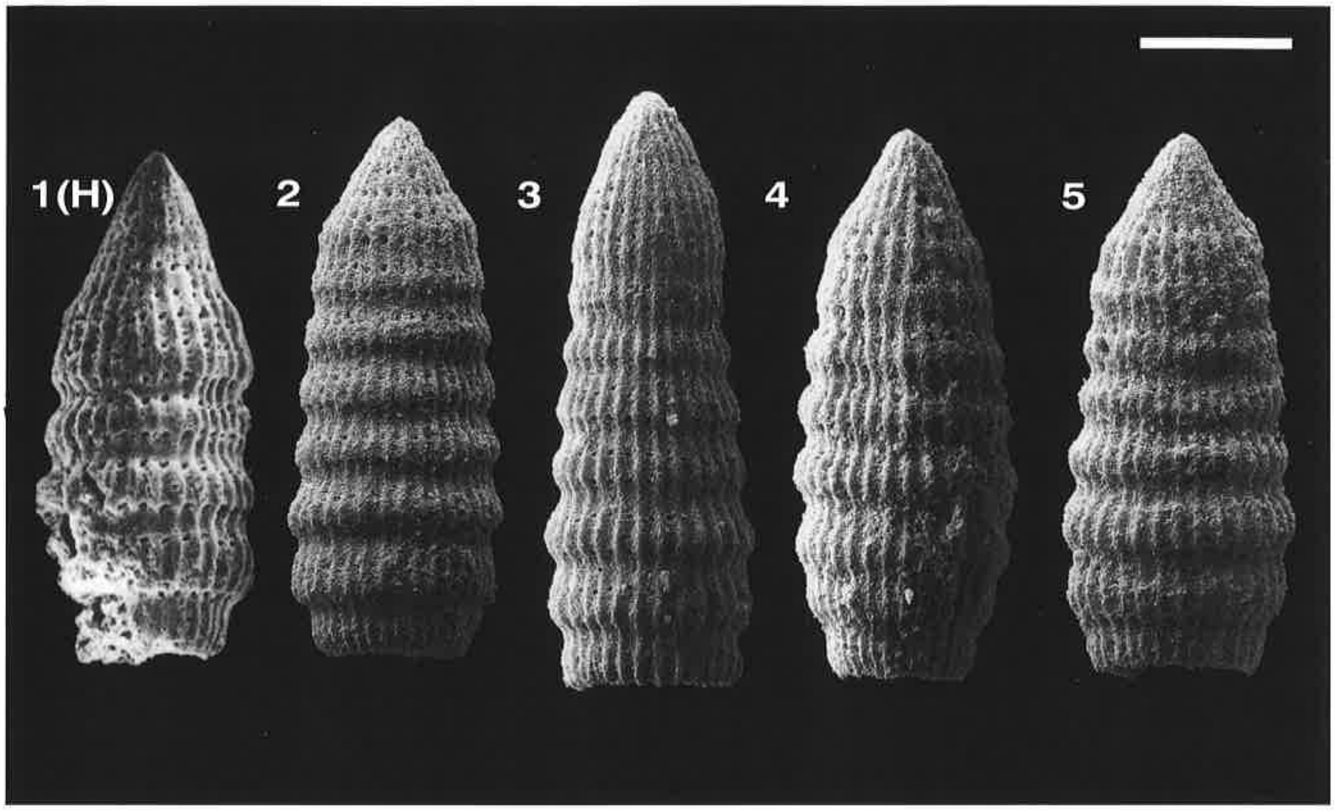


Plate 3305. *Archaeodictyomitra minoensis* (MIZUTANI). Magnification x300. **Fig. 1(H).** MIZUTANI 1981, pl. 63, fig. 9. **Fig. 2.** DU1883, R102. **Fig. 3.** DU1918, R102. **Fig. 4.** DU1866, R102. **Fig. 5.** DU1849, R102.

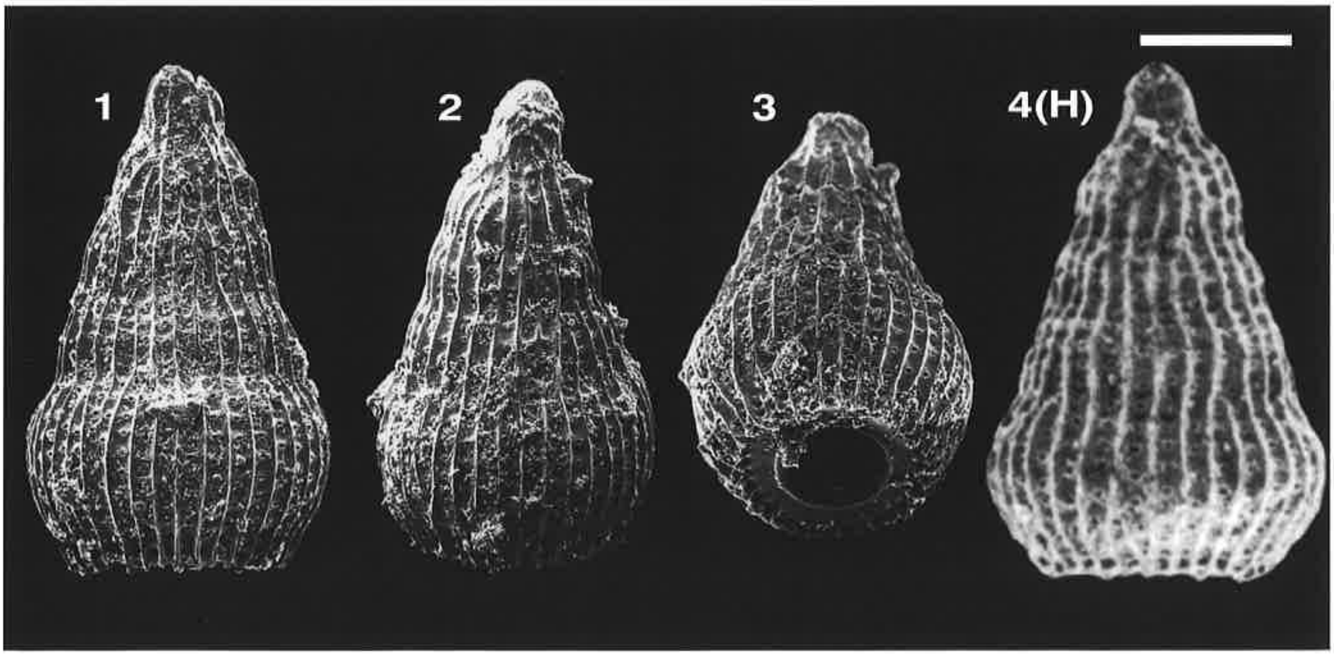


Plate 3236. *Archaeodictyomitra* (?) *mirabilis* AITA. Magnification x400. **Fig. 1.** POB81/2236, 534.122.1.43. **Fig. 2.** POB81/2237, 534.122.1.43. **Fig. 3.** POB81/2240, 534.122.1.43. **Fig. 4(H).** AITA 1987, pl. 9, fig. 7.

ARCHAEODICTYOMITRA (?) \ A 3235

Archaeodictyomitra (?) sp. A

Remarks.- This species differs from *A.* (?) *mirabilis* by having 2-3 rows of pores between costae, instead of one. and by having less and wider spaced costae. It differs from *A.* (?) *amabilis* by better developed constritions between postabdominal segments.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

ARCHAEOHAGIASTRUM 3609

Genus: *Archaeohagiastrum* BAUMGARTNER

Synonymy.-
Archaeohagiastrum BAUMGARTNER
BAUMGARTNER 1984, p. 758.

Type Species.- *Archaeohagiastrum munitum* BAUMGARTNER 1984.

Original Definition.- Test composed of four rays, placed at right angles and of about equal length. The rays are formed of a primary beam, three primary canals and six external beams.

Original Remarks.- The rays of *Archaeohagiastrum* correspond to the medullary rays of the more evolved hagiastrins and represent the simplest possible hagiastrid structure. It was referred to as ancestor of *Hagiastrum* in Baumgartner (1980, text- fig. 7, p. 284). *Tetraporobracchia* KOZUR & MOSTLER 1979 has the same ray structure but rays are arranged along tetraedric or cubic axes. *Archaeotriastrum* DE WEVER 1981 has a similar ray structure but has three rays. Because of its simple ray structure this genus is tentatively included with the hagiastrins. It should, together with *Archaeotriastrum,* be assigned to a new subfamily ancestral to the *Hagiastrinae.*

Etymology.- *Archaeo-* ancient (Greek), ancestral form to *Hagiastrum.*

Included Taxa.-
3149 *Archaeohagiastrum longipes* n.sp. BAUMGARTNER
3271 *Archaeohagiastrum munitum* BAUMGARTNER

ARCHAEOHAGIASTRUM LONGIPES 3149

Archaeohagiastrum longipes n.sp. BAUMGARTNER

Synonymy.-
Tetratrabs sp.
KISHIDA & SUGANO 1982, pl. 6, fig. 11.
Archaeohagiastrum sp. A
HATTORI 1987, pl. 3, figs. 3-4.
HATTORI 1988a, pl. 5, fig. B.
Archaeohagiastrum sp. 1
KITO 1989, p. 117, pl. 7, figs. 12-13, 15-16.
Tetratrabs sp. aff. *T. zealis* (OZVOLDOVA)
CARTER & JAKOBS 1991, p. 344, pl. 2, fig. 7.

Type designation.- OR 554, 79/4086

Original Definition.- Form with four smooth slender rays of about equal length about at right angles, constructed as with genus. One row of large circular pores between each external beam. Beam cross-section hexagonal. Central area small, smooth, with small, irregular pores or with 4-7 small nodes. Lateral beams are continuous around the central area. The external beams of rays are smooth or slightly nodose. Ray tip sometimes slightly thickened, with short three-bladed central spine.

Original Remarks.- This species differs from *A. munitum* by distincly longer and slenderer rays and a generally less nodose test surface. Central knobs are present but much less developed than with *A. munitum.*

Etymology.- *Longipes*, latin for "long-footed" named for its long rays compared to the type species of this genus.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Length of rays AX:	208	210	192	218
Length of rays BX:	198	-	-	-
Length of rays CX:	195	-	-	-
Length of rays DX:	-	-	-	-
Width of rays:	41	45	33	47
Width of central area:	70	75	65	82

Type Locality.- Sample OR 554 collected under the guidance of E.A. Pessagno, Snowshoe Formation, East-Central Oregon.

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

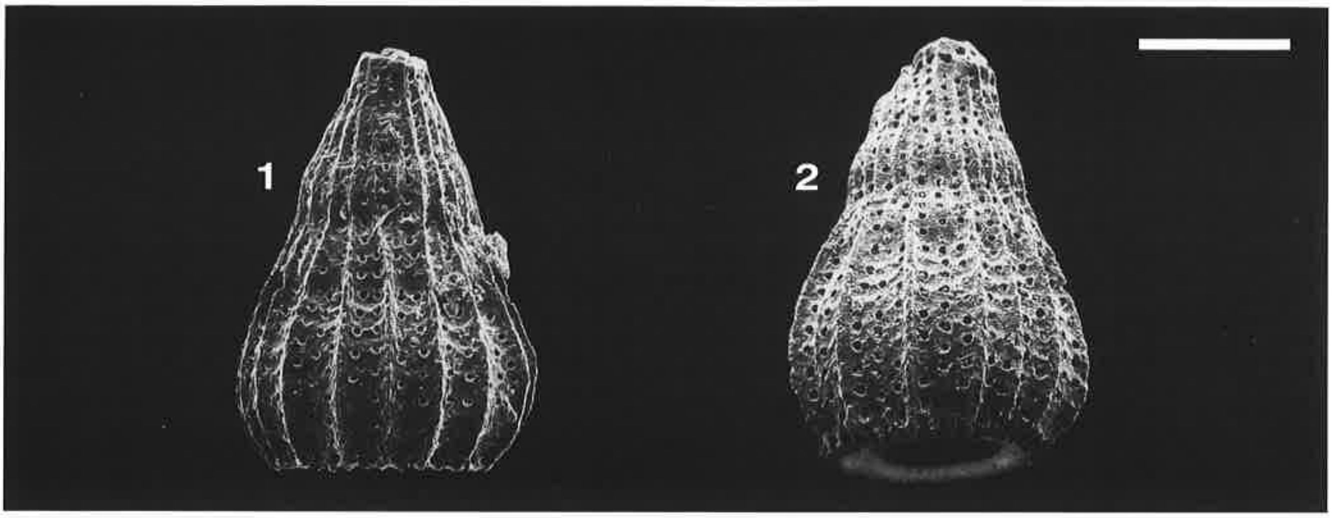


Plate 3235. *Archaeodictyomitra* (?) sp. A. Magnification x400. **Fig. 1.** POB81/2457, 534.125.5.40. **Fig. 2.** POB81/2462, 534.125.5.40.

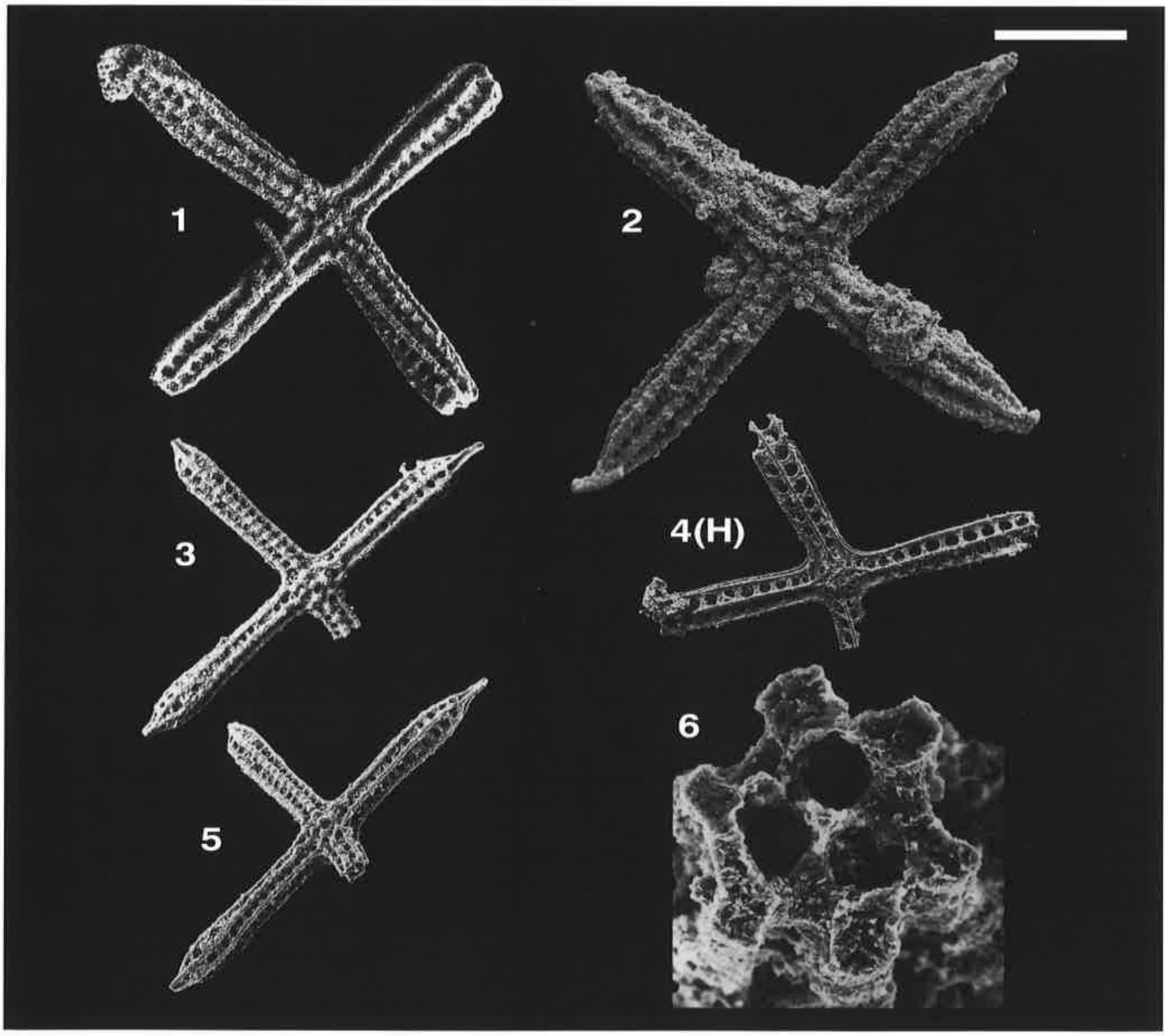


Plate 3149. *Archaeohagiastrum longipes* n.sp. BAUMGARTNER. Magnification x150, except Fig. 6 x1335. **Fig. 1.** POB81/2909, POB1341. **Fig. 2.** POB81/2955, POB1341. **Fig. 3.** POB81/3013, IN7. **Fig. 4(H).** POB79/4086, OR554. **Fig. 5**. POB79/4042, OR554. **Fig. 6.** POB79/4041 OR554.

ARCHAEOHAGIASTRUM MUNITUM — *3271*

Archaeohagiastrum munitum BAUMGARTNER

***Synonymy*.-**

Crucella sp. A
- SASHIDA et al. 1982, pl. 1, fig. 9.

Tetratrabs sp. B
- WAKITA 1982, pl. 5, fig. 4.

Archaeohagiastrum munitum BAUMGARTNER
- BAUMGARTNER 1984, p. 759, pl. 2, figs. 9-13.
- NAGAI 1985, pl. 2, figs. 5-5a.
- YAMAMOTO et al. 1985, p. 34, pl. 3, figs. 7a-b.
- DANELIAN 1989, p. 143, pl. 3, fig. 3.
- KITO 1989, p. 116, pl. 7, fig. 8.
- KITO et al. 1990, pl. 1, fig. 6.

Tetraditryma sp. B
- CARTER et al. 1988, p. 31, pl. 16, fig. 8.

***Original Definition*.-** Small form with four smooth to nodose rays of about equal length constructed as with genus. Central area small, occupied by four to five broad, highly raised, connected nodes, which alternate with four pores placed at the proximal termination of the median beams. The fifth node is central or slightly excentric and fused to one of the corner nodes. A nearly centrally placed pore often occurs. Lateral beams are continuous around the central area. The external beams of rays are slightly to strongly nodose, nodes increase in size towards central area and are sometimes connected by a blade like ridge. Ray tip blunt or with short central spine of round cross section.

***Original Remarks*.-** *A. munitum* differs from other yet undescribed species of this genus by being distinctly smaller and by having a strongly nodose test.

***Etymology*.-** *Munitum*: fortified, protected (Latin), referring to the nodose surface of test and central area.

Measurements (in μm).-
Based on 7 specimens.

	min.	max.	av.	HT
Length of rays AX:	114	-	-	-
Length of rays BX:	120	-	-	-
Length of rays CX:	108	-	-	-
Length of rays DX:	111	95	87	120
Width of rays:	51	42	35	51
Maximum length of spines:	66	48	28	66
Width of central nodose area:	65	60	47	76

***Type Locality*.-** Blake Bahama Basin, West Atlantic (DSDP Leg 71, Site 534).

***UAZones*.-** 2-8, late Aal. to mid Call.-early Oxf.

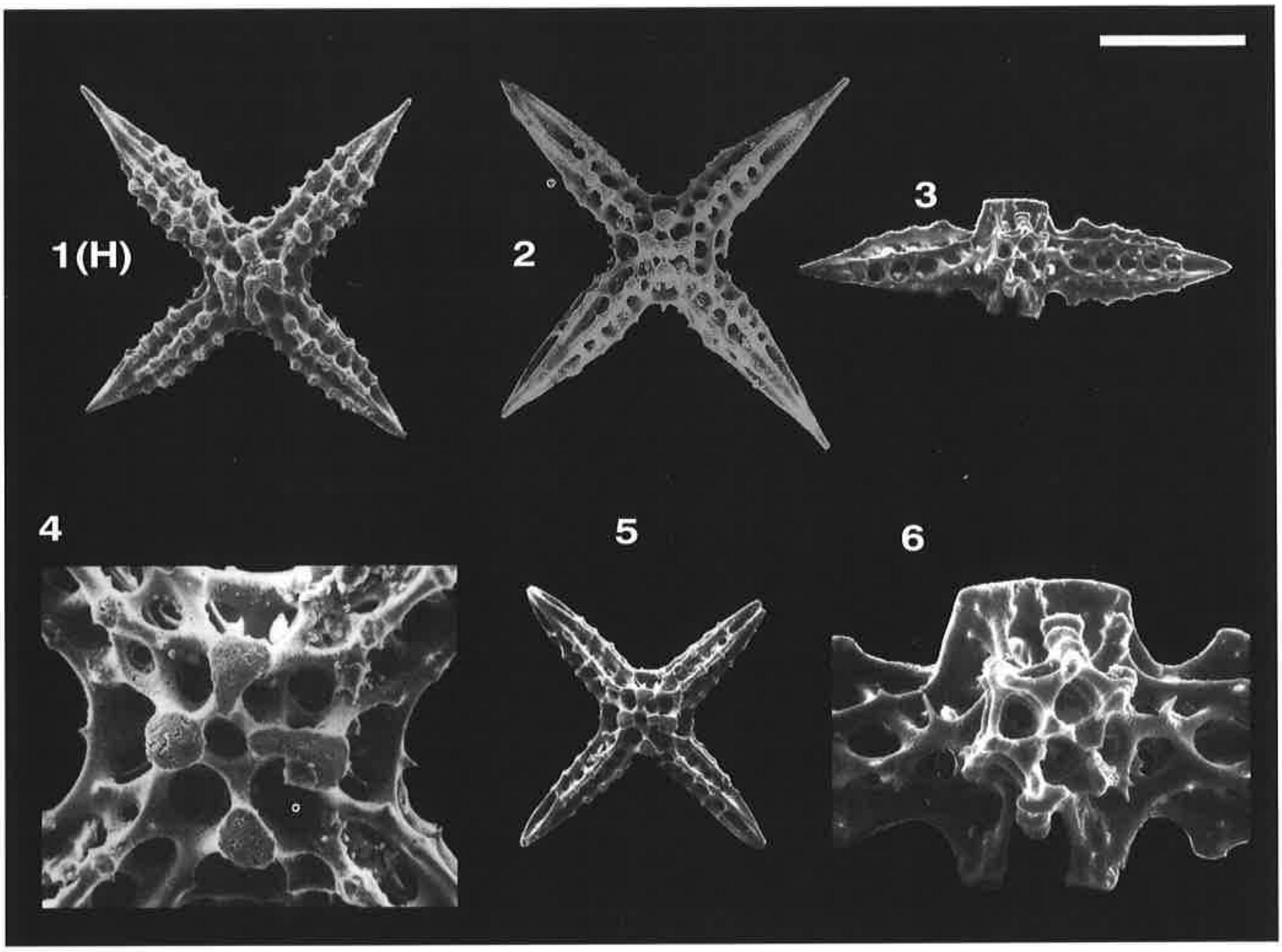


Plate 3271. ***Archaeohagiastrum munitum*** **BAUMGARTNER.** Magnification x200, except Figs. 4, 6 x650. **Fig. 1(H).** POB81/9140, 76.534A.125.5.111. **Fig. 2.** POB81/9174, 76.534A.125.5.72. **Fig. 3.** POB81/9151, 534A.126.2.125. **Fig. 4.** POB81/9176, 76.534A.126.2.125. **Fig. 5.** POB81/9175, 76.534A.126.2.125. **Fig. 6.** POB81/9152, 534A.126.2.125.

ARCHAEOSPONGOPRUNUM 3610

Genus: *Archaeospongoprunum* PESSAGNO

***Synonymy*.-**
Archaeospongoprunum PESSAGNO
PESSAGNO 1973, p. 57.

***Type Species*.-** *Archaeospongoprunum venadoensis* PESSAGNO 1973.

***Original Definition*.-** Test cylindrical, ellipsoidal, or ellipsoidal and lobate with two polar spines; polar spines triradiate or tetraradiate in axial section with longitudinally or spirally arranged ridges alternating with grooves. Spongy meshwork comprised of polygonal pore frames arranged in concentric layers.

***Original Remarks*.-** Species are differentiated on the general shape of the test and also on the design of the polar spines in both axial and longitudinal section. The polar spines are usually of unequal length.

***Etymology*.-** *Spongoprunum* = spongy plum.

***Included Taxa*.-**
5042 *Archaeospongoprunum patricki* JUD

ARCHAEOSPONGOPRUNUM PATRICKI 5042

Archaeospongoprunum patricki JUD

***Synonymy*.-**
Archaeospongoprunum tehamaensis PESSAGNO
SCHAAF 1981, p. 432, pl. 7, figs. 3, 5; pl. 10, figs. 7a-b.
ORIGLIA-DEVOS 1983, p. 126, pl. 14, fig. 33.
SCHAAF 1984, p. 157, figs. 7, 11.
CARAYON et al. 1984, pl. 1, fig. 8.
TUMANDA 1989, p. 34, pl. 1, fig. 12.
Archaeospongoprunum tehamaense PESSAGNO
WU 1986, pl. 1, fig. 10.
Archaeospongoprunum cf. *tehamaensis* PESSAGNO
IGO et al. 1987, text-fig. 2.5.
THUROW 1988, p. 398, pl. 6, fig. 1.
Archaeospongoprunum cortinaensis PESSAGNO
SCHMIDT-EFFING 1980, p. 246, text-fig. 15.
YAMAUCHI 1982, pl. 2, fig. 5.
OKAMURA et al. 1982, p. 98, pl. 16, fig. 1.
GORKA 1989, p. 339, pl. 12, figs. 5-6.
ORIGLIA-DEVOS 1983, p. 125, pl. 14, fig. 30.
THUROW 1988, p. 398, pl. 9, fig. 19.
TUMANDA 1989, p. 34, pl. 1, fig. 13.
Archaeospongoprunum sp. A
OKAMURA 1980, pl. 19, fig. 4.
TUMANDA 1989, p. 34, pl. 1, fig. 11.
Archaeospongoprunum sp.
PAVSIC & GORICAN 1987, p. 24, pl. 1, fig. 4.
STEIGER 1992, p. 29, pl. 4, figs. 3-4.
Archaeospongoprunum patricki JUD
JUD 1994, p. 63, pl. 4, figs. 2-4.

***Original Definition*.-** Subglobular to ellipsoidal test, tapering and passing gently to the base of the 2 polar spines. Surface of test formed by a meshwork of polygonal pore frames. Spines slender, pointed, subequal in length, with 3 deep primary grooves and 3 secondary smaller grooves on the main ridges. Generally one or both spines are more or less twisted.

***Original Remarks*.-** *Archaeospongoprunum patricki* n.sp. differs from *A. tehamaensis, A. cortinaensis, A. salumis*, all species described by Pessagno (1973), by the subglobular shape of the central part of the test and the gradual passage in outline between the globular portion and spines.

***Etymology*.-** This species is dedicated to Dr. Patrick De Wever, Laboratoire de Stratigraphie, Université Pierre et Marie Curie, Paris, France, honouring his contributions to the knowledge of Radiolaria.

***Measurements* (in μm).-**
Based on 7 specimens.

	HT	av.	min.	max.
Total length:	580	426	349	580
Length shell:	190	147	121	190
Width shell:	162	117	100	162
Maximum lenght spine:	195	149	121	195
Minimum lenght spine:	195	138	111	195

***Type Locality*.-** Breggia Gorge, near Chiasso, Ticino, Switzerland.

***UAZones*.-** 13-22, latest Tith. to late Barr.-early Apt.

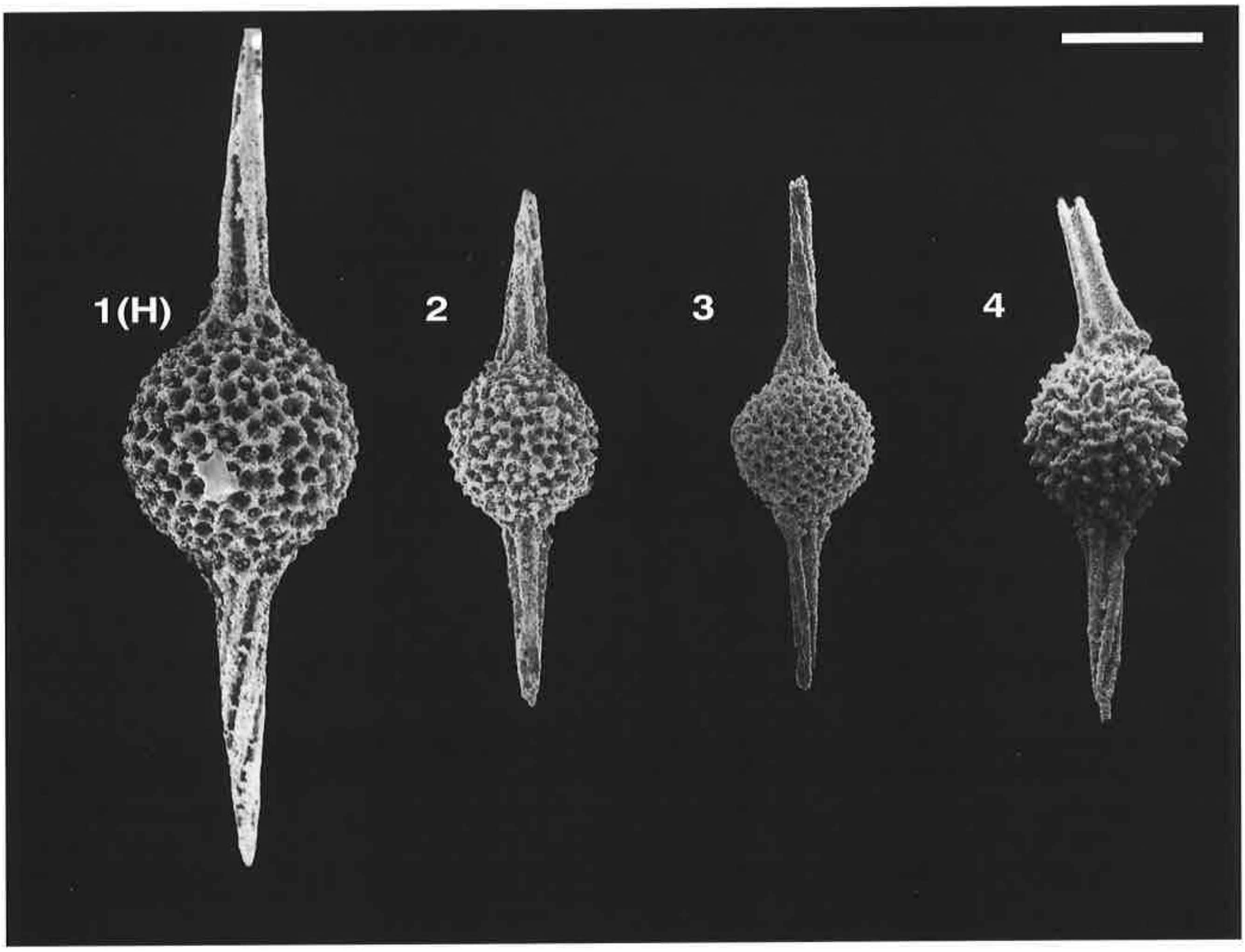


Plate 5042. *Archaeospongoprunum patricki* JUD. Magnification x200. **Fig. 1(H).** RJ1, Br28.85. **Fig. 2.** RJ133, Br1330. **Fig. 3.** RJ134, Pr225.3. **Fig. 4.** RJ34, Oman1.

ARCHAEOTRITRABS 3611

Genus: *Archaeotritrabs* STEIGER emend. JUD

Synonymy.-
Archaeotritrabs STEIGER
STEIGER 1992, p. 87.

Type Species.- *Archaeotritrabs gracilis* STEIGER 1992.

Original Definition.- "Test three-rayed, composed of armed hagiastrid with 6 longitudinal ribs, which generate a hexagonal cross section of the arms. The longitudinal ribs are noddy. Between them 6 rows of simple pore frames occur. The arm ends increase in width and have a rounded to trapezoidal contour. The arm ends can have spines."

Original Remarks.- "The genus *Archaeotritrabs* differs from the genera of the subfamiliy of the Tritrabinae by having simple pore rows between longitudinal ribs. After Baumgartner (1980) the Tritrabinae are defined by double pore rows. It is questionable whether these forms can be related to the Tritrabinae on the base of the hexagonal cross section of the arms. The morphological range of the group should extended in the sense of having simple pore rows. Otherwise a new subfamiliy has to be created to include simple pore rows on the same level as double pore rows. Because of the rare material this is actually impossible."

Actualized Definition.- (JUD, 1994) Test three-rayed. Rays of equal length, composed of 8 beams. Cross-section of rays rectangular to octogonal. Beams connected with one another by bars forming rectangular pores on the upper and lower sides of the test, and rectangular to trapezoidal pores on the lateral sides. Ray tips inflated, with small, polygonal pore-frames and usually with spines.

Actualized Remarks.- (JUD, 1994) The genus was described as possessing 6 longitudinal beams on each ray. This interpretation is a result of insufficient observation of the lateral parts of the rays. Specimens unquestionably assignable to *A. gracilis* STEIGER occurring in our material prove that this species has 8 beams and that the rays have a subrectangular cross-section. Moreover, cross-sections show that the rays have 4 channels and not 3, as characteristic of *Tritrabs* (P. Dumitrica, personal communication, and pl. 4, fig. 7, Jud 1994).

Included Taxa.-
5913 *Archaeotritrabs gracilis* STEIGER

ARCHAEOTRITRABS GRACILIS 5913

Archaeotritrabs gracilis STEIGER

Synonymy.-
Paronaella (?) *ewingi* PESSAGNO
HOLZER 1980, p. 159, pl. 1, figs. 16, 17, not 15.
Paronaella (?) *worzeli* PESSAGNO
HOLZER 1980, p. 160, pl. 2, fig. 11, not 10.
Gen. et sp. indet.
OKAMURA & UTO 1982, pl. 6, fig. 6.
Tetradytrima pseudoplena BAUMGARTNER
ORIGLIA-DEVOS 1983, p. 78, only pl. 10, fig. 1.
Archaeotritrabs gracilis STEIGER
STEIGER 1992, p. 40, pl. 8, figs. 6-8.
JUD 1994, p. 64, pl. 4, figs. 5-8.
Homoeoparonaella tricuspidata (RÜST)
STEIGER 1992, p. 41, pl. 9, figs. 1-2.

Original Description.- "Three rayed hagiastrid with 6 beams on each ray and hexagonal cross section of arms. Single rows of rectangular pores are set between beams. In the very small central area beams of the upper and lower test surface meet. Ray tips , rhomboedric, bulbose. On the three outer tips of each ray tip a primary spine with a triradiate base is placed".

Original Remarks.- "All specimens of the genus *Archaeotritrabs* found so far have the same characteristics and therefore belong to one species".

Actualized Remarks.- (JUD, 1994) The species shows a wide variability of the size of nodes, from forms with small nodes, similar to those of the holotype, to forms, herein illustrated, with strong, quadrangular nodes which cover almost the entire top and bottom faces of rays. Ray tips of all morphotypes are club-shaped and, when well preserved, bear 3 spines and numerous pores densely arranged in square or quincuncial pattern. Of the 3 spines one is axial, bladed and longer, the other two are laterally or obliquely directed. Contrary to the erroneous description by Steiger (1992), the lateral sides of rays show two beams, instead of one, connected by transverse bars forming wide quadrangular meshes. These beams make the cross section of arms rectangular or slightly octogonal.

Etymology.- *Gracilis* = delicate, fragile. The name is to characterize the very thin arms of the test.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Length of rays:	310	320	300	350
Width of rays:	40	43	40	50
Width of rays at tip:	120	122	120	125
Length of spine:	50	53	50	60

Type Locality.- Trattberg, section TE, sample TE 4, along the road Vordertrattberg-Hintertrattberg-Alm (Salzburg).

UAZones.- 16-21, early Val. to early Barr.

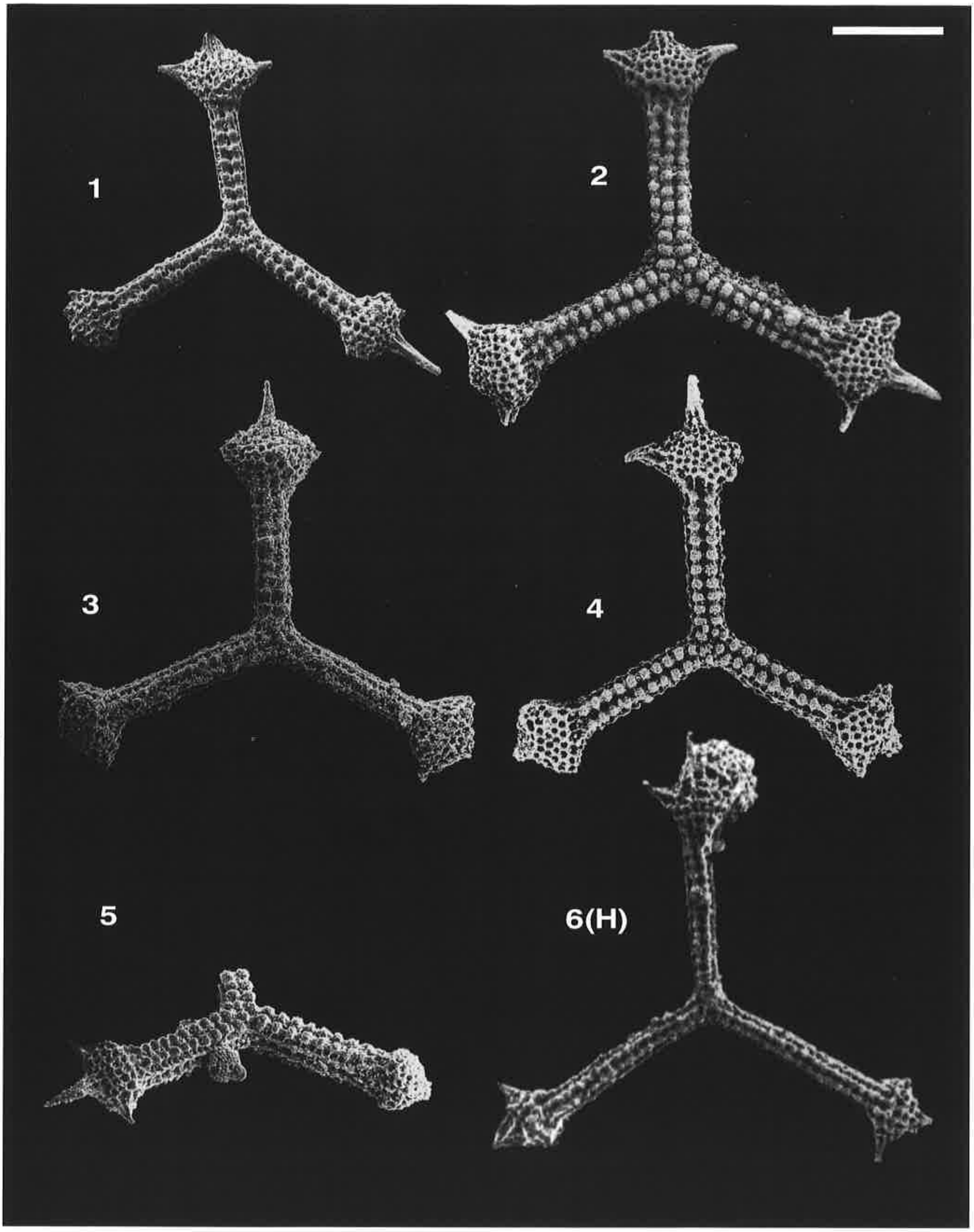


Plate 5913. ***Archaeotritrabs gracilis*** **STEIGER.** Magnification x150. **Fig. 1.** POB79/3108, MO1 46. **Fig. 2.** RJ336, Bo566.5. **Fig. 3.** TS7, Ga27/1. **Fig. 4.** RJ98, Br141.55. **Fig. 5.** RJ1127, Bo561.50. **Fig. 6(H).** TS21, TE4/2.

ARCHICAPSA 3612

Genus: *Archicapsa* HAECKEL

Synonymy.-
Archicapsa HAECKEL
HAECKEL 1881, p. 428.
HAECKEL 1887, p. 1191.

Type Species.- *Archicapsa pyriformis* RÜST 1885.

Original Definition.- "Obtuse Archicapsida (cephalis smooth, not spiny); test very smooth."

Original Remarks.- "Archicapsida without apical horn"

Etymology.- Greek. *Archicapsa* = primordial capsule

Included Taxa.-
4007 *Archicapsa* (?) *pachyderma* (TAN)

ARCHICAPSA (?) PACHYDERMA 4007

Archicapsa (?) *pachyderma* (TAN)

Synonymy.-
Cyrtocalpis pachyderma TAN
TAN 1927, p. 41, pl. 7, fig. 28.
Archicapsa sp. A
YAO et al. 1982, pl. 3, fig. 3.
MATSUOKA 1982a, pl. 1, figs. 9, 22-23.
YAO 1983, fig. 3.3.
YAO 1984, pl. 1, figs. 19-20.
Archicapsa sp.
KIDO 1982, pl. 5, fig. 12.
OWADA & SAKA 1982, pl. 2, fig. 17.
MIZUTANI et al. 1984, pl. 1, fig. 14.
Archicapsa sp. A of YAO
ISHIDA 1985, pl. 1, fig. 9.
Archicapsa pachyderma (TAN)
MATSUOKA & YAO 1986, pl. 1, fig. 5; pl. 3, figs. 1a-b.
KIDO 1982, pl. 2, fig. 9.
Archicapsa cf. *pachyderma* (TAN)
SAITO 1989, pl. 1, figs. 5, 19.

Original Definition.- "Shell oval, irregular in shape, with a large pylom. Shell-wall very thick, with scattered round and funnel-shaped pores with double rim.

Definition.- Shell ovoidal, small, usually less than 130 μm in height. Wall very thick, perforated. Pores small to medium-sized, circular to subcircular and irregularly arranged.

Original Remarks.- "*C. pachyderma* is very similar to *Archicapsa guttiformis* TAN, pl. 7, fig. 30 which, however, posesses no pylome. Looking at the small number of pores and the varying thickness of the shell-wall, it is similar to *Cenellipsis bergontianus* CARNAVALE 1908 (p. 19, pl. 3, figs. 5, 6, 7 from the M. Miocene of Bergonzano). Our specimen is monaxon, has more variable shell-wall in thickness and posesses a pylome".

Remarks.- Larger forms excluded (>130 μm height).

Type Locality.- Rotti Island, Moluccas Archipielago, East Indian Ocean.

UAZones.- 3-4, early-mid Baj. to late Baj.

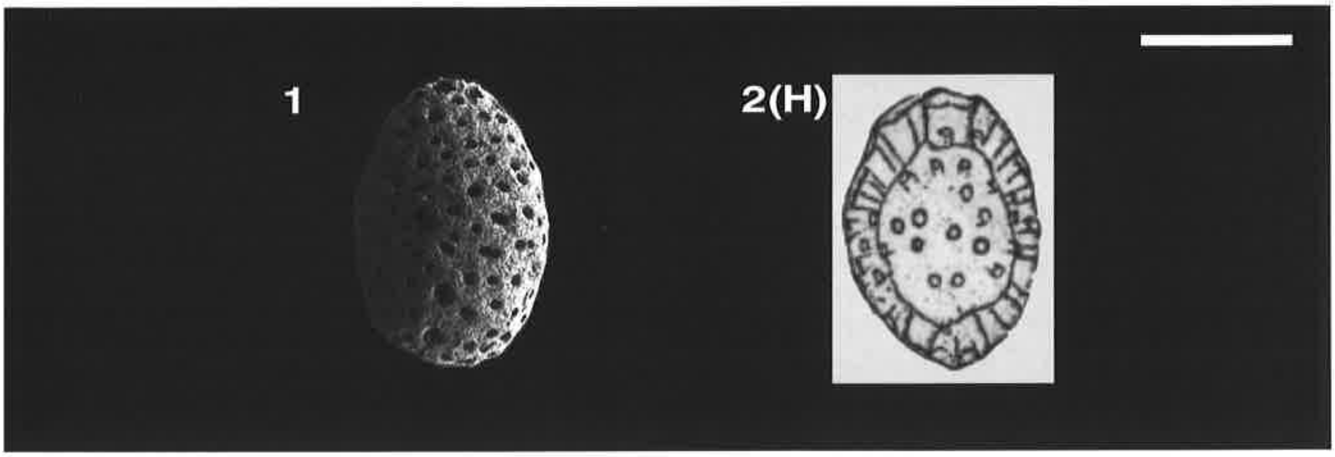


Plate 4007. *Archicapsa* (?) *pachyderma* (TAN). Magnification x350 **Fig. 1.** MA4234, F-18, **Fig. 2(H).** TAN 1927, pl. 7, fig. 28.

ARES 3613

Genus: *Ares* DE WEVER

***Synonymy*.-**
Ares DE WEVER
DE WEVER 1982a, p. 202.
Parares TAKEMURA
TAKEMURA 1986, p. 46.

***Type Species*.-** *Ares armatus* DE WEVER 1982a.

***Original Definition*.-** "Form with three stout spines, curved or not which correspond to prolongations of cephalic actines A V D. The six collar pores vary in size, the biggest are cardinal pores and the smallest the jugular ones. Collar structure is not plane, jugular and cervical pores are oblique to cardinal ones.

Actines A and V are free, D is attached to the main body by bridges. Cephalis is small and hemispheric. The thorax is robust and bears two spines which prolong cephalic actines D and V. Pores of the flared part (abdomen?, velum?) are disposed in more or less regular rows."

***Original Remarks*.-** "This genus differs from *Dictyoceras* by the existence of two thoracic arms instead of three. It differs from other genus by its two characteristic arms."

***Remarks*.-** The genus *Parares* TAKEMURA is herein synonymized with *Ares* DE WEVER. The differences between them (presence or absence of an external spine A and cylindrical or conical shape) are considered to be of specific rather than generic level. Takemura (1986) himself noted that a specimen of his *Parares* possessed a short bladed apical horn.

***Etymology*.-** *Ares* is the Greek god of war, son of *Zeus* and *Hera,* who fought at Troya where his daughter *Penthesilea* was killed by *Achilles.*

***Included Taxa*.-**
4061 *Ares cylindricus* s.l. (TAKEMURA)
3001 *Ares cylindricus cylindricus* (TAKEMURA)
4032 *Ares cylindricus flexuosus* (TAKEMURA)
4008 *Ares* sp. A

ARES CYLINDRICUS S.L. — *4061*

***Ares cylindricus* s.l. (TAKEMURA)**

Synonymy.-
Parares cylindricus TAKEMURA
TAKEMURA 1986, p. 46, pl. 4, figs. 3-7.
Parares flexuosus TAKEMURA
TAKEMURA 1986, p. 47, pl. 4, figs. 8-11.
Nassellaria gen. et sp. indet. C in YAO et al. 1982
? DE WEVER & CORDEY 1986, pl. 1, fig. 11.
Parares (?) aff. *P. cylindricus* TAKEMURA
HATTORI 1987, pl. 20, fig. 9.
see also subspecies.

Included Taxa.-
3001 *Ares cylindricus cylindricus* (TAKEMURA)
4032 *Ares cylindricus flexuosus* (TAKEMURA)

UAZones.- 1-6, early-mid Aal. to mid Bath.

ARES CYLINDRICUS CYLINDRICUS — *3001*

***Ares cylindricus cylindricus* (TAKEMURA)**

Synonymy.-
Parares cylindricus TAKEMURA
TAKEMURA 1986, p. 46, pl. 4, figs. 3-7.
KITO 1989, p. 204, pl. 23, fig. 11.
Nassellaria gen. et sp. indet. C in YAO et al. 1982
? DE WEVER & CORDEY 1986, pl. 1, fig. 11.
Parares (?) aff. *P. cylindricus* TAKEMURA
HATTORI 1987, pl. 20, fig. 9.
Parares flexuous TAKEMURA
TAKEMURA 1986, p. 47, pl. 4, figs. 8-11.
KITO 1989, p. 204, pl. 23, fig. 12.

Original Definition.- Cephalis small, poreless and spherical, with well developed and triradiate vertical spine. Vertical spine curved downward and in some specimens, slightly curved upward distally. Thorax cylindrical and long, with elliptical pores arranged longitudinally and hexagonally. No apertural ring at the end of the thorax. Dorsal spine strong and triradiate, about twice as long as thorax. Dorsal spine curved slightly proximally and distally straight and slightly twisted anticlockwisely. Some bars connecting dorsal spine and thoracic wall at several points in some specimen.

Original Remarks.- *Parares cylindricus* n.sp. differs from *P. flexuous* n.sp. in cylindrical thorax and distally straight dorsal spine.

Etymology.- The species name, *cylindricus*, cylindrical in English is derived from the shape of thorax.

Measurements (in μm).-
Based on 10 specimens. Length of shell including two spines, 470-610; Height of cephalo-thorax, 185-270; Maximum width of shell including two spines, 345-465; Width of thorax, 105-135.

Type Locality.- Sample TKN-105, Komami, Yamato village, Gifu Prefecture, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

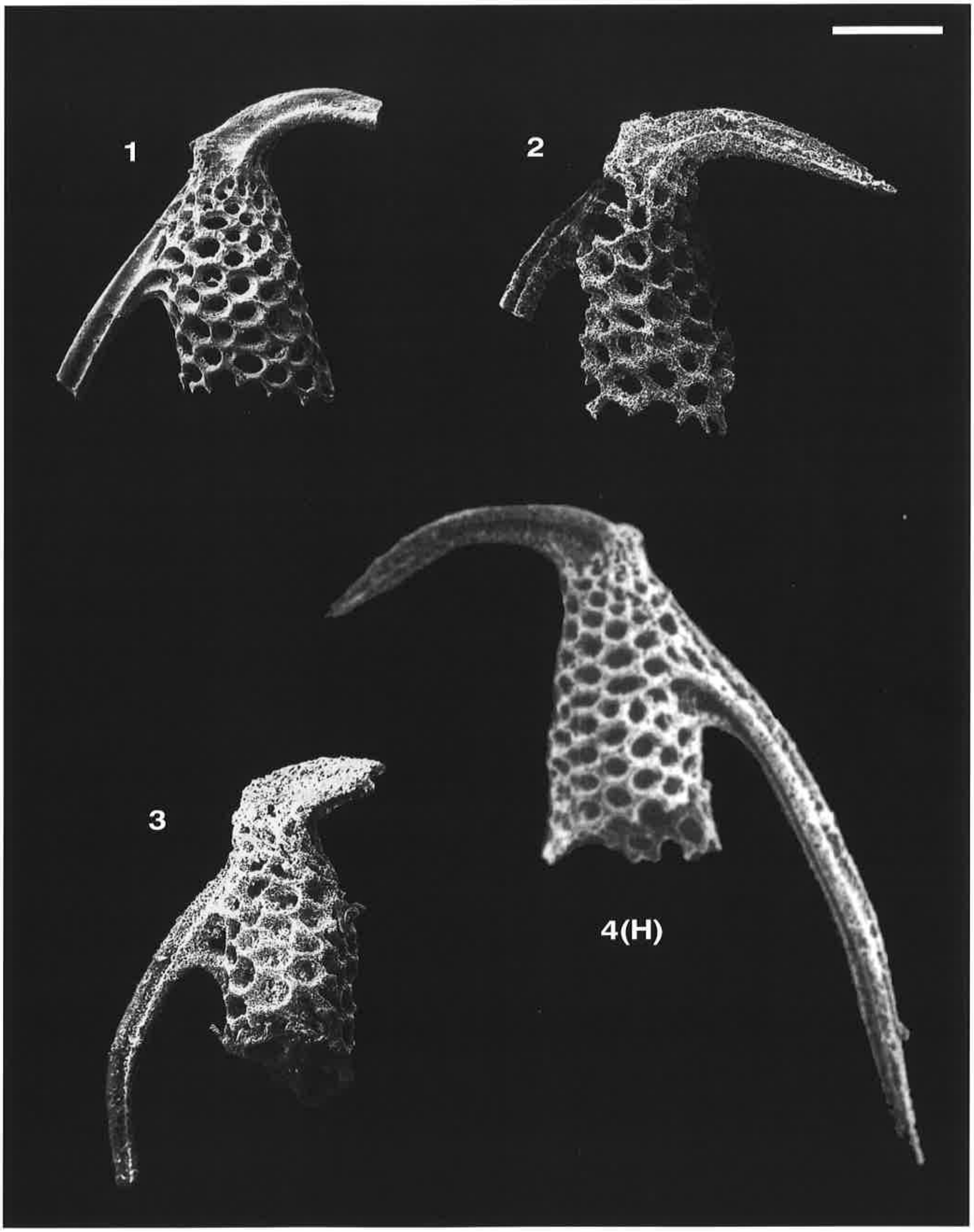


Plate 3001. ***Ares cylindricus cylindricus*** **(TAKEMURA).** Magnification x250. **Fig. 1.** POB81/2986, IN7. **Fig. 2.** POB81/2832, POB1341. **Fig. 3.** POB81/2830, POB1341. **Fig. 4(H).** TAKEMURA 1986, pl. 4, fig. 4.

ARES CYLINDRICUS FLEXUOSUS 4032

Ares cylindricus flexuosus (TAKEMURA)

Synonymy.-
Parares flexuous TAKEMURA
TAKEMURA 1986, p. 47, pl. 4, figs. 8-11.
KITO 1989, p. 204, pl. 23, fig. 12.

Original Definition.- Cephalis small, spherical and poreless, with stout and triradiate vertical spine, which is curved downward distally. Thorax conical to subconical and slightly narrow distally, without apertural ring. Thoracic pores spherical to ellipsoidal, usually arranged longitudinally and hexagonally. Dorsal spine which is twisted anticlockwisely strong, triradiate and remarkably curved downwardly.

Original Remarks.- *Parares flexuous* n.sp. is distinguished from *P. cylindricus* by its conical to subconical thorax and markedly curved dorsal spine.

Remarks.- The name *flexuous* is emended (I.C.Z.N., art.33a(I)) into *flexuosus,* which is the correct Latin name.

Etymology.- The species name, *flexuous,* means bending, derived from its curved dorsal spine.

Measurements (in μm).-
Based on 4 specimens. Length of shell including two spines, 280-335; Height of cephalo-thorax, 145-175; Maximum width of shell including two spines, 360-420; Width of thorax, 100-110.

Type Locality.- Sample TKN-105, Komami, Yamato Village, Gifu Prefecture, central Japan.

UAZones.- 4-6, late Baj. to mid Bath.

ARES | A 4008

Ares sp. A

Synonymy.-
Parares sp.
TAKEMURA 1986, p. 47, pl. 4, fig. 12.
Parares (?) sp. A
? HATTORI 1987, pl. 20, fig. 8.

Remarks.- This species differs from *A. cylindricus* by having a short triradiate apical horn.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

argolidensis >> *HOMOEOPARONAELLA ARGOLIDENSIS* 3103

argolidensis >> *HOMOEOPARONAELLA ARGOLIDENSIS AFF.* 2003

ARTOCAPSA 3801

Genus: *Artocapsa* HAECKEL

Type Designation.- *Artocapsa fusiformis* HAECKEL 1887.

Original Definition.- "Tetracyrtida clausa eradiata, acuta, capitulo spinoso, non laevi."

Included Taxa.-
3924 *Artocapsa* (?) *amphorella* JUD

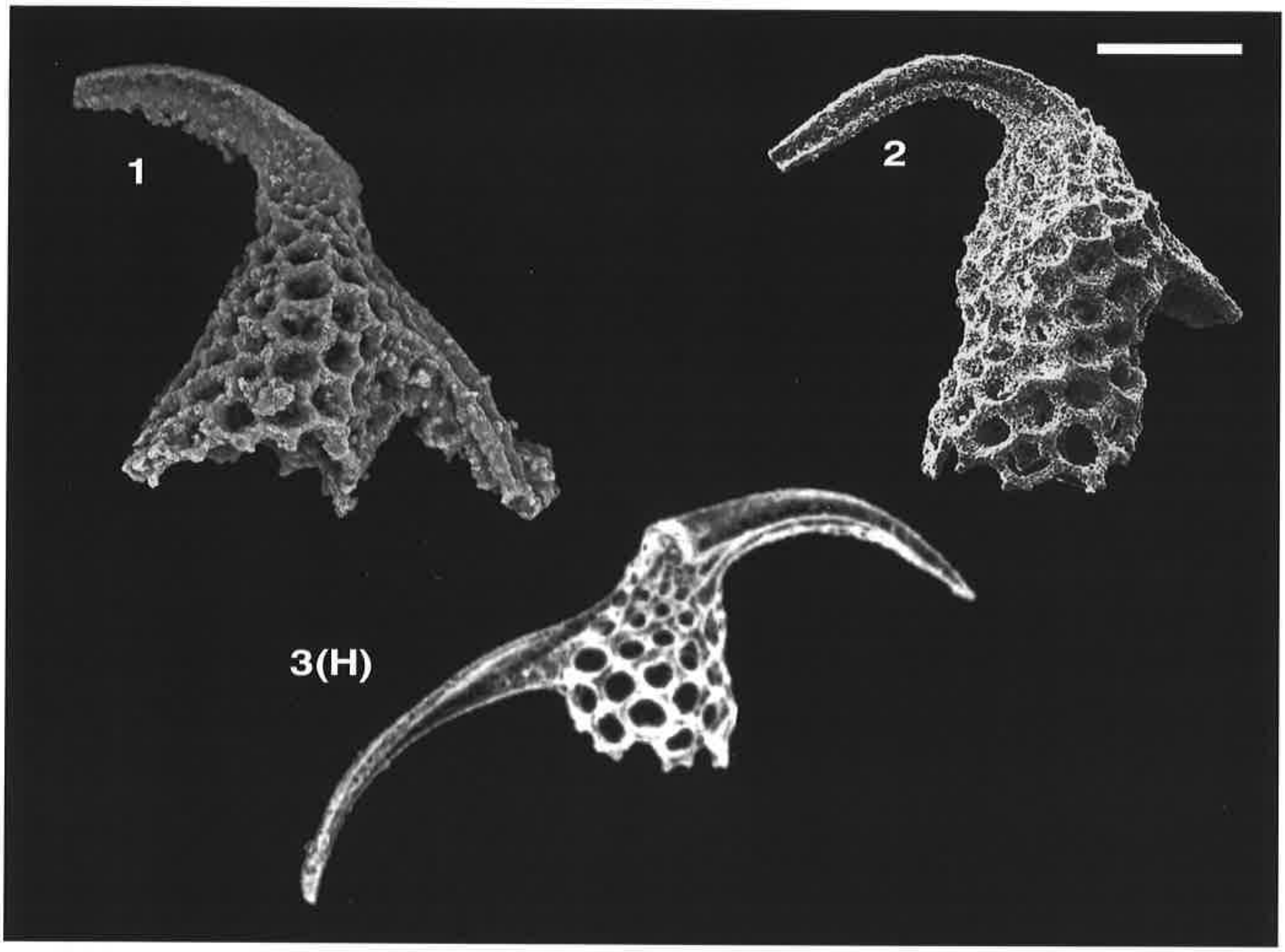


Plate 4032. ***Ares cylindricus flexuosus*** **(TAKEMURA).** Magnification x250. **Fig. 1.** KI8855-1966, S66. **Fig. 2.** POB81/2840, POB1341. **Fig. 3(H).** TAKEMURA 1986, pl. 4, fig. 8.

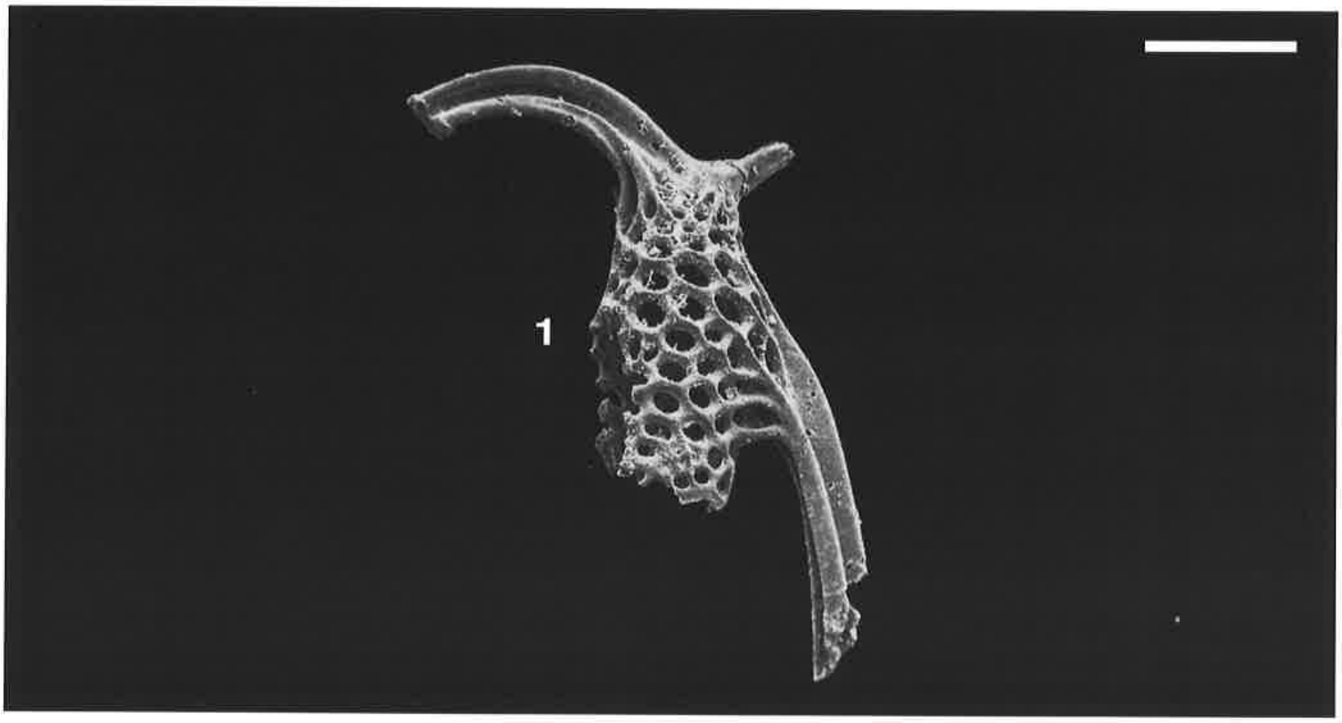


Plate 4008. ***Ares*** **sp. A.** Magnification x250. **Fig. 1.** POB81/2993, IN7.

ARTOCAPSA (?) AMPHORELLA 3924

Artocapsa (?) *amphorella* JUD

Synonymy.-
Artocapsa (?) *amphorella* JUD
JUD 1994, p. 65, pl. 4, figs. 9-10.

Original Definition.- Spindle-shaped test of unknown number of segments. Proximal half of test rapidly increasing in width, then rapidly decreasing, terminating into a small, conical, relatively short tube. Boundary between distal tube and main test marked in outline by a visible change in outline. Apical portion bearing a very short horn. Test wall seems to be double-layered, with an inner layer of small pores and an outer layer of coarse irregular meshwork. Distal tube single-layered and always closed and prolonged into a short conical spine.

Original Remarks.- *Artocapsa amphorella* n.sp. has a similar surface structure as *Syringocapsa longitubus* n.sp. It differs clearly from the latter by its spindle-shaped form, by lacking the long apical horn and the long cylindrical distal tube. We have included in this species two extreme morphotypes: a short one with slightly inflated proximal and distal portions, and a longer one with a more concave apical portion and a thinner conical distal portion. Between them there are transitional forms.

Etymology.- From the Latin *amphorella* = small amphora.

Measurements (in μm).-
Based on 19 specimens.

	HT	av.	min.	max.
Total height:	417	323	248	417
Max. width:	158	131	88	170
Length extension:	129	91	60	129
Width at base ext.:	64	58	36	68

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 13-14, latest Tith. to early-early late Berr.

asparagus >> RISTOLA ASPARAGUS 5575

aspera >> PSEUDOEUCYRTIS ASPERA 5576

asymbatos >> STICHOMITRA ASYMBATOS AFF. 5672

baileyi >> MIRIFUSUS DIANAE BAILEYI 3406

banale >> CANOPTUM BANALE 5785

bandyi >> PARONAELLA BANDYI 3135

barbui >> HOLOCRYPTOCANIUM BARBUI 6107

barmsteinensis >> PYRAMISPONGIA BARMSTEINENSIS 6109

beniderkoulensis >> LINARESIA BENIDERKOULENSIS 3813

bernoullii >> THETIS (?) BERNOULLII 3003

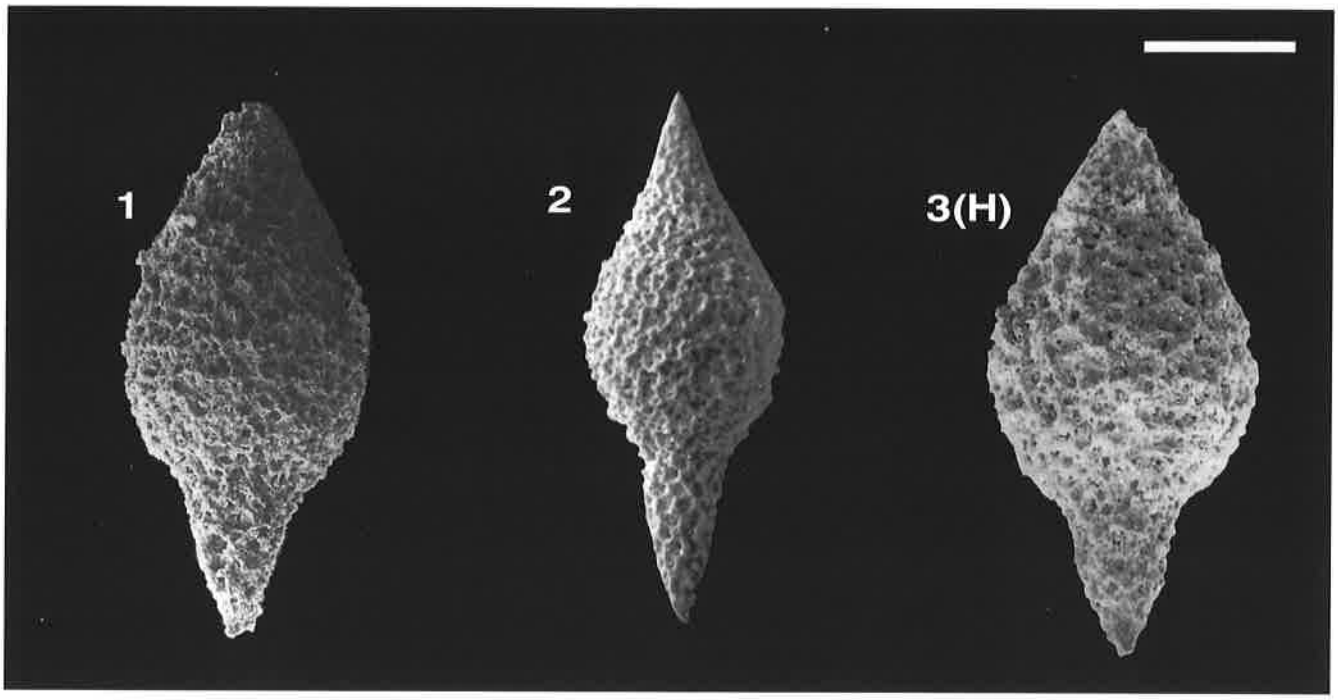


Plate 3924. *Artocapsa* (?) *amphorella* JUD. Magnification x200. **Fig. 1.** RJ43, V -6. **Fig. 2.** RJ229, V -6. **Fig. 3(H).** RJ1250, V -6.50.

BERNOULLIUS *3614*

Genus: *Bernoullius* BAUMGARTNER

Synonymy.-
Bernoullius BAUMGARTNER
BAUMGARTNER 1984, p. 759.

Type Species.- *Eucyrtis* (?) *dicera* BAUMGARTNER 1980.

Original Definition.- Spongodiscid spumellarian with distinct bilateral symmetry: A delicate, finely spongy main body of lattened egg-shape carries on the narrow end two symmetric, strongly developed, usually triradiate lateral spines and sometimes one central spine.

Original Remarks.- Because of the clear bilateral symmetry, the spines were interpreted as cephalic horns of a nassellarian by Baumgartner in Baumgartner et al. 1980. Well preserved specimens from DSDP Site 534A show that the spines are attached to a finely spongy body lacking any resemblance to nassellarian morphology. For most specimens, the spongy body is not aspoorly preserved as spongy round mass at the base of the spines. Kozur & Mostler (1979, pl. 21, fig. 2) illustrated a Triassic form which possibly belongs to this genus.

Etymology.- Dedicated to Daniel Bernoulli, Zurich, Switzerland, in honour of his contribution to the understanding of ancient passive continental margins in the Alpine-Mediterranean realm.

Included Taxa.-
3221 *Bernoullius cristatus* BAUMGARTNER
3223 *Bernoullius dicera* (BAUMGARTNER)
4009 *Bernoullius furcospinus* KITO, DE WEVER, DANELIAN & CORDEY
5357 *Bernoullius* (?) *manica* JUD
5359 *Bernoullius* (?) *monoceros* JUD
4010 *Bernoullius rectispinus* s.l. KITO, DE WEVER, DANELIAN & CORDEY
4011 *Bernoullius rectispinus rectispinus* KITO, DE WEVER, DANELIAN & CORDEY
4064 *Bernoullius rectispinus leporinus* CONTI & MARCUCCI
3222 *Bernoullius rectispinus delnortensis* PESSAGNO, BLOME & HULL
2017 *Bernoullius rectispinus* ssp. B
5369 *Bernoullius spelae* JUD

BERNOULLIUS CRISTATUS 3221

***Bernoullius cristatus* BAUMGARTNER**

Synonymy.-
Eucyrtis (?) *dicera* BAUMGARTNER
BAUMGARTNER et al. 1980, p. 6, fig. 6 only.
Eucyrtis (?) sp. A
KOCHER 1981, pl. 13, figs. 19-20.
Bernoullius cristatus BAUMGARTNER
BAUMGARTNER 1984, p. 760, pl. 2, figs. 14-15.
DANELIAN 1989, p. 144, pl. 3, figs. 4-6.
KITO 1989, p. 157, pl. 17, fig. 1.
PESSAGNO et al. 1993, p. 119, pl. 1, fig. 14.
CONTI & MARCUCCI 1991, pl. 1, fig. 8.
Bernoullius cf. *B.cristatus* BAUMGARTNER
CONTI & MARCUCCI 1991, p. 798, pl. 1, fig. 9.

Original Definition.- Form with two stout triradiate spines, which touch each other at the base and stand at an angle of 90 to 120 degrees. Proximal portion of spines straight or slightly outwardly curved, short distal portion kinked to a horizontal or downward position. The upwards directed ridge of the spines becomes bladelike near the kink and forms one or two characteristic teeth pointing upwards. Sometimes additional small teeth arise from the lateral ridges of the spines.

Original Remarks.- This form differs from *B. dicera* by the presence of teeth and a kinked distal portion of the two spines. Stratigraphic data suggest that this form is ancestral to *B. dicera*.

Etymology.- *Cristatus*: equipped with teeth (Latin).

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
W. between ends of spine:	315	318	250	405
Width of spines at the base:	50	42	33	67
Length of spongy portion:	135	106	56	158

Type Locality.- DSDP Leg 76, Site 534, Blake Bahama Basin, West Atlantic.

UAZones.- 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

BERNOULLIUS DICERA 3223

***Bernoullius dicera* (BAUMGARTNER)**

Synonymy.-
Lophophaena sp.
OZVOLDOVA 1979, p. 259, pl. 4, figs. 4-5.
Eucyrtis (?) *dicera* BAUMGARTNER
BAUMGARTNER et al. 1980, p. 54, pl. 3, fig. 16; pl. 6, fig. 10, not fig. 6.
KOCHER 1981, p. 67, pl. 13, figs. 17-18.
DE WEVER & CABY 1981, pl. 2, fig. I.
Cuniculiformis (?) *diceris* (BAUMGARTNER)
EL KADIRI 1984, p. 70.
Bernoullius dicera (BAUMGARTNER)
BAUMGARTNER 1984, p. 760, pl. 2, fig. 16.
AITA 1987, p. 63.
DANELIAN 1989, p. 145, pl. 3, fig. 9.
KITO 1989, p.157, pl. 17, fig. 2.
WIDZ 1991, p.244, pl. 1, fig. 15.

Original Definition.- Cephalis bearing two stout, outwardly curved, triradiate horns (vertical and apical ?), bearing sometimes two or three upwards directed teeth near distal end. The three narrow grooves of the horns lead to cephalic pores. The three broad ridges are bifurcating at their base giving place to other pores. Cephalis covered by dense spongy, polygonal meshwork, inner structure not observable. Thorax and following (if any) segments conical, externally smooth, covered by dense irregular spongy meshwork. Distal end always ragged and obviously broken off at, or below base of cephalis for most specimens. Rare specimens show few irregularly placed tiny spines on post-thoracic (?) segments.

Original Remarks.- It is not likely that this species is related to *Eucyrtis conoidea* RÜST. Future, more complete, material may perhaps justify the erection of a new genus. The cephalic horns are very distinctive and usually preserved, even in moderate samples. The inner structure (segmentation) has not been observed and thus remains questionable.

Etymology.- *Diceras, -a* = ancient Greek, with two horns.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Width between ends of horns:	300	358	300	398
Width of horns at base:	50	55	50	70
Width of cephalis:	90	100	88	133

Type Locality.- Angelokastron, Korinthos, Greece.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

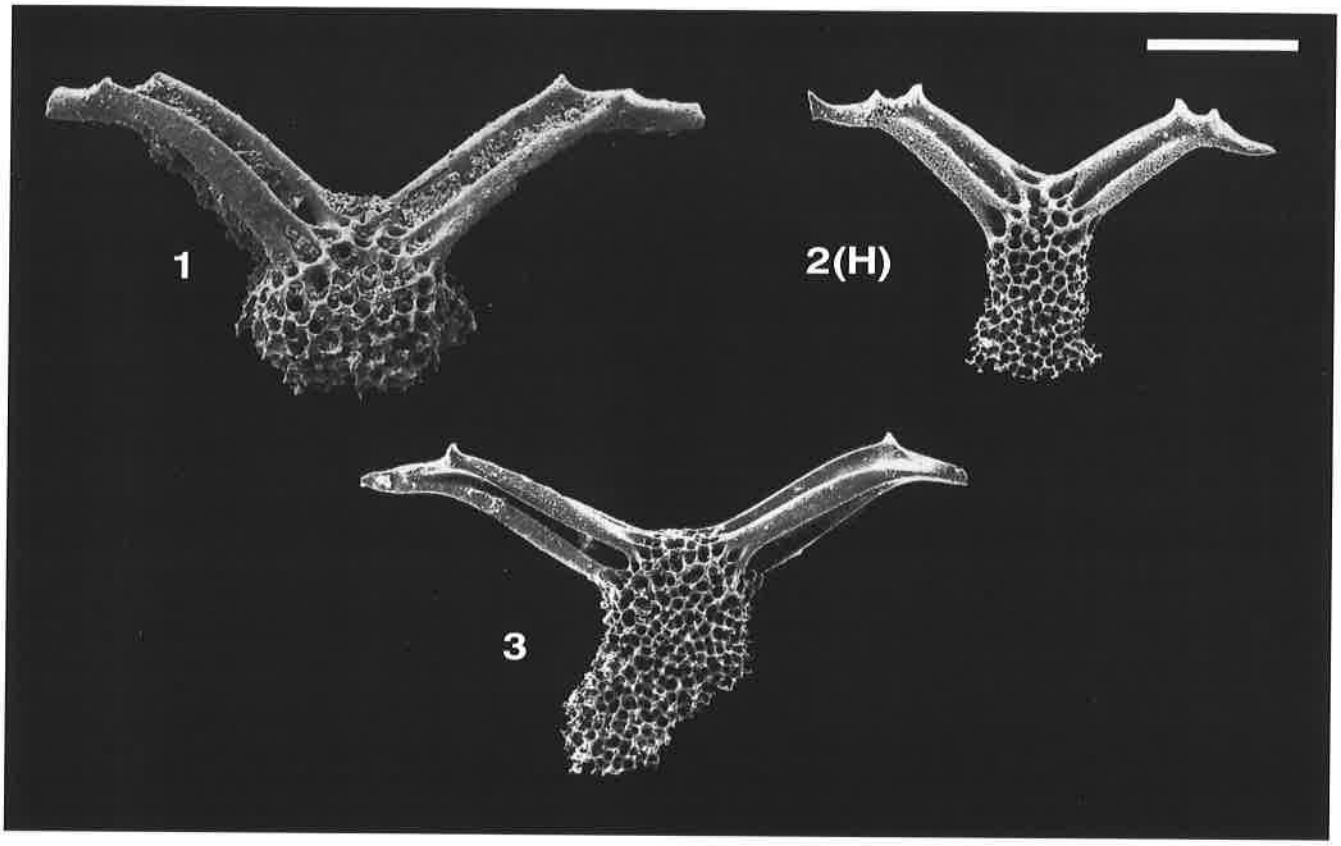


Plate 3221. ***Bernoullius cristatus*** **BAUMGARTNER.** Magnification x200. **Fig. 1.** POB81/1433, 534A.125.2.36. **Fig. 2(H).** POB81/9197, 76.534A.125.5.72. **Fig. 3.** POB81/9198, 76.534A.125.5.72.

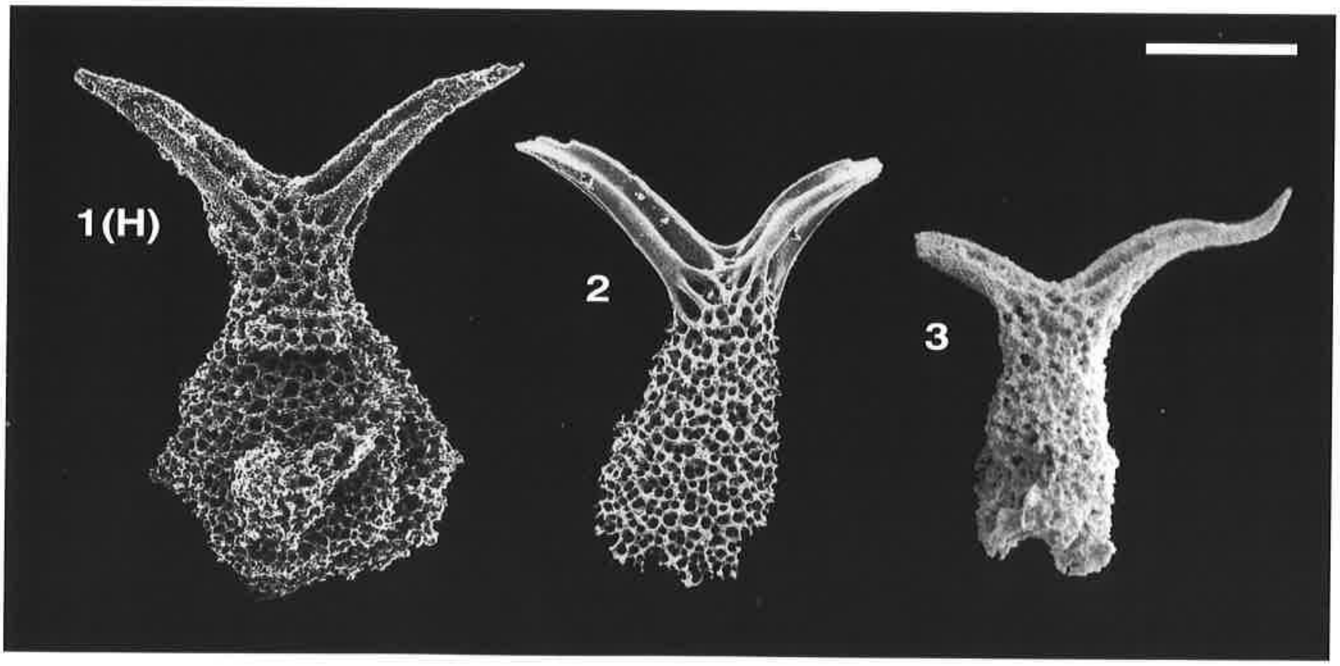


Plate 3223. ***Bernoullius dicera*** **(BAUMGARTNER).** Magnification x200. **Fig. 1(H).** POB78/6155, POB899.51. **Fig. 2.** POB81/9200, 76.534A.125.5.72. **Fig. 3.** GO 900222, BM 102.

BERNOULLIUS FURCOSPINUS 4009

Bernoullius furcospinus KITO, DE WEVER, DANELIAN & CORDEY

Synonymy.-

Bernoullius sp. B
DANELIAN 1989, p. 145, pl. 3, fig. 12.
Bernoullius sp. 1
KITO 1989, p. 158, pl. 17, figs. 4, 5, 7, 10, 14.
Bernoullius furcospinus, KITO DE WEVER, DANELIAN & CORDEY
KITO et al. 1990, p. 344, pl. 2, figs. 1-3, 6, 8.
Spongiostoma ? furcospinus (KITO & DE WEVER)
TONIELLI 1991, p. 26, pl. 1, fig. 3.

Original Definition.- Large *Bernoullius* having two spines with some short secondary spines and three primary and three secondary grooves. Test with two stout triradiate spines, which have well developed secondary grooves and some short secondary spines at the end of spine. The spines are straight or slightly curved upward and stand at right angles in general. The thick spongy main body is composed of roughly organized concentric spongy layers in the transversal section of the axis of the test. A small spheric mass is visible at the cross point of two spines in the test. No complete specimen was observed.

Original Remarks.- This species differs from other *Bernoullius* by the secondary spines. Some specimens in sample S70 have very weakly developed secondary spines and the base of spine covered with spongy test. The form is considered as an intermediate form between *B. rectispinus* n.sp. and this species. All specimens having secondary spines are included in this species.

Etymology.- The species name *furcospinus* derives *furcosus, -a, -um* (adj. branched) +*spineus, -a, -um* (adj. *spinosus*) from the Latin.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Length of spine:	163	152	68	195
Width of main body:	139	119	11	162

Type Locality.- Contrada La Ferta (Sicily, Italy).

UAZones.- 1-4, early-mid Aal. to late Baj.

BERNOULLIUS (?) MANICA 5357

Bernoullius (?) *manica* JUD

Synonymy.-

Bernoullius (?) *manica* JUD
JUD 1994, p. 65, pl. 4, fig. 11.

Original Definition.- Flat, subtriangular, spade-shaped test with single spine. A massive blunt spine with several longitudinal, continuous and discontinuous ridges and grooves, is placed on the proximal portion of the test. The latter has dense spongy meshwork and bears some rare small radial ridges and spines. On the sides of the subtriangular test tubular extensions are developed, which are obviously prolonged into the test, on the surface of which they are distinguished by a slight radial depression which starts from the base of the spine.

Original Remarks.- For biostratigraphic data only specimens having distinct lateral tubular, sleeve-like extensions were included in *Bernoullius* (?) *manica* n.sp. Complete and well preserved specimens were rare. The species has an extremely short biostratigraphic range in our material.

Etymology.- From the Latin *manica* = sleeve, as suggested by the lateral prolongations of the test.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min	max.
Max. width:	418	383	312	419
Max. height:	236	207	182	236
Length spines:	118	111	100	127

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 20-21, late Haut. to early Barr.

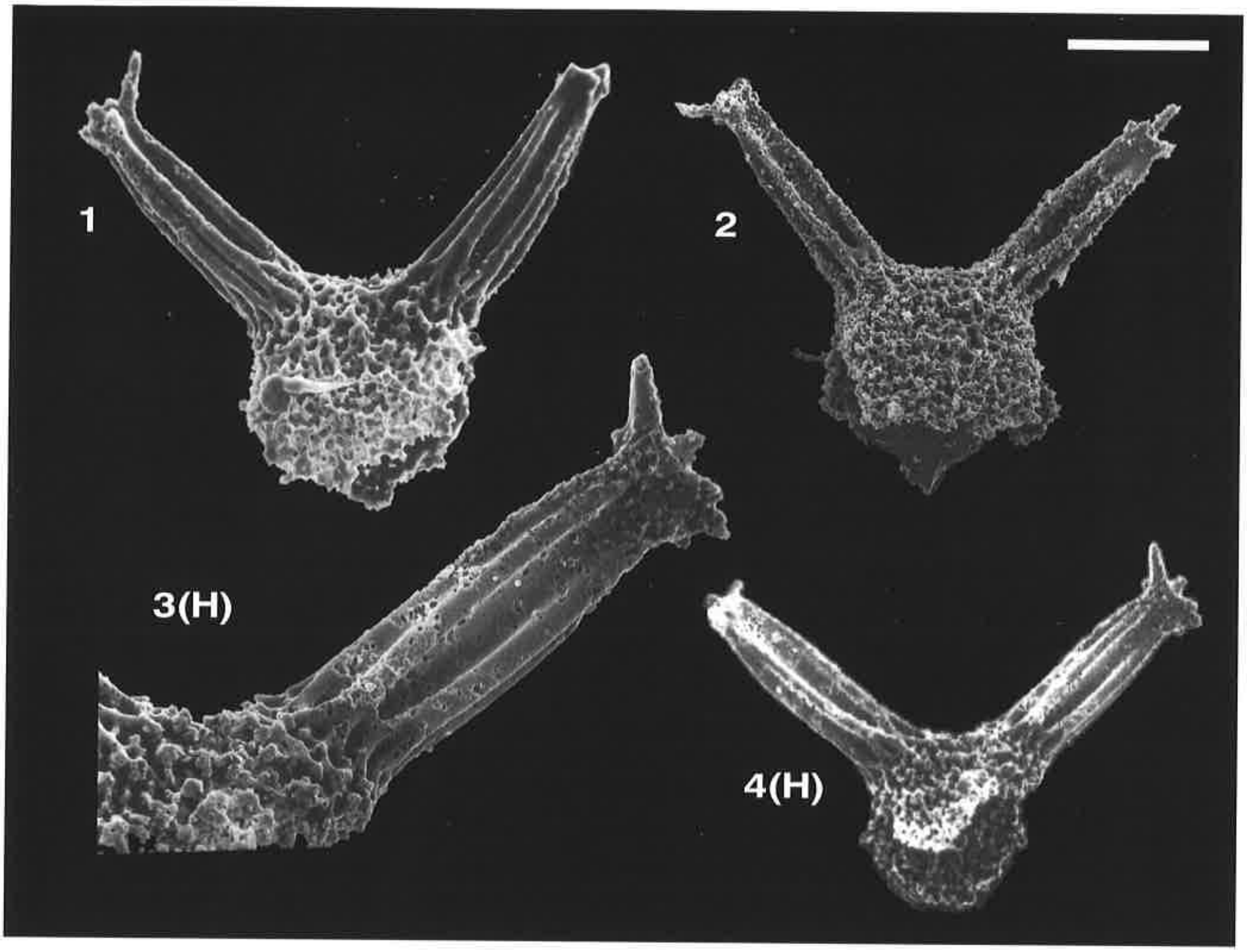


Plate 4009. *Bernoullius furcospinus* KITO, DE WEVER, DANELIAN & CORDEY. Magnification x200, except fig.3 x 400. **Fig. 1.** KI8705-2, S69. **Fig. 2.** KI8719-2A, S69. **Fig. 3(H).** KI8719-4A, S69. **Fig. 4(H).** KI8719-2A, S69.

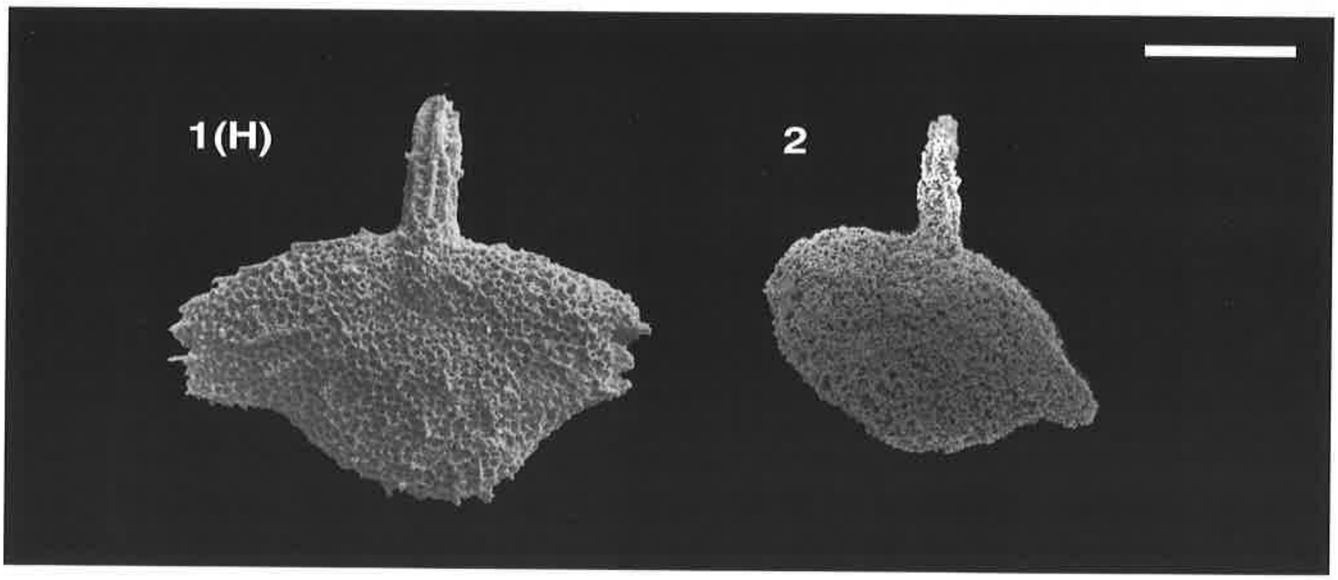


Plate 5357. *Bernoullius* (?) *manica* JUD. Magnification x150. **Fig. 1(H).** RJ1323, B0580.10. **Fig. 2.** RJ11, Br141.55.

BERNOULLIUS (?) MONOCEROS 5359

Bernoullius (?) *monoceros* JUD

Synonymy.-
Bernoullius (?) *monoceros* JUD
JUD 1994, p. 66, pl. 4, figs. 12-13.

Original Definition.- Flat, subtriangular to elliptical test with single spine. Spine massive, blunt, with several longitudinal ridges and grooves. On some specimens the horn is prolonged on both faces of the test forming a prominent small band. Test with dense, spongy meshwork. A thick spongy collar may be developed around the base of the spine.

Original Remarks.- *Bernoullius* (?) *monoceros* n.sp. was questionably assigned to the genus *Bernoullius* BAUMGARTNER. Having only one spine and a test larger in width than in height it does not correspond exactly with the definition of this genus. Some specimens show slight signs of tubular openings on the two lateral sides of the test, indicating a close relationship to *Bernoullius* (?) *manica* n.sp. For biostratigraphic data only specimens without visible tubular protrusions were taken in account as belonging to this species.

Etymology.- From the Greek *monos* = single and *keros* = horn.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total height test:	236	213	162	252
Maximum width test:	374	304	272	374
Length apical spine:	128	110	69	141
Thickness apical spine:	49	44	38	50

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

BERNOULLIUS RECTISPINUS S.L. 4010

Bernoullius rectispinus s.l. KITO, DE WEVER, DANELIAN & CORDEY

Synonymy.-
See subspecies

Included Taxa.-
4064 *Bernoullius rectispinus leporinus* CONTI & MARCUCCI
4011 *Bernoullius rectispinus rectispinus* KITO, DE WEVER, DANELIAN & CORDEY
3222 *Bernoullius rectispinus delnortensis* PESSAGNO, BLOME & HULL.
2017 *Bernoullius rectispinus* ssp. B

UAZones.- 1-9, early-mid Aal. to mid-late Oxf.

BERNOULLIUS RECTISPINUS DELNORTENSIS 3222

Bernoullius rectispinus delnortensis, PESSAGNO, BLOME & HULL

Synonymy.-
? *Bernoullius* sp. A
GORICAN 1987, p. 181, pl. 1, fig. 17.
Bernoullius delnortensis, PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 120, pl. 1, figs. 4, 15, 26.

Original Definition.- Test relatively slender, flaring slightly laterally away from spines. Primary spines straight, rather short and massive, triradiate in axial section with three longitudinal ridges alternating with three longitudinal grooves. Longitudinal grooves, narrow, deeply incised, gradually decreasing in width in a distal direction. Ridges wide proximally, becoming progressively narrower in a distal direction.

Original Remarks.- This form greatly resembles *Bernoullius* sp. A of Gorican (1987). It possesses straight, short, subequal spines with parallel sided, deeply incised grooves separating wide, longitudinal ridges which wedge out distally. *Bernoullius* sp. A of Gorican, however, possesses short spines which are nearly equal in length and are somewhat shorter than those of *B. delnortensis*. *B. delnortensis* differs from *B.* sp. A (herein) by having considerably shorter, wider, and more massive primary spines. *B. delnortensis* differs from *B. cristatus* BAUMGARTNER (1984) by having spines which are straight and lack curved tips.

Remarks.- This subspecies differs from *Bernoullius rectispinus rectispinus* by having smaller size. The species also differs from *Bernoullius dicera* and *B. cristatus* by having straight spines.

Etymology.- This species is named for Del Norte County, California.

Measurements (in μm).-
Based on 4 specimens (see Pessagno et al. 1993 for explanation of system of measurements for this species).

	HT	av.	min.	max.
AA':	210	206	195	225
Sx:	165	130	105	165
S'x':	-	136	123	150
BB':	135	135	105	180
SS':	-	187	180	195

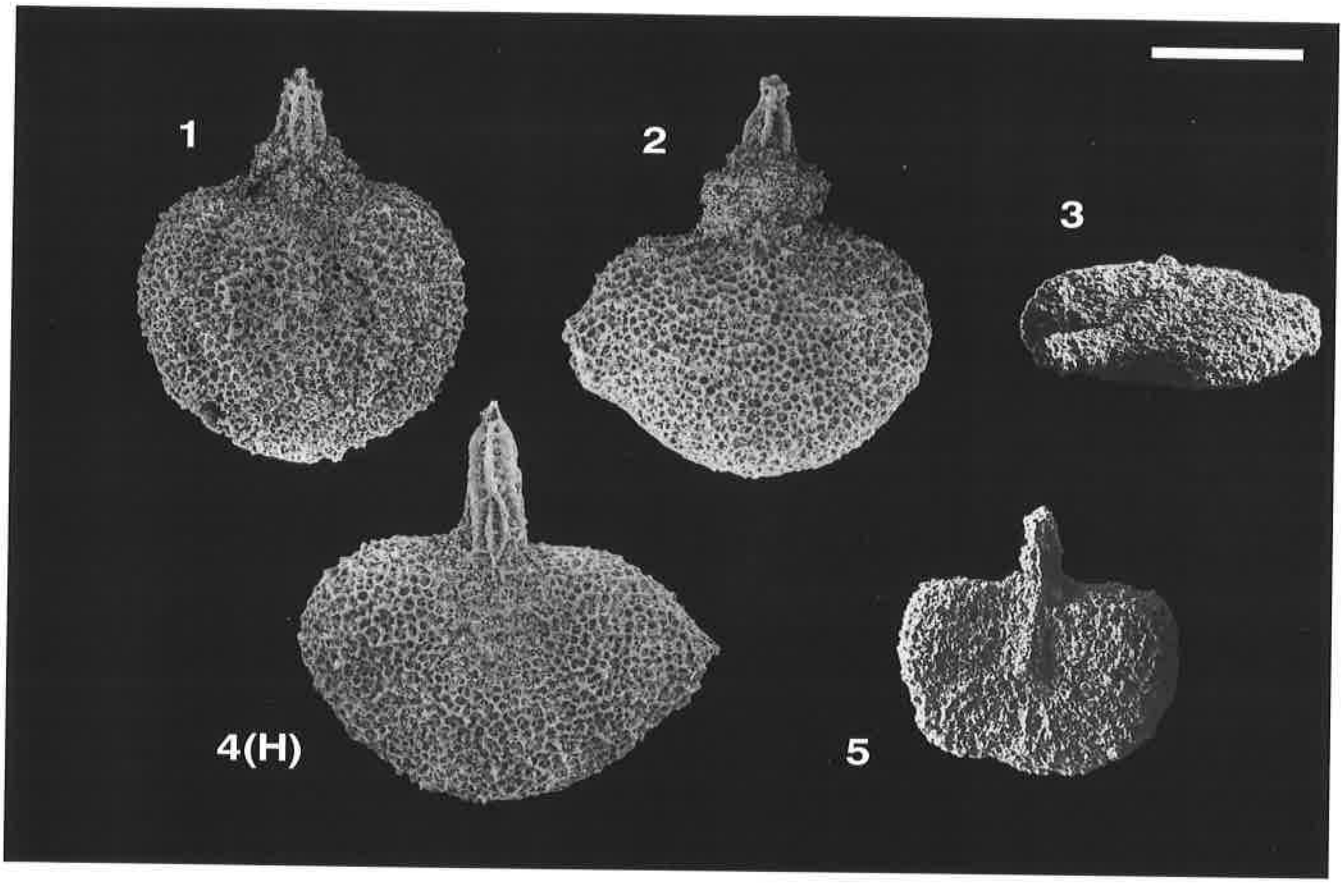


Plate 5359. Bernoullius (?) ***monoceros*** **JUD.** Magnification x150. **Fig. 1.** RJ388, Bo566.5. **Fig. 2.** RJ375, Bo566.5. **Fig. 3.** RJ938, GC887.0. **Fig. 4(H).** RJ378, Bo566.5. **Fig. 5.** RJ937, GC887.0.

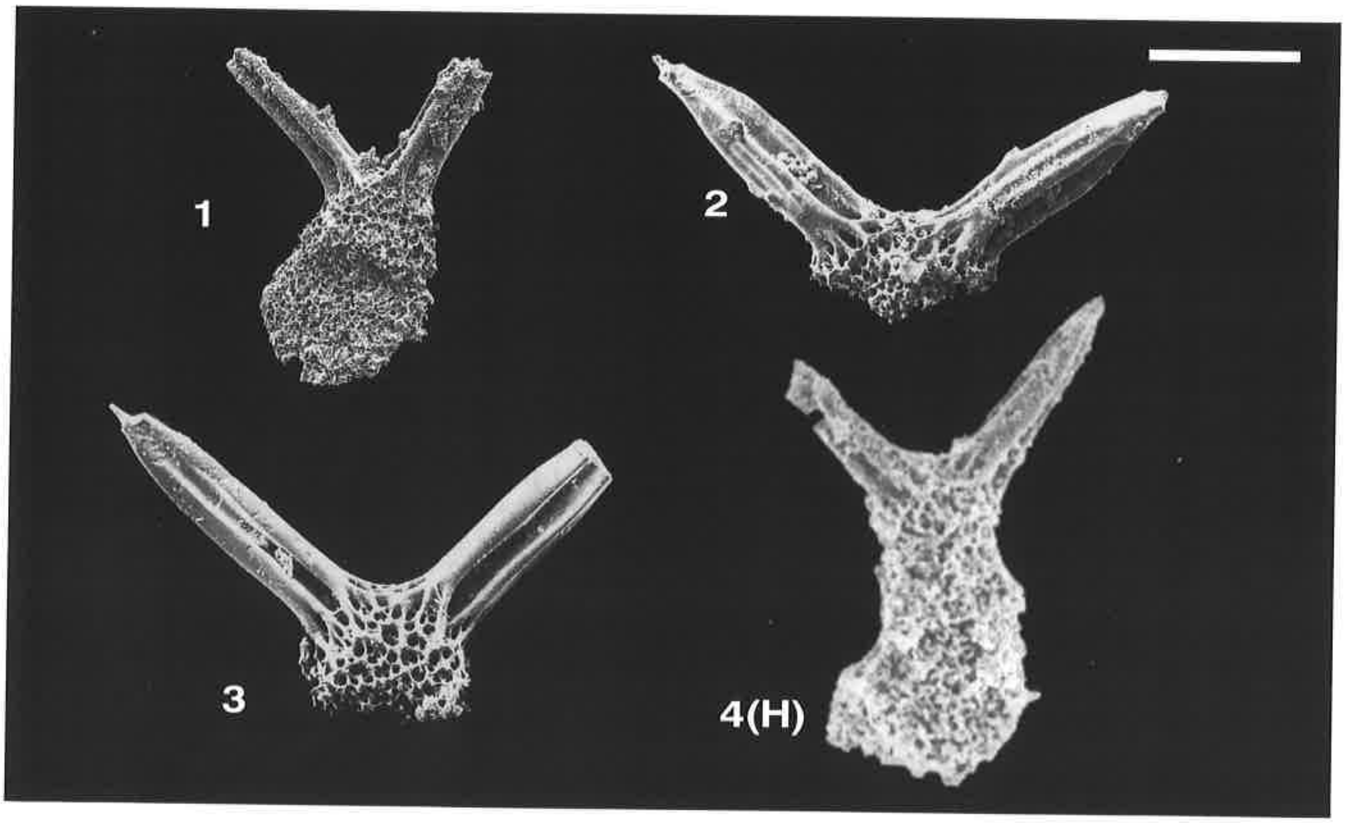


Plate 3222. ***Bernoullius rectispinus delnortensis*** **PESSAGNO, BLOME & HULL.** Magnification x200. **Fig. 1.** POB81/1477, 534A.125.2.36. **Fig. 2.** POB81/2266, 534A.122.1.43. **Fig. 3.** POB81/9199, 76.534A.125.5.72. **Fig.**

Type Locality.- Volcanopelagic strata above Josephine ophiolite,Smith River subterrane, Klamath Mountains, northwestern California

UAZones.- 2-7, late Aal. to late Bath.-early Call.

BERNOULLIUS RECTISPINUS LEPORINUS 4064

Bernoullius rectispinus leporinus CONTI & MARCUCCI

Synonymy.-
Bernoullius sp. B
? GORICAN 1987, p. 181, pl. 1, fig. 18.
Bernoullis leporinus leporinus CONTI & MARCUCCI
CONTI & MARCUCCI 1991, p. 798, pl. 1, figs. 10, 12.
Bernoullis brokenkettlensis PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 119, pl. 1, figs. 5-7, 24, 28.

Original Definition.- Large form with rounded spongy body and two straight spines. The spines are triradiate and end with a thinner sting. They form an angle of 80-110. In some specimens is developed a system of three primary and three secondary narrower grooves on each spine. A neck is present at the junction of spines with the body. The body is finely spongy and some elongated pores are present at the base of the spines. The spongy body is flat in lateral view and becomes thicker in the distal part, with a bellows-like outline. (20 specimens).

Original Remarks.- This form differs from *B. dicera* (BAUMGARTNER) and *B. cristatus* BAUMGARTNER for two straight spines, the larger size and the round form of the body; from *B. rectispinus* KITO for the round form of the body, the width of the neck and the larger size. It also differs from *Spongiostoma saccideum* CARTER et al. for the presence of a neck instead of a short hinge, the shape and the width of the two spines, always markedly triradiate.

Etymology.- *Leporinus* (Latin: *lepus, leporis* = hare, *leporinus* = hare-like), with two spines like ears of hare.

Measurements (in μm).-
Based on 20 specimens.

	min.	max.	av.	HT
W. between end of spines:	239	459	386	459
Width of spines at base:	48	73	62	64
Lenght of spines:	187	333	277	312
Lenght of body:	204	300	262	282
Thic. body in distal part:	35	87	62	65
Angle between the spines:	83	110	92	83
Width of neck:	130	216	171	167

Type Locality.- Sample GR 6, Ponte di Laoscuro (Eastern Liguria - Italy).

UAZones.- 2-6, late Aal. to mid Bath.

BERNOULLIUS RECTISPINUS RECTISPINUS 4011

Bernoullius rectispinus rectispinus KITO, DE WEVER, DANELIAN & CORDEY

Synonymy.-
Eucyrtis dicera BAUMGARTNER
CARAYON et al. 1984, pl. 1, fig. 10.
Bernoullius sp. 2
KITO 1989, p. 158, pl. 17, figs. 8-9, 11-13.
Bernoullius rectispinus KITO.
KITO et al. 1990, p. 347, pl. II, figs. 4, 5, 7, 9, 10.
Bernoullius irwini PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 120, pl. 1, figs. 1, 10, 13, 27.

Original Definition.- Large *Bernoullius* having two straight and long spines with three primary and three secondary grooves. Test as with genus, bearing two stout and straight spines with 3 wide primary grooves and three well developed secondary grooves. Two spines are almost equal in length and usually stand at right angle. Basal part of spines are covered with spongy mesh work. Main body is composed of spongy layers. A small laticed shell is situated at the cross point of two spines in main body. No complete specimen was observed.

Original Remarks.- This species is quite similar to *Bernoullius*. sp. B. in Gorican (1987), but it differs in the form of the main body. This species is similar to *Bernoullius* sp. A in Gorican (1987), but it differs from the latter by its size and two long spines with well developed secondary grooves.

Remarks.- The species name *rectispinus* derives *rectus, -a, -um* (adj. straight) + *spineus, -a, -um* (adj. spinous) from Latin.

Measurements (in μm).-

	HT	av.	min.	max.
Length of spines:	362-338	268	162	366
Width of body:	213	164	102	187

Type Locality.- Contrada La Ferta (Sicily, Italy).

UAZones.- 1-4, early-mid Aal. to late Baj.

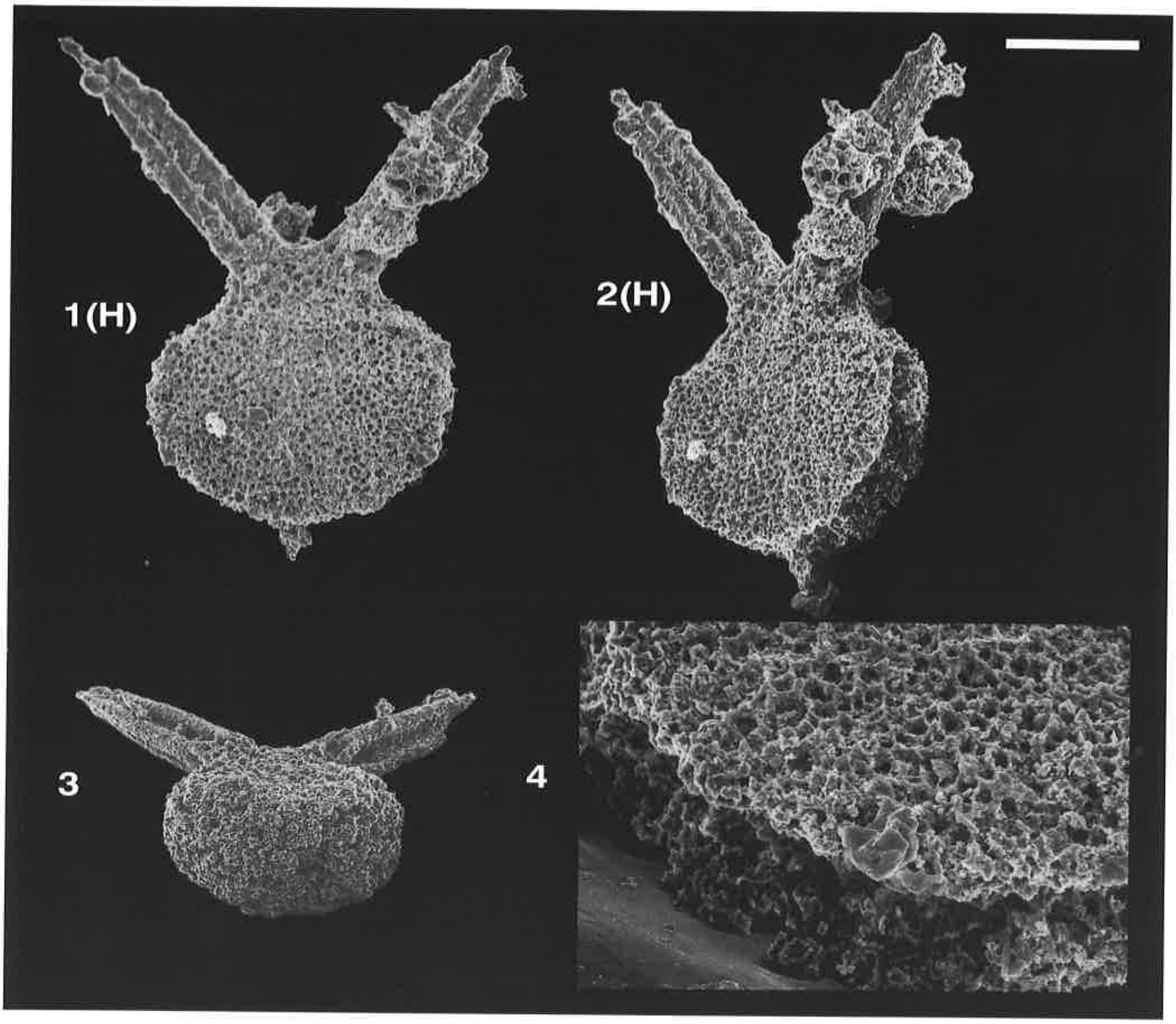


Plate 4064. ***Bernoullius rectispinus leporinus*** **CONTI & MARCUCCI.** Magnification x150, except Fig. 4 x400. **Fig. 1(H).** MC15/90, GR6. **Fig. 2(H).** MC17/90, GR6. **Fig. 3.** MC09/53, GR6. **Fig. 4.** MC18/90, GR6.

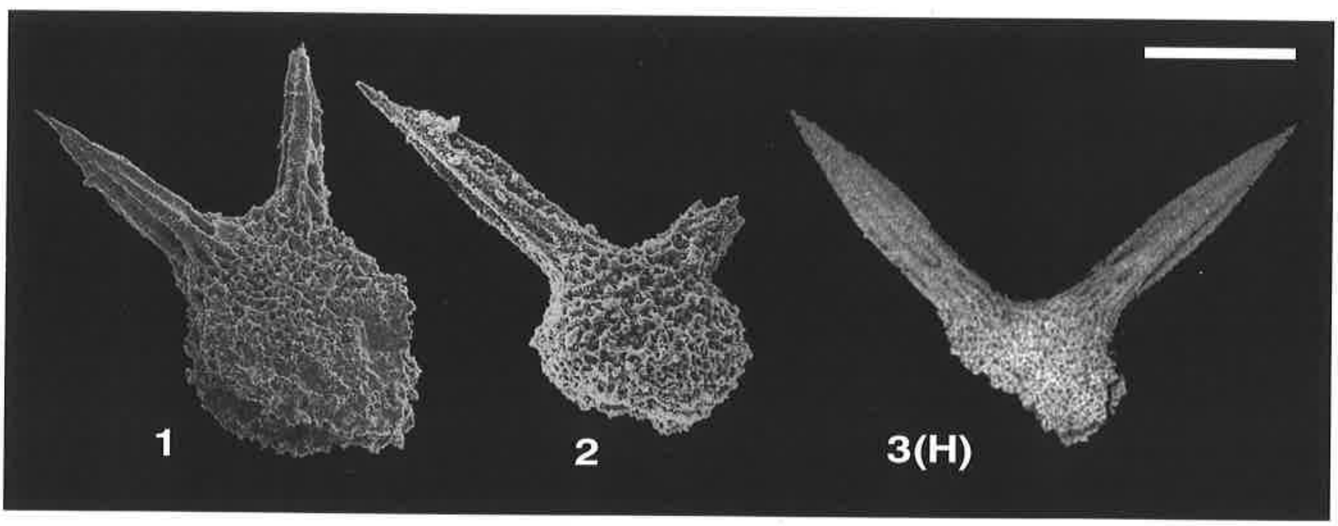


Plate 4011. ***Bernoullius rectispinus rectispinus*** **KITO, DE WEVER, DANELIAN & CORDEY.** Magnification x150. **Fig. 1.** MC27/90, GR6. **Fig. 2.** GO890407, ZB28. **Fig. 3(H).** KITO et al. 1990, pl. II, fig. 5.

BERNOULLIUS RECTISPINUS | B — 2017

Bernoullius rectispinus ssp. B

Remarks.- *Bernoullius rectispinus* ssp. B is quite similar to *Benoullius rectispinus rectispinus* KITO, DE WEVER, DANELIAN & CORDEY for the general shape and the presence of two stout and straight spines with three wide primary grooves, but we distinguish this form by the absence of well developed secondary grooves and by the basal portion of spines which is not covered by spongy meshwork. *Bernoullius rectispinus* ssp. B is also closely related to *Bernoullius irwini* PESSAGNO, BLOME & HULL. *Bernoullius rectispinus* ssp. B differs from *Bernoullius irwini* , because it includes a wider range of morphologies. *Bernoullius rectispinus* ssp. B can be from circular to oval in outline and the angle between the primary spines can be from acute to obtuse. In addition, the parallel-sided longitudinal grooves are generally wide.

UAZones.- 2-7, late Aal. to late Bath.-early Call.

BERNOULLIUS SPELAE — 5369

Bernoullius spelae JUD

Synonymy.-
gen. et sp. indet.
SCHAAF 1981, pl. 17, fig. 4.
Bernoullius spelae JUD
JUD 1994, p. 66, pl. 4, figs. 14-15; pl. 5, figs. 1-2.

Original Definition.- Slightly flattened test with 3 massive straight spines. Test oval in face view, thickening from apical to distal portion, where the two faces are separated by a deep lateral groove. Test comprised of dense spongy meshwork. Central and proximal part of the two faces covered with irregularly arranged nodes. Apical part with generally three-bladed, pointed main spines, rarely more, of which the middle one is stronger.

Original Remarks.- *Bernoullius spelae* n.sp. differs from all other species of the genus *Bernoullius* by having 3 main spines of unequal length and sometimes additional shorter spines variably arranged near the main spines, and by possessing prominent nodes on both faces of the test. The morphology of this species is similar to that of the species of the genus *Spongiostoma* CARTER known from the Toarcian. From the type species of this genus it differs by having several strong spines, which touch each other at their base, instead of only 2, and by its occurrence in the Lower Cretaceous. Complete specimens were rarely found, most specimens having only the proximal half of the test preserved.

Etymology.- This species is dedicated to Spela Gorican, a radiolarist at University of Lausanne, Switzerland, to honour her contributions to the knowledge of Mesozoic radiolarians, her help and her friendship.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Length of test:	167	158	148	196
Width of test:	141	159	141	178
Maximum length of spine:	141	110	88	141
Minimum length of spine:	34	58	34	76
Thickness of test:	75	-	-	-

Type Locality.- Breggia Gorge, Ticino, Southern Switzerland.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

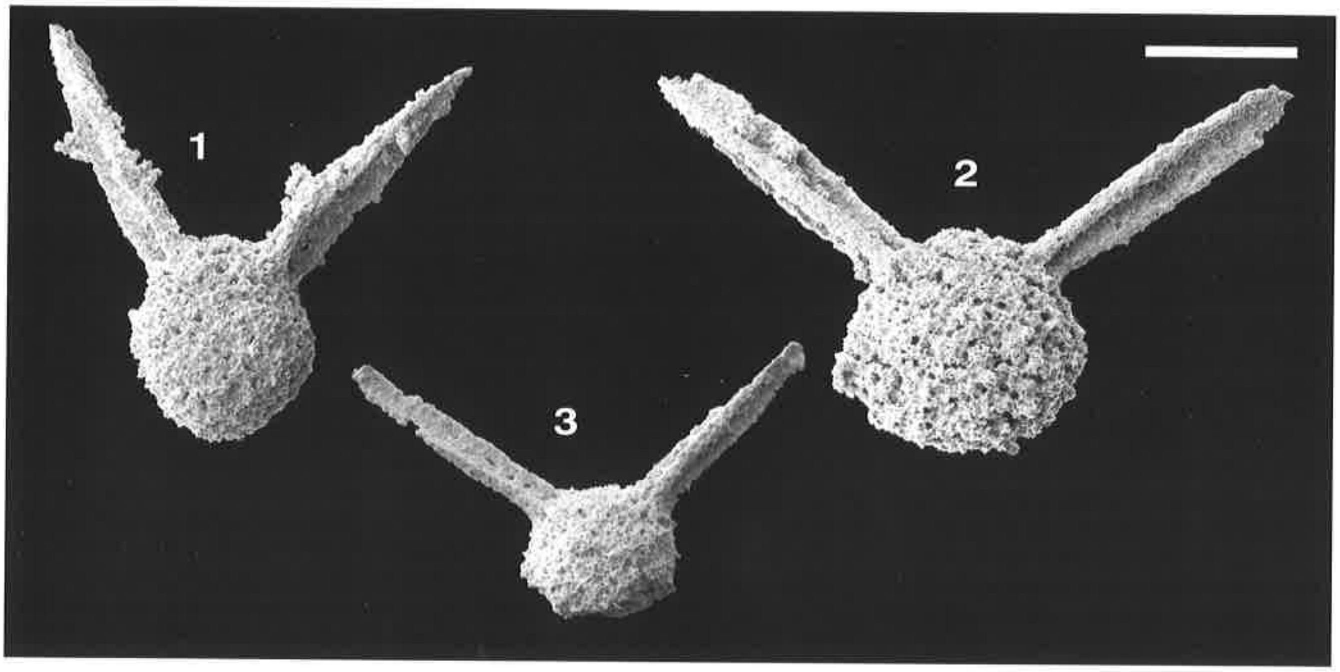


Plate 2017. *Bernoullius rectispinus* ssp. B. Magnification x150. **Fig. 1.** AB6488, TM90.32.a59. **Fig. 2.** AB6623, TM64.74.a78. **Fig. 3.** AB1690, TM109.25.m.12

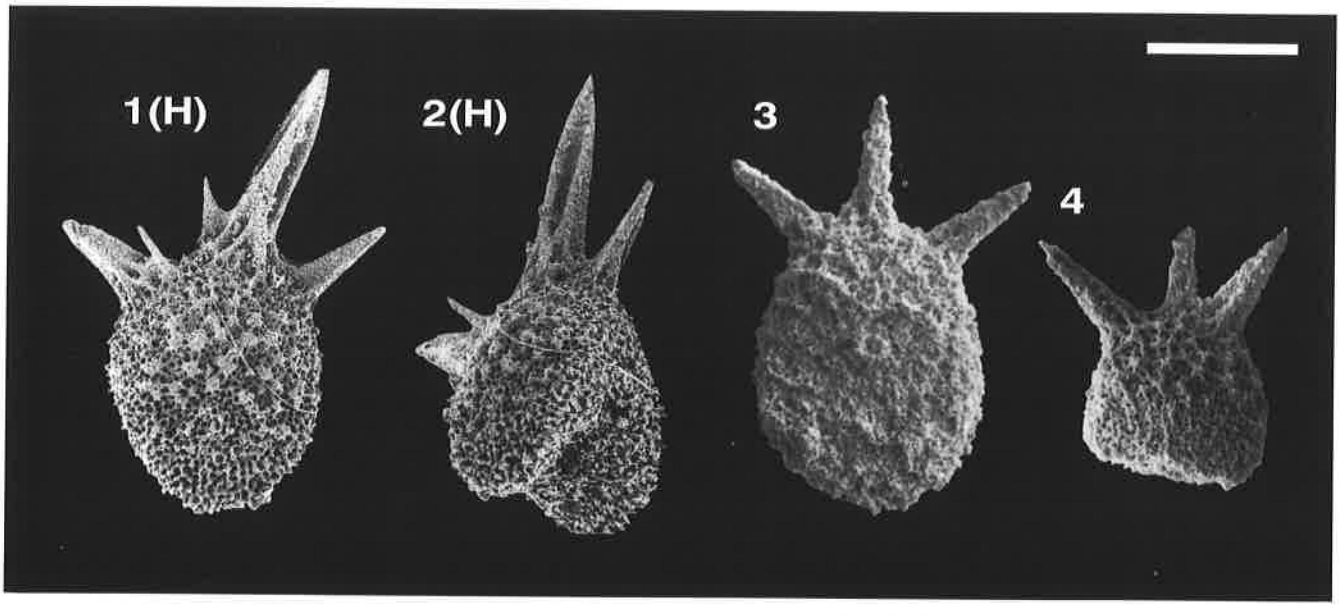


Plate 5369. *Bernoullius spelae* JUD. Magnification x200. **Fig. 1(H).** RJ29, Br28.85. **Fig. 2(H).** RJ30, Br28.85. **Fig. 3.** RJ1022, GC824.00. **Fig. 4.** RJ1334, Bo580.10.

berriasianum >> *PANTANELLIUM BERRIASIANUM* 3280

bicornis >> *THEOCAPSOMMA BICORNIS* 3276

bifida >> *TETRADITRYMA CORRALITOSENSIS BIFIDA* 4048

biordinalis >> *ANGULOBRACCHIA BIORDINALIS* 3145

biscutum >> *HALESIUM BISCUTUM* 5166

bisellea >> *EMILUVIA BISELLEA* 4018

BISTARKUM 3800

Genus: *Bistarkum* YEH

Synonymy.-
Bistarkum YEH
YEH 1987a, p. 42.

Type Species.- *Bistarkum rigidum* YEH 1987a.

Original Definition.- Test medium to large in size, with two rays linearly aligned. Rays nearly equal in length, often terminated with expanded tips. Tips subcircular, elliptical in outline. Meshwork of test comprised of sponge layers or regular (i. e., triangular) or irregular polygonal pore frames. Cross section of rays ellipsoidal, rectangular, or subrectangular in outline. Rays with or without spines at distal surface of tips or along sides of rays.

Original Remarks.- The name *Bistarkum* is introduced to avoid assigning species to *Amphibrachium* whose definition is obscured by poor descriptions and illustrations of its type species.

Etymology.- *Bistarkum* is a name formed by an arbitrary combination of letters.

Included Taxa.-
3918 *Bistarkum brevilatum* JUD
5199 *Bistarkum irazuense* (AITA)
3919 *Bistarkum valdorbiense* JUD

BISTARKUM BREVILATUM 3918

Bistarkum brevilatum JUD

Synonymy.-
Bistarkum brevilatum JUD
JUD 1994, p. 67, pl. 5, figs. 3-6.

Original Definition.- Test of 2 broad rays with bulbous ends. Upper and lower surfaces with 4-6 generally regular, longitudinal rows of nodes connected by irregularly placed small bars. Lateral sides of shell with spongy meshwork. Bulbous ends with irregularly arranged nodes interconnected by bars. Well preserved specimens with short spines on bulbous ends of which one is generally axial.

Original Remarks.- *Bistarkum brevilatum* n.sp. differs from *Amphibrachium* sp. A. BAUMGARTNER 1980 by having large nodes on upper and lower surfaces of the rays, and well-defined bulbous ends, which are wider than the main rays and bear, when well preserved, long conical, bladed spines.

Etymology.- Latin *brevis* = short and *latus* = broad.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Length of test:	167	158	148	196
Width of Test:	141	159	141	178
Length of spine:	141	85	34	141
Thickness of test:	75	-	-	-

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 13-14, latest Tith. to early-early late Berr.

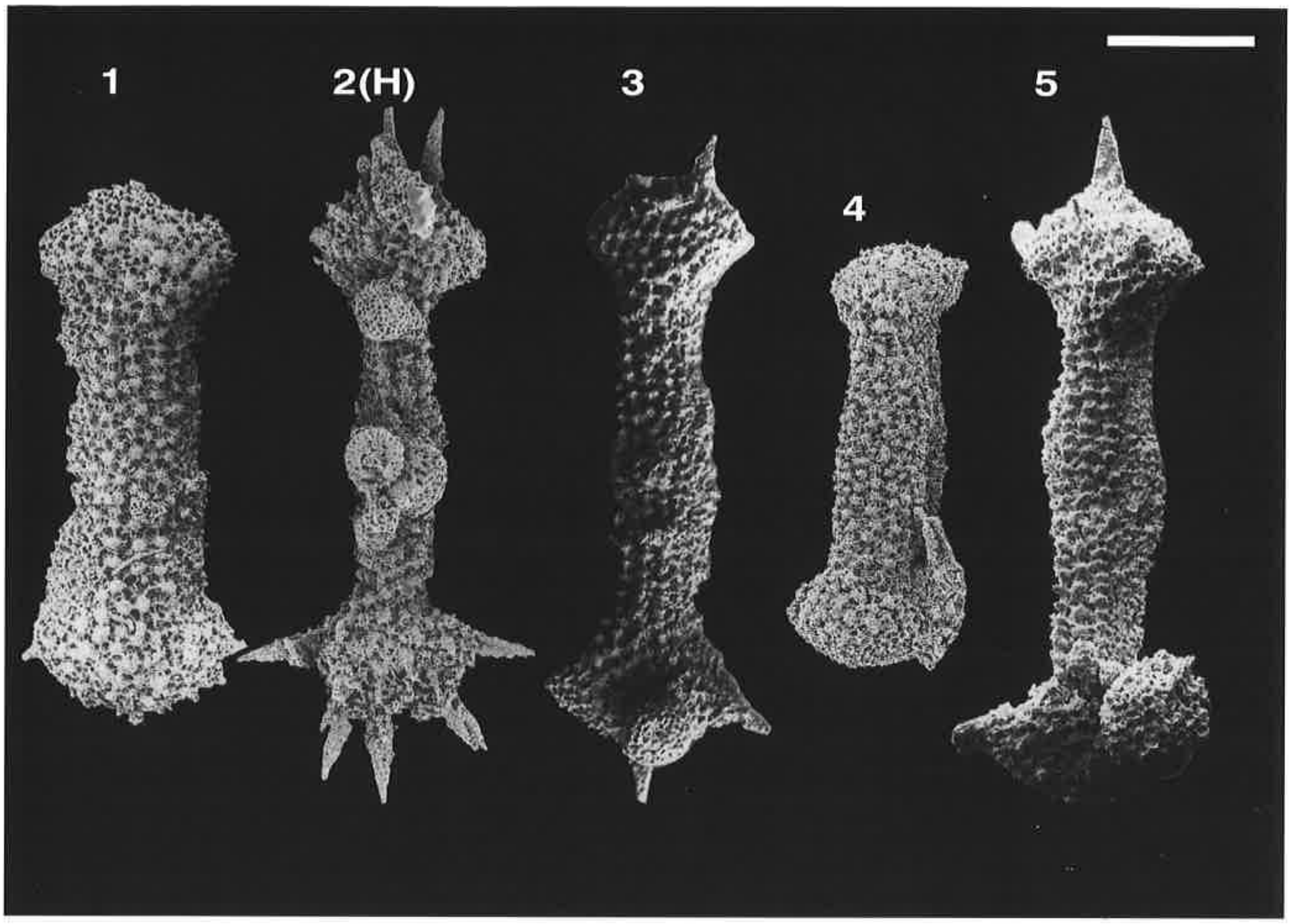


Plate 3918. ***Bistarkum brevilatum*** **JUD.** Magnification x100. **Fig. 1.** RJ4, V -6. **Fig. 2(H).** RJ15, V -6. **Fig. 3.** RJ1200, Bo311.20. **Fig. 4.** RJ10, V -6. **Fig. 5.** RJ21, Bo311.2.

BISTARKUM IRAZUENSE 5199

Bistarkum irazuense (AITA)

Synonymy.-
? *Amphibrachium amphigyum* LI
? LI 1986, p. 312, pl. 1, fig. 9.
Amphibracchium irazuense AITA
AITA 1987, p. 68, pl. 1, figs. 1-2; pl. 8, figs. 1-2.
Bistarkum irazuense (AITA)
JUD 1994, p. 67, pl. 5, fig. 7.

Original Definition.- Elongate test with two nearly equal-sized spongy rays. Rays tapering to a short central spine. Meshwork fine, irregular on central area, relatively coarse meshwork on ray ends with small circular to oval pores.

Original Remarks.- This new species resembles *Amphibracchium* sp. A of Baumgartner (1980, p. 300, pl. 9, fig. 19) in the overall shape, but is distinguished from it in having shorter rays and distinct ray tips with short central spines.

Etymology.- This species is named for Mt. Irazu, Higashitsuno village, Shikoku, Japan.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
Total length :	325	286	213	365
Maximum width of rays:	105	83	68	100
Maximum length of spines:	33	34	33	35

Type Locality.- Irazuyama Formation, Shikoku, Japan.

UAZones.- 14-21, early-early late Berr. to early Barr.

BISTARKUM VALDORBIENSE 3919

Bistarkum valdorbiense JUD

Synonymy.-
Bistarkum valdorbiense JUD
JUD 1994, p. 67, pl. 5, figs. 8-9.

Original Definition.- Test long, slender, relatively flat consisting of 2 rays with bulbous, spiny ends. Rays forming an angle of about 160°-170°. Surface with irregular meshwork of fine bars and small nodes at junctions. Central area of test somewhat broader than rays. Width of rays increases slightly towards their ends. Nodose structure emphasized on both ends, which are enlarged and armed with short, irregularly arranged spines on the external rim. Some specimens possess an axially placed bracchiopyle.

Original Remarks.- *Bistarkum valdorbiense* n.sp. differs from *Bistarkum brevilatum* n.sp. by lacking, on the upper and lower faces of the test, the generally longitudinal arrangement of nodes connected by small bars, by its thinner rays, by lacking bulbous ends of rays, by having numerous short, broad spines, and by having developed in some cases a bracchiopyle on the ray tips.

Etymology.- After type locality, Valdorbia, in the Appennines, Umbria-Marche, Italy.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total length:	807	828	647	900
Width of rays:	100	96	76	117
Width of tips:	146	141	100	192
Thickn. of rays:	-	-	66	-

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 13-17, latest Tith. to late Val.

blakei >> *TRIACTOMA BLAKEI* 3095

boesii >> *PARVICINGULA BOESII GR.* 3185

boneti >> *NAPORA BONETI* 3037

bossoensis >> *CRUCELLA BOSSOENSIS* 5204

breggiensis >> *OBESACAPSULA BREGGIENSIS* 3955

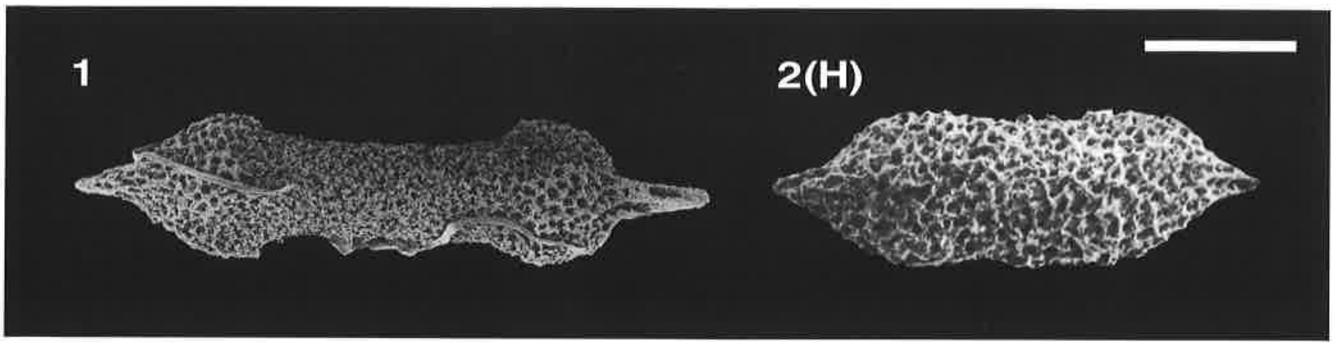


Plate 5199. *Bistarkum irazuense* (AITA). Magnification x200. **Fig. 1.** RJ186, Bo566.5. **Fig. 2(H).** AITA 1987, pl. 8, fig. 1.

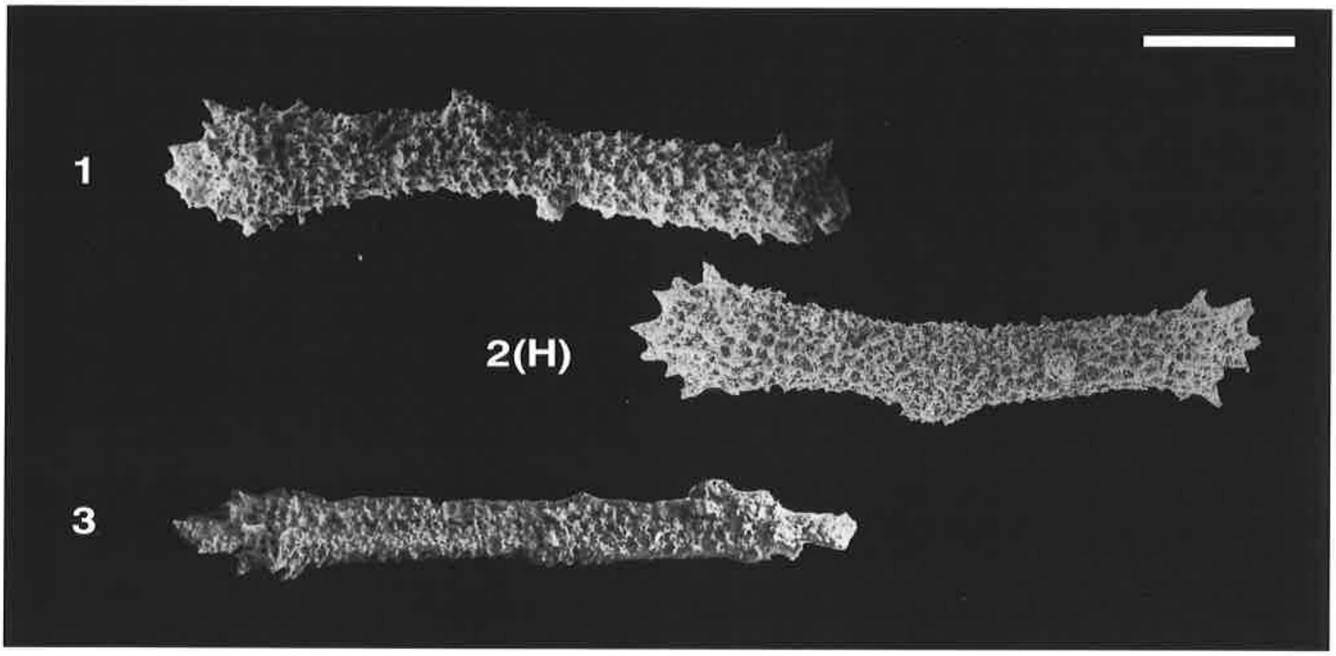


Plate 3919. *Bistarkum valdorbiense* JUD. Magnification x100. **Fig. 1.** RJ214, V -6. **Fig. 2(H).** RJ8, V -6. **Fig. 3.** RJ1291, V -10.

brevicostatum >> TRANSHSUUM BREVICOSTATUM GR. *3181*

brevilatum >> BISTARKUM BREVILATUM *3918*

broennimanni >> PARONAELLA BROENNIMANNI *3137*

bulbosa >> TETRATRABS BULBOSA *3122*

bullata >> OBESACAPSULA BULLATA *5568*

cameroni >> ELODIUM CAMERONI *3411*

CANOPTUM 3615

Genus: *Canoptum* PESSAGNO

Synonymy.-
Canoptum PESSAGNO
PESSAGNO et al. 1979, p. 182.

Type Species.- *Canoptum poissoni* PESSAGNO, in PESSAGNO et al. 1979.

Original Definition.- Test spindle-shaped (often conical when broken) with dome-shaped cephalis lacking horn. Thorax and abdomen trapezoidal in outline. Postabdominal segments subtrapezoidal in outline, separated from each other by rather broad, slightly perforate, circumferential ridges at the joints; pores on ridges circular to elliptical in shape, not set in pore frames. Ridges of inner layer considerably narrower. Area between a given ridges imperforate or sparsely perforate. Segments somewhat constricted between joints and circumferential ridges. Each postabdominal segment separated by partitions with large, circular apertures.

Original Remarks.- *Canoptum* n.gen. differs from *Spongocapsula* PESSAGNO in having a two-layered test wall lacking spongy meshwork. It differs from *Parvicingula* PESSAGNO in possessing a two-layered test with a microgranular outer layer lacking discrete pore frames.

Etymology.- *Canoptum* is an arbitrary combination of letters.

Included Taxa.-
5785 *Canoptum banale* JUD

CANOPTUM BANALE 5785

Canoptum banale JUD

Synonymy.-
Canoptum banale JUD
JUD 1994, p. 68, pl. 5, fig. 10.

Original Definition.- Conical test of 7-9 segments. Proximal portion (comprising cephalis and thorax) conical, smooth, poreless, separated by a slight constriction from the following segment. It seems that a row of pores also separates the cephalis from the thorax. The following segments increase gradually in width and in height. The first postabdominal segment is distinctly less high than all other following segments and is thus very characteristic of this species. Constrictions between the following postabdominal segments are wide and concave. On all postabdominal segments pores are small and irregularly arranged. Two specimens were found with a short apical horn.

Original Remarks.- *Canoptum banale* n.sp. differs from the other species of the genus *Canoptum* PESSAGNO by possessing a distinct first postabdominal segment which is much smaller than all the following ones. Since it seems that the test is partly spongy, this species could also be assigned to the genus *Spongocapsula* PESSAGNO. Most specimens were found consisting of 8 segments.

Etymology.- *Banale* was latinized from the French banal = commonplace, uninteresting.

Measurements (in μm).-
Based on 14 specimens.

	HT	av.	min.	max.
Lenght to 8th segm.:	325	320	300	370
Height 1st pab. segm.:	26	22	20	26
Height of 8th segm.:	60	60	45	75
Width of 8th segm.:	166	170	150	183

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-16, latest Tith. to early Val.

cantuchapai >> *PANTANELLIUM CANTUCHAPAI AFF.* 5065

capita >> *HEMICRYPTOCAPSA CAPITA* 4026

carinatus >> *ACANTHOCIRCUS CARINATUS* 5012

carpathicum >> *WILLIRIEDELLUM CARPATHICUM* 4055

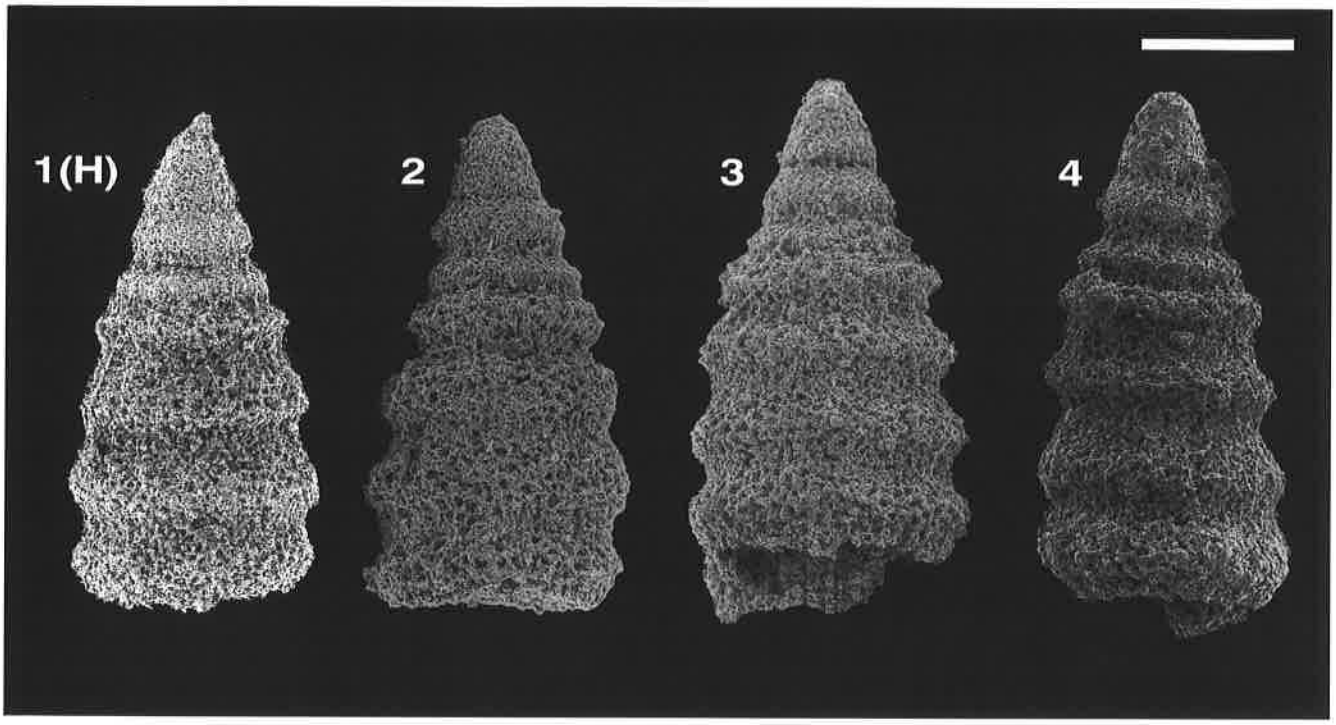


Plate 5785. ***Canoptum banale*** **JUD.** Magnification x200. **Fig. 1(H).** RJ289, Br28.85. **Fig. 2.** RJ388, Br1330. **Fig. 3.** RJ466, Br1330. **Fig. 4.** RJ100, Br1330.

carpatica >> *CINGULOTURRIS CARPATICA*		*3193*

carpatica >> *PSEUDODICTYOMITRA CARPATICA*		*3293*

casmaliaensis >> *TRITRABS CASMALIAENSIS*		*3117*

catenaria >> *ORBICULIFORMA (?) CATENARIA*		*3205*

catenarum >> *STYLOCAPSA CATENARUM*		*3044*

caudatum >> *YAMATOUM CAUDATUM*		*2016*

CECROPS 6000

Genus: *Cecrops* PESSAGNO

Synonymy.-
Cecrops PESSAGNO
PESSAGNO 1977b, p. 32.

Type Species.- *Staurosphaera septemporata* PARONA 1890.

Original Definition.- Test as with family. Cortical shell with 4 primary spines oriented along 2 axes at right angles to each other and continuous with radial beams that connect with first medullary shell; 1 spine along each of 2 axes shorter than other.

Original Remarks.- *Cecrops* differs from *Pantanellium* by having 4 rather than 2 primary spines and radial beams. The former genus bears no resemblance to *Staurosphaera* HAECKEL (type species = *S. crassa* DUNIKOWSKI).

Etymology.- *Cecrops-opis* (Latin, Masc.) = first mythical king of Athens.

Included Taxa.-
5229 *Cecrops septemporatus* (PARONA)
5068 *Cecrops* (?) *sexaspina* JUD

CECROPS SEPTEMPORATUS 5229

Cecrops septemporatus (PARONA)

Synonymy.-
Staurosphaera septemporata PARONA
PARONA 1890, p. 151, pl. 2, figs. 4- 5.
CITA & PASQUARE 1959, p. 398, fig. 3, not 7.
MOORE 1973, p. 824, pl. 2, fig. 2.
FOREMAN 1973b, p. 259, pl. 3, fig. 4.
RIEDEL & SANFILIPPO 1974, p. 780, pl. 1, figs. 6-8.
FOREMAN 1975, p. 609, pl. 2E, fig. 7; pl. 3, fig. 6.
MUZAVOR 1977, p. 53, pl. 1, figs. 9-10.
NAKASEKO et al. 1979, p. 24, pl. 2, figs. 5-6.
KANIE et al. 1981, pl. 1, fig. 5.
SCHAAF 1981, p. 439, pl. 7, figs. 8a-b; pl. 16, figs. 10a-b.
NAKASEKO & NISHIMURA 1981, p. 161, pl. 1, fig. 2.
KIMINAMI et al. 1985, pl. 2, fig. 7.
TUMANDA 1989, p. 8, pl. 1, fig. 5.
Staurolonche robusta RÜST
FISCHLI 1916, text-fig. 36.
Staurolonche sp. FISCHLI
FISCHLI 1916, text-fig. 37.
Cecrops septemporatus (PARONA)
PESSAGNO 1977b, p. 33, pl. 3, fig. 11.
BAUMGARTNER et al. 1980, p. 51, pl. 2, fig. 7.
OKAMURA & UTO 1982, pl. 7, fig. 19.
BAUMGARTNER 1984, p. 761, pl. 2, figs. 17-18.
SCHAAF 1984, p. 136-137, figs. 1a-b, 2a-b, 3a-b.
THUROW 1988, p. 398, pl. 9, fig. 18.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 15.
MATSUOKA 1992, pl. 1, fig. 1.
JUD 1994, p. 68, pl. 5, figs. 11-12.
Cecrops septemporata (PARONA)
NAKAGAWA et al. 1980, pl. 1, figs. 2, 5.
KOCHER 1981, p. 59, 60, pl. 12, fig. 25.
TAJIKA & IWATA 1983, pl. 1, fig. 6.
Sphaerostylus septemporatus (PARONA)
SANFILIPPO & RIEDEL 1985, p. 590, figs. 4.6a-d.
Cecrops septemporatus (PARONA)
KITO 1987, pl. 1, fig. 1.
IGO et al. 1987, text-fig. 2.6.

Original Definition.- "Shell with seven big pores, of which six are subround and disposed round the subhexagonal seventh situated in the centre of the shell. Four big spines of equal length are arranged regularly around the shell and thus forming a cross."

Measurements (in μm).-
Diameter of the shell 91, diameter of the central pore 24, length of the spines 122, width of the spines at their base 30.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 17-21, late Val. to early Barr.

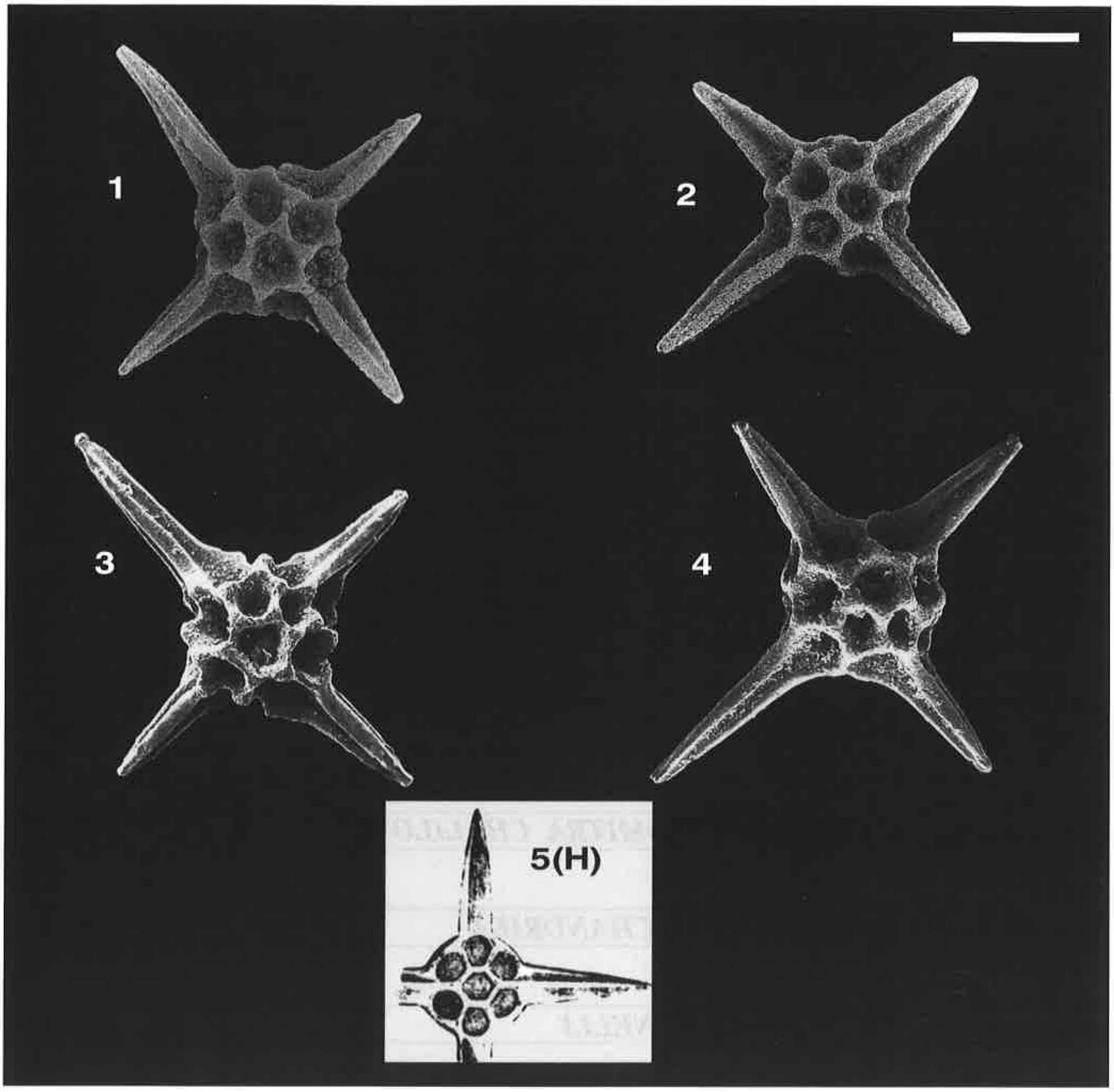


Plate 5229. ***Cecrops septemporatus*** **(PARONA).** Magnification x200. **Fig. 1.** RJ311, Bo566.5. **Fig. 2.** RJ580, Bo566.5. **Fig. 3.** POB80/2699, V-37. **Fig. 4.** POB79/4278, MO2 46. **Fig. 5(H).** PARONA 1890, pl. 2, fig. 4.

CECROPS (?) SEXASPINA 5068

Cecrops (?) *sexaspina* JUD

***Synonymy*.-**
Cecrops (?) *sexaspina* JUD
JUD 1994, p. 68, pl. 5, figs. 13-14.

***Original Definition*.-** Small central sphere with few very large pentagonal or hexagonal pore frames and six spines. A long, massive triradiate spine protrudes from each pole and 4 short, thinner triradiate spines are evenly spaced about the equatorial region. The junctions of the pore-frames are at the base of the massive ridges of the spines.

***Original Remarks*.-** *Cecrops* (?) *sexaspina* n.sp. differs from *Cecrops septemporatus* (PARONA) by having six spines of which four are placed in equatorial position. It differs also from *Pantanellium berriasianum* BAUMGARTNER in having only 4 spines arranged about the equatorial zone of test.

***Etymology*.-** From the Latin *sex* = six and *spina* = spine.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Total length:	276	287	245	311
Height central test:	88	92	79	111
Maximum equat. w.:	173	176	155	217

***Type Locality*.-** Cava Rusconi, Cittiglio, Northern Italy.

***UAZones*.-** 17-20, late Val. to late Haut.

cetia >> OBESACAPSULA CETIA 3203

chalilovi >> ARCHAEODICTYOMITRA CHALILOVI 5582

chandrika >> DIBOLACHRAS CHANDRIKA 3265

channelli >> XITUS (?) CHANNELLI 5673

charlottensis >> TYMPANEIDES CHARLOTTENSIS 3408

chenodes >> MIRIFUSUS CHENODES 3162

chica >> EMILUVIA CHICA DECUSSATA 5132

chica >> EMILUVIA CHICA GR. 3213

chrafatensis >> LINARESIA CHRAFATENSIS 3074

cincta >> PARVICINGULA (?) CINCTA AFF. 5724

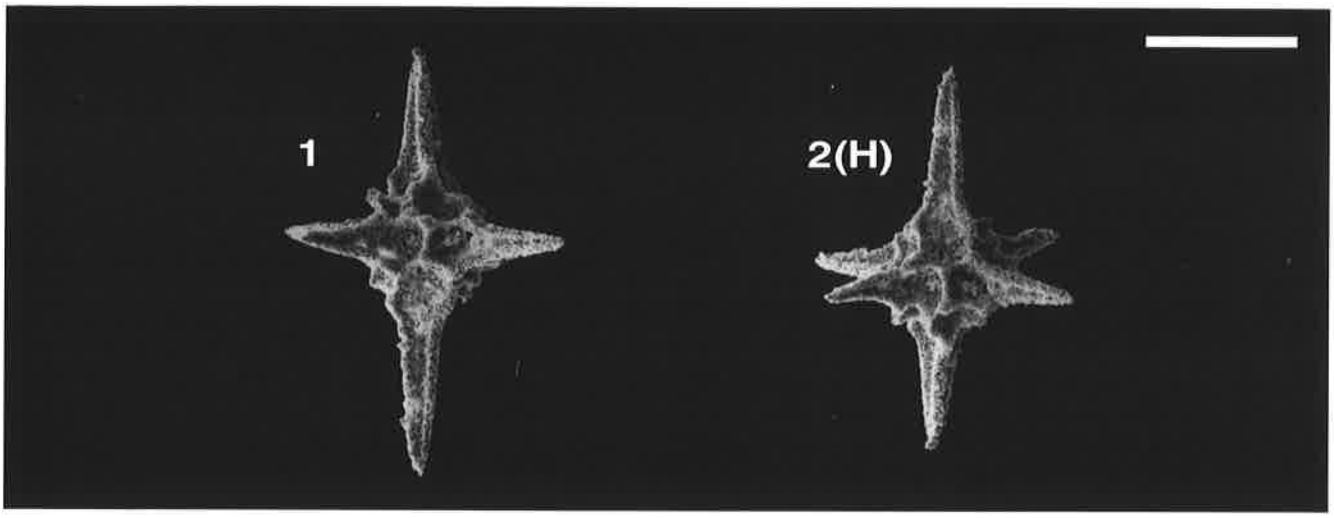


Plate 5068. *Cecrops* (?) *sexaspina* JUD. Magnification x200. **Fig. 1.** RJ1823, Ru135.5. **Fig. 2(H).** RJ1846, Ru135.5.

CINGULOTURRIS 3617

Genus: *Cinguloturris* DUMITRICA

Synonymy.-
Cinguloturris DUMITRICA
DUMITRICA & MELLO 1982, p. 22.

Type Species.- *Cinguloturris carpatica* DUMITRICA, in DUMITRICA & MELLO 1982.

Original Definition.- Test multisegmented, conical, elongate. Cephalis and thorax conical, imperforate, without or with a slight collar constriction. Posthoracic chambers convex in outline and commonly poreless on the middle part. All strictures between joints, beginning with the lumbar one, with pores irregularly arranged and marked outside by more or less evident constrictions in the earlier stages but gradually thickened and convex in outline toward the middle and terminal parts. The thickening is due to appearance of a spongy-like network. Inner walls separating the joints imperforate and T-shaped around the central circular opening.

Original Remarks.- *Cinguloturris* n.gen. is probably more or less related to *Pseudodictyomitra* PESSAGNO, from which it differs in having a spongy-like network or irregularly arranged pores within the zone of stricture between segments rather than two rows of pores. Although the middle part of segments is commonly poreless, the pitted surface suggests an origin of the genus in a form with completely lattice segments. *Cinguloturris* could also be related to the Xitidae PESSAGNO that have also thickenings of the sutural zones.

Etymology.- The name comes from the Latin nouns *cingulum* - belt and *turris* - tower. Feminine gender.

Included Taxa.-
3193 *Cinguloturris carpatica* DUMITRICA
6101 *Cinguloturris cylindra* KEMKIN & RUDENKO

CINGULOTURRIS CARPATICA 3193

Cinguloturris carpatica DUMITRICA

Synonymy.-
Cinguloturris carpatica DUMITRICA
DUMITRICA & MELLO 1982, p. 23, pl. 4, figs. 7-11.
YAO 1984, pl. 2, fig. 28.
ISHIDA 1985a, ? pl. 3, fig. 14; pl. 4, figs. 13-14.
MATSUOKA & YAO 1985, pl. 2, fig. 13.
TANAKA et al. 1985, pl. 1, fig. 12.
AITA 1985, fig. 7.12.
KISHIDA & HISADA 1986, pl. 2, fig. 12.
MATSUOKA 1986a, pl. 2, fig. 16; pl. 3, figs. 11a-b.
MATSUOKA & YAO 1986, pl. 2, fig. 14.
AITA 1987, p. 64, pl. 10, fig. 12.
OZVOLDOVA 1988, pl. 6, fig. 8.
? KAWABATA 1988, pl. 2, fig. 10.
WAKITA 1988, pl. 4, fig. ? 16; pl. 5, fig. 8.
KATO & IWATA 1989, pl. 5, fig. 5; pl. 6, fig. 10.
YASUDA 1989, pl. 1, fig. 14.
WIDZ 1991, p. 244, pl. 1, fig.11.
YAO 1991, pl. 4, fig. 11.
MATSUOKA 1992, pl. 3, fig. 2; pl. 4, fig. 1.
Unnamed multicyrtoid nassellarian
? ADACHI 1982, pl. 2, figs. 9, ? 10.
YAMAMOTO 1983, pl. 1, fig. 10.
Theoperidae gen. et sp. indet I
AITA 1982, pl. 2, fig. 18.
Theoperid gen. et sp. indet.
AOKI & TASHIRO 1982, pl. 2, fig. 9.
Stichomitra sp. A
? YAO et al. 1982, pl. 4, fig. 20.
Dictyomitra sp. B
ISHIDA 1983, pl. 5, figs. 3-4.
Cinguloturris sp. aff. *C. carpatica* DUMITRICA
YAO 1984, pl. 3, fig. 19.
Cinguloturris sp. cf. *C. carpatica* DUMITRICA
TANAKA et al. 1985, pl. 1, fig. 7.
Cinguloturris
OZVOLDOVA 1987, pl. 2, fig. 7.
Cinguloturris sp. cf. *C. carpatica* DUMITRICA
KURIMOTO 1989, pl. 1, fig. 17.

Original Definition.- Test as with genus, made of seven to eight, possible more segments. Diameter of segments increases rapidly up to the third segment and slower in the following ones. The spongy network between segments very well developed beginning especially with the fourth or fifth constriction which becomes convex in outline and tends to reach the diameter of the adjoining segments from which it is separated by rather deep strictures. In other specimens these strictures are less obvious, the spongy network filling completely the space between segments. Although the last segment is generally not preserved in our specimens, it seems that it is inverted conical.

Remarks.- We include with this species a considerable variation of conical shapes and variable development of the spongy circumferential layer on each segment. The portion of segments not covered by a spongy layer may be either smooth or pitted.

Measurements (in μm).-
Lenght specimen with 7 segments 240-290, max. diam. 125-145.

Type Locality.- Birsa Tamasa valley, Piatra Craiului, East Carpathians, Romania.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

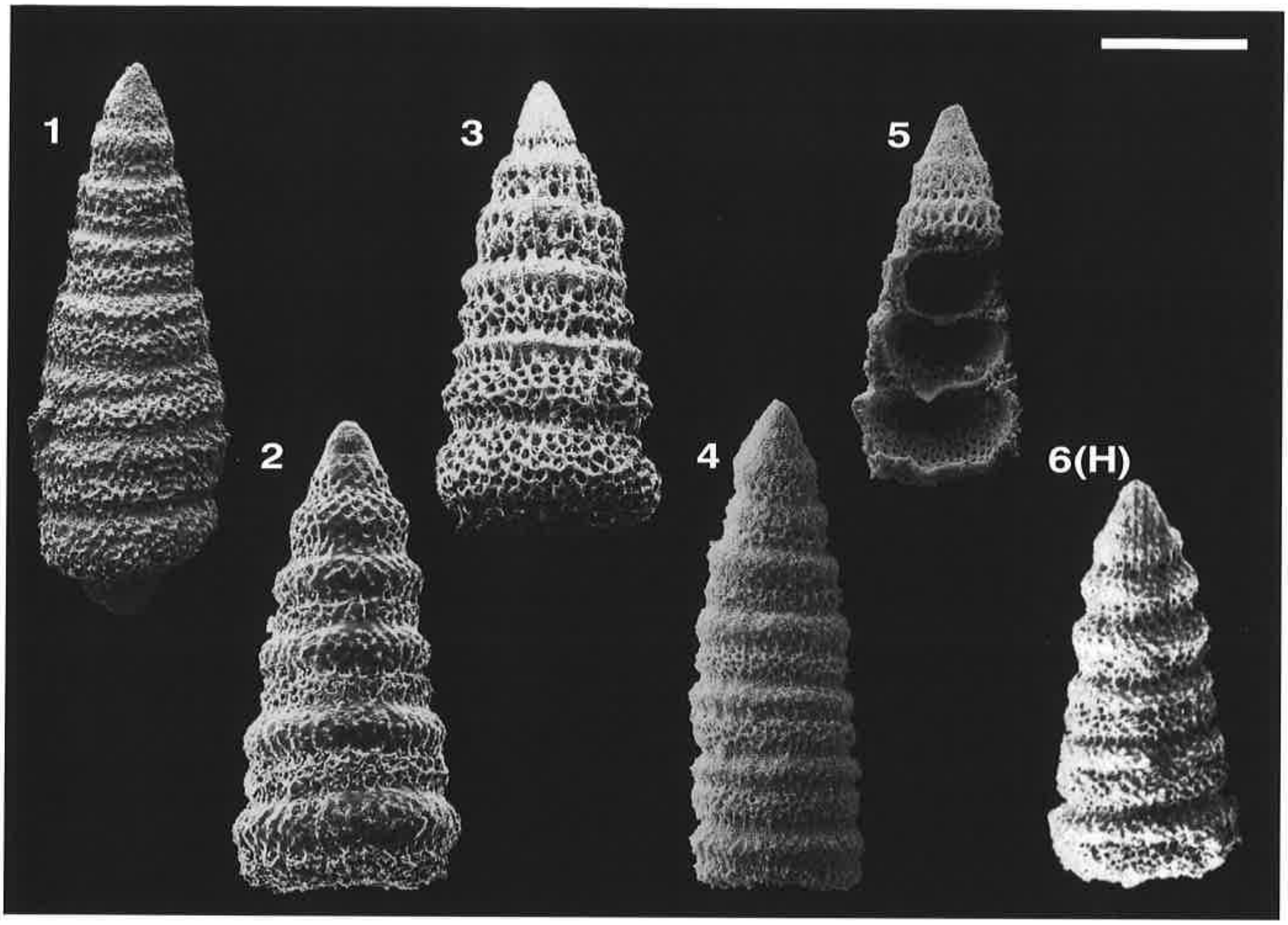


Plate 3193. ***Cinguloturris carpatica*** **DUMITRICA.** Magnification x200. **Fig. 1.** POB79/1497, POB899.61. **Fig. 2.** POB78/3622, POB28.65. **Fig. 3.** POB81/9008, 76.534A.106.1.29. **Fig. 4.** DU3078, PJ9. **Fig. 5.** DU2651, PJ17. **Fig. 6(H).** DUMITRICA & MELLO 1982, pl. 4, fig. 9.

CINGULOTURRIS CYLINDRA 6101

Cinguloturris cylindra KEMKIN & RUDENKO

Synonymy.-
Cinguloturris sp. aff. *C. carpatica* DUMITRICA
WAKITA 1988, pl. 6, fig. 14.
Cinguloturris sp. KATO & IWATA
KATO & IWATA, 1989, pl. 2, fig. 7.
Cinguloturris cylindra KEMKIN & RUDENKO
KEMKIN & RUDENKO, 1993, p. 116, text-fig. lb, pl. 2, figs. 3, 9-15.
Cinguloturris arabica JUD
JUD, 1994, p. 69, pl. 5, figs. 15-16.

Original Definition.- Test cylindrical with 4-5 segments a and 4-5 segments *b*. Diametre of segments increases rapidly up to the second, then toward the aperture it changes very little. Segments *a* convex with costate surface, nonperforated. Segments *b* in upper part of test (first segment) concave, second segment b straight, the others convex, perforated (up to approximately 5 irregular rows of pores). Segments *a* and *b* separated from one another by a row of large pores.

Actualized Definition.- Conical test of 8-10 segments. Cephalis, thorax and abdomen conical, smooth. Thorax, abdomen and first postabdominal segment separated from one another by a single row of small pores. All postabdominal segments with the upper part inflated, poreless, bearing numerous prominent longitudinal costae. Distal part of segments constricted internally and covered by a relatively thick spongy meshwork with irregularly arranged pores. First segments increasing in diameter rapidly up to the second postabdominal segment. Remaining postabdominal segments increase very slowly, forming a slightly cylindrical body. Last segment of inverted conical shape, with smooth spongy surface and with a wide aperture.

Original Remarks.- *C. cylindra* n.sp. differs from *C. carpatica* by the subcylindrical shape of its test, smaller H/D max., greater height of segments *a* and *b*, greater number of pores on segments b, and also by the presence of costae on segments *a*.

Remarks.- *Cinguloturris cylindra* differs from *Cinguloturris carpatica* DUMITRICA by possessing costae on the upper part of the postabdominal segments. Complete specimens with the last segment preserved were rarely found.

Etymology.- From the Greek *cylindra* - cylindrical.

Measurements (in μm).-
Based on 7 specimens. H: 200-300, D max.: 131-150, H of segments a from 1218 to 18-28, H of segments b from 9-15 to 21-40, HID max. 1.77.

Type Locality.- Chernaya River, Vladivostok, Russia.

UAZones.- 12-17, early-early late Tith. to late Val.

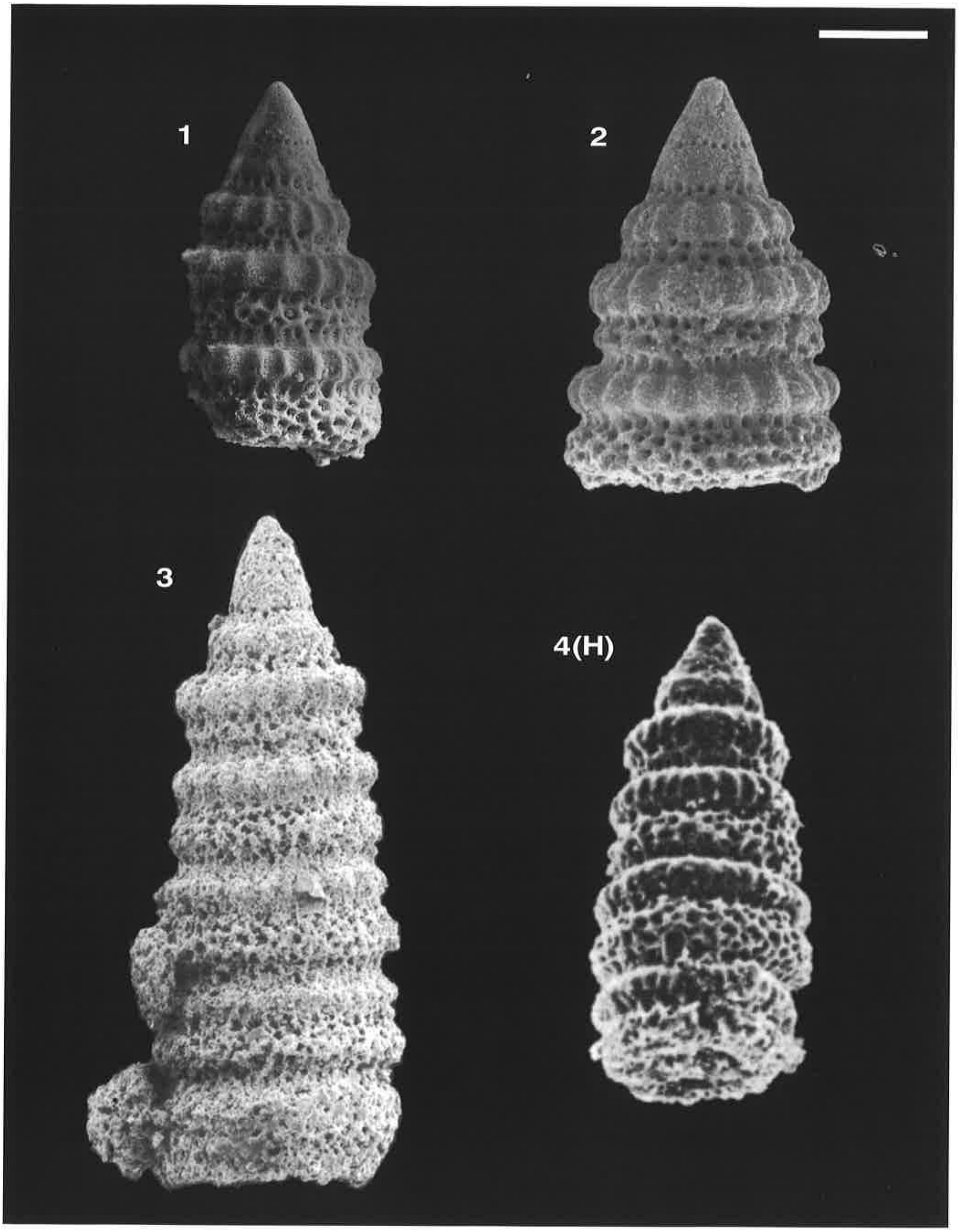


Plate 6101. ***Cinguloturris cylindra*** **KEMKIN & RUDENKO.** Magnification x300. **Fig. 1.** RJ20, Oman25. **Fig. 2.** 106-7, KI106-7, NK81072501. **Fig. 3.** RJ93, BR 1330 **Fig. 4(H).** KEMKIN & RUDENKO, 1993, pl. 2, fig. 3.

collina* >> *CRUCELLA COLLINA **5194**

columbaria* >> *EUCYRTIS COLUMBARIA **5620**

columnum* >> *WRANGELLIUM COLUMNUM **5580**

concentrica* >> *SETHOCAPSA (?) CONCENTRICA **5433**

conexa* >> *TRICOLOCAPSA CONEXA **3297**

conoformis* >> *DICOLOCAPSA (?) CONOFORMIS **4013**

convexa* >> *STICHOCAPSA CONVEXA **3055**

cordis* >> *THEOCAPSOMMA CORDIS **3277**

corniculum* >> *SAITOUM CORNICULUM **3023**

cornuta* >> *TRIACTOMA CORNUTA **3166**

coronaria* >> *HIGUMASTRA CORONARIA **3108**

coronata* >> *GODIA CORONATA **6125**

coronata >> SPONGOCAPSULA CORONATA AFF.	*5773*

coronata >> SYRINGOCAPSA CORONATA	*5417*

coronata >> SYRINGOCAPSA CORONATA AFF.	*5416*

corpulenta >> PARONAELLA CORPULENTA AFF.	*3310*

corralitosensis >> TETRADITRYMA CORRALITOSENSIS BIFIDA	*4048*

corralitosensis >> TETRADITRYMA C. CORRALITOSENSIS	*3124*

corralitosensis >> TETRADITRYMA CORRALITOSENSIS S.L.	*3273*

cosmoconica >> PARVICINGULA COSMOCONICA	*3255*

crassa >> PALINANDROMEDA CRASSA	*3009*

cretacea >> RISTOLA CRETACEA	*3165*

cristatum >> PSEUDOCROLANIUM CRISTATUM	*5521*

cristatus >> BERNOULLIUS CRISTATUS	*3221*

CROLANIUM 6001

Genus: *Crolanium* PESSAGNO

***Synonymy*.-**
Crolanium PESSAGNO
PESSAGNO 1977b, p. 53.

***Type Species*.-** *Crolanium triquetrum* PESSAGNO 1977b.

***Original Definition*.-** Test as with family but triangular in axial section of distal half; 3 ridges, often spinose in character, occurring externally corresponding to vertices of triangular cross sections. Final postabdominal chamber with a conical, porous cover plate with a circular central aperture having a tubular extension (pl. 9, figs. 9, 24).

***Original Remarks*.-** *Crolanium* n.gen. is compared to *Xitus* under the latter genus.

***Remarks*.-** Species have been differentiated by the relative length of the test and by differences in surface ornamentation.

***Etymology*.-** The name *Crolanium* is formed by an arbitrary combination of letters.

***Included Taxa*.-**
5532 *Crolanium pythiae* SCHAAF
6123 *Crolanium* spp.

CROLANIUM PYTHIAE 5532

Crolanium pythiae SCHAAF

***Synonymy*.-**
Dictyomitra (?) sp.
FOREMAN 1975, p. 615, pl. 2H, fig. 4.
Crolanium pythiae SCHAAF
SCHAAF 1981, p. 432-433, pl. 20, figs. 5a-c.
SCHAAF 1984, p. 159, figs. 1-3.
SANFILIPPO & RIEDEL 1985, p. 616, figs. 13.1 a-e.
THUROW 1988, p. 399, pl. 6, fig. 23.
AGUADO et al. 1991, fig. 7.7.
MATSUOKA 1992, pl. 1, fig. 9.
JUD 1994, p. 69, pl. 6, figs. 1-2.

***Original Definition*.-** The shell is conical and consists of 10 to 12 uniform segments which increase gradually in length distally. Characteristic of this form are the three tubular feet which permit recognition even in poorly preserved material. Externally there is little or no segmental division, except for sometimes very slight constrictions. Pores are small, rounded, arranged randomly or in transverse rows.

***Original Remarks*.-** *Crolanium pythiae* differs from all others of the genus in having three tubular projections instead of solid spines.

***Actualized Remarks*.-** (JUD, 1994) For biostratigraphic data we included only specimens having a terminal segment with three tubular extensions. All other forms showing similar surface structure of the test, but lacking tubular terminal extensions have been included with *Crolanium* spp. Our specimens correspond well to this species, having a total length of 290-434 μm and a width at the base of the tubular extensions of 110-151 μm.

***Etymology*.-** The shape of this radiolarian is reminiscent of the seat of *Pythia*, a principal personality in Greek mythology, Apollo's priestess in the panhellenic sanctuary of Delphi, and is therefore named *pythiae*.

***Measurements* (in μm).-**
Based on 9 specimens. Length 250 to 420; greatest width without the tubular feet 130 to 180.

***Type Locality*.-** DSDP Leg 62 Site 463, Mid-Pacific Mountains.

***UAZones*.-** 17-22, late Val. to late Barr.-early Apt.

CROLANIUM SPP. 6123

Crolanium spp.

***Synonymy*.-**
Crolanium spp.
JUD 1994, p. 70, pl. 6, figs. 3-6.

***Original Definition*.-** Test conical, of 7 or more segments. Terminal segment triangular, bearing extensions. Apical segments poreless, surface with irregularly placed ribs, the cephalis bearing a small horn. All following segments gradually increasing in width, with several transverse rows of small pores per segment. Surface slightly spiney with irregularly placed discontinuous ribs. Terminal segment triangular in cross-section, sometimes bearing spiny extensions or 3 curved spines on the three edges. On some specimens it terminates with a short closed tube.

***Original Remarks*.-** Included herein are all specimens with elongate conical test terminating with a triangular, pyramidal distal portion, with 5-6 transverse rows of small pores per segment. The surface of the test has

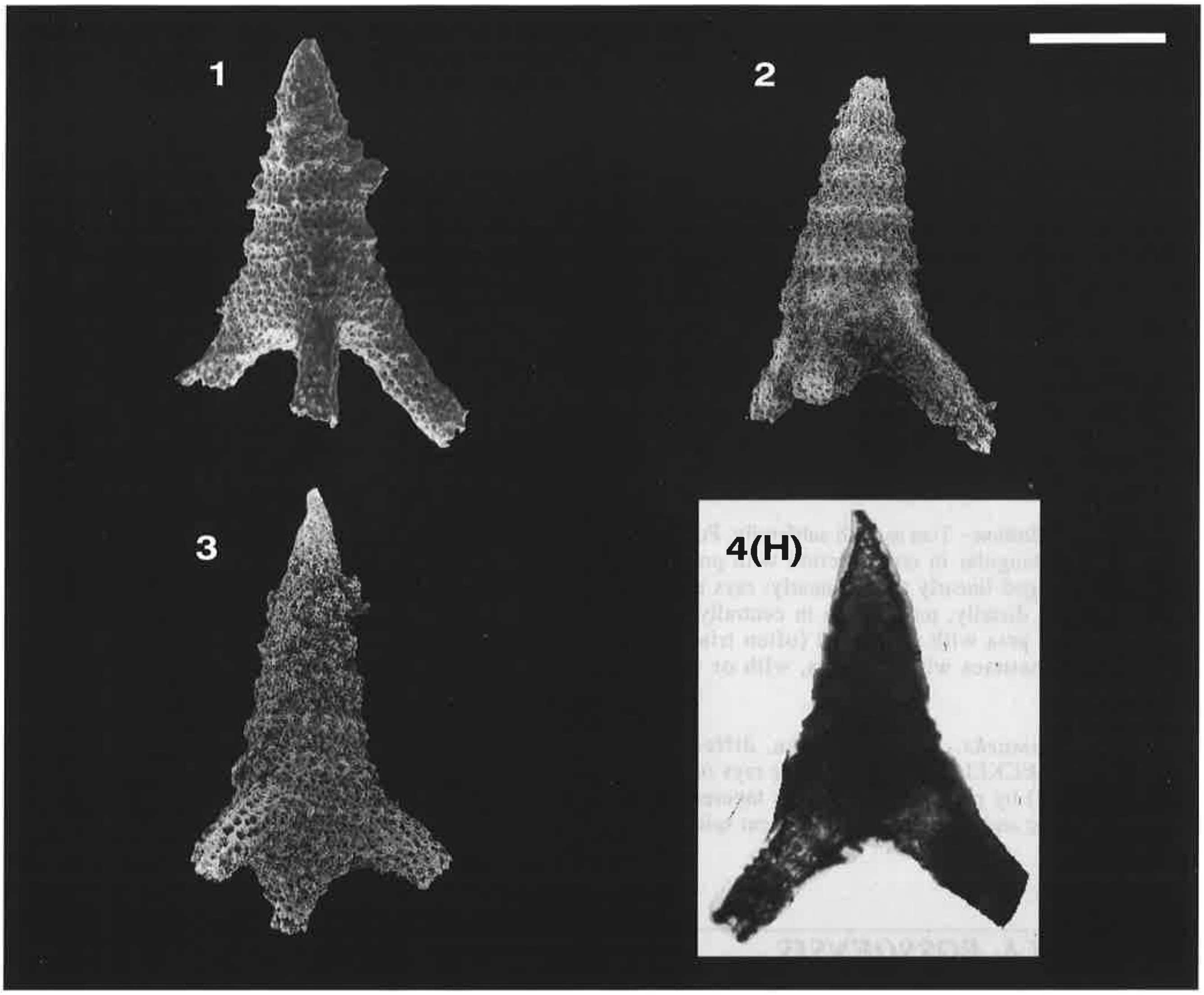


Plate 5532. *Crolanium pythiae* SCHAAF. Magnification x200. **Fig. 1.** DU873, BrMO46. **Fig. 2.** RJ110, Bo566.5. **Fig. 3.** RJ109, Bo 566.5. **Fig. 4(H).** SCHAAF 1981, pl. 20, fig. 5a.

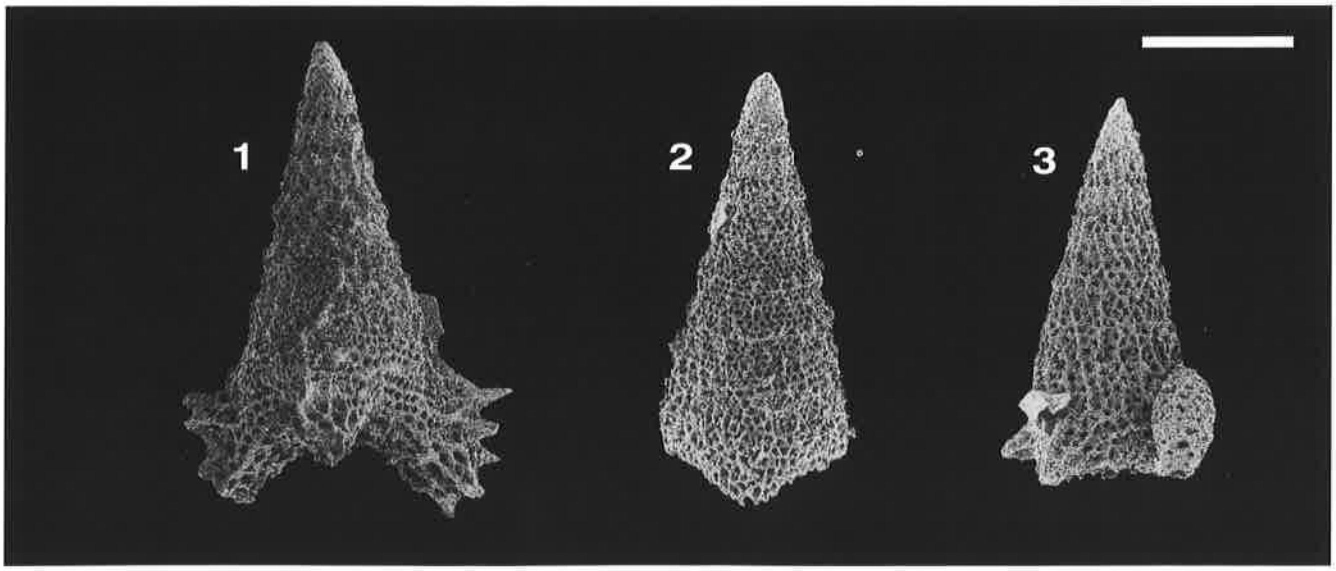


Plate 6123. *Crolanium* spp. Magnification x200. **Fig. 1.** RJ273, Br 28.85. **Fig. 2.** RJ358, 28.85. **Fig. 3.** RJ360, Br28.85.

longitudinally to diagonally arranged small, slightly spiny ridges, and the 3 edges of the terminal segment bear 3 spines of variable size and shape or 3 spiny, wing-like extensions. Some specimens were found also with a terminal tube. The specimens have a total length (based on 3 specimens) of 273-315 μm and a total width (without spines or wings) of 97-130 μm and are thus a little shorter and smaller than *Crolanium pythiae* SCHAAF.

UAZones.- 16-22, early Val. to late Barr.-early Apt.

CRUCELLA 3619

Genus: *Crucella* PESSAGNO

Synonymy.-
Crucella PESSAGNO
PESSAGNO 1971a, p. 52.

Type Species.- *Crucella messinae* PESSAGNO 1971a.

Original Definition.- Test as with subfamily. Four rays, elliptical to rectangular in cross-section with polygonal meshwork arranged linearly to sublinearly; rays equal in length; tapering distally; terminating in centrally placed spines. Central area with polygonal (often triangular) meshwork; sometimes with a lacuna, with or without patagium.

Original Remarks.- *Crucella* n.gen. differs from *Hagiastrum* HAECKEL (1) by possessing rays of nearly equal length; (2) by possessing rays with tapered rather than bulbous tips; and (3) by having prominent spine at the tip of each ray.

Remarks.- Criteria used in species determination include the longitudinal and axial shape of the rays; the length of the rays in relation to the width of the rays and to the size of the central area; the character of the terminal spines at the ray tips; the surface texture on the central area and on the rays; the character of the central area - it is important to view both sides of the specimen as some specimens have been found to have a lacuna on only one side of the central area.

Etymology.- *Crux, crucis* (Latin, F.) = cross.

Included Taxa.-
5204 *Crucella bossoensis* JUD
5194 *Crucella collina* JUD
5196 *Crucella* sp. aff. *C. espartoensis* PESSAGNO
5902 *Crucella* (?) *inflexa* (RÜST)
5628 *Crucella lipmanae* JUD
5143 *Crucella remanei* JUD
3131 *Crucella theokaftensis* BAUMGARTNER

CRUCELLA BOSSOENSIS 5204

Crucella bossoensis JUD

Synonymy.-
Crucella cachensis PESSAGNO
TAKETANI 1982a, p. 50, pl. 9, fig. 16.
THUROW & KUHNT 1986, pl. 9, figs. 5-6.
THUROW 1987, pl. 4, figs. 7-10.
THUROW 1988, p. 399, pl. 2, fig. 13.
BAUMGARTNER 1992, p. 319, pl. 4, figs. 2-3.
Crucella ozvoldovae KOZUR
DOSTZALY 1988, pl. 1, figs. 5-6.
Crucella bossoensis JUD
JUD 1994, p. 70, pl. 6, figs. 7-10.

Original Definition.- Test four-rayed. Rays pyramidal, with vertical lateral sides, and relatively long conical distal spines. Top and bottom faces of rays commonly with three to four beams connected by transverse bars forming generally quadrangular meshes. This regular structure may be seen on the whole length of rays or only on a part of them. Central area of test with large lacuna. Border of lacuna not raised; central part filled with dense spongy meshwork. Interradial zones of test with narrow patagium disposed only in the proximal part.

Original Remarks.- *Crucella bossoensis* n.sp. can be compared with *Crucella cachensis* PESSAGNO (1971a) from which it differs in lacking a broad raised border around the lacuna.

Etymology.- Named after the type locality near the river Bosso in the Umbria-Marche area, Italy.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Length of rays:	160-175	164	150	180
Width of rays in prox. port.:	40	45	40	55
Diameter of lacuna:	50	53	50	60

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 16-22, early Val. to late Barr.-early Apt.

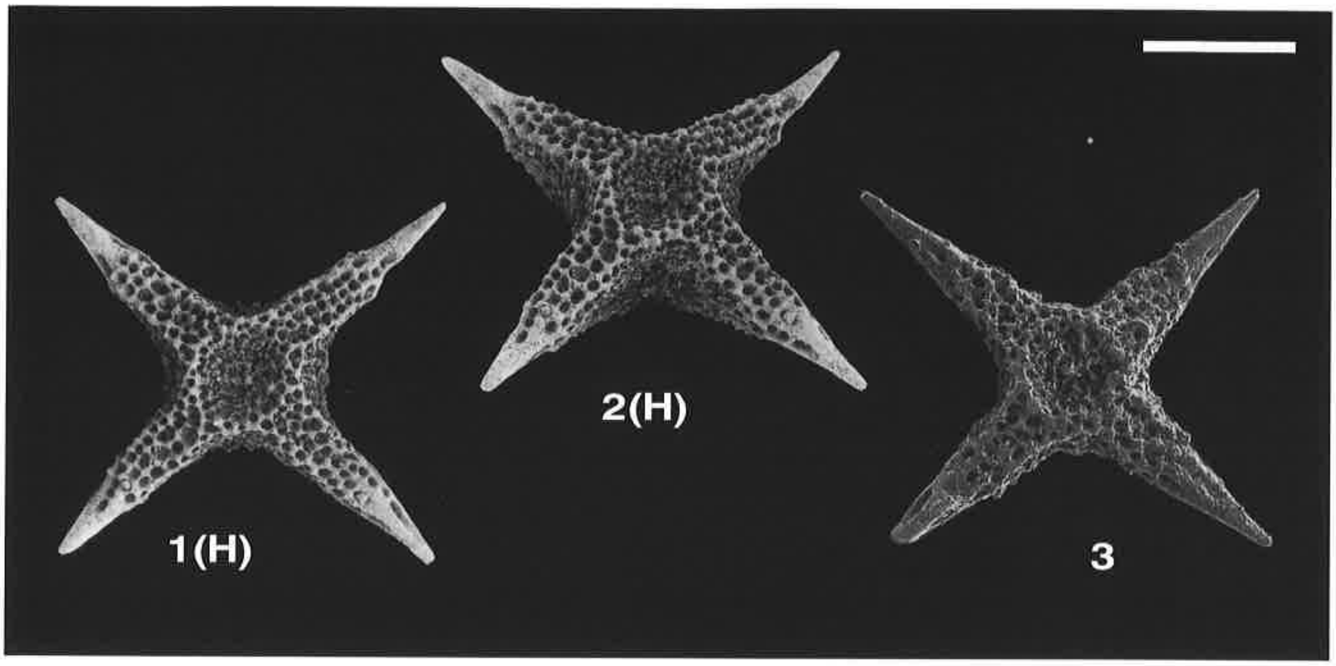


Plate 5204. ***Crucella bossoensis*** **JUD.** Magnification x200. **Fig. 1(H).** RJ458, Bo566.5. **Fig. 2(H).** RJ457, Bo566.5. **Fig. 3.** POB79/3354, MO1 52.

CRUCELLA COLLINA 5194

Crucella collina JUD

Synonymy.-
Crucella sp.
MUZAVOR 1977, p. 62, pl. 3, fig. 5.
Crucella messinae PESSAGNO
TAKETANI 1982a, p. 50, pl. 9, fig. 17.
Crucella espartoensis PESSAGNO
THUROW 1988, p. 399, pl. 2, fig. 14.
Crucella collina JUD
JUD 1994, p. 70, pl. 6, figs. 11-12; pl. 7, figs. 1-2.

Original Definition.- Test with 4 rays at right angles. Rays decreasing in height from the central area towards the distal ends. Rays separated in the central area from each other by an interradial depression. Surface with irregular pore frames which on some specimens are dense in the proximal and wider in the distal portion of the rays. Sides of test deeply concave. On some rare specimens relicts of probable terminal spines have been observed. Interradial space filled with dense patagium.

Original Remarks.- *Crucella collina* n.sp. differs from *Crucella espartoensis* PESSAGNO by lacking the deep, circular depression in the center of both surfaces of the test, and from *Crucella messinae* PESSAGNO by lacking the cylindrical shape of rays.

Etymology.- From the Latin *collina* = hill.

Measurements (in μm).-
Based on 12 specimens.

	HT	av	min.	max.
Length of rays:	166	190	166	232

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Switzerland.

UAZones.- 13-21, latest Tith. to early Barr.

CRUCELLA ESPARTOENSIS AFF. 5196

Crucella sp. aff. *C. espartoensis* PESSAGNO

Synonymy.-
? *Crucella espartoensis* PESSAGNO
PESSAGNO 1971a, p. 54, pl. 18, figs. 1-4.
PESSAGNO 1977b, pl. 5, fig. 1.
TAKETANI 1982a, p. 50, pl. 9, fig. 15.
GORKA 1989, p. 331, pl. 11, fig. 6.
Crucella cf. *espartoensis* PESSAGNO
GORKA 1989, p. 331, fig. 2.
Crucella cachensis PESSAGNO
GORKA 1989, p. 331, pl. 11, figs. 3-4.
Crucella spp.
NAKASEKO et al. 1979, pl. 8, figs. 3-4.
Crucella sp.
GORKA 1989, p. 332, pl. 11, fig. 5.
Crucella sp. cf. *C. cachensis* PESSAGNO
? OZVOLDOVA & SYKORA 1984, p. 264, pl. 5, figs. 5-7.
Crucella sp. aff. *C. espartoensis* PESSAGNO
JUD 1994, p. 71, pl. 6, fig. 13.

Definition.- (JUD, 1994) Test four-rayed with central lacuna. The 4 rays are broad, prominent, rounded on their surface, decreasing in thickness and width distally, and having rounded ends. Surface of rays with coarse, irregular poreframes. Interradial space partly filled with dense patagium, which is much thinner than the rays.

Remarks.- (JUD, 1994) Our specimens differ from *Crucella espartoensis* PESSAGNO by having a deeper central lacuna, by having rays which are not enlarged distally, but decrease in thickness and width, by lacking terminal spines and by having a finer meshwork. One specimen had a length of rays of 244 μm by which means more than twice the length of the holotype of *Crucella espartoensis* PESSAGNO whose length of rays is of only 110 μm.

UAZones.- 17-21, late Val. to early Barr.

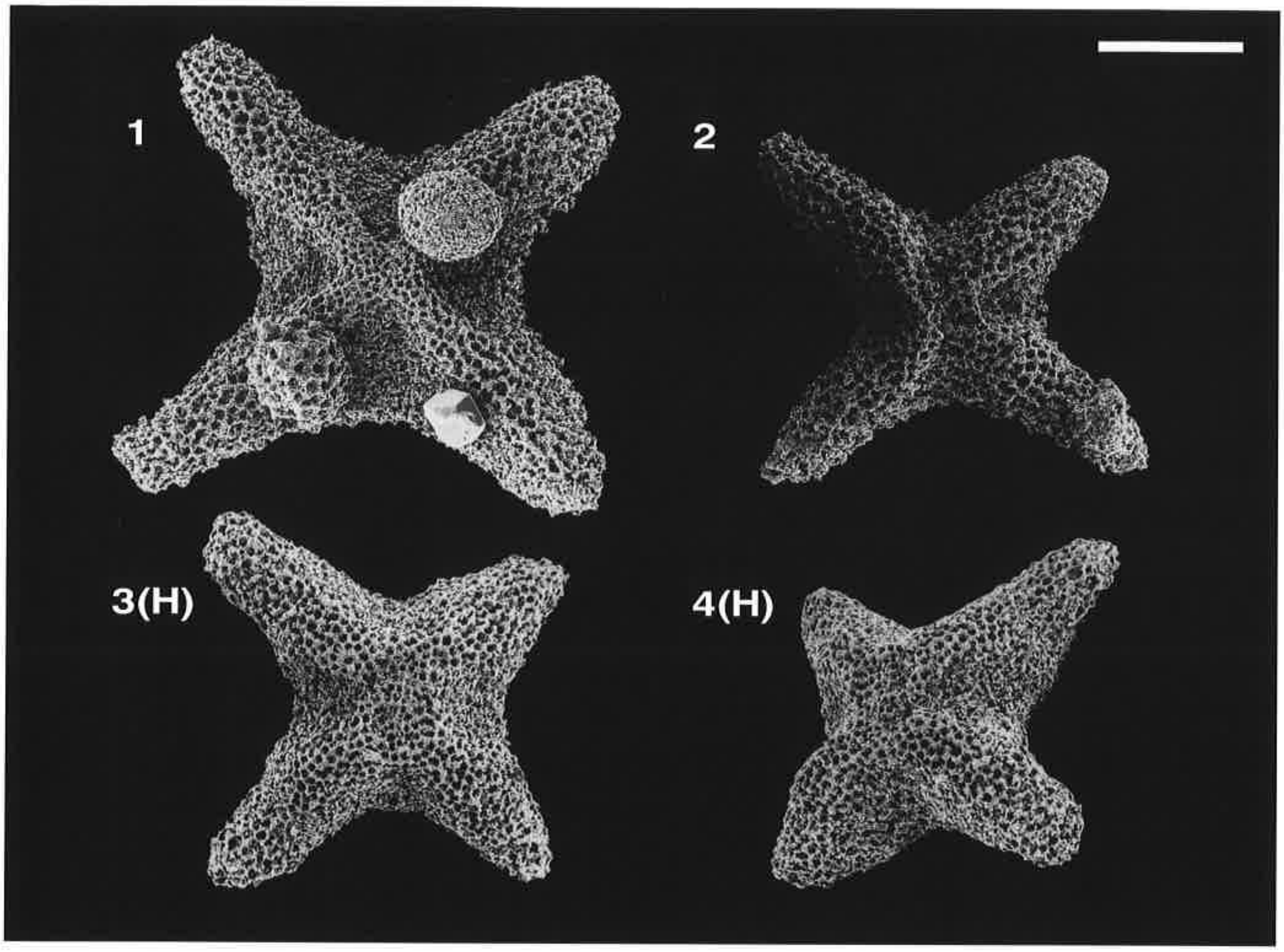


Plate 5194. ***Crucella collina*** **JUD.** Magnification x200. **Fig. 1.** RJ150, Bo449.5. **Fig. 2.** RJ161, Br1330. **Fig. 3(H).** RJ79, Br28.85. **Fig. 4(H).** RJ80, Br28.85.

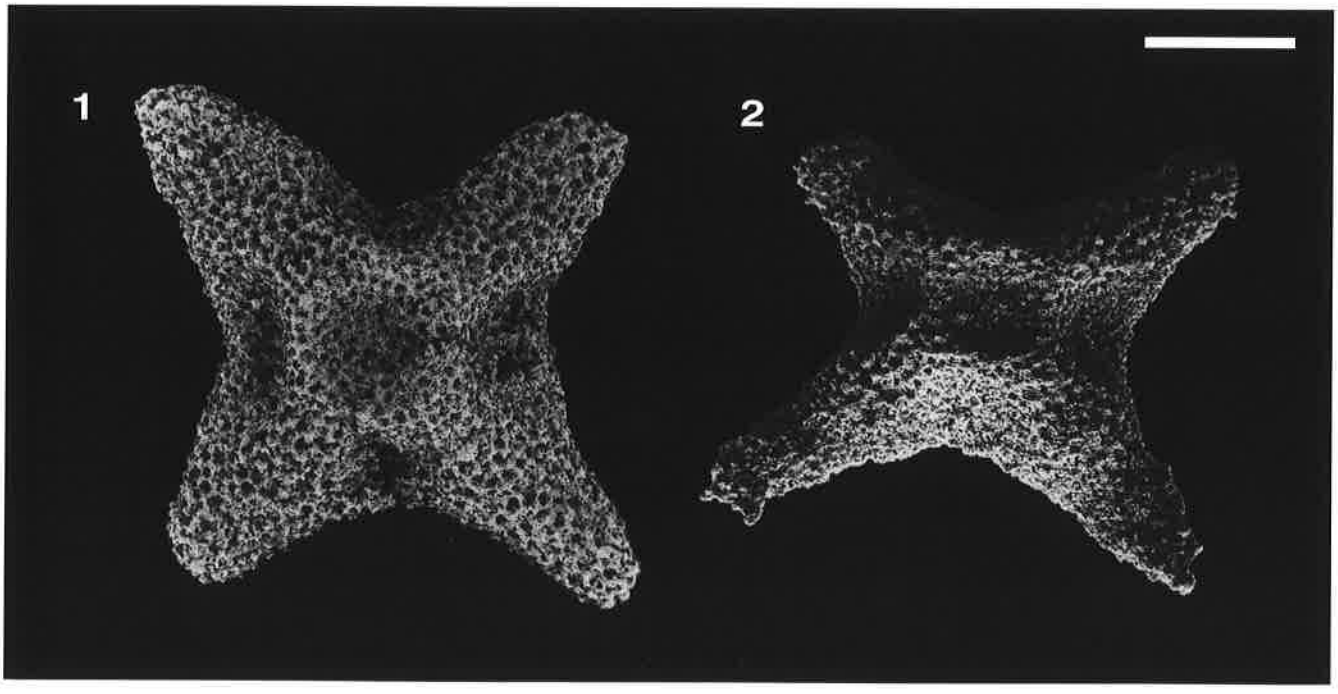


Plate 5196. ***Crucella*** **sp. aff.** ***C. espartoensis*** **PESSAGNO.** Magnification x200. **Fig. 1.** RJ458, Br28.85. **Fig. 2.** POB79/5027, POB1205.1.

CRUCELLA (?) INFLEXA 5902

Crucella (?) *inflexa* (RÜST)

Synonymy.-
Stephanastrum inflexum RÜST
RÜST 1898, p. 32, pl. 11, fig. 2.
SCHAAF 1981, p. 439, pl. 14, figs. 4a-b.
BAUMGARTNER 1992, p. 326, pl. 13, figs. 1-2.
Hagiastrid 2 gen. and sp. indet.
RENZ 1974, p. 792, pl. 1, fig. 9.
Crucella (?) *inflexa* (RÜST)
JUD 1994, p. 71, pl. 7, figs. 3-6.

Original Definition.- "Large, almost square latticed test with 4 very slender, equal rays, starting in the center of the test enlarging very much distally, to be broadest on the rounded ends. Surface with straight longitudinal rows of middle-sized pores. The rather large band of patagium seems to be bent alternately up and even more down in the interradial space.The two opposite bands are covered with very small pores".

Actualized Definition.- (JUD, 1994) Test four-rayed with interradial patagium, forming a flat square. Rays slender, with pores generally irregularly arranged, sometimes also disposed in sigmoidal rows, terminating with long, strong, three-bladed spines. Rays prominent, thicker than interradial patagium and terminating into long strong three-bladed spines. Patagium consists of a fine, thin meshwork in the proximal interradial part, and of a coarse network on the periphery of the test, forming a thick, inflated band, convex in outline.

Actualized Remarks.- (JUD, 1994) *Crucella* (?) *inflexa* differs from all species of the genus *Crucella* described by Pessagno by having three-bladed spines and an interradial patagium with a thick peripheral band. The specimen illustrated by Rüst lacks spines, fact probably due to the section, which is not exactly in the equatorial plane but slightly above or below it. It is also possible that Rüst illustrated a specimen with spines broken off. In our material there are numerous such specimens, probably due to bad preservation. Our specimens have a length of rays (based on 5 specimens) of 200-221 μm without spines. Spines measured on two specimens had a maximum length of 107 and 121 μm. This means that our specimens are smaller than those described by Rüst.

Measurements (in μm).-
Width of test 438, length of diagonal diameter 583, length of rays 285, width of rays at tips 155.

Type Locality.- Maiolica Formation, Cittiglio, Province Varese, North Italy.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

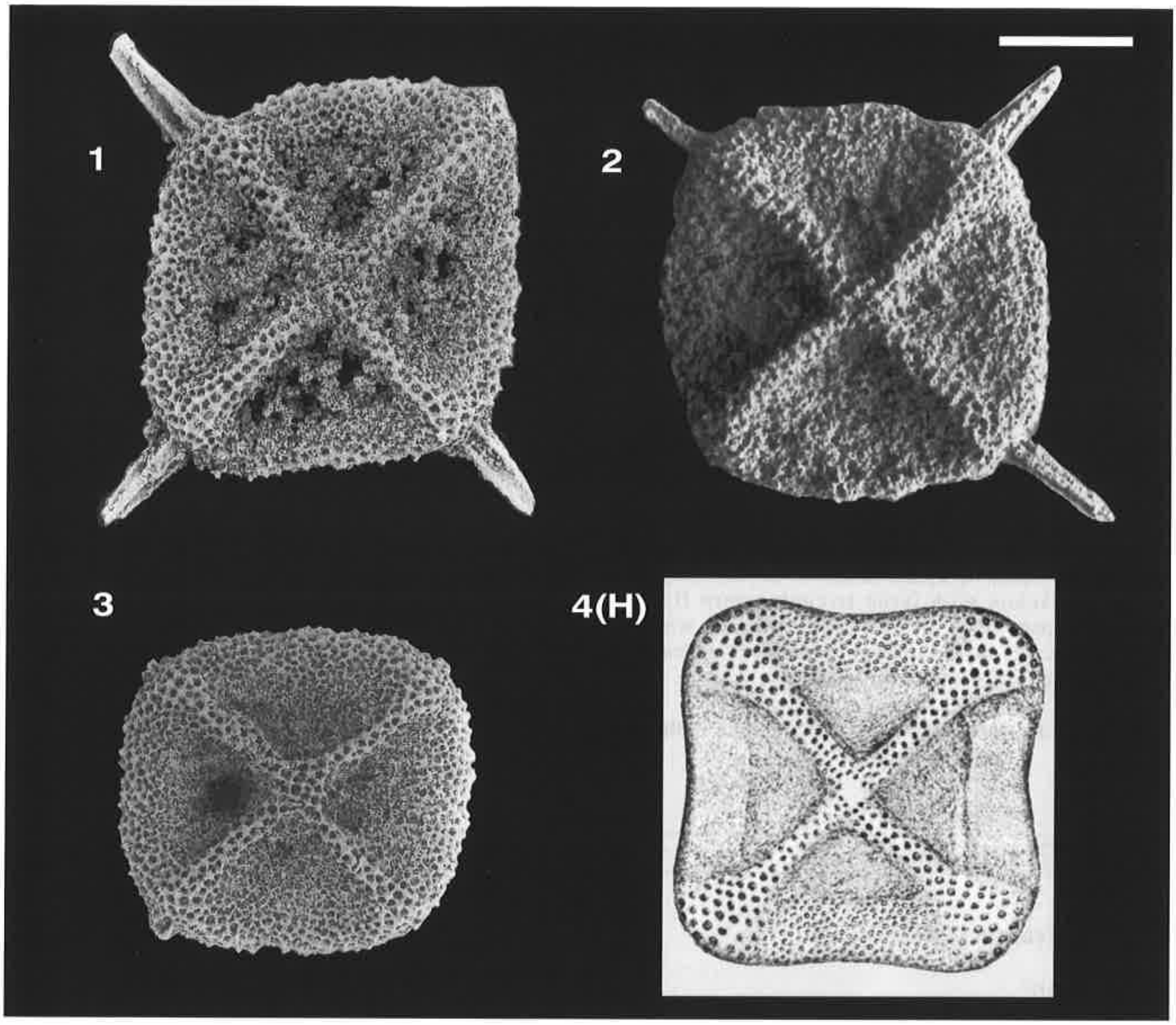


Plate 5902. *Crucella* (?) *inflexa* (RÜST). Magnification x150. **Fig. 1.** RJ402, Bo566.5. **Fig. 2.** RJ730, GC817.90. **Fig. 3.** RJ400, Bo566.5. **Fig. 4(H).** RÜST 1898, pl. 11, fig. 2.

CRUCELLA LIPMANAE 5628

Crucella lipmanae JUD

Synonymy.-
Crucella aster LIPMAN
NAKASEKO & NISHIMURA 1981, p. 148, pl. 2, figs. 9-10.
Crucella spp.
NAKASEKO et al. 1979, p. 21, pl. 8, figs. 3-4.
Pseudocrucella (?) sp. C.
THUROW 1988, p. 404, pl. 10, fig. 6.
Crucella lipmanae JUD
JUD 1994, p. 71, pl. 7, figs. 7-8.

Original Definition.- Square test of 4 rays and interradial patagium. Central portion of test with maximal thickness and a deep subcircular lacuna. Rays form a kind of narrow cross-shaped ridge originated in the high border of the central lacuna. Rays decreasing in thickness distally, each one bearing a three-bladed terminal spine, usually some spines broken off by fossilisation. Surface of rays and border of lacuna with large irregular pore frames. Interradial space filled up with dense patagium which is thinning towards the periphery; the latter is concave or wide V-shaped in the interradial space.

Original Remarks.- Our specimens resemble the one illustrated by Nakaseko & Nishimura (1981, pl. 8, fig. 10 only) and assigned to *Crucella aster* LIPMAN. No description however was given by the authors. The specimen illustrated by them as well as our specimens do not resemble at all those illustrated by Lipman (1952, pl. 2, figs. 6, 7) under that name. *Crucella lipmanae* n.sp. differs from *Crucella* sp. aff. *C. espartoensis* in having rays forming only narrow ridges and in possessing terminal spines.

Etymology.- This species is dedicated to R. K. Lipman, honouring her contributions to the knowledge of Mesozoic radiolarians.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Diagonal length test:	346	368	346	383
Width of lacuna:	77	79	77	83
Length of spines:	-	-	83	-

Type Locality.- Cava Rusconi, Cittiglio, Northern Italy.

UAZones.- 17-19, late Val. to early Haut.

CRUCELLA REMANEI 5143

Crucella remanei JUD

Synonymy.-
Crucella remanei JUD
JUD 1994, p. 72, pl. 7, figs. 9-12.

Original Definition.- Test of 4 rays with terminal spines. Central part with 4 characteristic tubercles in interradial position. Rays equal in length, pointing distally, terminating with long three-bladed spines. Pore-frames polygonal, somewhat denser on tubercles than on base of spines. Length of spines about half the length of whole ray.

Original Remarks.- *Crucella remanei* n.sp. is well distinguished from all species of the genus thus far described by the presence of the 4 centrally placed tubercles.

Etymology.- This species is dedicated to Prof. Dr. Jürgen Remane, Institute of Geology, University of Neuchâtel, Switzerland, honouring his contributions to the knowledge of Calpionellids and his work in determining them in our samples.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total length rays:	214	215	172	268
Length of spines:	107	99	77	143

Type Locality.- Cava Rusconi, Cittiglio, district Varese, Northern Italy.

UAZones.- 17-21, late Val. to early Barr.

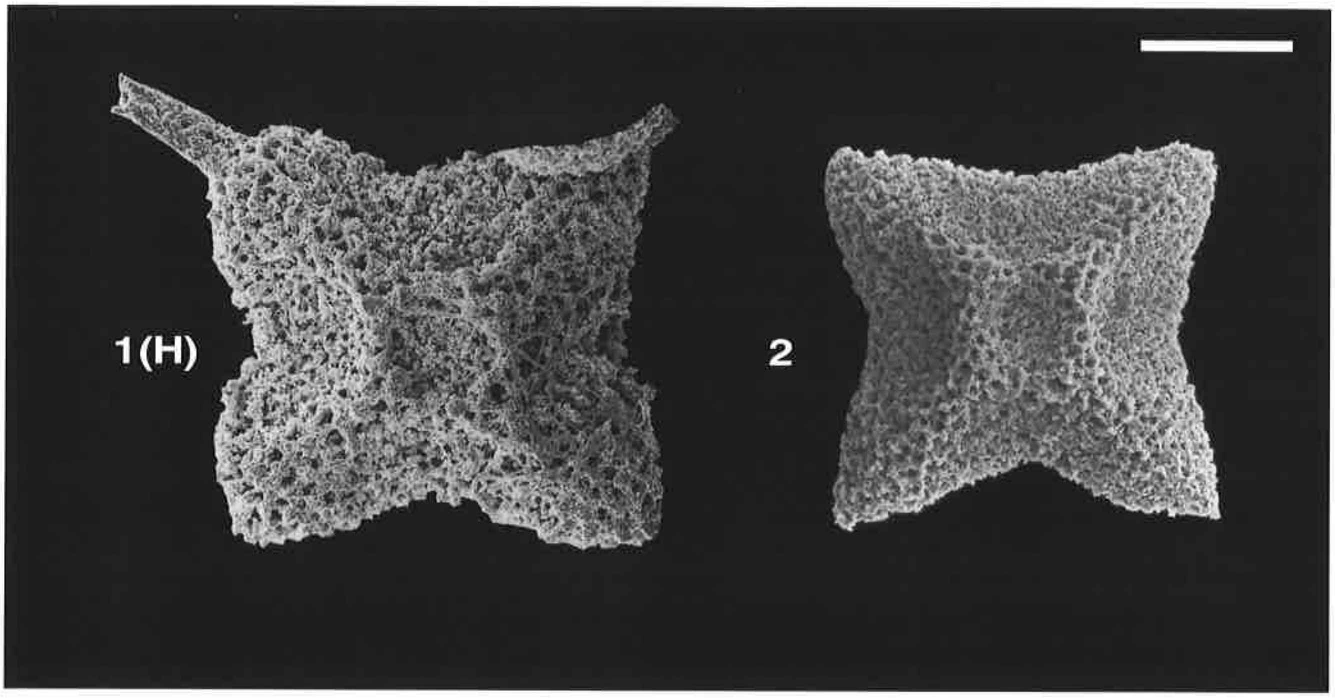


Plate 5628. *Crucella lipmanae* JUD. Magnification x200. **Fig. 1(H).** RJ53, Ru146.5. **Fig. 2.** RJ45, Bo617.0.

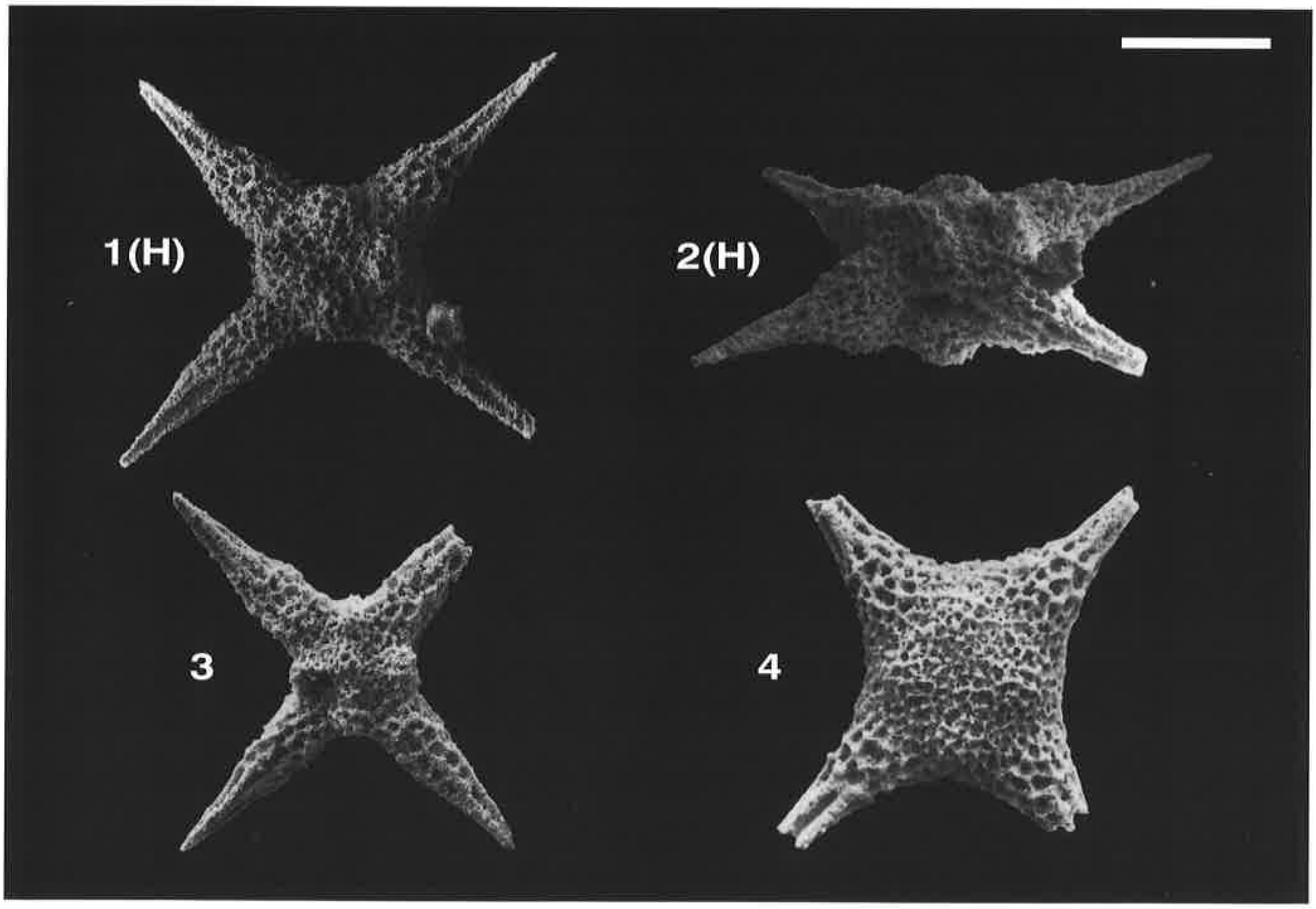


Plate 5143. *Crucella remanei* JUD. Magnification x200. **Fig. 1(H).** RJ1603, Ru135.50. **Fig. 2(H).** RJ1604, Ru135.50. **Fig. 3.** RJ1812, Bo566.50. **Fig. 4.** RJ1163, Bo561.5.

CRUCELLA THEOKAFTENSIS 3131

Crucella theokaftensis BAUMGARTNER

Synonymy.-
Crucella theokaftensis BAUMGARTNER
BAUMGARTNER 1980, p. 308, pl. 8, figs. 19-22; pl. 12, fig. 1.
AITA 1982, pl. 3, fig. 12.
? NAGAI 1985, pl. 5, figs. 5, 5a.
AITA 1987, p. 63, pl. 1, fig. 8; pl. 8, fig. 3.
KITO 1987, pl. 1, fig. 10.

Original Definition.- Test as with genus, central area inflated subspherical on both sides raised over rays. Rays slender conical tapering into long triradiate spines. Central area with small, irregular pore frames, ray with lengthened pores becoming larger toward the base of the spines, sometimes weakly linearly arranged.

Original Remarks.- This species is related to *C. messinae* but differs in having an inflated central area with smaller pores and slenderer conical rays. The specimen from the lowest sample of the Argolis Peninsula POB 899 (pl. 8. fig. 19; pl. 12, fig. 1) differs from the topotypic material (POB 986) in having much shorter spines and a smaller test; see measurements.

Etymology.- Named for the type locality.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Length of rays AX:	140	119	97	210
Length of rays BX:	210	-	-	-
Length of rays CX:	200	-	-	-
Length of rays DX:	-	-	-	-
Width of rays at base:	70	65	50	80
L. longest spine:	150	61	50	150

Type Locality.- Locality D of Baumgartner (1980); Argolis Peninsula (Peloponennesus, Greece).

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

cruciferum >> *PARAHSUUM CRUCIFERUM* 2010

crystallinum >> *WILLIRIEDELLUM CRYSTALLINUM* 3069

cucurbiformis >> *THEOCAPSOMMA CUCURBIFORMIS* 3047

cuestaense >> *HSUUM CUESTAENSE AFF.* 3182

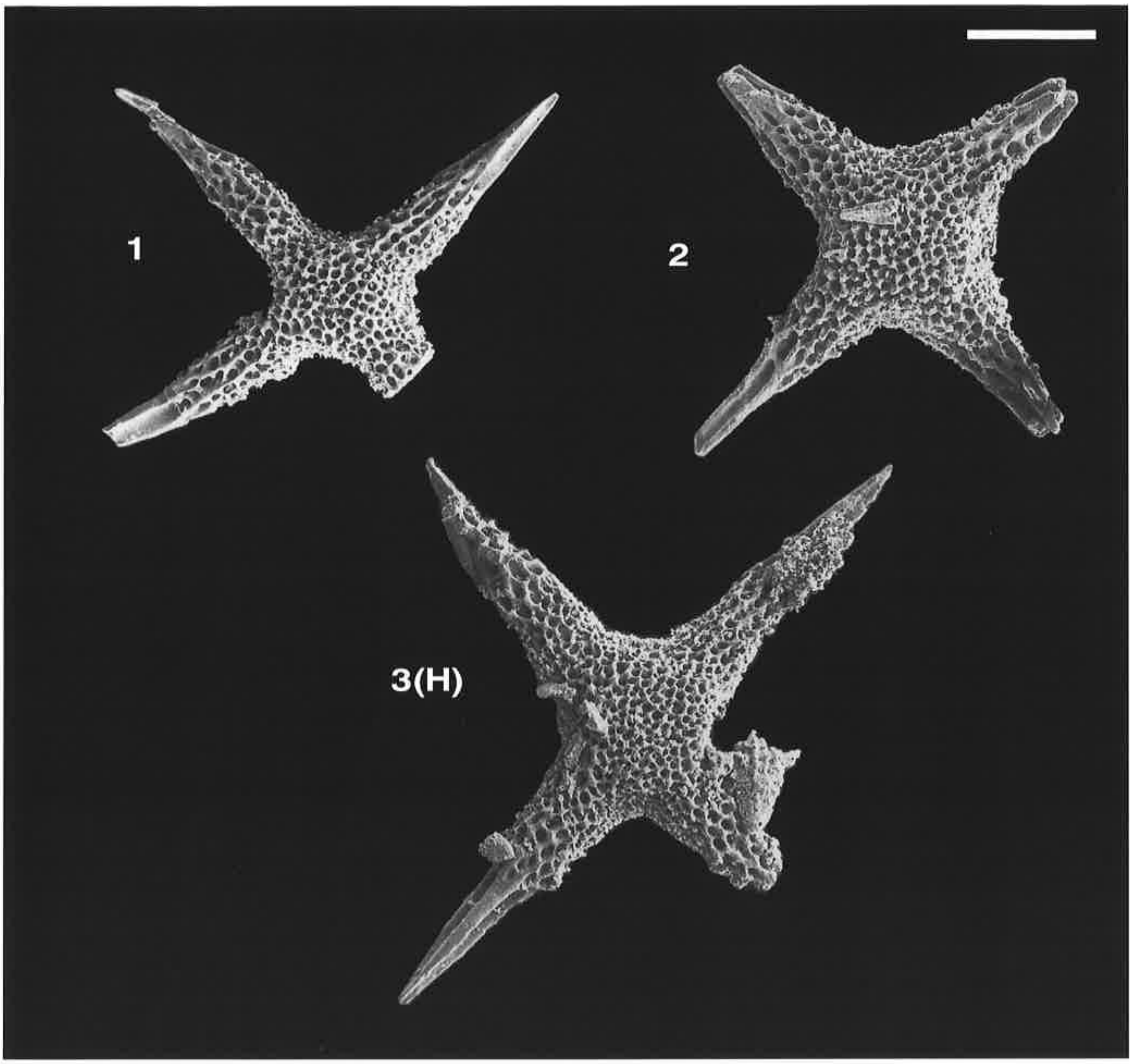


Plate 3131. ***Crucella theokaftensis*** **BAUMGARTNER.** Magnification x200. **Fig. 1.** POB78/8104, POB986.52. **Fig. 2.** POB78/8130, POB986.52. **Fig. 3(H).** POB78/8207, POB986.51.

CYCLASTRUM 6002

Genus: *Cyclastrum* RÜST

Synonymy.-
Cyclastrum RÜST
RÜST 1898, p. 28.

Type Species.- *Cyclastrum infundibuliforme* RÜST 1898.

Original Definition.- Three rays are linked at their distal ends by a band of patagium.

Included Taxa.-
5261 *Cyclastrum infundibuliforme* RÜST
5266 *Cyclastrum* (?) *luminosum* JUD
5903 *Cyclastrum* (?) *planum* JUD
5290 *Cyclastrum rarum* (SQUINABOL)
5901 *Cyclastrum* (?) *trigonum* (RÜST)

CYCLASTRUM INFUNDIBULIFORME 5261

Cyclastrum infundibuliforme RÜST

Synonymy.-
Cyclastrum infundibuliforme RÜST
RÜST 1898, p. 28, pl. 9, fig. 5.
HOLZER 1980, pl. 2, fig. 6.
BAUMGARTNER 1992, p. 319, pl. 5, figs. 1, 6.
JUD 1994, p. 72, pl. 8, figs. 1-3.

Original Definition.- "Big, flat, circular to triangular shell, with three rays merging in the central depressed area, the distal parts of the rays forming inflated bodies. There are no pores visible on the surface of the rays, the distal parts are covered by rows of regularly disposed pores of middle size. The three distal inflated bodies are connected with each other by a ring-like patagium, which possesses on its surface densely arranged small pores".

Actualized Definition.- (JUD, 1994) Three-rayed test with distal ends connected by a thick rounded triangular patagium. Rays of equal length, very thin with fine spongy network, sometimes with slightly visible longitudinal disposition of pores. Ends of rays inflated, globular, with large meshes in either linear or irregular arrangement. Patagium filling the interradial space, forming convex outlines. Patagium thick on the external rim, where it forms a thick rounded triangular peripheral band, and thin in the interradial part, where it is often dissolved. Some specimens with patagium covering the three-rayed structure on the upper and lower surface. Spongy network of patagium on external rim coarser than in the central part.

Original Remarks.- "Not rare and variable in size".

Actualized Remarks.- (JUD, 1994) Our specimens correspond perfectly to the description and illustration of Rüst (1898). The length of rays varies between 210 and 300 μm.

Measurements (in μm).-
Diameter of the whole shell 524, diameter of the distal bodies 142, width of the external ring 118.

Type Locality.- Cava Rusconi, Cittiglio, Northern Italy.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

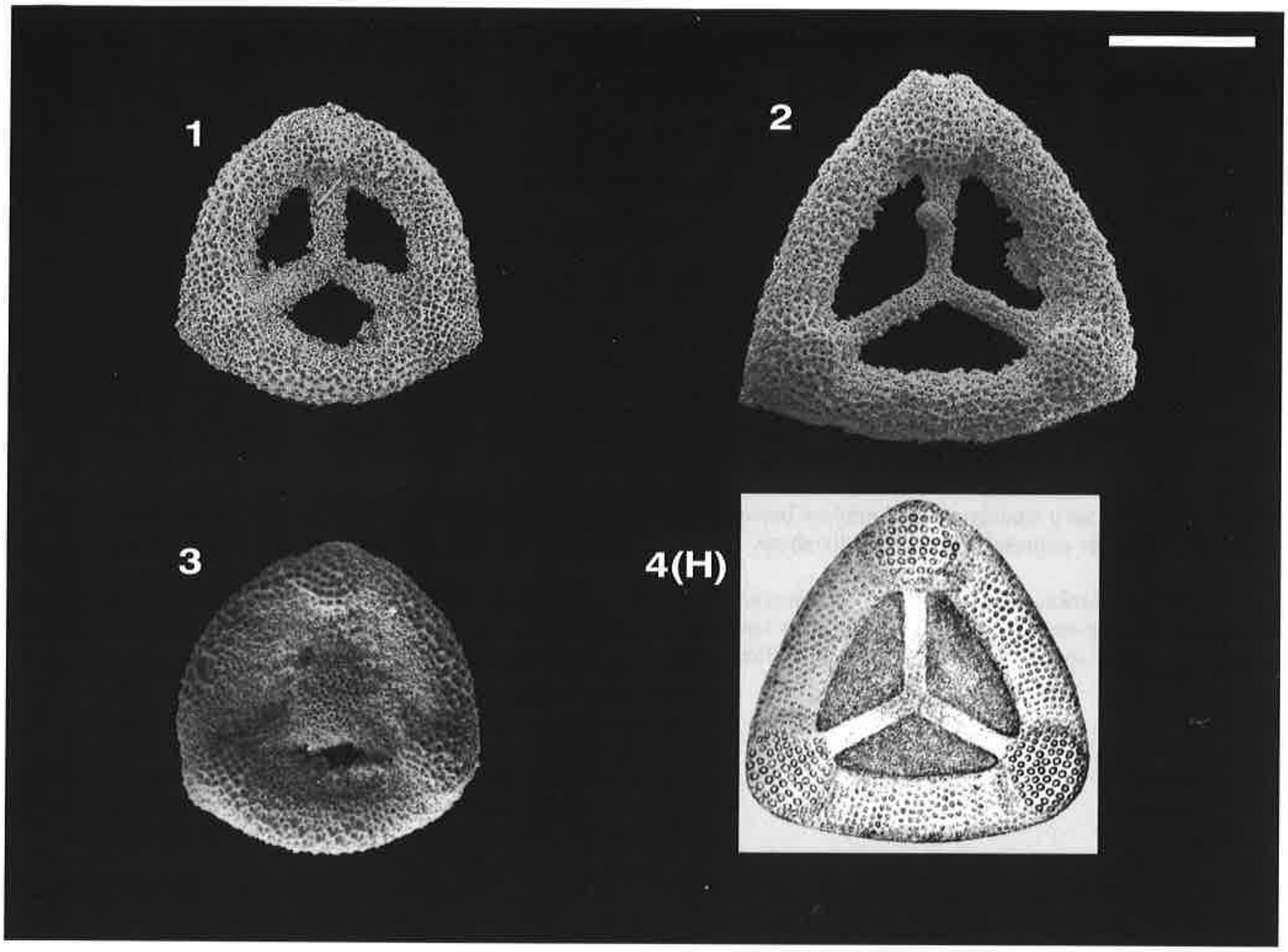


Plate 5261. ***Cyclastrum infundibuliforme*** **RÜST.** Magnification x100. **Fig. 1.** RJ397, Bo566.5. **Fig. 2.** RJ55, Ru146.5. **Fig. 3.** RJ1154, Bo561.5. **Fig. 4(H).** RÜST 1898, pl. 9, fig. 5.

CYCLASTRUM (?) LUMINOSUM — *5266*

***Cyclastrum* (?) *luminosum* JUD**

***Synonymy*.-**
Cyclastrum (?) *luminosum* JUD
JUD 1994, p. 73, pl. 8, fig. 4.

***Original Definition*.-** Spongy, triangular to subtriangular test with one slender, bladed, pointed spine on each corner representing the termination of the three arms, which are completely covered by patagium. Spongy meshwork of patagium thick and coarser, with larger meshes on the external border which is narrow and vertical. Patagium in the inner part of test thin, forming a wide depression on each face. The three arms are only exceptionally and very weakly seen. Boundary between the outer border and the depression not distinctly sharp.

***Original Remarks*.-** *Cyclastrum* (?) *luminosum* n.sp. differs from all the species of the genus thus far known by lacking a visible three-rayed structure. It differs from *Cyclastrum infundibuliforme* RÜST and *Cyclastrum rarum* SQUINABOL by lacking the bulbous thickenings on the corners, by possessing spines on the corners of the triangular test, and from *Cyclastrum* (?) *planum* n.sp. by its straight or only slightly convex periphery.

***Etymology*.-** From the Latin *luminosus*, luminous.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Radius excl. spines:	127	141	127	158
Length spines:	67	69	56	92
Thickness of test:	65	-	-	-

***Type Locality*.-** Breggia-Gorge, Ticino, Switzerland.

***UAZones*.-** 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

CYCLASTRUM (?) PLANUM — *5903*

***Cyclastrum* (?) *planum* JUD**

***Synonymy*.-**
Cyclastrum sp. B
HOLZER 1980, pl. 2, fig. 5 only
Cyclastrum (?) *planum* JUD
JUD 1994, p. 73, pl. 8, figs. 5-8.

***Original Definition*.-** Three-rayed test with a subtriangular to circular patagium. Rays elliptical in cross-section, composed of numerous (8-10) longitudinal beams connected by transverse bars forming longitudinal rows of square to subcircular pores. Ray tips with three, bladed and pointed spines, a strong, central main spine and two lateral shorter spines protruding the periphery of the test. Patagium devided into two parts by a sharp ridge, an external narrower and an internal wider part. External part is thinning towards periphery and is formed of coarse, irregular meshwork. Periphery is ragged and bears numerous small thorns. Surface structure of the rays is almost always expressed on this part. Internal portion of test wide and depressed, with dense, thin patagium which may cover completely the three-rayed structure.

***Original Remarks*.-** *Cyclastrum* (?) *planum* n.sp. differs clearly from *Cyclastrum infundibuliforme* RÜST and *Cyclastrum rarum* (SQUINABOL) by the structure of the rays which consist of longitudinal beams connected by transverse bars forming longitudinal rows of square to subcircular pores. This suggests that this species should be assigned to another genus. *Cyclastrum* (?) *planum* n.sp. is very close to *Cyclastrum decorum* PETERCAKOVA by the structure and morphology of the three rays. It differs clearly from the latter by the presence of the sharp ridge dividing the patagium into an internal and an external part.

***Etymology*.-** From the Latin *planus*, flat.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Length of rays:	273	204	180	273

***Type Locality*.-** Fiume Bosso, Umbria-Marche, Italy.

***UAZones*.-** 19-22, early Haut. to late Barr.-early Apt.

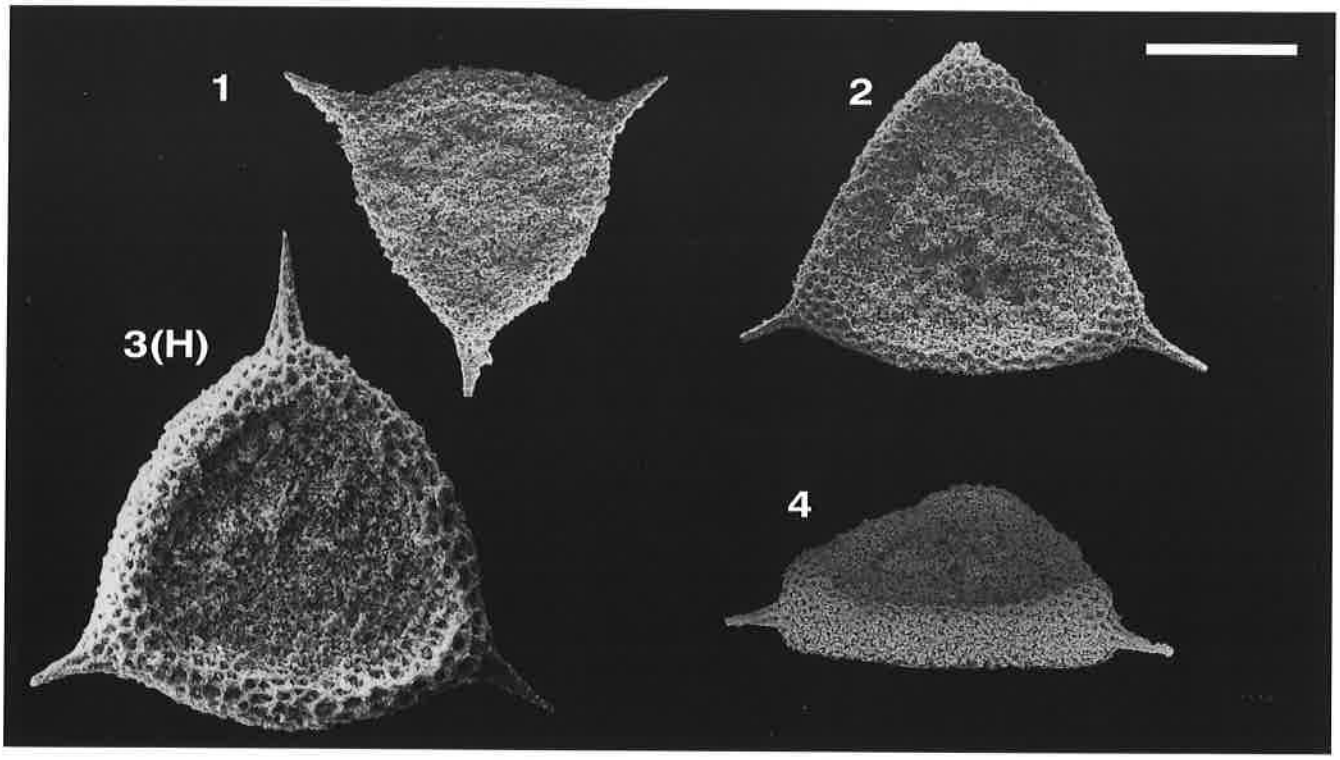


Plate 5266. ***Cyclastrum* (?) *luminosum* JUD.** Magnification x150. **Fig. 1.** RJ2, Br141.55. **Fig. 2.** RJ3, Br141.55. **Fig. 3(H).** RJ3685, Bo581.65. **Fig. 4.** RJ4, Br141.55.

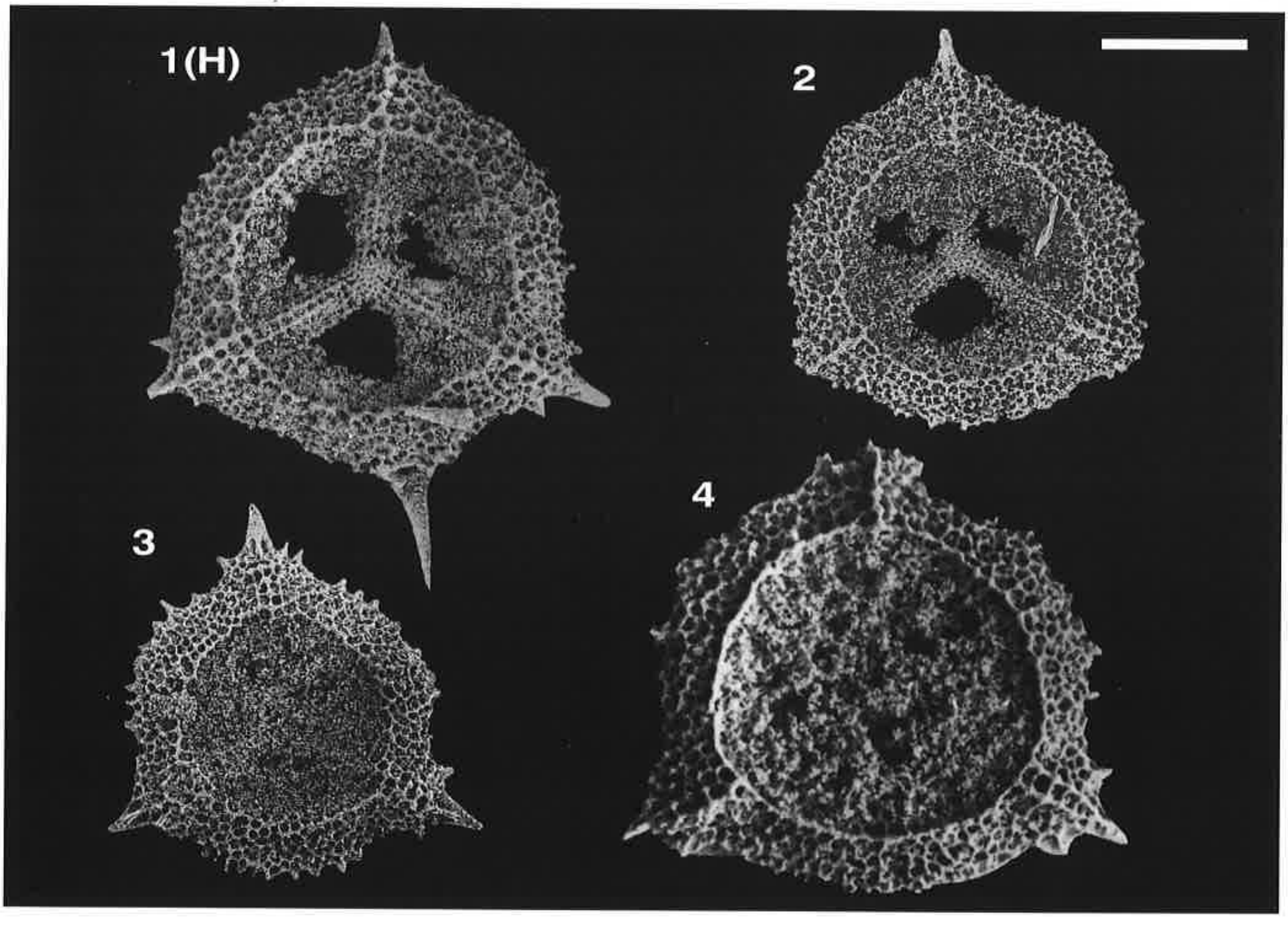


Plate 5903. ***Cyclastrum* (?) *planum* JUD.** Magnification x150. **Fig. 1(H).** RJ381, Bo566.5. **Fig. 2.** RJ389, Bo566.5. **Fig. 3.** RJ418, Bo566.5. **Fig. 4.** RJ1153, Bo561.50.

CYCLASTRUM RARUM 5290

Cyclastrum rarum (SQUINABOL)

***Synonymy*.-**
Dictyocoryne rara SQUINABOL
SQUINABOL 1914, p. 279, pl. 2, fig. 8.
Cyclastrum rarum (SQUINABOL)
JUD 1994, p. 74, pl. 8, fig. 9.

***Original Definition*.-** "Spongy shell with three, because of fossilization reasons, rather badly preserved rays, which are gradually thickening from the central area towards the external part, where they are connected by a spongeous patagium, which starts at the extremity of the rays. Towards the central area the patagium is missing, leaving between the three rays open spaces of triangular shape."

***Actualized Definition*.-** (JUD, 1994) Three-rayed test with distal ends connected by a thick patagium. Rays thin, more or less circular in cross-section, equal in length, with numerous longitudinal beams connected by transverse bars forming longitudinal rows of pores. Ends of rays bulbous in the zone of the thick patagium, with short, blunt, spongy extensions outside it. Bulbous part of rays with large pores disposed in irregular or linear patterns. Patagium is thick on the external rim, and thin in the internal part, where it is filling the interradial space completely and where often it is not preserved. Spongy network of outer rim somewhat coarser than inside the rim.

***Actualized Remarks*.-** (JUD, 1994) *Cyclastrum rarum* (SQUINABOL) differs from *Cyclastrum infundibuliforme* RÜST by possessing rays with blunt extensions. A single intermediate form with only very short extensions suggests that *Cyclastrum rarum* and *Cyclastrum infundibuliforme* are closely related forms. The visible structure of the rays reminds of the genus *Patulibracchium* PESSAGNO. Our specimens have an average length of rays of 280 μm (min. 234, max. 327) and of tip-tip distance of 498 μm (min. 408, max. 600), which are considerably larger values than those indicated by Squinabol.

Measurements (in μm).-
Length of rays (open part) 86, maximal length of one side of the shell with patagium 390, minimal length 246, width of the rays 21-37, width of the patagium-ring 30-60.

***Type Locality*.-** Colli Euganei, southern Venetian Alps, central Italy.

***UAZones*.-** 15-21, late Berr.-earliest Val. to early Barr.

CYCLASTRUM (?) TRIGONUM 5901

Cyclastrum (?) *trigonum* (RÜST)

***Synonymy*.-**
Spongotripus pauper RÜST
? PARONA 1890, p. 11, pl. 4, fig. 8.
Spongotripus trigonus RÜST
RÜST 1898, p. 34, pl. 11, fig. 13.
Cyclastrum sp. A
HOLZER 1980, pl. 2, fig. 4.
Paronaella sp. A
MIZUTANI et al. 1982, p. 61, pl. 6, fig. 2.
Cyclastrum (?) *trigonum* (RÜST)
JUD 1994, p. 74, pl. 8, figs. 10-11.

***Original Definition*.-** "Large, subcircular, triangular test with rather loose, spongy meshwork, with three, slender pointed spines on the three corners, which continue into the internal part of the test."

***Actualized Definition*.-** (JUD, 1994) Three-rayed test with interradial patagium, forming an equilateral triangle. On well preserved specimens the three-rayed initial skeleton shows several beams with transverse bars, forming longitudinal rows of pores. Tips of rays inflated, with larger pores in longitudinal arrangement, terminating with a very slender, bladed spine. Interradial space filled with a flat, compact patagium.

***Actualized Remarks*.-** (JUD, 1994) By the structure of the three-rayed initial skeleton *Cyclastrum trigonum* (RÜST) indicates a close relationship to *Cyclastrum* (?) *planum*, JUD from which it differs by its more triangular shape, by lacking the large rim of coarse irregular meshwork and by the rays having only a very thin main spine and no short secondary spines. Our specimens have a length of rays including the spine of 196-289 μm. The spines measure 44-68 μm and the sides of the test have a length of 252-389 μm. Our specimens differ therefore from those described by Rüst in having a larger size of test but much shorter terminal spines on the rays.

Measurements (in μm).-
Length of side of test 260, length of spines 85.

***Type Locality*.-** Cava Rusconi, Cittiglio, Northern Italy.

***UAZones*.-** 16-21, early Val. to early Barr.

cylindra >> CINGULOTURRIS CYNLINDRA 6101

cylindricus >> ARES CYLINDRICUS CYLINDRICUS 3001

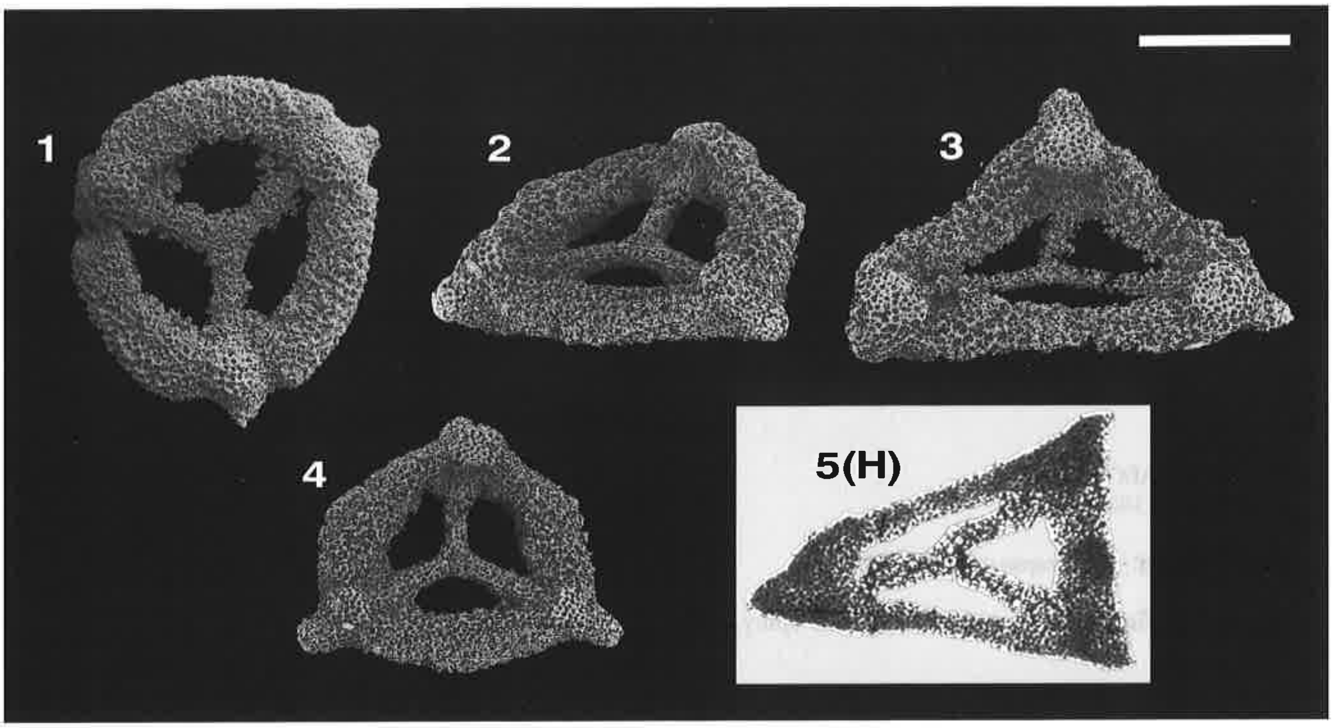


Plate 5290. *Cyclastrum rarum* (SQUINABOL). Magnification x100. **Fig. 1.** RJ209, Pr225.3. **Fig. 2.** RJ107, Bo449.5. **Fig. 3.** RJ106, Bo449.5, x160. **Fig. 4.** RJ108, Bo449.5. **Fig. 5(H).** SQUINABOL 1914, pl. 2, fig. 8.

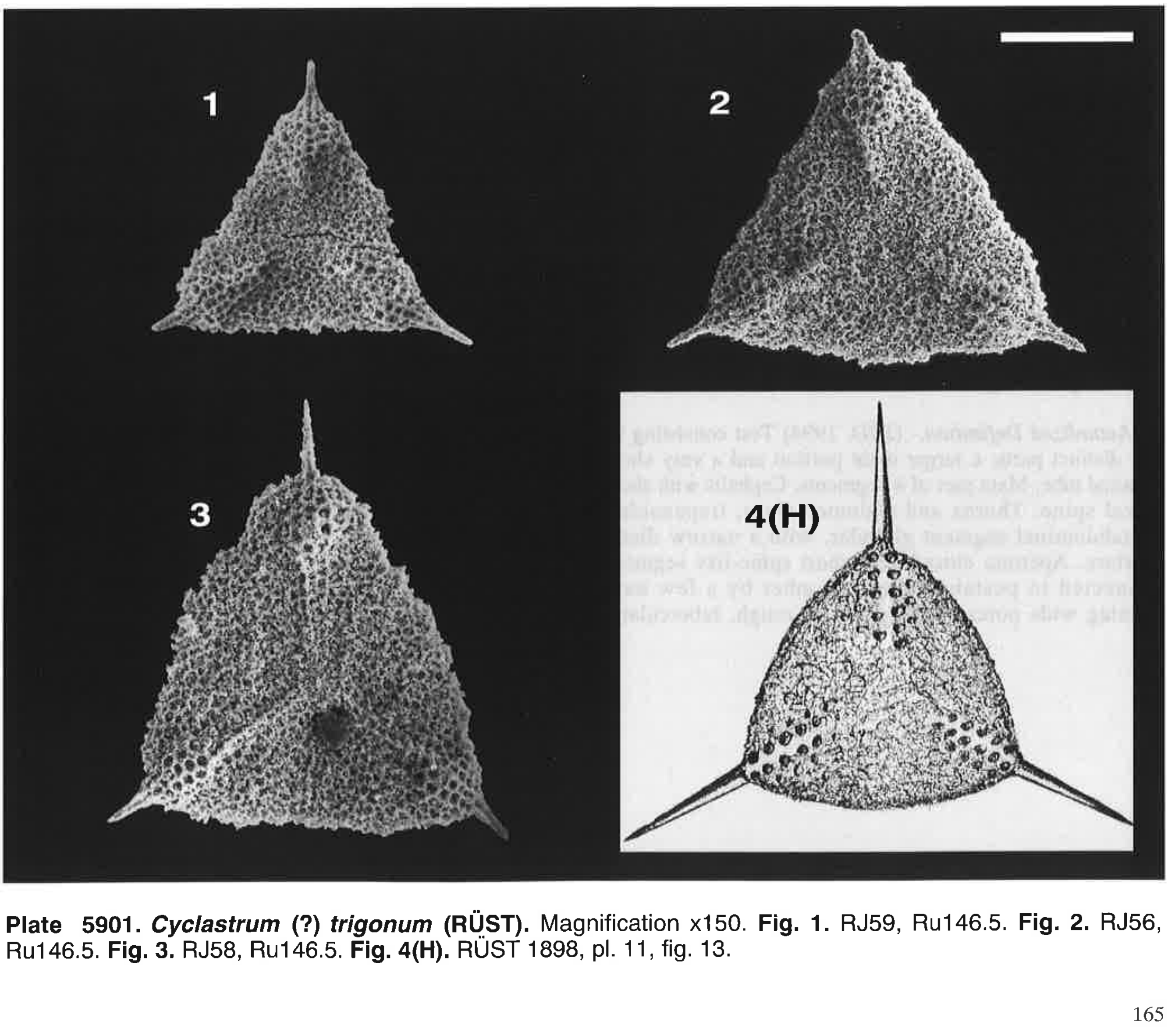


Plate 5901. *Cyclastrum* (?) *trigonum* (RÜST). Magnification x150. **Fig. 1.** RJ59, Ru146.5. **Fig. 2.** RJ56, Ru146.5. **Fig. 3.** RJ58, Ru146.5. **Fig. 4(H).** RÜST 1898, pl. 11, fig. 13.

cylindricus >> *ARES CYLINDRICUS FLEXUOSUS* 4032

cylindricus >> *ARES CYLINDRICUS S.L.* 4061

CYRTOCAPSA 3622

Genus: *Cyrtocapsa* HAECKEL

Synonymy.-
Cyrtocapsa HAECKEL
HAECKEL 1881, p. 439.

Type Species.- *Cyrtocapsa ovalis* RÜST 1885.

Original Definition.- Acute (with cephalis spiny, not smooth).

Original Remarks.- "Stichocapsida (vel Stichocyrtida eradiata clausa) with an apical horn on the cephalis, without basal terminal spine."

Remarks.- Species have been differentiated on overall test shape and on the character of the test surface.

Etymology.- Greek. *Cyrtocapsa* = Basket capsule.

Included Taxa.-
5506 *Cyrtocapsa* (?) *grutterinki* TAN
3050 *Cyrtocapsa* (?) *kisoensis* YAO
3307 *Cyrtocapsa mastoidea* YAO

CYRTOCAPSA (?) GRUTTERINKI 5506

Cyrtocapsa (?) *grutterinki* TAN

Synonymy.-
Cyrtocapsa grutterinki TAN
TAN 1927, p. 65, pl. 13, fig. 111.
Cyrtocapsa grutterinki TAN
JUD 1994, p. 74, pl. 8, fig. 12; pl. 9, fig. 1.

Original Definition.- "This species is apparently in an adult stage. The pylome is overgrown by a hyaline cap, possessing a few big pores opening into a space wherein the pylome terminates. Such a cap is seen on *Hemicryptocapsa capita,* pl. 9, fig. 67 and on *Artocapsa bicornis,* pl. 16, fig. 142."

Actualized Definition.- (JUD, 1994) Test consisting of two distinct parts: a larger main portion and a very short terminal tube. Main part of 4 segments. Cephalis with short apical spine. Thorax and abdomen short, trapezoidal. Postabdominal segment globular, with a narrow distal aperture. Aperture closed by a short spine-like segment connected to postabdominal chamber by a few bars forming wide pores. Surface of test rough, tuberculate, some tubercles bearing spines. Pores circular, dense, arranged in a more or less quincuncial pattern.

Original Remarks.- "If we strictly follow the systematics of Haeckel, this specimen must be named *Artocapsa grutterinki.*"

Actualized Remarks.- (JUD, 1994) No specimens were found without terminal conical segment. The knowledge of the inner structure of our specimens are based on investigations of P. Dumitrica , on samples of Romania where specimens with the terminal part of test bröcken off were also found.

Measurements (in μm).-
Length 314, max. width 184, length of apical horn 26, length of pylom cap with horn 86, max. thickness of wall 22.

Type Locality.- Rotti Island, Moluccas Archipielago, East Indian Ocean.

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

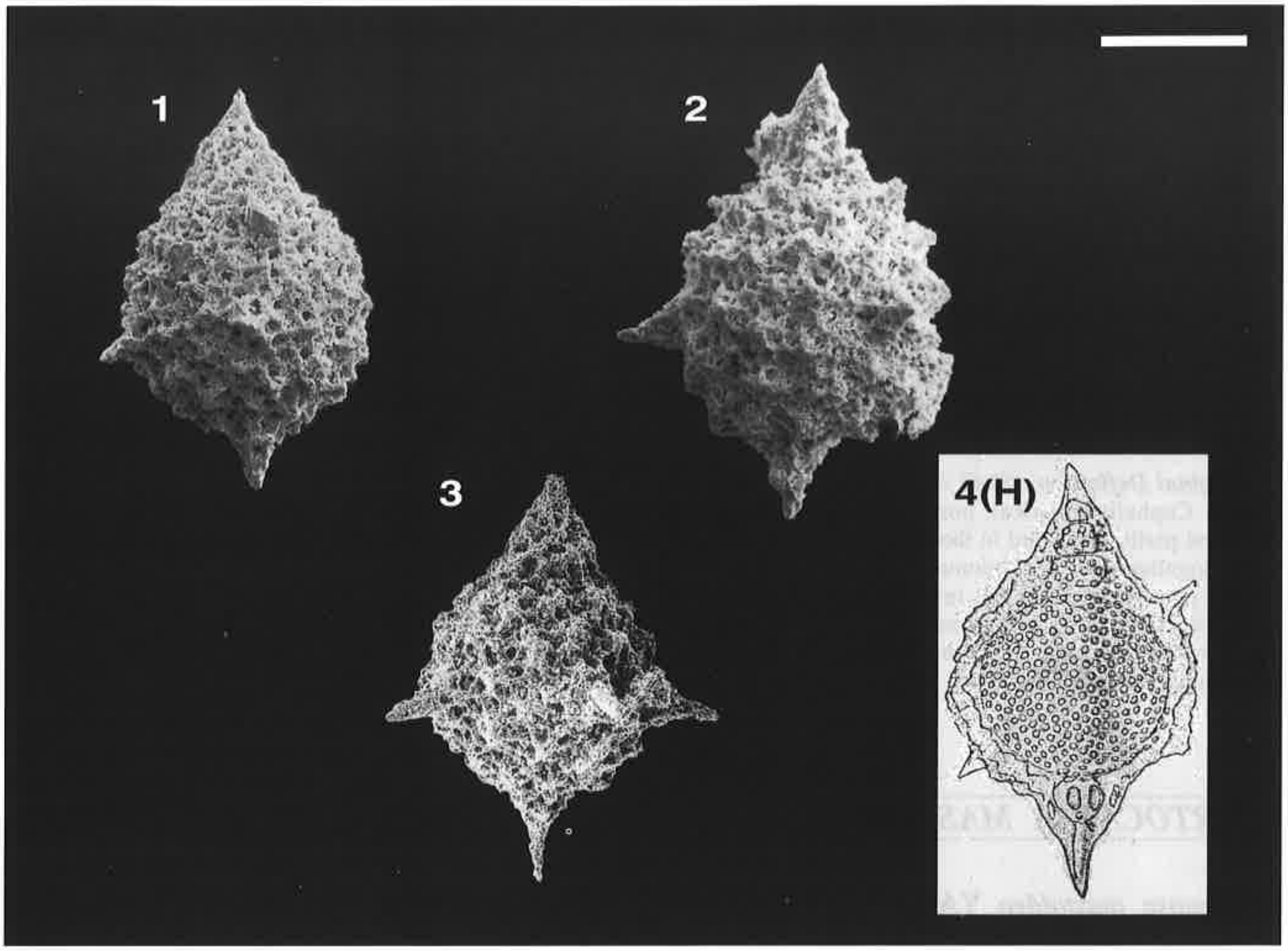


Plate 5506. *Cyrtocapsa* (?) *grutterinki* TAN. Magnification x200. **Fig. 1.** RJ88, Bo311.20. **Fig. 2.** RJ25, Pi 10.0. **Fig. 3.** RJ296, Bo370.10. **Fig. 4(H).** TAN 1927, pl. 13, fig. 111.

CYRTOCAPSA (?) KISOENSIS 3050

Cyrtocapsa (?) *kisoensis* YAO

***Synonymy*.-**
Cyrtocapsa (?) *kisoensis* YAO
YAO 1979, p. 37-39, pl. 8, figs. 9-16.
YAO et al. 1982, pl. 3, fig. 13.
MATSUOKA 1982a, pl. 1, figs. 4, 20.
MATSUOKA 1983a, p. 24, pl. 9, fig. 9.
BAUMGARTNER 1985, fig. 37.h-i.
MATSUOKA & YAO 1986, pl. 1, fig. 9.
TAKEMURA 1986, p. 55, pl. 7, figs. 11-13.
HATTORI 1988a, pl. 9, fig. H.

***Original Definition*.-** Shell of four segments, spindle-shaped. Cephalis spherical, poreless with a thick apical horn, and partly depressed in thoracic cavity. Cephalis and thorax together conical. Abdomen cylindrical, extended at median part. Fourth segment inverted conical as large as thorax or a little larger with a terminal constricted aperture. Pores small, circular, arranged irregularly. Strictures between segments indistinct.

***Original Remarks*.-** This species is similar to *Lithocampe cryptocephala* DUMITRICA 1970, but differs from it in having a thick apical horn.

***Remarks*.-** Generic assignment is questionable.

***Etymology*.-** This species is named after the Kiso mountains, northeast of the Inuyama area, central Japan.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Height of test	170	160	118	193
Width of test:	65	63	54	73

***Type Locality*.-** Sample IN-11, Inuyama area, Gifu Prefecture, central Japan.

***UAZones*.-** 3-4, early-mid Baj. to late Baj.

CYRTOCAPSA MASTOIDEA 3307

Cyrtocapsa mastoidea YAO

***Synonymy*.-**
"Cyrtocapsa" sp.
ICHIKAWA & YAO 1973, pl. 4, figs. 1-3.
Cyrtocapsa mastoidea YAO
YAO 1979, p. 36, pl. 8, figs. 1-8.
KIDO et al. 1982, pl. 4, fig. 7.
MATSUOKA 1982a, pl. 1, fig. 7.
MIZUTANI & KOIKE 1982, pl. 1, fig. 9.
WAKITA 1982, pl. 3, fig. 9.
YAO et al. 1982, pl. 3, fig. 14.
MATSUOKA 1983a, p. 24, pl. 9, fig. 8.
MIZUTANI et al. 1984, pl. 1, fig. 10.
MATSUOKA & YAO 1986, pl. 1, fig. 10.
SATO et al. 1986, fig. 17.13.
YOKOTA & SANO 1986, pl. 1, fig. 8.
GORICAN 1987, p. 182, pl. 2, fig. 3.
HATTORI 1987, pl. 13, fig. 13.
YAO 1991, pl. 3, fig. 4.
Yaocapsa macroporata KOZUR
KOZUR 1984, p. 57, pl. 7, fig. 4.
GRILL & KOZUR 1986, pl. 2, fig. 6.
Yaocapsa mastoidea (YAO)
KOZUR 1991, pl. 2, fig. 3.

***Original Definition*.-** Shell of five segments. Cephalis spherical, porelesss with a short apical horn. Internally, a branched vertical spine (as in Foreman, 1966, figs. 4-6) present. Thorax and abdomen together truncate-conical without stricture externally. Fourth segment truncate-subspherical with basal thickened-wall, and a constricted aperture or a central opening. Second to fourth segments with pores and smooth surface. Pores small, circular, arranged regularly and partly irregularly. Fifth segment small, cylindrical proximally and medianly, and hemispherical distally with a short spine in some specimens. Last segment with thin wall, and with large, circular pores.

***Original Remarks*.-** This species is characterized by the fifth segment which forms a basket-like shell and covers the aperture of fourth segment. It is doubtful that the fifth segment is an independent one.

***Remarks*.-** Forms posessing large pores are included in this species.

***Etymology*.-** This species is named from the Latin adjective *mastoideus,* meaning mastoid.

Measurements (in μm).-
Based on 12 specimens.

	HT	min.	max.	av.
Height overall:	165	145	180	160
Height of cephalis:	20	18	26	21
Height of thorax:	23	20	27	24
Height of abdomen:	25	20	32	25
Height of fourth segment:	58	48	70	59
Height of fifth segment:	30	25	37	30
Height of apical horn:	3	1	5	3
Height of basal spine:	10	2	15	7
Maximum width of shell:	88	67	98	81

***Type Locality*.-** Sample IN-1, Inuyama area, Gifu Prefecture, central Japan.

***UAZones*.-** 3-4, early-mid Baj. to late Baj.

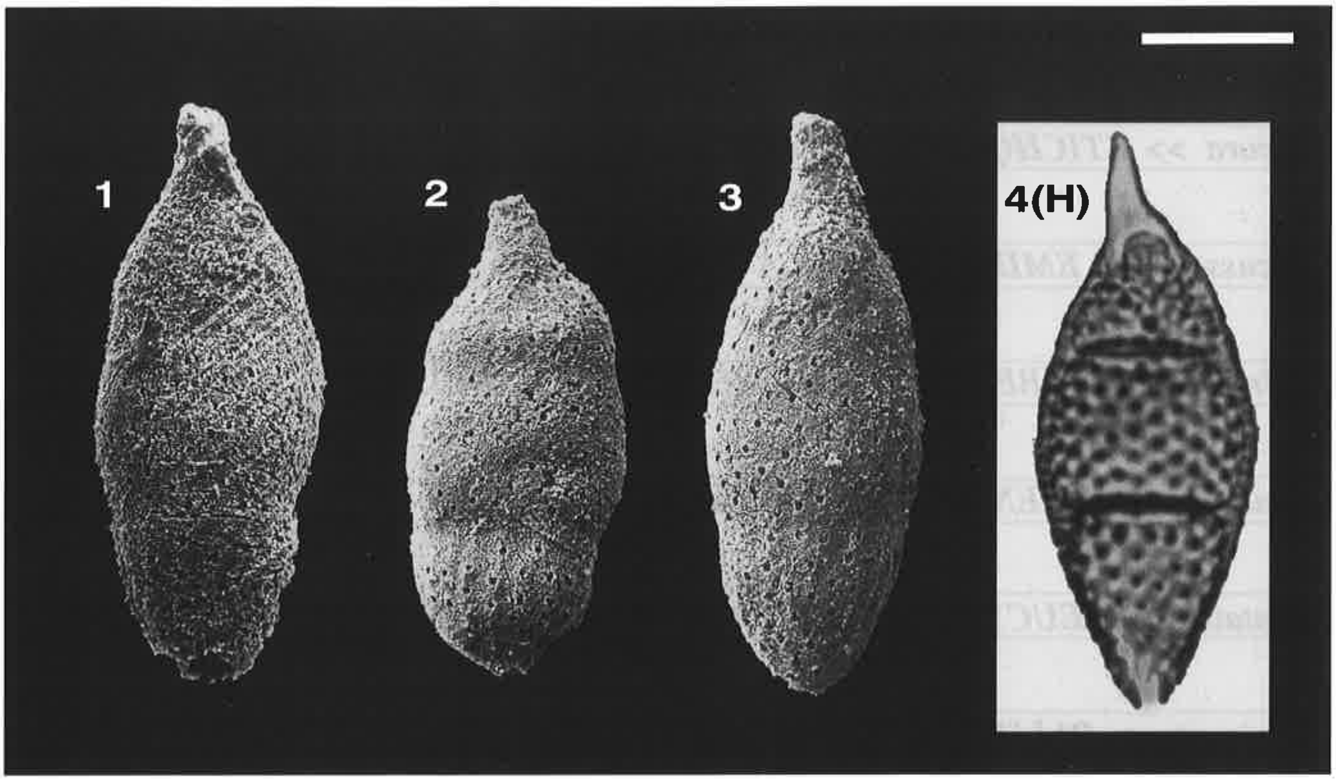


Plate 3050. ***Cyrtocapsa* (?) *kisoensis* YAO.** Magnification x500. **Fig. 1.** POB80/3955, POB1262. **Fig. 2.** POB80/2850, POB1262. **Fig. 3.** POB80/2848, POB1262. **Fig. 4(H).** YAO 1979, pl. 8, fig. 11.

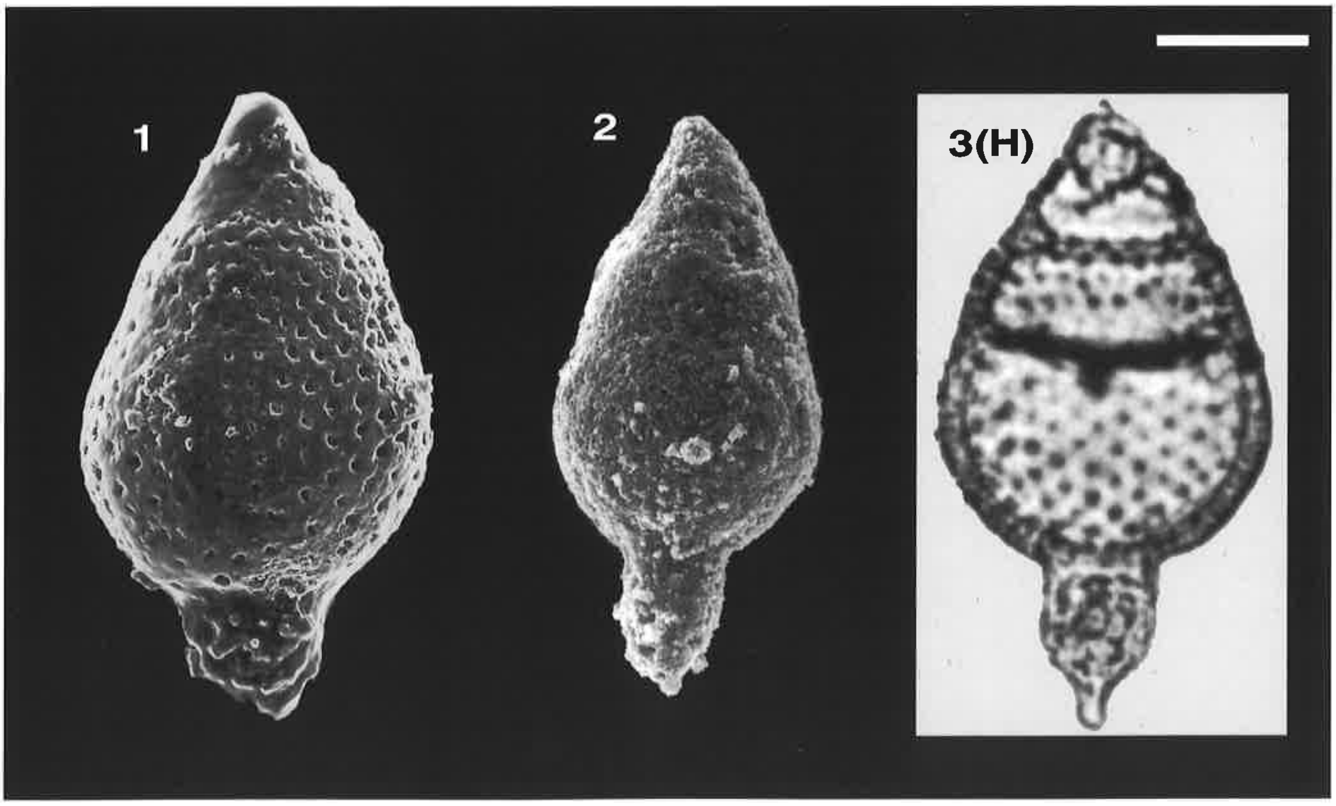


Plate 3307. ***Cyrtocapsa mastoidea* YAO.** Magnification x500. **Fig. 1.** POB82/9004, 2.18.1.79. **Fig. 2.** GO890131, ZB28. **Fig. 3(H).** YAO 1979, pl. 8, fig. 3.

daneliani >> *NOVIXITUS (?) DANELIANI* *5524*

decora >> *STICHOCAPSA DECORA* *3269*

decussata >> *EMILUVIA CHICA DECUSSATA* *5132*

delnortensis >> *BERNOULLIUS RECTISPINUS DELNORTENSIS* *3222*

dentata >> *ACAENIOTYLE DENTATA* *3281*

dentatum >> *EUCYRTIDIELLUM UNUMAENSE DENTATUM* *3015*

depressa >> *PALINANDROMEDA DEPRESSA* *3005*

depressa >> *PALINANDROMEDA DEPRESSA AFF.* *3415*

depressum >> *WRANGELLIUM DEPRESSUM* *3284*

DEVIATUS	*3634*

Genus: *Deviatus* LI

Synonymy.-
Foremanella MUZAVOR
MUZAVOR 1977, p. 67.
Deviatus LI
LI 1986, p. 312.
Noviforemanella PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 123.

Type Species.- *Paronaella* (?) *diamphidia* FOREMAN 1973.

Original Definition.- Test composed of an undeveloped primary ray and two strong rays. Outline of test horseshoe- or saddle-shaped. Spongy or polygonal pores of meshwork with nodes at vertices. Tip of rays also with nodes at vertices, and with spines arranged irregularly.

Actualized Definition.- (SANFILIPPO & RIEDEL 1985) Two arms are curved to form a horseshoe-shaped structure, and the third, straight arm meets this at an oblique or right angle. The original definition also requires that a brachiopyle is lacking, and that the entire structure is irregularly spongy, but these characters can rarely be established in imperfectly preserved specimens.

(PESSAGNO et al. 1993) Test consisting of three rays. Two rays not in same plane as third ray and assuming a horseshoe-like configuration due to asymmetrical accretion of pore frames on inner portions of ray tips. Rays with spinose tips and linear to sublinear arrangement of pore frames. Patagium not observed.

Actualized Remarks.- (MUZAVOR, 1977) "This Genus *Foremanella* differs from *Patulibracchium* and *Halesium* by lacking a bracchiopyle. *Paronaella* has three rays of about equal length and structure, placed at about equal angles."

(PESSAGNO et al., 1993) This genus differs from *Paronaella* by having two asymmetrical rays which are not situated in the same plane and assume a horse-shoe-shaped configuration.

Included Taxa.-
4073 *Deviatus diamphidius* s.l. (FOREMAN)
3112 *Deviatus diamphidius diamphidia* (FOREMAN)
3111 *Deviatus diamphidius hipposidericus* (FOREMAN)

DEVIATUS DIAMPHIDIUS S.L. 4073

Deviatus diamphidius s.l. (FOREMAN)

Synonymy.-
Paronaella (?) *diamphidia* FOREMAN
FOREMAN 1973b, p. 262, pl. 8, fig. 3-4.
FOREMAN 1975, p. 612, pl. 5, fig. 4-5.
BAUMGARTNER 1980, p. 302, pl. 4, fig. 4.
Paronaella (?) *hipposidericus* FOREMAN
FOREMAN 1975, p. 612, pl. 2E, figs. 1-2; pl. 5, figs. 3, 7, 10.
Foremanella alpina MUZAVOR
MUZAVOR 1977, 67, pl. 3, fig. 8.
Foremanella diamphidia (FOREMAN)
BAUMGARTNER 1984, p. 765, pl. 6, fig. 18.
JUD 1994, p. 77, pl. 10, figs. 7-9.
Foremanella hipposidericus (FOREMAN)
BAUMGARTNER 1984, p. 765, pl. 6, fig. 19.
see also subspecies

Included Taxa.-
3112 *Deviatus diamphidius diamphidia* (FOREMAN)
3111 *Deviatus diamphidius hipposidericus* (FOREMAN)

UAZones.- 8-22, mid Call.-early Oxf. to late Barr.-early Apt.

DEVIATUS DIAMPHIDIUS DIAMPHIDIUS 3112

Deviatus diamphidius diamphidius (FOREMAN)

Synonymy.-
Paronaella (?) *diamphidia* FOREMAN
FOREMAN 1973b, p. 262, pl. 8, figs. 3-4.
RIEDEL & SANFILIPPO 1974, pl. 12, fig. 4.
FOREMAN 1975, p. 612, pl. 5, figs. 4-5.
FOREMAN 1978, p. 744, pl. 1, figs. 5-6.
BAUMGARTNER 1980, p. 302, pl. 4, fig. 4.
SCHAAF 1981, p. 436, pl. 13, fig. 4.
Paronaella diamphidia FOREMAN
BOUYSSE et al. 1983, fig. 4. 3.
Foremanella alpina MUZAVOR
MUZAVOR 1977, p. 67, pl. 3, fig. 8.
Foremanella diamphidia (FOREMAN)
BAUMGARTNER 1984, p. 765, pl. 6, fig. 18.
MATSUOKA & YAO 1985, pl. 2, fig. 9.
SANFILIPPO & RIEDEL 1985, p. 593, figs. 5.4a-b.
AITA & OKADA 1986, p. 112, pl. 1, fig. 10.
AITA 1987, p. 63, pl. 8, fig. 11.
KITO 1987, pl. 1, fig. 5.
PAVSIC & GORICAN 1987, p. 25, pl. 3, fig. 11.
DOSTZALY 1988, pl. 1, fig. 1.
DANELIAN 1989, p. 154, pl. 5, fig. 1.
MATSUOKA 1992, pl. 2, fig. 11.
STEIGER 1992, p. 46, pl. 10, fig. 15.
Paronaella (?) sp.
YAO 1984, pl. 3, fig. 25.
Foremanella diamphidia diamphidia FOREMAN
BAUMGARTNER 1992, p. 321, pl. 7, fig. 1.

Original Definition.- The shell is basically a three armed hagiastrid with longitudinal structure, if any, completely masked by an irregular spongy meshwork (patagium ?). This is developed more particularly on two of the arms to form an approximate horseshoe shape, with the less-developed third arm extending obliquely from the apex of the horseshoe. On well-preserved specimens, short, irregularly arranged, lamellar spines are present near the ends of the three arms.

Original Remarks.- This very distinctive form differs from other species of *Paronaella* in the development of an irregular spongy meshwork on two of its arms. Forms with the third arm equal, except for the absence of the patagium and extending vertically rather than obliquely, are not included (pl. 8, fig. 5).

Etymology.- Greek *diamphidios, -e, -on = diamphidius, -a, -um* utterly different.

Measurements (in μm).-
Based on 10 specimens. Greatest distance between outer margins of two most doninant arms, 170-280; between inner margin near end of two most prominent arms, 70-150.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 8-14, mid Call.-early Oxf. to early-early late Berr.

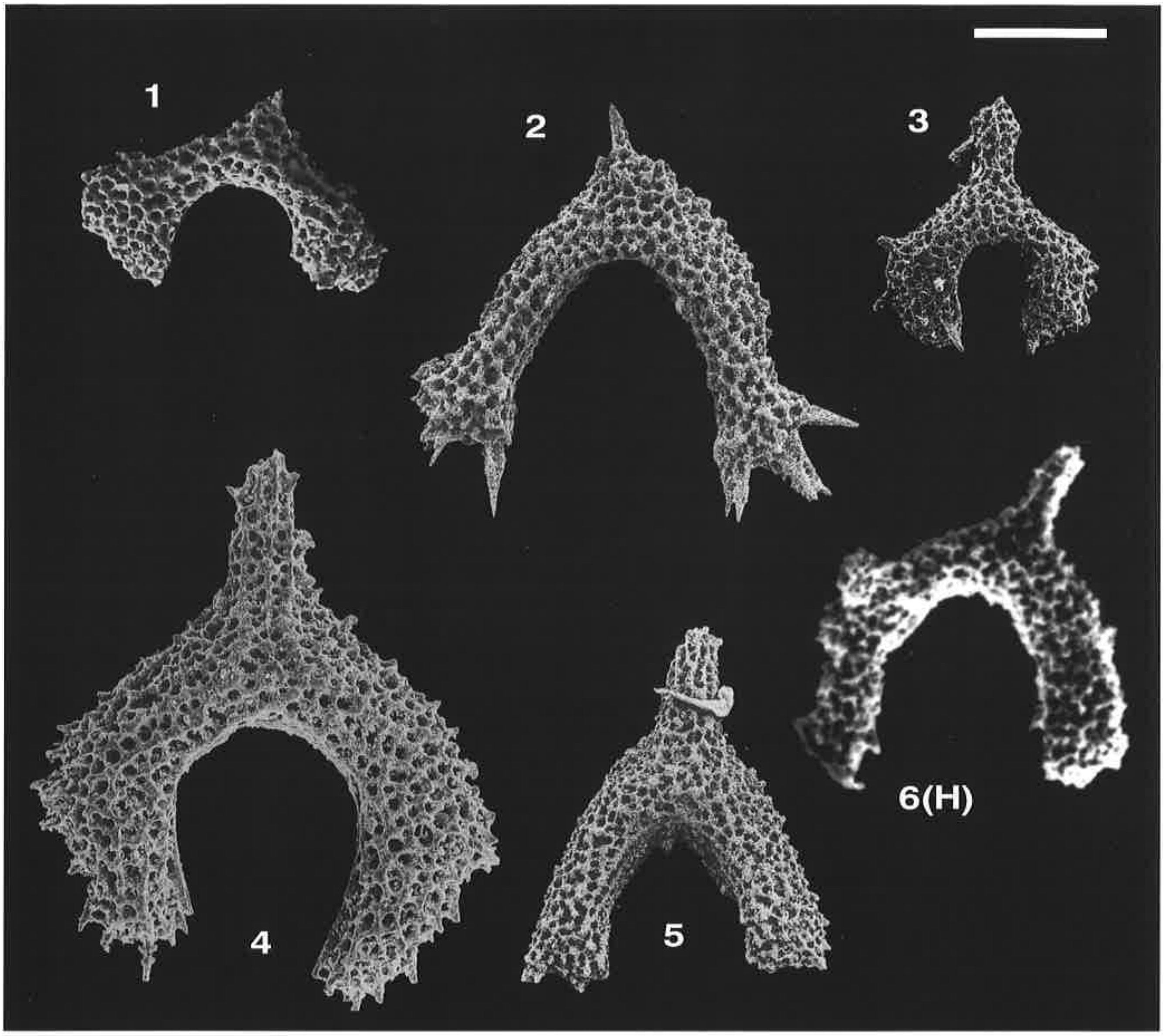


Plate 3112. ***Deviatus diamphidius diamphidius*** **(FOREMAN).** Magnification x200. **Fig. 1.** POB78/3811, POB28.67. **Fig. 2.** DU3554, MO46. **Fig. 3.** POB78/6175, POB899.52. **Fig. 4.** RJ130, Br1330. **Fig. 5.** RJ410, Bo566.5, x270. **Fig. 6(H).** FOREMAN 1973b, pl. 8, fig. 3.

DEVIATUS DIAMPHIDIUS HIPPOSIDERICUS — *3111*

Deviatus diamphidius hipposidericus (FOREMAN)

Synonymy.-
Paronaella (?) sp. aff. *P.* (?) *diamphidia* FOREMAN
FOREMAN 1973b, p. 262, pl. 8, fig. 5.
Paronaella (?) *hipposidericus* FOREMAN
FOREMAN 1975, p. 612, pl. 2E, figs. 1-2; pl. 5, figs. 3, 7, 10.
BAUMGARTNER 1980, p. 302, pl. 4, figs. 1-3.
BAUMGARTNER et al. 1980, p. 57, pl. 2, fig. 4.
Foremanella hipposidericus (FOREMAN)
BAUMGARTNER 1984, p. 765, pl. 6, fig. 19.
SANFILIPPO & RIEDEL 1985, p. 593, fig. 5.3.
AITA 1987, p. 63, pl. 12, fig. 8.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, figs. 2-3.
OZVOLDOVA 1990, pl. 1, fig. 5.
WIDZ 1991, p. 246, pl. 1, fig. 27.

Original Definition.- The shape of the shell is similar to that of *P.* (?) *diamphidia* except that the odd arm, extending from the apex of the horseshoe, generally extends vertically, and that the basic structure of all three arms shows them to be approximately equal in size, except for the addition of a spongy patagium on the margin of two of the arms. All three arms show a distinct linear structure.

Etymology.- From the Greek adjectival form of *hipposideros*, *hipposidericus*, pertaining to a horseshoe.

Measurements (in μm).-
Based on 5 specimens. Greatest distance, exclusive of spines, between outer margin of two most prominent arms, 295-325; between inner margin, near end, of two most prominent arms, 115-130.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

Range.- 9-13, mid-late Oxf. to latest Tith.

deweveri >> NAPORA DEWEVERI — *3035*

dhimenaensis >> PARVICINGULA DHIMENAENSIS S.L. — *3197*

dhimenaensis >> PARVICINGULA D. DHIMENAENSIS — *4072*

dhimenaensis >> PARVICINGULA DHIMENAENSIS | A — *4071*

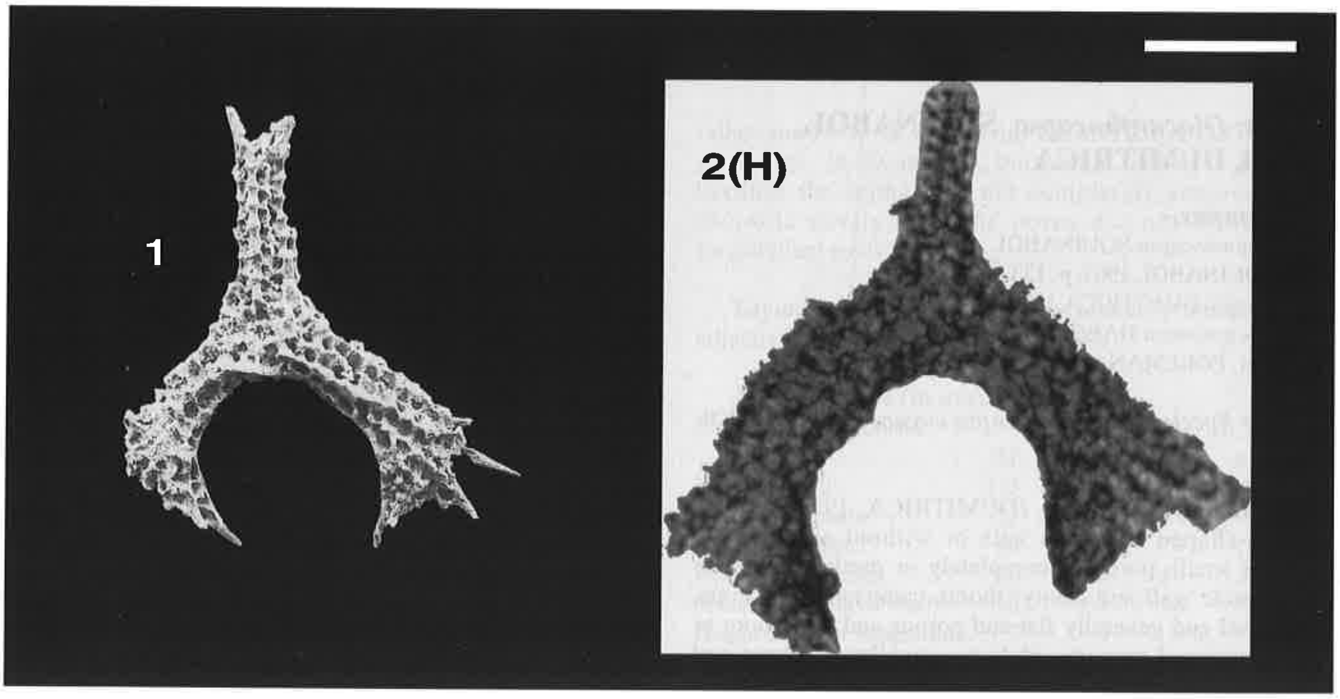


Plate 3111. ***Deviatus diamphidiatus hippodisericus*** **(FOREMAN).** Magnification x200. **Fig. 1.** POB78/8152, POB986.52. **Fig. 2(H).** FOREMAN 1975, pl. 5, fig. 7.

DIACANTHOCAPSA 3623

Genus: *Diacanthocapsa* SQUINABOL, emend. DUMITRICA

Synonymy.-
Diacanthocapsa SQUINABOL
SQUINABOL 1903, p. 133.
emend. DUMITRICA 1970, p. 61.
Theocapsomma HAECKEL
part. FOREMAN 1968, p. 29.

Type Species.- *Diacanthocapsa euganea* SQUINABOL 1903.

Actualized Definition.- (DUMITRICA, 1970) Oval or spindle-shaped tricyrtids with or without apical horn; cephalis small, poreless, completely or partly encased in the thoracic wall and cavity; thorax campanulate, porous, with basal end generally flat and porous and with more or less constricted opening; abdomen smaller or larger and usually thinner-walled than the thorax, with constricted, sometimes laterally directed aperture; with or , perhaps sometimes, without sutural pore in lumbar position.

Actualized Remarks.- (DUMITRICA, 1970) The systematic position of some species assigned to *Diacanthocapsa* yet remains a disputable matter. In Squinabol's intention the genus had to include dicyrtids with two polar spines. However, the morphological resemblance between some of the species here described and the two ones described by Squinabol (1903, 1904) proves that the members of this genus are in fact cryptocephalic tricyrtids. On the other hand, the apical horn, however long it might be, does not seem to have any generic value but a specific one. So much the less the antapical spine.

The sutural pore seems to be an element of a great value for this genus, both from the taxonomical viewpoint and for the knowledge of its phylogenetical relationships. It is surely present in all species we studied, and this fact makes us suppose its existence in Squinabol's and Foreman's species, too. The sutural pore of *Diacanthocapsa* has a lumbar position, being located to the right or to the left of the vertical spine, just as in the cryptothoracic tricyrtids.

The constricted aperture is characteristic for most species. It is either axially or laterally directed and it is possible that these two types constitute a basis for future generic or subgeneric subdivisions. The laterally directed aperture creates a considerable asymmetry of the shell. But the same asymmetry can be created by a slight or even strong curvature of the abdomen. The sense of the curvature or of the apertural opening seems not to be constant for all species. In Foreman's data they are ventral. On the contrary, our researches carried out on *D. ovoidea* and *D. umbilicata* proved that the direction of the aperture is always dorsal, namely opposite to the sutural pore. About the other characters of the thorax and abdomen see p. 610. *Diacanthocapsa* seems to be related to *Myllocercion* FOREMAN by its encased cephalis, by its thorax, the base of which is constricted and slightly encased, and by its fragile abdomen with very constricted aperture. It may be also related to Williriedellids by its sutural pore and by its sometimes slightly encased thorax. Species have been differentiated by the variations in general test shape and the relative sizes of the thoracic and abdominal segments.

Included Taxa.-
4012 *Diacanthocapsa normalis* YAO
3054 *Diacanthocapsa* (?) *operculi* YAO

DIACANTHOCAPSA NORMALIS 4012

Diacanthocapsa normalis YAO

Synonymy.-
Diacanthocapsa normalis YAO
YAO 1979, p. 28, pl. 2, figs. 1-15.
YAO et al. 1982, pl. 3, fig. 9.
MATSUOKA & YAO 1986, pl. 3, fig. 6.
not BAUMGARTNER 1984, p. 761, pl. 2, fig. 20.

Original Definition.- Shell of three segments, oval. Cephalis spherical, poreless, partly encased in thoracic cavity. Thorax hemispherical or campanulate, thick-walled relatively. Thoracic base flat with a large central opening. Abdomen hemispherical, smaller than thorax. At thorax-abdomen joint, stricture indistinct. Pores small, circular, sparsely arranged. Aperture narrow, circular, opens at end of short projection.

Original Remarks.- This species differs from *Diacanthocapsa umbilicata* DUMITRICA (1970, p. 63-64, pl. 6, figs. 30-34; pl. 7, fig. 36; pl. 20, figs. 123-124) in that the cephalis is not completely encased in the thoracic wall and cavity, that the stricture at the thorax-abdomen joint is indistinct, and that the aperture is not lateral. This species is rather similar to *D. acuminata* DUMITRICA (1970, p. 65, pl. 7, figs. 38-39 and 43), but cannot belong to the latter because the cephalis is not completely encased in the thoracic cavity, and the pores are not arranged in longitudinal rows.

Etymology.- This species is named from the Latin adjective *normalis*, meaning normal.

Measurements (in μm).-
Based on 20 specimens.

	HT	min.	max	av.
Height overall:	115	82	129	107
Height of cephalis:	23	18	28	22
Height of thorax:	60	45	70	59
Height of abdomen:	40	25	54	39
Maximum width of shell:	50	57	98	75
Height diameter of aperture:	7	4	8	6

Type Locality.- Sample IN-7, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 3-4, early-mid Baj. to late Baj.

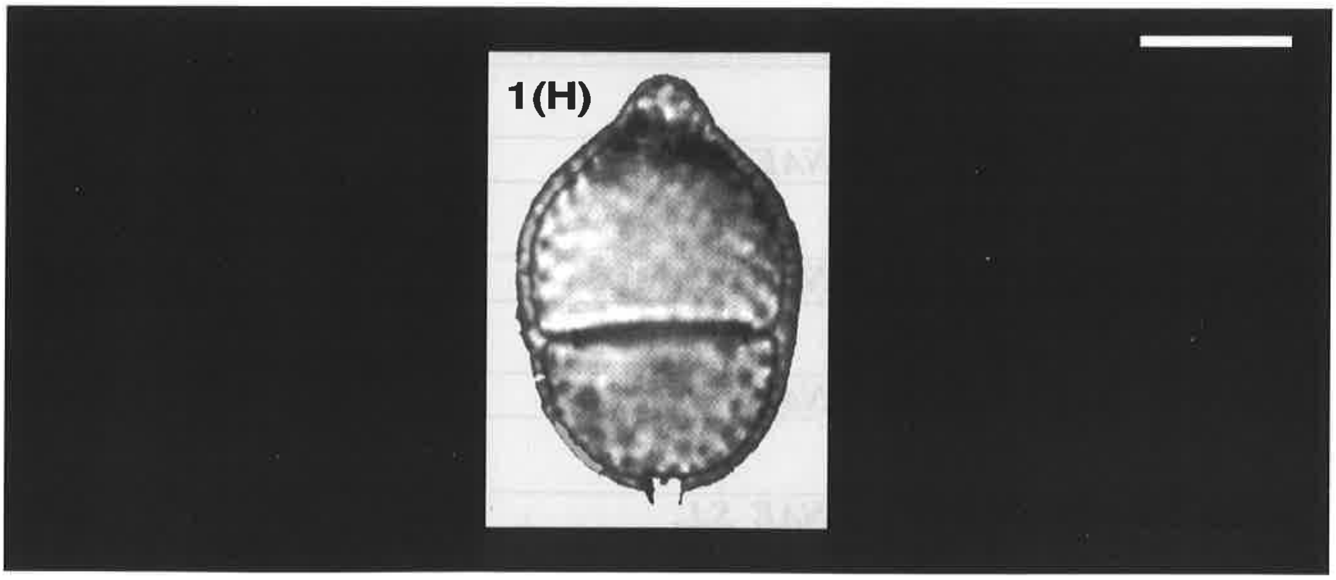


Plate 4012. *Diacanthocapsa normalis* YAO. Magnification x500. **Fig. 1(H).** YAO 1979, pl. 2, fig. 1a.

DIACANTHOCAPSA (?) OPERCULI 3054

***Diacanthocapsa* (?) *operculi* YAO**

Synonymy.-
Diacanthocapsa (?) *operculi* YAO
YAO 1979, p. 29, pl. 2, figs. 16-27.
YAO et al. 1982, pl. 3, fig. 10.
BAUMGARTNER 1985, fig. 37.g.
MATSUOKA & YAO 1986, pl. 3, fig. 7.
Diacanthocapsa normalis YAO
BAUMGARTNER 1984, p. 761, pl. 2, fig. 20.

Original Definition.- Shell of four segments, oval. Cephalis spherical, poreless, partly or completely encased in thoracic wall and cavity. Thorax and abdomen hemispherical respectively with thick wall and sparse, small, circular pores. In some specimens, a transverse ridge present on inner surface of thoracic wall. At thorax-abdomen joint, stricture indistinct. Fourth segment small, dish-like with large pores at proximal part arranged in one transverse row, and small pores in median and distal parts. Wall of fourth segment thin without aperture.

Original Remarks.- *Diacanthocapsa* (?) *operculi* n.sp. is obviously cryptocephalic species. It is not clear whether the fourth segment is regarded as a segment or an appendage of abdomen. This species, therefore, is doubtfully assigned to *Diacanthocapsa* which is a tricyrtid.

Remarks.- This species is distinguished from other species of *Diacanthocapsa* by posessing a dish-like basal appendage.

Etymology.- This species is named from the Latin noun *operculum*, meaning lid.

Measurements (in μm).-
Based on 12 specimens.

	HT	min.	max.	av.
Height overall:	98	78	111	96
Height of cephalis:	23	18	24	20
Height of thorax:	39	35	45	39
Height of abdomen:	34	26	47	36
Height of fourth segment:	15	7	20	15
Maximum width of shell:	69	50	80	69

Type Locality.- Sample IN-1, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

diamphidius >> *DEVIATUS DIAMPHIDIUS DIAMPHIDIUS* 3112

diamphidius >> *DEVIATUS DIAMPHIDIUS HIPPOSIDERICUS* 3111

diamphidius >> *DEVIATUS DIAMPHIDIUS S.L.* 4073

dianae >> *MIRIFUSUS DIANAE BAILEYI* 3406

dianae >> *MIRIFUSUS DIANAE DIANAE* 3274

dianae >> *MIRIFUSUS DIANAE MINOR* 3286

dianae >> *MIRIFUSUS DIANAE S.L.* 3161

diaphorogona >> *ACAENIOTYLE DIAPHOROGONA GR.* 3090

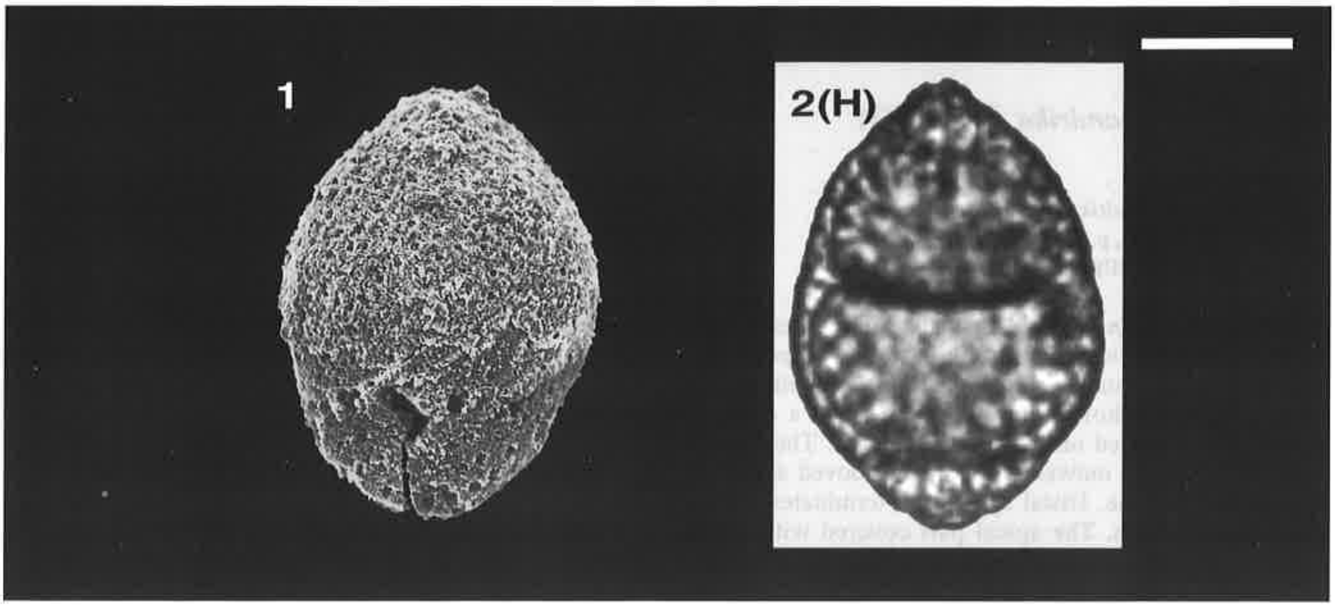


Plate 3054. *Diacanthocapsa* (?) *operculi* YAO. Magnification x600. **Fig. 1.** POB80/3961, POB1262. **Fig. 2(H).** YAO 1979, pl. 2, fig. 19.

DIBOLACHRAS 3624

Genus: *Dibolachras* FOREMAN

Synonymy.-
Dibolachras FOREMAN
FOREMAN 1973b, p. 265.

Type Species.- *Dibolachras tytthopora* FOREMAN 1973b.

Original Definition.- The shell is of three to four (?) segments, the small proximal part made up of all but the large distalmost segment which is expanded and bears only two spines and a porous terminal tube.

Original Remarks.- This genus differs from *Podobursa* in having only two spines.

Remarks.- Species can be distinguished by the length of the spines and by the shape of the lateral spines in axial section. A possibly important diagnostic feature to note is the arrangement of surface ornament on the large distalmost segment.

Etymology.- Greek. *dibolos* two-pointed + *achras* f. wild pear = *dibolachras f.* two-pointed wild pear.

Included Taxa.-
3265 *Dibolachras chandrika* KOCHER
5422 *Dibolachras tytthopora* FOREMAN

DIBOLACHRAS CHANDRIKA 3265

Dibolachras chandrika KOCHER

Synonymy.-
Dibolachras chandrika KOCHER
KOCHER 1981, p. 61, pl. 13, figs. 1-2.
BAUMGARTNER 1984, 761, pl. 2, fig. 19.

Original Definition.- "Test of four segments, last segment inflated, spherical, with a conical appendage. Cephalis small, rounded, bearing a short, smooth apical horn. Cephalis, thorax and abdomen form a conical proximal part placed on the fourth segment. The largest segment bears two outwardly directed, grooved spines in the equatorial plane. Distal appendage terminates with a small smooth horn. The apical part covered with small pores, last segment and its appendage have larger hexagonally arranged pores (pore pattern of the appendage somewhat irregular)."

Original Remarks.- "The generic assignment is probably somewhat questionable since a third lateral spine has never been observed but the angle between two existing spines is always less than 180 degrees.

This form is very similar to *Theosyringium robustum* VINASSA (1900, p. 343, pl. B, fig. 30; also in Neviani (1900) p. 662, fig. 20-21) but the latter has no lateral spines. This species differs from *Podobursa triacantha* (FISCHLI) especially by the number of lateral spines and by shorter distal apendage."

Remarks.- The forms herein included with this species are characterized by their short inflated character and by very short lateral spines on the fourth segment that may vary in number from 2 to 4.

Etymology.- Dedicated to Ma Anand Chandrika.

Measurements (in μm).-
Based on 12 specimens. Height of proximal cone: 57-83, height of fourth segment: 143-180, height of appendage: 42-92, width of fourth segment: 170-214.

Type locality.- Mte. Generoso, Switzerland.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

DIBOLACHRAS TYTTHOPORA 5422

Dibolachras tytthopora FOREMAN

Synonymy.-
Dibolachras tytthopora FOREMAN
FOREMAN 1973b, p. 265, pl. 11, fig. 4; pl. 16, fig. 15.
FOREMAN 1975, p. 617, pl. 2L, figs. 2-3; pl. 6, fig. 16.
SCHAAF 1981, p. 433, pl. 5, figs. 3a-b; pl. 26, figs. 1a-b, 4.
SCHAAF 1984, p. 147, figs. 1 a-b, 2, 3a-b.
SANFILIPPO & RIEDEL 1985, p. 609, fig. 11.4a-b.
THUROW 1988, p. 400, pl. 7, fig. 20.
JUD 1994, p. 75, pl. 9, figs. 2-4.

Original Definition.- The shell is of three or four segments, pyriform with a slender, closed, terminal tube and two very sturdy, three-bladed, outward-directed spines. Preservation and the rather dense shell wall of small irregular pores make it impossible to distinguish individual segments. The narrow proximal part is apparently composed of small cephalis bearing a moderate to fairly long, smooth or only slightly ridged, apical horn and one or two small postcephalic segments with small irregular pores, sometimes with a spongy overlay. The large subglobose abdomen has slightly larger pores, on some specimens very irregular and sometimes with a slightly spongy overlay or with surface slightly nodose. Its terminal tube has larger rounded pores and terminates in a smooth spine.

Original Remarks.- Younger forms tend to be larger with a longer horn and longer spines and the surface of the abdomen tends to be weakly nodose. This species differs from *D. apletopora* in the character of the pores, its pyriform shape, and the wings which are three-bladed throughout their length.

Etymology.- Greek *tytthos* small + *poros* n. pore = *tytthoporus, -a, um,* small pored.

Measurements (in μm).-
Based on 15 specimens. Length overall (estimated), 295-450; length exclusive of tube, 185-260 (majority 200-230), of wings, 50-125; width of abdomen, 85-190 (majority 125-160).

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

dicera >> BERNOULLIUS DICERA 3223

dickinsoni >> ZARTUS DICKINSONI GR. 3041

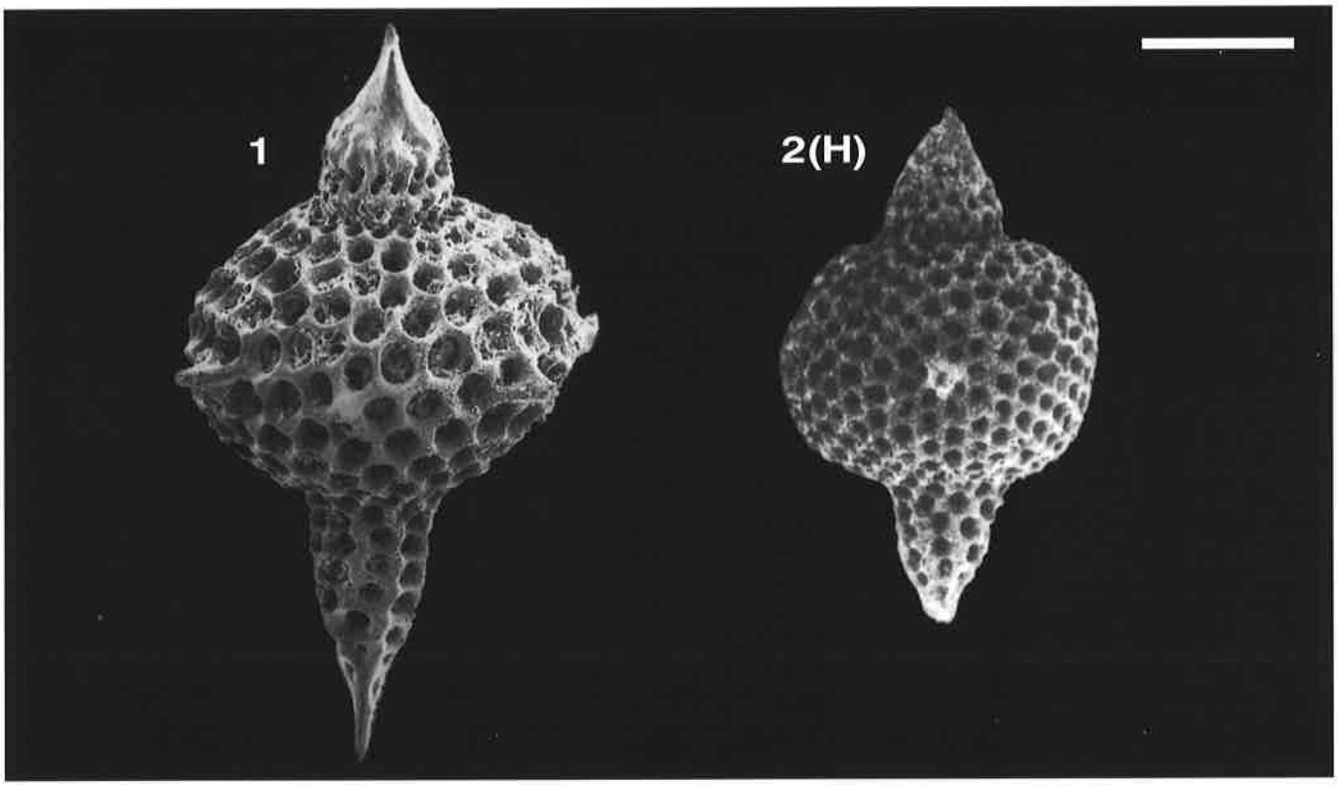


Plate 3265. *Dibolachras chandrika* KOCHER. Magnification x200. **Fig. 1.** POB81/9039, 534A.106.1.29. **Fig. 2(H).** KOCHER 1981, pl. 13, fig. 2.

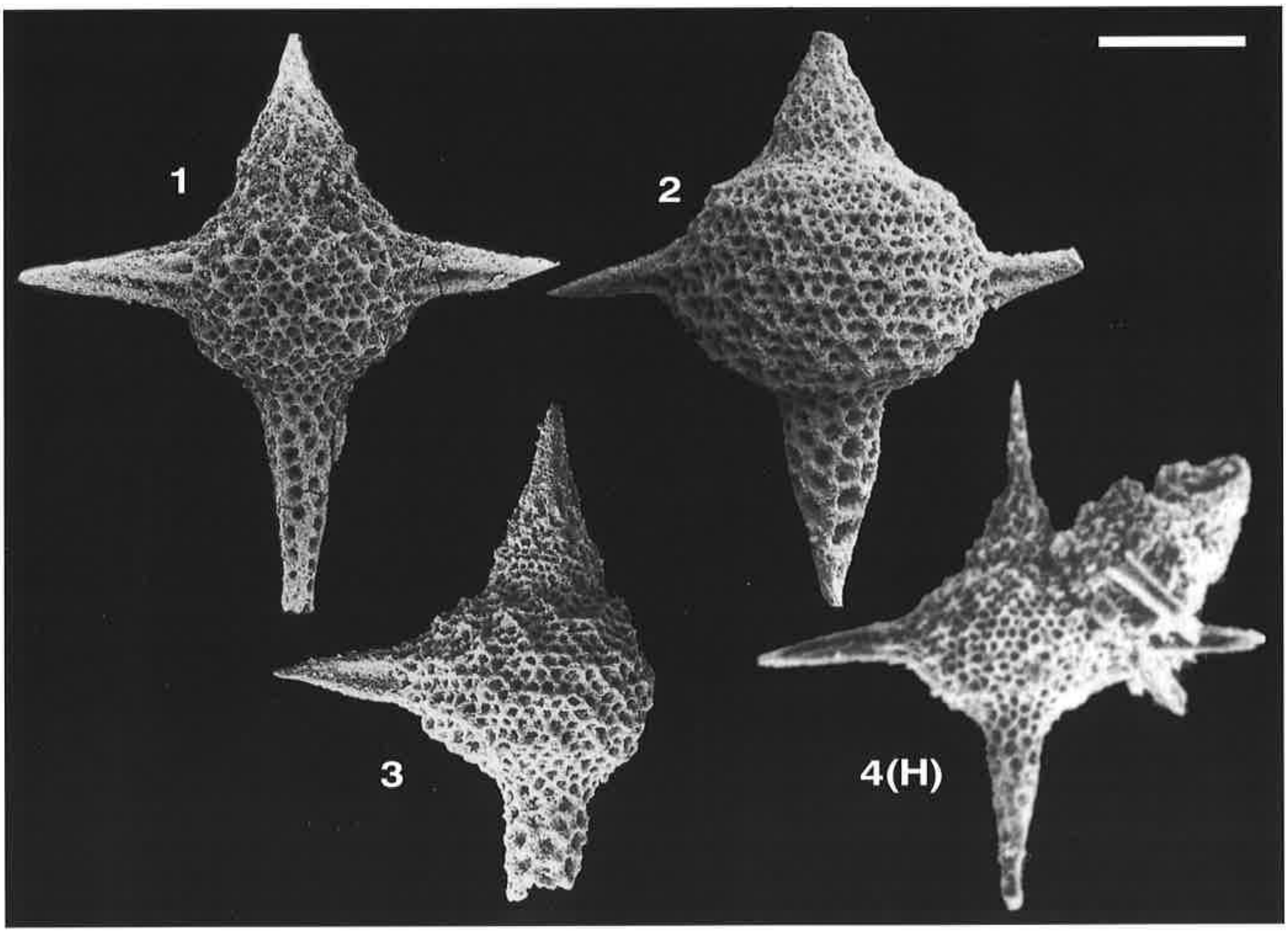


Plate 5422. *Dibolachras tytthopora* FOREMAN. Magnification x200. **Fig. 1.** RJ537, Bo566.5. **Fig. 2.** RJ210, Pr225.3. **Fig. 3.** RJ211, Pr225.3. **Fig. 4(H).** FOREMAN 1973b, pl. 11, fig. 4.

DICOLOCAPSA 3625

Genus: *Dicolocapsa* HAECKEL

Synonymy.-
Dicolocapsa HAECKEL
HAECKEL 1881, p. 433.
HAECKEL 1887, p. 1312.

Type Species.- *Dicolocapsa murina* RÜST (1885).

Original Definition.- "With cephalis bearing a tube (one pore produced laterally into a tube)."

Original Remarks.- "Sensu emendato Sethocapsida (vel Dicyrtida eradiata clausa) with a free cephalis, without apical horn".

Etymology.- Greek. *dicolocapsa*, two jointed capsule.

Included Taxa.-
4013 *Dicolocapsa* (?) *conoformis* MATSUOKA

DICOLOCAPSA (?) CONOFORMIS 4013

Dicolocapsa (?) *conoformis* MATSUOKA

Synonymy.-
Dicolocapsa conoformis MATSUOKA
MATSUOKA 1983a, p. 13, pl. 1, figs. 1-3b; pl. 5, figs. 1-6b; pl. 6, figs. 1-4.
MATSUOKA & YAO 1986, pl. 2, fig. 9; pl. 3, fig. 13.
WAKITA 1988, pl. 3, fig. 14.

Original Definition.- Shell of two segments, turbinate, thin walled. Cephalis small, spherical internally, porous. Collar stricture distinct externally. Thorax funnel-shaped, porous with a small, circular, constricted aperture. Outer surface of cephalis somewhat rough, thorax smooth. Pores small, circular, uniform in size, densely distributed in cephalic surface, sparsely in thoracic surface where they are arranged diagonally.

Original Remarks.- This species is distinguished from the species hitherto referred to *Dicolocapsa*, such as *Dicolocapsa murina* RÜST, by having a funnel-shaped thorax.

Etymology.- This species is named for the Latin ajective *conoformis*, meaning cone-shaped.

Measurements (in μm).-
Based on 16 specimens. Total height, 100-120 (111); maximum width of shell, 65-85 (77); diameter of cephalis, 14-20 (17); diameter of aperture, 5-8 (6).

Type Locality.- Sample S-17, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 6-6, mid Bath.

dicranacanthos >> *ACANTHOCIRCUS T. DICRANACANTHOS* 3087

DICROA 6003

Genus: *Dicroa* FOREMAN

Synonymy.-
Dicroa FOREMAN
FOREMAN 1975, p. 609.

Type Species.- *Dicroa periosa* FOREMAN 1975.

Original Definition.- A spherical or elliptical shell bearing two or three bifurcated polar spines.

Original Remarks.- Species belonging to this genus are known from the late Early Cretaceous of DSDP Leg 32, North Pacific, and from the early Santonian of Trinidad.

Remarks.- This genus is rarely recorded and specimens are usually incomplete.

Etymology.- The generic name is from the Greek feminine noun *dikroa*, fork.

Included Taxa.-
5046 *Dicroa periosa* FOREMAN

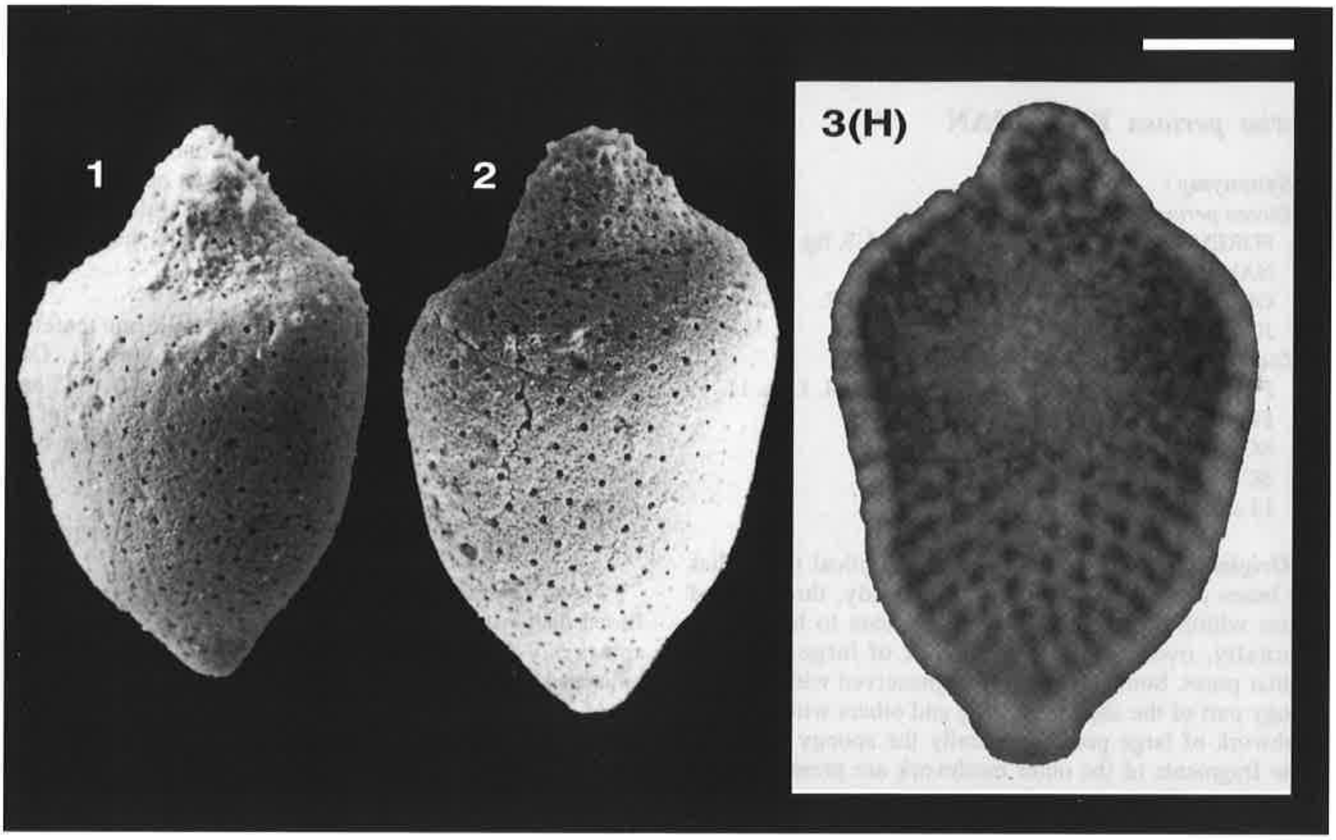


Plate 4013. *Dicolocapsa* (?) *conoformis* MATSUOKA. Magnification x800. **Fig. 1.** MA1060, OCUMR2551, S-17. **Fig. 2.** MA849, OCUMR2549, S-17. **Fig. 3(H).** MATSUOKA 1983a, pl. 5, fig. 3b.

DICROA PERIOSA 5046

Dicroa periosa FOREMAN

Synonymy.-
Dicroa periosa FOREMAN
FOREMAN 1975, p. 609, pl. 2E, fig. 8; pl. 3, fig. 8.
NAKASEKO et al. 1979, p. 21, pl. 4, fig. 8.
ORIGLIA-DEVOS 1983, p. 40, pl. 1, figs. 6-7.
JUD 1994, p. 75, pl. 9, fig. 5.
Dicroa sp. A FOREMAN
FOREMAN 1975, p. 609, pl. 2E, figs. 9-11; pl. 3, fig. 11.
PESSAGNO 1977b, p. 36, pl. 4, figs. 2-3, 5.
SCHAAF 1981, p. 433, pl. 16, fig. 8.
SCHAAF 1984, p. 158, figs. 10a-b.
LI & WU 1985, pl. 1, figs. 1, 6.

Original Definition.- The shell is elliptical to circular and bears two approximately equal, sturdy, three-bladed spines which bifurcate. The shell appears to be spongy internally, overlain by a meshwork of large, regular, angular pores. Some specimens are preserved with only the spongy part of the shell remaining and others with only the meshwork of large pores. Generally the spongy shell and some fragments of the outer meshwork are present. When the shell is elliptical, the largest dimension is along the polar plane. The forked ends of the exceptionally large, sturdy polar spines tend to recurve inwards.

Original Remarks.- *Trisphaera bicornispinosa* ZHAMOIDA 1968, is apparently a related form. It differs in having smaller pores and three spines; poor preservation makes the character of the forked spines uncertain. A single fragment of a form with a branched spine, not included in this species, was observed in 303 A-3, CC (plate 3, figure 12). It differs in its smaller size and having a shell that has smaller pores and is slightly nodose.

Remarks.- No specimens were found in our material having developed the very long, curved spines. Our specimens resemble those illustrated by Foreman 1975 and described as *Dicroa* sp. A (p. 609, pl. 2E, figs. 9-11; pl. 3, fig. 11) which we consider as belonging also to the type species.

Etymology.- From the Greek adj. *periosus*, immense.

Measurements (in μm).-
Based on 14 specimens. Length overall 1000-1230, of polar spines 320-540 (majority 400-500); width between tips of bifurcated spine 250-575 (majority 385-460), of spine near base 20-45 (majority 30-45), of shell in polar plane 100-175, in equatorial plane 100-170.

Type Locality.- DSDP Leg 32, Site 306, north Pacific Ocean.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

DICTYOMITRA 6004

Genus: *Dictyomitra* ZITTEL, emend. PESSAGNO

Synonymy.-
Dictyomitra ZITTEL
ZITTEL 1876, p. 77.
PESSAGNO 1976, p. 50.

Type Species.- *Dictyomitra multicostata* ZITTEL 1876.

Original Definition.- "I propose to name *Lithocampe* HAECKEL *Dictyomitra*. E. Haeckel described the characters as following (i.e. p. 312): Latticed test composed of several parts, divided by two or more circular, circumferential constrictions, disposed above each other, into unequal parts, without all extensions and without apical spine, with simple, wide, not latticed basal aperture."

Actualized Definition.- (PESSAGNO, 1976) Test elongate, conical, lobate, with well developed strictures; mature individuals becoming somewhat spindle-shaped. Cephalis smooth to faintly costate to markedly costate; all subsequent chambers with well-developed, linearly arranged costae; pores distributed in single (rarely double) rows between costae, becoming relict on earlier chambers except in position of strictures; primary pores in position of strictures occasionally with accessory flaps preserved (pl. 14, fig. 5-6); pores increasing progressively in size on each post abdominal chamber.

Actualized Remarks.- (PESSAGNO, 1976) *Dictyomitra* ZITTEL is compared to *Archaeodictyomitra*, n.gen. under the latter genus. It differs from *Diplostrobus* SQUINABOL by lacking an apical horn and by having a much shorter final post-abdominal chamber (=segment). *Dictyomitra,* sensu stricto, as defined above, first appeared in the middle Turonian. Transitional specimens indicate that *Dictyomitra* evolved from *Archaeodictyomitra* at that time. Costate forms with well-developed strictures also occur in the Cenomanian and Lower Cretaceous. These forms differ, however, from *Dictyomitra*, sensu stricto, by having two to three staggered rows of primary pores at the strictures and discontinuous costae. *Dictyomitra* can be distinguished from *Archaeodictyomitra* by the distribution of the primary pores and by the former possessing a more lobate outline.

Etymology.- *Dictyomitra* = Net-cap. Greek.

Included Taxa.-
5927 *Dictyomitra pseudoscalaris* (TAN) sensu SCHAAF

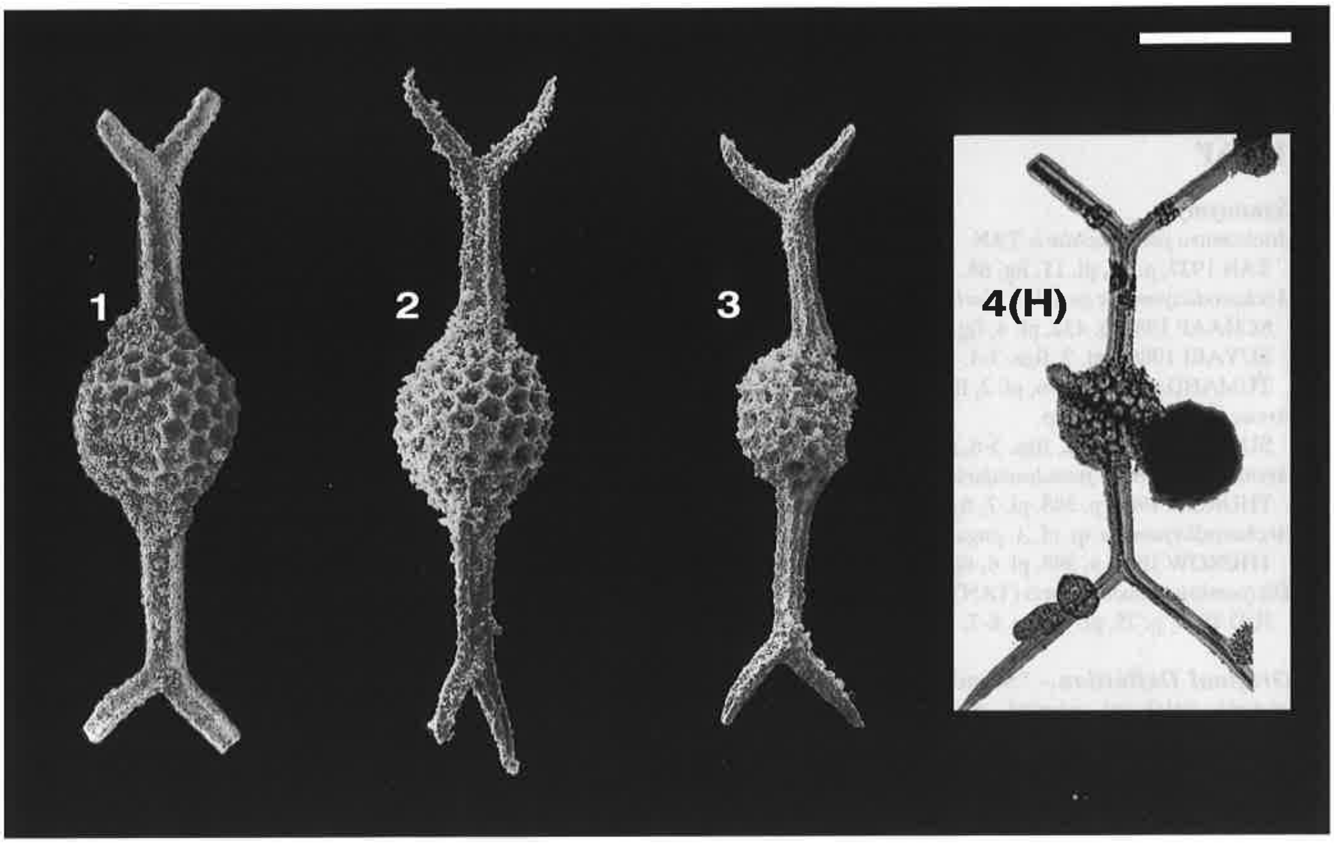


Plate 5046. *Dicroa periosa* FOREMAN. Magnification x200 except Fig. 4(H) x100. **Fig. 1.** RJ411, Bo566.5. **Fig. 2.** RJ615, Bo566.5. **Fig. 3.** RJ45, Bo581.65. **Fig. 4(H).** FOREMAN 1975, pl. 3, fig. 8.

DICTYOMITRA PSEUDOSCALARIS 5927

Dictyomitra pseudoscalaris (TAN) sensu SCHAAF

Synonymy.-
Stichomitra pseudoscalaris TAN
TAN 1927, p. 56, pl. 11, fig. 84.
Archaeodictyomitra pseudoscalaris (TAN)
SCHAAF 1981, p. 432, pl. 4, fig. 5; pl. 21, figs. 13a-b.
SUYARI 1986b, pl. 2, figs. 3-4.
TUMANDA 1989, p. 36, pl. 2, fig. 12.
Archaeodictyomitra ? spp.
SUYARI 1986b, pl. 2, figs. 5-6, not. 7-8.
Archaeodictyomitra pseudoscalaris (TAN)
THUROW 1988, p. 398, pl. 7, fig. 14.
Archaeodictyomitra sp. cf. *A. puga* SCHAAF
THUROW 1988, p. 398, pl. 6, fig. 18; pl. 7, fig. 15.
Dictyomitra pseudoscalaris (TAN) sensu SCHAAF
JUD 1994, p. 75, pl. 9, figs. 6-7.

Original Definition.- "Slender, conical shell of 10 segments without septal constrictions. Cephalis hemispherical with small pores, without apical horn. Second to fifth segment with two rows of pores, the pores of the uppermost row being the largest ones. The pores of the second row are placed on circumferential ribs. All following segments have three rows of pores, the largest pores being placed in the uppermost row. The other two rows are placed just above one another. The ornamentation of the shell consists of longitudinal ribs, which start on the thorax, forming a ring of extensions around the aperture. The mentioned circumferential ribs are more flat than the longitudinal ones."

Actualized Definition.- (JUD, 1994) Shell large, conical, of 9-11 segments with slightly convex sides. Cephalis, thorax and sometimes abdomen forming a conical part without constrictions between segments. Boundary between segments marked by a row of pores. Constrictions on the following segments not corresponding to the internal partition, which is situated above the constrictions. Segments gradually increasing in diameter and slightly in height up to the 9th segment. The following one or two are markedly decreasing in diameter, giving the entire test an elongated oval shape. 11-12 longitudinal costae are visible on half of the diameter. Costae are sharp, continuous along the test, decreasing in height and number from the 4th segment upwards to cephalis. Each segment has 2-3 rows of pores of which the uppermost one has larger pores and is situated below the internal wall separating the segments. On most specimens the pores are generally elongated in transverse direction.

Original Remarks.- "This form is very similar to *Dictyomitra multicostata* ZITTEL, of which it differs by the shape of the pores and by lacking deep constrictions, a constant characteristic feature of all specimens from Bebalain having longitudinal ribs. There are also some similarities to *Dictyomitra scalaris* HINDE, with which it has the lacking of septal constrictions in common, but neither the description nor the illustration of Hinde allow a more exact identification. There are also similarities to *D. macrocephala* CAYEUX (Craie du Bassin de Paris, p. 203, pl. VIII-65) of the Upper Cretaceous, which differs by the arrangement of the pores and the presence of septal constrictions of our specimen."

Actualized Remarks.- (SCHAAF, 1981) In some specimens, pores are less regularly arranged than in the original figure, and intersegmental structures are sometimes expressed in the external contour.

(JUD, 1994) The specimen illustrated and described as *Archaeodictyomitra pseudoscalaris* by SCHAAF 1981 resembles quite well what we have found in our material. All these specimens and all others so far illustrated differ from the type specimen of *Stichomitra pseudoscalaris* TAN by being generally much broader, by possessing in some cases very pronounced constrictions and the row of the largest pores being placed clearly above and not below the constrictions. Most of our forms are incomplete and most also broadly conical. Some rare complete specimens were found with the last segments preserved. These segments are inverted conical. The ratio calculated between maximum length of 11 segments and the maximum width of test shows that the specimen illustrated by Tan (with the ratio of 2:7) is distinctly smaller and longer than that of Schaaf (2:2) and ours (2:2, average of 6 complete specimens).

Measurements (in μm).-
Maximum length of test, 290; maximum width of last segment, 110.

Type Locality.- Rotti Island, Moluccas Archipelago, East Indian Ocean.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

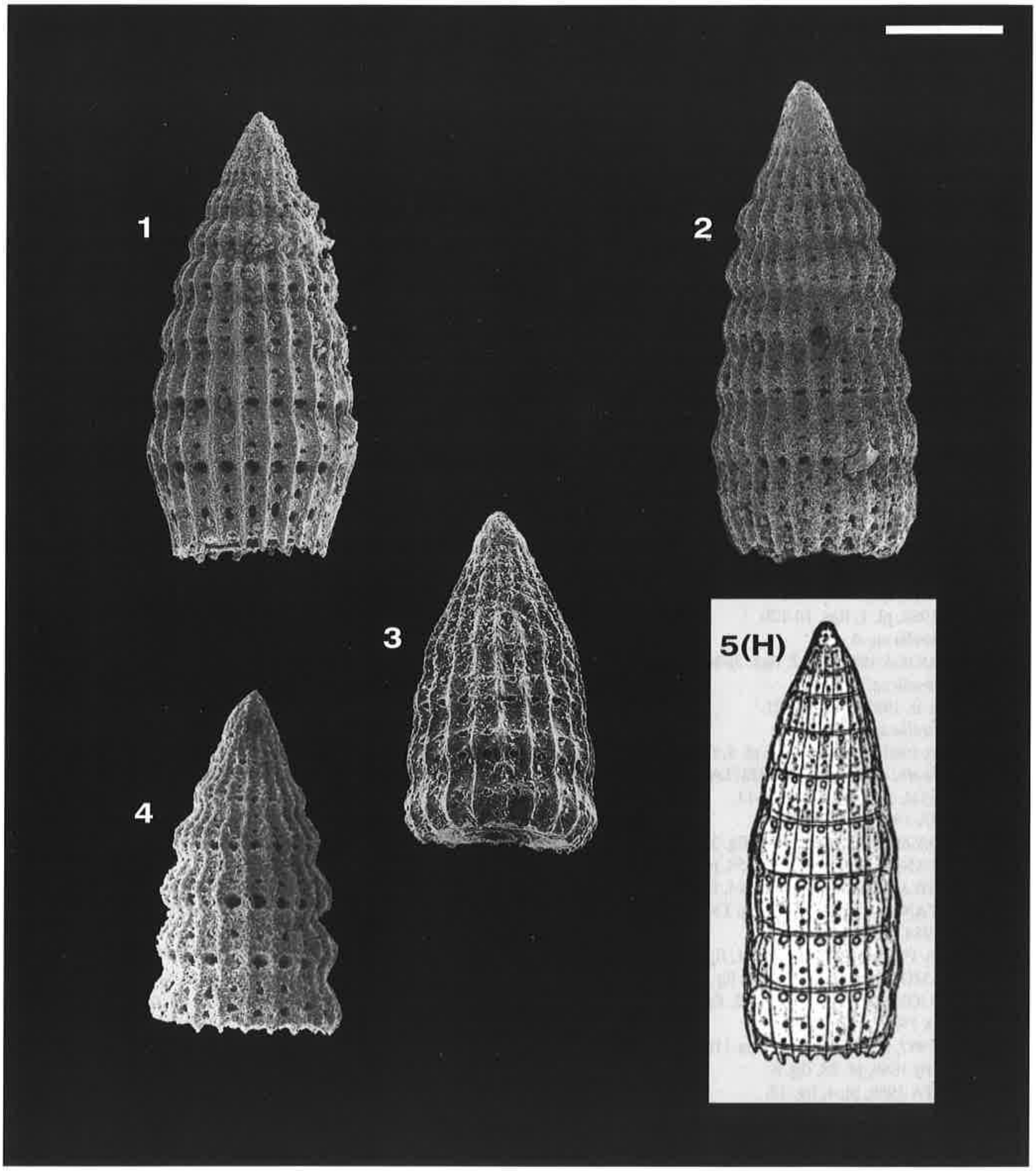


Plate 5927. *Dictyomitra pseudoscalaris* (TAN) sensu SCHAAF. Magnification x250. **Fig. 1.** RJ56, Br141.55. **Fig. 2.** RJ144, Bo566.5. **Fig. 3.** DU88 L-F-278. **Fig. 4.** RJ149, Pr225.3. **Fig. 5(H).** TAN 1927, pl. 11, fig. 84.

DICTYOMITRELLA 3628

Genus: *Dictyomitrella* HAECKEL

Synonymy.-
Dictyomitrella HAECKEL
HAECKEL 1887, p. 1476.

Type Species.- *Eucyrtidium articulatum* EHRENBERG 1875, subsegment designation by Campbell 1954, p. D140.

Original Definition.- "Shell smooth, with joints nearly equal in length."

Remarks.- Species are distinguished by abundance and distribution of pores and by character of latitudinal ridges.

Etymology.- *Dictyomitra* = Net-cap. Greek.

Included Taxa.-
4014 *Dictyomitrella* (?) *kamoensis* MIZUTANI & KIDO

DICTYOMITRELLA (?) KAMOENSIS 4014

Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO

Synonymy.-
"Dictyomitrella" sp. A
MIZUTANI et al. 1981, p. 197, fig. 2a.
Canoptum (?) sp.
AITA 1982, pl. 1, figs. 10-12b.
Dictyomitrella sp. A
MATSUOKA 1982a, pl. 2, figs. 3a-b.
Dictyomitrella sp. D
YAO et al. 1982, pl. 3, fig. 21.
Dictyomitrella sp. E
ISHIDA 1983, pl. 4, figs. 4-5; pl. 6, fig. 4.
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO
KIDO et al. 1982, pl. 2, figs. 9-11.
KOJIMA 1982, pl. 1, fig. 3.
OWADA & SAKA 1982, pl. 1, fig. 14.
MIZUTANI & KIDO 1983, p. 258, pl. 53, figs. 2-4b.
ADACHI & KOJIMA 1983, pl. 14, fig. 6.
MIZUTANI et al. 1984, pl. 1, fig. 13.
YAO 1984, pl. 2, fig. 13.
ISHIDA 1985, pl. 2, fig. 5; ? pl. 1, fig. 4.
YAMAMOTO et al. 1985, pl. 4, fig. 1.
MATSUOKA & YAO 1986, pl. 2, fig. 7.
ISHIDA 1986, pl. 1, fig. 4.
AITA 1987, p. 65, pl. 4, figs. 10a-11b; pl. 10, fig. 13.
ADACHI 1988, pl. 28, fig. 8.
WAKITA 1988, pl. 4, fig. 13.
YAMAGATA 1989, pl. 2, fig. 8.
"Dictyomitrella" kamoensis MIZUTANI & KIDO
HATTORI & YOSHIMURA 1982, pl. 3, fig. 3.
Ristola kamoensis
KISHIDA & HISADA 1986, pl. 8, fig. 7.
Dictyomitrella (?) sp. A
? HATTORI 1987, pl. 18, fig. 15.
Dictyomitrella (?) sp. B
? HATTORI 1987, pl. 18, fig. 16.
"Dictyomitrella" spp.
? HATTORI 1989, pl. 32, figs. G-H.

Original Definition.- Test conical to subcylindrical having six to nine segments. Cephalis dome-shaped without horn, and with or without small pores at joint to thorax. Thorax truncate-conical with one row of pores at the joint to abdomen. Abdomen and post-abdominal chambers also truncate-conical, a few last chambers cylindrical in form, and increasing slightly in height and moderately in width. Abdomen and post-abdominal chambers separated by nodose circumferential ridges have each one row of paired pores just below and above the ridges, pores increasing in size toward distal segments. Ten to fifteen pores visible along circumferential ridges. Abdomen and post-abdominal chambers have tetragonally-arranged two rows of circular pits somewhat larger than neighbouring pores, pits and pores arranged trigonally.

Original Remarks.- We tentatively assign this species to genus *Dictyomitrella,* belonging to a conical or subcylindrical multicyrtid Nassellaria, which has circumferential ridges with each one row of pores below and above and has imperforate surface on medial part of post-abdominal segments. *Dictyomitrella* (?) *kamoensis* n.sp. is quite similar to *Canoptum* (?) sp. A of Pessagno & Whalen 1982 p. 125, pl. 7, figs. 14, 16), but diagnostically differs from the latter by lacking inner layer of polygonal pore frames (pl. 53, figs. 4a-b). *Dictyomitrella* (?) *kamoensis* n.sp. has a single layer of thick wall with smooth inner surface and two rows of circular pits on outer surface. *Dictyomitrella* (?) *kamoensis* n.sp. differs from *Dictyomitrella* sp. A De Wever et al. 1979, p. 90, pl. 5, figs. 12, 16, by possessing one row of pores not only just below but also just above the nodose circumferential ridges. It also differs from *Triassocampe* of Dumitrica et al. 1980 by having segments with the largest diameter in its lower part.

Etymology.- This species is named for Kamo-gun, Gifu Prefecture, its type locality.

Measurements (in μm).-
Based on 11 specimens.

	HT	min.	max.	av.
Maximum length:	180	130	180	156
Maximum width:	95	85	105	92

Type Locality.- Sample 396, Kamiaso Bridge section, Kamiaso, Gifu Prefecture, central Japan.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

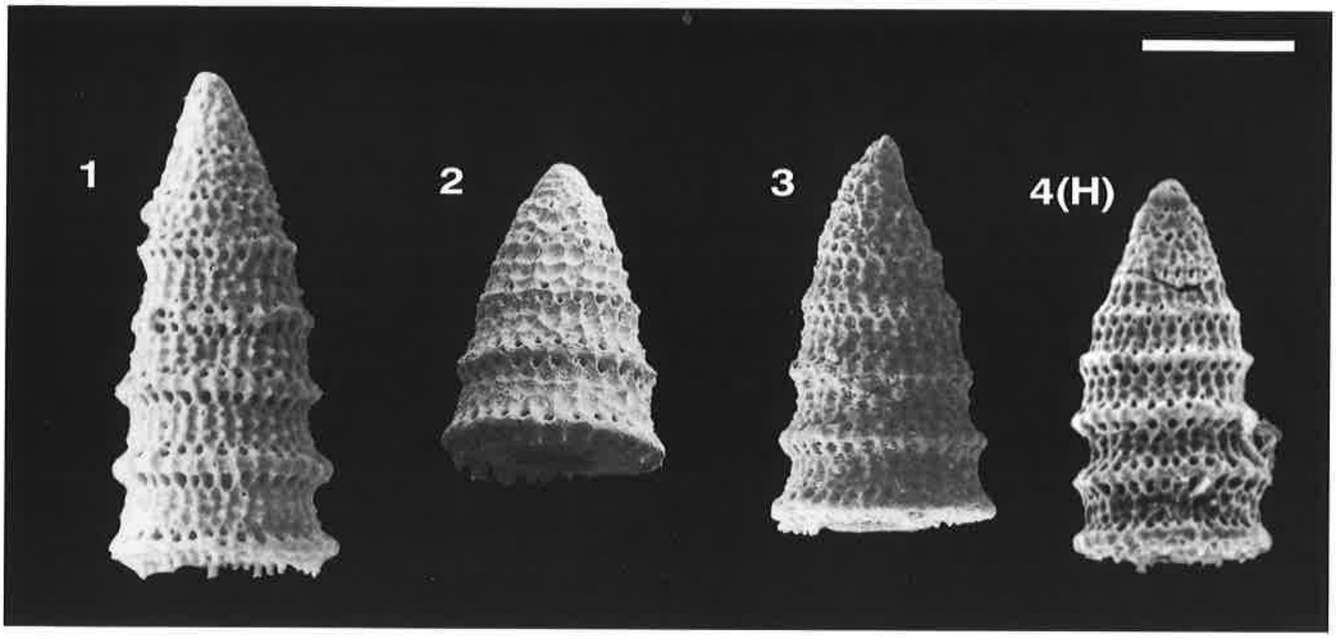


Plate 4014. ***Dictyomitrella* (?) *kamoensis* MIZUTANI & KIDO.** Magnification x400. **Fig. 1.** MA1116, S-02. **Fig. 2.** GO903128, GL207. **Fig. 3.** MA7-1503. **Fig. 4(H).** MIZUTANI & KIDO 1983, pl. 53, fig. 2.

digitata >> *ANGULOBRACCHIA DIGITATA* 3147

diplocyclis >> *PARASATURNALIS DIPLOCYCLIS* 2013

DITRABS 3629

Genus: *Ditrabs* BAUMGARTNER

Synonymy.-
Ditrabs BAUMGARTNER
BAUMGARTNER 1980, p. 293.

Type Species.- *Amphibrachium sansalvadorensis* PESSAGNO, 1971.

Original Definition.- Test as with subfamily, composed of 2 rays of equal length. Central area small, ray tips expanded, bulbous, with small or no spine.

Original Remarks.- *Ditrabs* n.gen. differs from *Amphibrachium* by the presence of 6 external beams (3 on each side) and by having an inner structure as all Tritrabinae n. subfam.

Etymology.- Latin: *di-,* two; *trabs, trabis* (feminine), beam, rafter - composed of two rafters.

Included Taxa.-
3912 *Ditrabs* (?) *osteosa* JUD
3227 *Ditrabs sansalvadorensis* (PESSAGNO)

DITRABS (?) OSTEOSA 3912

Ditrabs (?) *osteosa* JUD

Synonymy.-
Amphibracchium sp.
MUZAVOR 1977, pl. 3, fig. 7.
Angulobracchiine gen. et sp. indet.
STEIGER 1992, p. 51, pl. 13, figs. 5-7.
Ditrabs (?) *osteosa* JUD
JUD 1994, p. 76, pl. 9, figs. 8-10.

Original Definition.- Long slender two-rayed test. Rays square to rectangular in cross-section. Rays with 3 longitudinal beams on upper and lower sides. Beams with nodes connected by delicate bars, diagonally arranged and forming two rows of alternate pores in the depression between the beams. Central part with pore pattern disturbed and with a very short protrusion on a single side of the rays suggesting a relic ray. Sides of test straight or concave with transverse bars connecting the marginal beams of the two faces, forming two longitudinal rows of alternate pores. Tips of rays enlarged with irregular pore-frames and small nodes at pore-wall junctions. Well preserved specimens bear short, pointed spines on tips.

Original Remarks.- *Ditrabs* (?) *osteosa* n.sp. differs from *Ditrabs sansalvadorensis* (PESSAGNO) by the structure of test on its lateral sides and by the square to rectangular cross-section.

Etymology.- From the Greek *osteon* = bone, latinized adjective.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Total length:	655	793	634	952
Width of rays:	52	50	41	58
Width of tips:	221	172	138	221
Height of rays:	60	63	50	82

Type Locality.- Breggia-Gorge, near Chiasso, Ticino Southern Switzerland.

UAZones.- 13 - 16, latest Tith. to early Val.

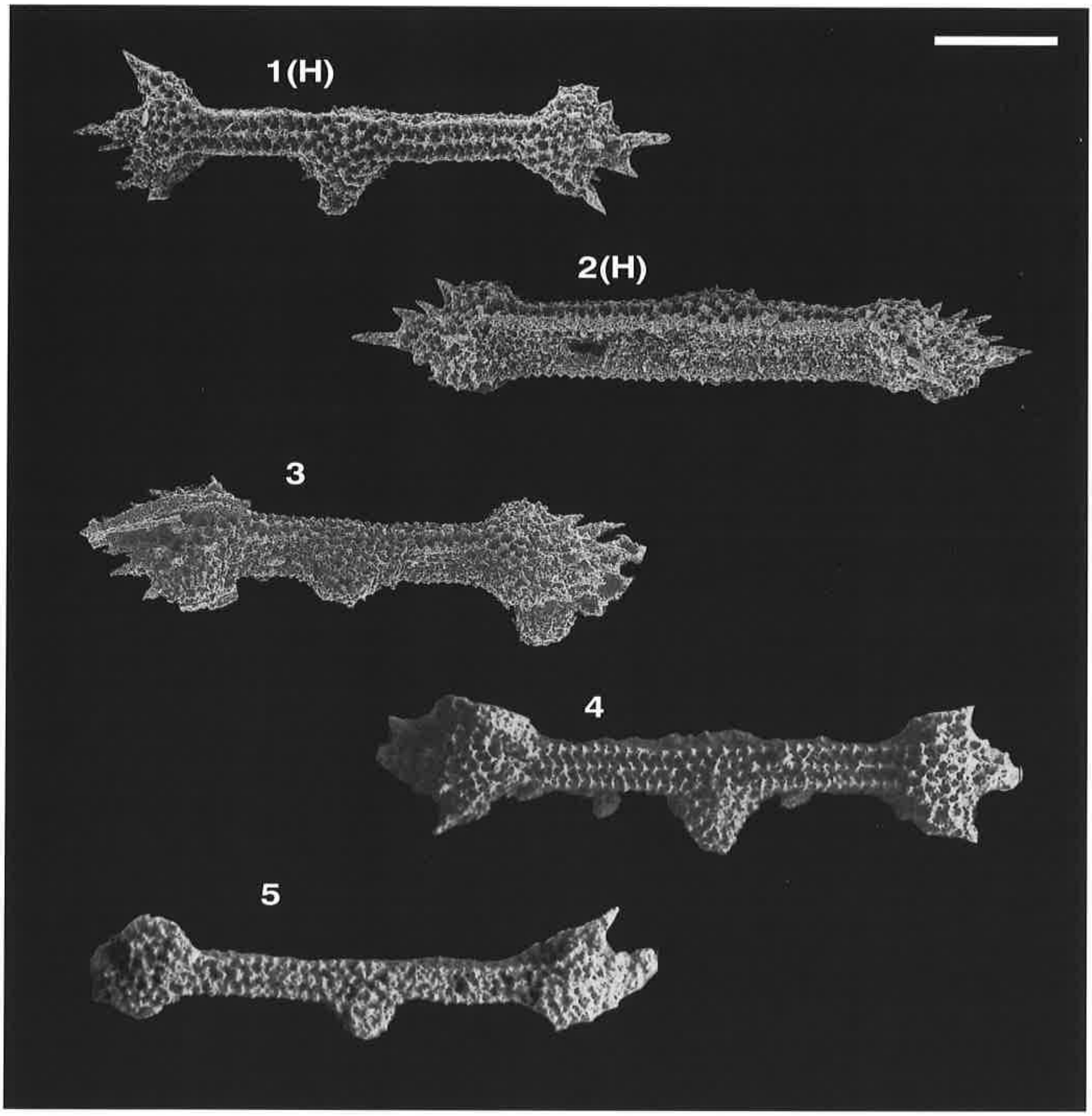


Plate 3912. *Ditrabs* (?) *osteosa* JUD. Magnification x150. **Fig. 1(H).** RJ53, Br1330. **Fig. 2(H).** RJ55, Br1330. **Fig. 3.** RJ18, Br1330. **Fig. 4.** RJ847, Pi57.5. **Fig. 5.** RJ849, Pi57.50.

DITRABS SANSALVADORENSIS 3227

Ditrabs sansalvadorensis (PESSAGNO)

Synonymy.-

Amphibracchium sansalvadorensis PESSAGNO
PESSAGNO 1971a, p. 21, pl. 19, figs. 9-10.
Amphibracchium petersoni PESSAGNO
PESSAGNO 1971a, p. 21, pl. 19, figs. 1, 8.
Ditrabs sansalvadorensis (PESSAGNO)
BAUMGARTNER et al. 1980, p. 52, pl. 2, fig. 9.
KOCHER 1981, p. 63, pl. 13, fig. 3.
BAUMGARTNER 1984, p. 761, pl. 2, fig. 21.
AITA & OKADA 1986, p. 109, pl. 1, figs. 6-7.
DE WEVER et al. 1986, pl. 7, fig. 12.
PAVSIC & GORICAN 1987, p. 24, pl. 2, fig. 8.
STEIGER 1992, p. 37, pl. 7, figs. 1-2.
JUD 1994, p. 76, pl. 9, fig. 11.

Original Definition.- Test as with genus. One ray slightly shorter than other; both rays elliptical in axial section. Meshwork with square pore frames arranged in a markedly linear fashion in three rows. Rays with bulbous tips with several irregularly distributed short spines. Central area small.

Original Remarks.- *A. sansalvadorensis* differs from *A. diminutum* RÜST (1) by having proportionately longer rays; (2) by having markedly straight rays with square meshwork; and (3) by having short spines on its ray tips.

Etymology.- This species is named for the island of San Salvador in the Bahama Islands.

Measurements (in μm).-
Length of rays: Holotype, 500-550; Paratype, 380-560. Width of rays: Holotype, 40; Paratyper 50-60.

Type Locality.- DSDP Leg1, Site 5A, Blake Bahama Basin.

UAZones.- 11-21, late Kimm.-early Tith. to early Barr.

dorysphaeroides >> *SETHOCAPSA DORYSPHAEROIDES* 5544

durisaeptum >> *AMPHIPYNDAX DURISAEPTUM* 4005

echinatus >> *UNUMA ECHINATUS* 3231

echiodes >> *SUNA ECHIODES* 3094

elegans >> *HOMOEOPARONAELLA ELEGANS* 3104

elegans >> *HOMOEOPARONAELLA ELEGANS AFF.* 2004

elegans >> *PARVICINGULA ELEGANS AFF.* 3188

elegans >> *SAITOUM ELEGANS* 3022

elegantissima >> *THANARLA ELEGANTISSIMA* 5296

elisabethae >> *PSEUDOCRUCELLA ELISABETHAE* 3947

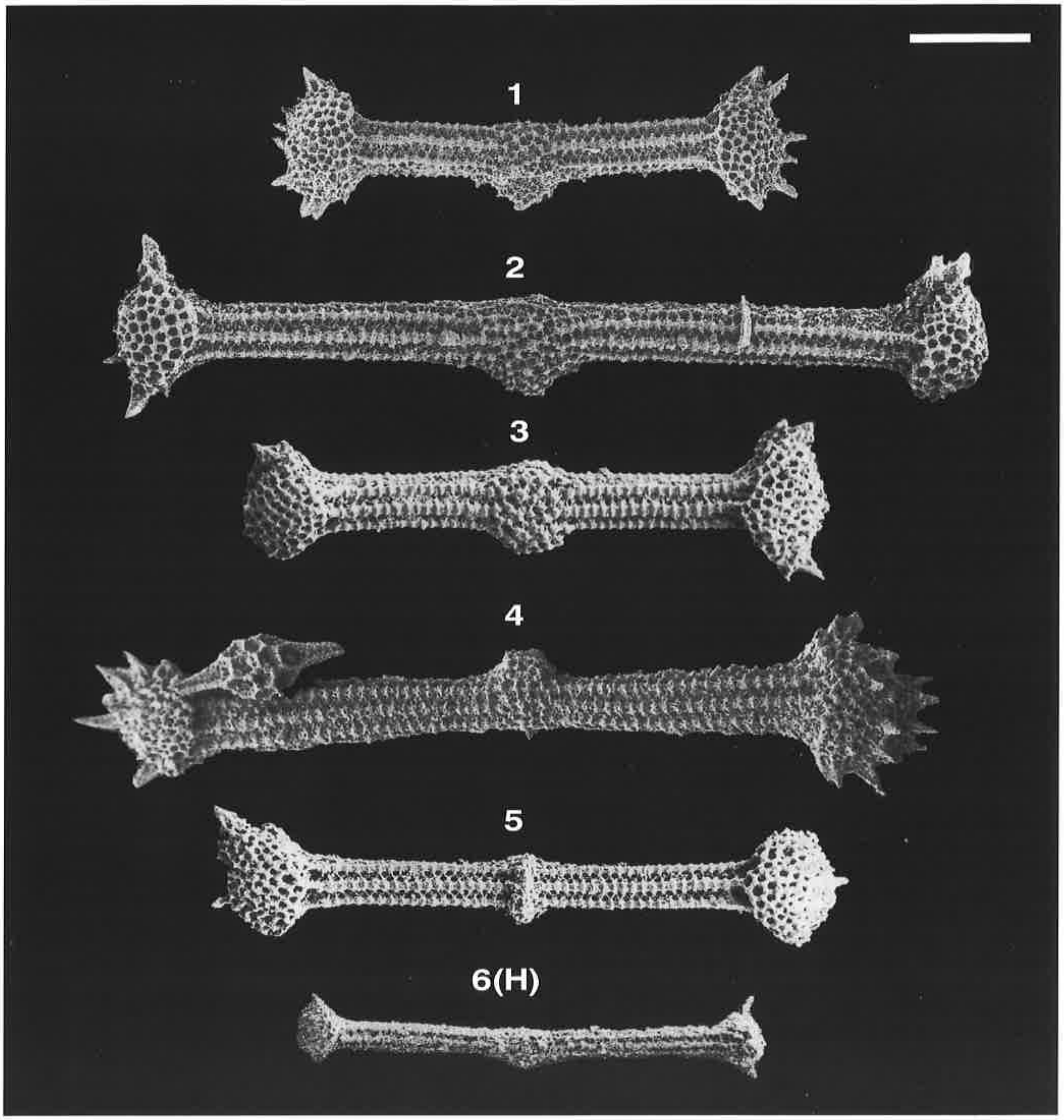


Plate 3227. *Ditrabs sansalvadorensis* (PESSAGNO). Magnification x150, except Fig. 6(H) x75. **Fig. 1.** RJ110, Br28.85. **Fig. 2.** RJ4, Br28.85. **Fig. 3.** POB79/3370, MO1 46. **Fig. 4.** POB79/5036, POB1205.1. **Fig. 5.** POB81/0962, MO46a'. **Fig. 6(H).** PESSAGNO 1971a, pl. 19, fig. 9.

ELODIUM 3823

Genus: *Elodium* CARTER

Synonymy.-
Elodium CARTER
CARTER et al. 1988, p. 56.

Type Species.- *Elodium cameroni* CARTER 1988.

Original Definition.- Test conical and large, with well developed horn and numerous closely spaced post-abdominal chambers separated by nodose circumferential ridges. Three rows of longitudinally aligned circular to subcircular pores in polygonal (mostly tetragonal) pore frames, between circumferential ridges. Lateral pore rows flanking ridges slope steeply away from ridges. Post-abdominal chambers constricted between ridges. Pores in constricted area may be irregular to absent on distalmost chambers of test. Cephalis and thorax sparsely perforate to imperforate, covered with outer layer of microgranular silica; this covering may extend onto earliest post-abdominal chambers.

Original Remarks.- *Elodium* n.gen. possesses three rows of primary (open) pores between circumferential ridges; it differs from *Parvicingula* PESSAGNO in that these pores are longitudinally aligned rather than offset.

Etymology.- *Elodium* is formed by an arbitrary combination of letters (ICZN, 1985, Appendix D, Pt. VI Recommendation 40, p. 201).

Included Taxa.-
3411 *Elodium cameroni* CARTER

ELODIUM CAMERONI 3411

Elodium cameroni CARTER

Synonymy.-
Elodium cameroni CARTER
CARTER et al. 1988, p. 56, pl.13, figs. 1, 2, 6, 9.
TIPPER et al. 1991, pl. 9, fig. 12.
CARTER & JACOBS 1991, p. 342, pl. 3, fig. 18.

Original Definition.- Test large with 10 to 14 strongly constricted post-abdominal chambers separated by nodose circumferential ridges; nodes low and rounded. Cephalis and thorax trapezoidal in external outline, partially perforate, covered by veneer of microgranular silica. Cephalis has strong, asymmetric apical horn. All pores on post-abdominal chambers circular and primary (open); those within constricted areas smaller, disappearing on distalmost chambers. Earliest post-abdominal chambers trapezoidal, increasing gradually in width and height, distal chambers almost cylindrical with slight decrease in height.

Etymology.- This species is named in honour of B.E.B. Cameron for his important contribution to the Mesozoic stratigraphy and foraminiferal biostratigraphy of the Queen Charlotte Islands, B.C.

Measurements (in μm).-
Based on 20 specimens.

	HT	av.	min.	max.
Length excluding horn:	369	352	280	450
Maximum width:	161	159	147	185

Type Locality.- GSC Locality C-080597. Phantonm Creek Formation, Graham Island, British Columbia.

UAZones.- 1-2, early-mid Aal. to late Aal.

EMILUVIA 3631

Genus: *Emiluvia* FOREMAN, emend. FOREMAN, emend. PESSAGNO

Synonymy.-
Emiluvia FOREMAN
FOREMAN 1973b, p. 262.
emend. FOREMAN, 1975, p. 612.
emend. PESSAGNO, 1977a, p. 76.

Type Species.- *Emiluvia chica* FOREMAN 1973b.

Original Definition.- The shell is rectangle, or modified rectangle, with four spines, one at each corner arranged to form a cross. Surface with nodes arranged in a pseudoaulophacid pattern over-all or only partially.

Original Remarks.- This genus differs from *Alievium* in having a shell of rectangular shape with four spines arranged in a cross. The presence of the two species of *Emiluvia* described here in sediments of Neocomian-?Late Jurassic age extend the range of the family Pseudoaulophacidae from the previously earliest known form in the late Aptian of the Blake-Bahama Basin.

Actualized Definition.- (FOREMAN, 1975) In the material from DSDP Leg 20 from which this genus was originally defined, only the external characteristics of its constituent species could be examined, and thus seemed appropriate to place this genus in the Family Pseudoaulophacidae. Since then internal casts have been observed. These show an internal structure which suggests that a more appropriate assignment might be the Family

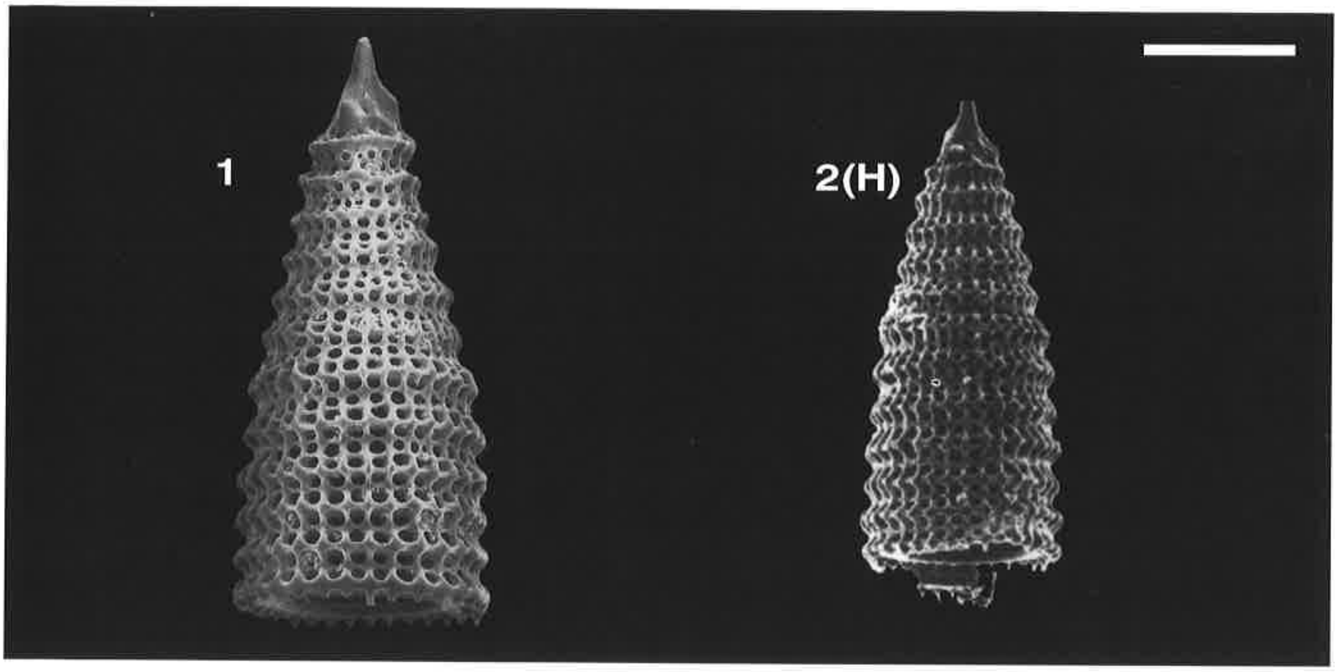


Plate 3411. ***Elodium cameroni*** **CARTER.** Magnification x200. **Fig. 1.** CA39/15, GSC99419, GSC C-156399. **Fig. 2(H).** CARTER et al. 1988, pl. 13, fig. 2.

Phacodiscidae. However, the presence of an actual phacoid shell is still doubtful, and thus the assignment is only questionably made. This genus differs from others in the Family Phacodiscidae in that its constituent species have at least a partially nodular surface connected by bars, as for the Pseudoaulophacidae.

(PESSAGNO, 1977a) Surfaces of cortical shell planiform; sides concave to vertical. Top and bottom surfaces of cortical shell with two layers: (1) an inner layer of massive polygonal pore frames and a secondary outer layer consisting of nodes (usually massive) interconnected by fragile bars to form triangular, tetragonal, or irregularly polygonal pore frames. Nodes of second layer superimposed on vertices of polygonal pore frames beneath. Numerous secondary radial beams extending from cortical shell at point of nodes to first medullary shell (pl. 5, figs. 5-7). Four primary spines with alternating longitudinal ridges and grooves.

Actualized Remarks.- (PESSAGNO, 1977a) Foreman (1973b, p. 262) originally placed *Emiluvia* in the Pseudoaulophacidae RIEDEL because of the presence of pseudoaulophacid-like meshwork. Triangular pore frames do occurr on some species of *Emiluvia*; however, even with these species such pore frames are interspersed with rectangular pore frames. Pore frames vary from triangular to rectangular to irregularly polygonal. Furthermore, they are not arranged in numerous concentric layers as in the case of the Pseudoaulophacidae s.s. The wall of the cortical shell *Emiluvia* consists of two layers on the top and bottom surfaces of the test; the sides of the test are single-layered.

Etymology.- *Emiluvia* (f.) is an anagram of the closely related genus *Alievium.*

Included Taxa.-
4018 *Emiluvia bisellea* n.sp. DANELIAN
3213 *Emiluvia chica* gr. FOREMAN
5132 *Emiluvia chica decussata* STEIGER
3225 *Emiluvia hopsoni* PESSAGNO
3253 *Emiluvia lombardensis* n.sp. BAUMGARTNER
3212 *Emiluvia nana* n.sp. BAUMGARTNER
4015 *Emiluvia ordinaria* OZVOLDOVA
4069 *Emiluvia orea* s.l. BAUMGARTNER
3224 *Emiluvia orea orea* BAUMGARTNER
4070 *Emiluvia orea ultima* n.ssp. BAUMGARTNER & DUMITRICA
3066 *Emiluvia pessagnoi* FOREMAN
3226 *Emiluvia pessagnoi multipora* STEIGER
4017 *Emiluvia pessagnoi pessagnoi* FOREMAN
3210 *Emiluvia premyogii* BAUMGARTNER
3215 *Emiluvia salensis* PESSAGNO
3216 *Emiluvia sedecimporata* (RÜST)
2002 *Emiluvia splendida* CARTER

EMILUVIA BISELLEA — *4018*

Emiluvia bisellea n.sp. DANELIAN

Synonymy.-
Staurosphaera antiqua RÜST
MUZAVOR 1977, p. 52, pl. 1, fig. 8.
Emiluvia chica s.l. FOREMAN
ORIGLIA-DEVOS 1983, pl. 14, fig. 8 only.
Emiluvia sp. A
DANELIAN 1989, p. 154, pl. 4, figs. 16-18.

Type Designation.- TD 87024/17, CSA6-2.

Original Definition.- The shell is quadrangular in vertical view, "pulled out" at each corner from where a stout three-bladed spine arises. Lateral surfaces between spines are concave, except when they are covered by a spongy patagium, which is rarely preserved. The shell is discoidal in lateral view, its bottom and top cortical surfaces being planiform to slightly convex. The arrangement of the pore frames on the shell surface is very distinctive: a central square surrounded by four hexagons. The interior of each hexagon is divided into six triangles, radiating from its centre. A quite well developed node is situated at each corner of the adjoining triangles and an extra pair of nodes is situated at the base of each spine.

Original Remarks.- This species differs from all other *Emiluvia* by its characteristics shell surface geometrical meshwork.

Etymology.- Arbitrary combination of letters (I.C.Z.N., App. D, V, 26).

Measurements (in μm).- Diagonal width of cortical shell (spine to spine including nodes): 152-210; width between lateral sides (midpoint to midpoint between spines): 100-125; lenght of spines: 138-175.

Type Locality.- Section situated 500 m south of the Skandhalon village, along a path leading to an abandoned quarry; Epirus, north-western Greece.

UAZones.- 11-11, late Kimm.-early Tith. to late Kimm.-early Tith.

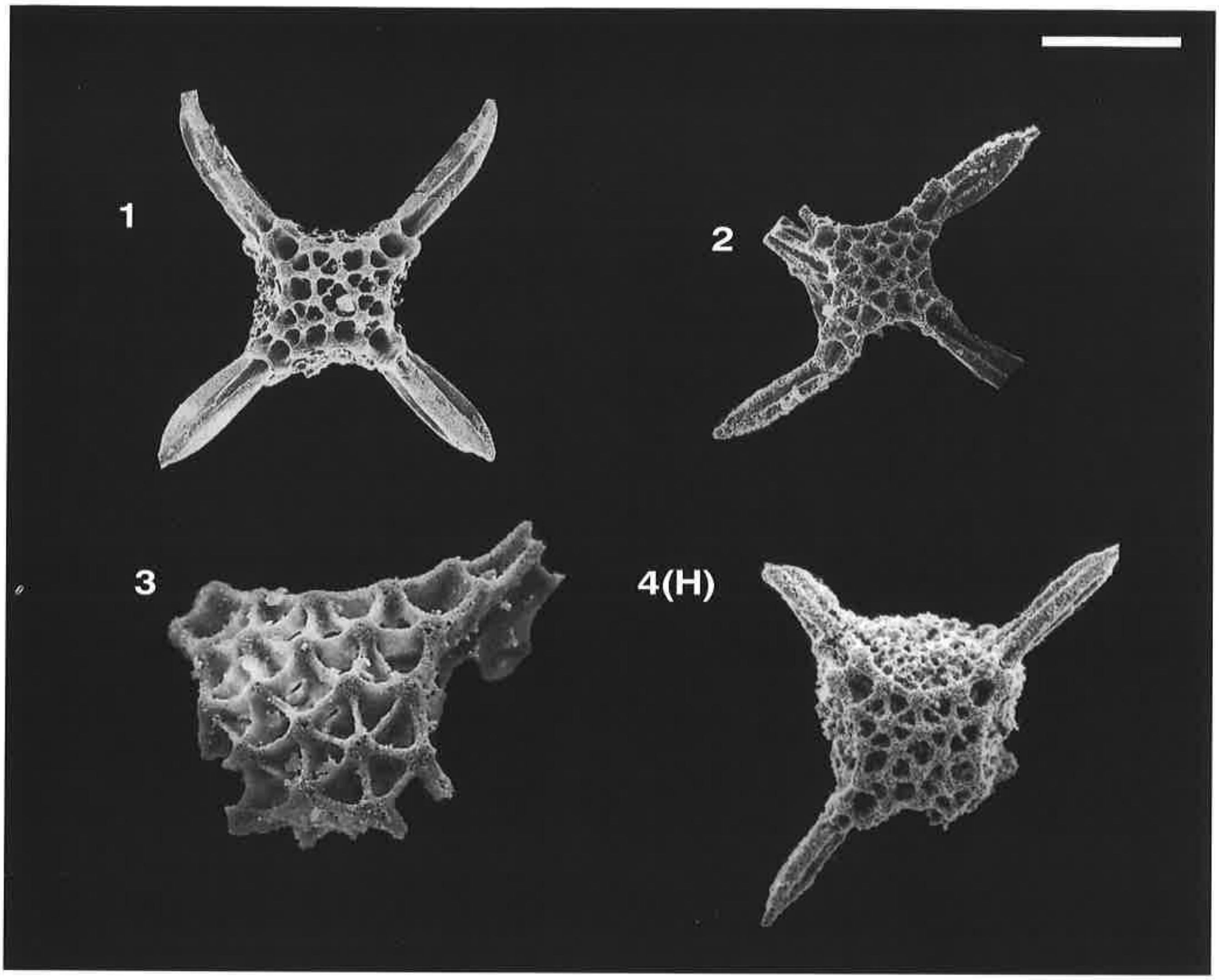


Plate 4018. *Emiluvia bisellea* n.sp. DANELIAN. Magnification x150, except Fig. 3 x300. **Fig. 1**. POB78/8108, POB986.52. **Fig. 2.** TD87019/17, ASB1-1. **Fig. 3.** TD88018/01, ASB1-1. **Fig. 4(H).** TD 87024/17. csa6-2.

EMILUVIA CHICA S.L. 3213

Emiluvia chica s.l. FOREMAN

Synonymy.-
Emiluvia chica FOREMAN
FOREMAN 1973b, p. 262, pl. 8, fig. 7.
DE WEVER et al. 1986, pl. 7, fig. 4.
PESSAGNO 1977a, p. 76, pl. 4, figs. 11-13.
KITO 1987, pl. 1, fig. 2.
OZVOLDOVA & PETERCAKOVA 1987, pl. 32, figs. 3-4.

Original Definition.- The shell is small, rectangular with concave sides in transverse section, elliptical in vertical section. It bears a three-bladed spine at each corner. No more than two complete spines were observed on a specimen. These varied somewhat in length on individual specimens. The surface is covered with large nodes, of which two at the base of each spine on both faces of the rectangle are especially large. The remaining nodes, not quite so large, are arranged in rows with connecting bars to form rectangles or less regularly with connecting bars to form triangles as in the Pseudoaulophacidae.

Original Remarks.- This species differs from the similar *E. pessagnoi* as described under that species.

Actualized Definition.- (FOREMAN, 1975) The specimens observed in the DSDP Leg 32 material agree well with the earlier description based on material from DSDP Leg 20. In addition, internal casts show the presence of a probable small internal phacoid shell (pl. 5, fig. 12).

Etymology.- Spanish *chico, -a = chicus, -a, um* small.

Measurements (in μm).-
Based on 10 specimens. Width of shell from point midway between spines to opposite side, 100-140 (majority 110-125); approximate number of nodes across shell from spine to the opposite spine is five to six.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 3-18, early-mid Baj. to latest Val.-earliest Haut.

EMILUVIA CHICA DECUSSATA 5132

Emiluvia chica decussata STEIGER

Synonymy.-
Emiluvia tecta STEIGER (invalid name)
STEIGER 1992, p. 54-55.
Emiluvia tecta decussata STEIGER
STEIGER 1992, p. 55, pl. 15, fig. 3.
Emiluvia tecta diagonalis STEIGER
STEIGER 1992, p. 56, pl. 15, fig. 4.
Emiluvia chica decussata STEIGER
JUD 1994, p. 76, pl. 9, figs. 12-14.

Original Definition.- "*E. tecta* with an inter-nodal pattern consisting of 12 nodes disposed in two double-rows which cross each other. Pillow-like test with square outline. Each edge of the square bears a triradiate spine. The cortical shell shows polygonal pores and 19 to 25 marginal nodes which are regularly distributed and central nodes which are irregularly distributed. Some additional nodes are possible. Opposite spines show identical characters. Comparing the diagonnally arranged spines the structures of one diagonal are, with respect to the other diagonal, twisted by 180°. The number of nodes show two maxima: 20 and 24 nodes."

Original Remarks.- "*Emiluvia tecta decussata* differs form the other subspecies of *Emiluvia tecta* by the characteristic pattern of the Internodes. They correspond to the basic pattern 1."

Actualized Remarks.- (JUD, 1994) In a recent attempt to establish a detailed systematics of the species of *Emiluvia* occurring in the Tithonian-Valanginian interval Steiger (1992) described a new species, *E. tecta*, with two subspecies: *E. tecta decussata* STEIGER and *E. tecta diagonalis* STEIGER. No nominal subspecies was separated and no holotype was established for *E. tecta*. In this situation the species is invalid and according to ICZN art. 23eIII we use *E. tecta decussata* as a replacing name of this species. On the other way we find that this species is very similar to or even entirely synonym with *E. chica* FOREMAN. Until the taxonomy of all these forms is resolved we consider Steiger's species as a subspecies of *E. chica* and not an independent species, the differences between them being insignificant.

Etymology.- *Decussatus* = cross-shaped.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of spines:	157	137	120	157
Width of central area:	114	124	90	180

Type locality.- Gartenau, Ga39, quarry near St. Leonhard (Salzburg, Austria).

UAZones.- 13-18, latest Tith. to latest Val.-earliest Haut.

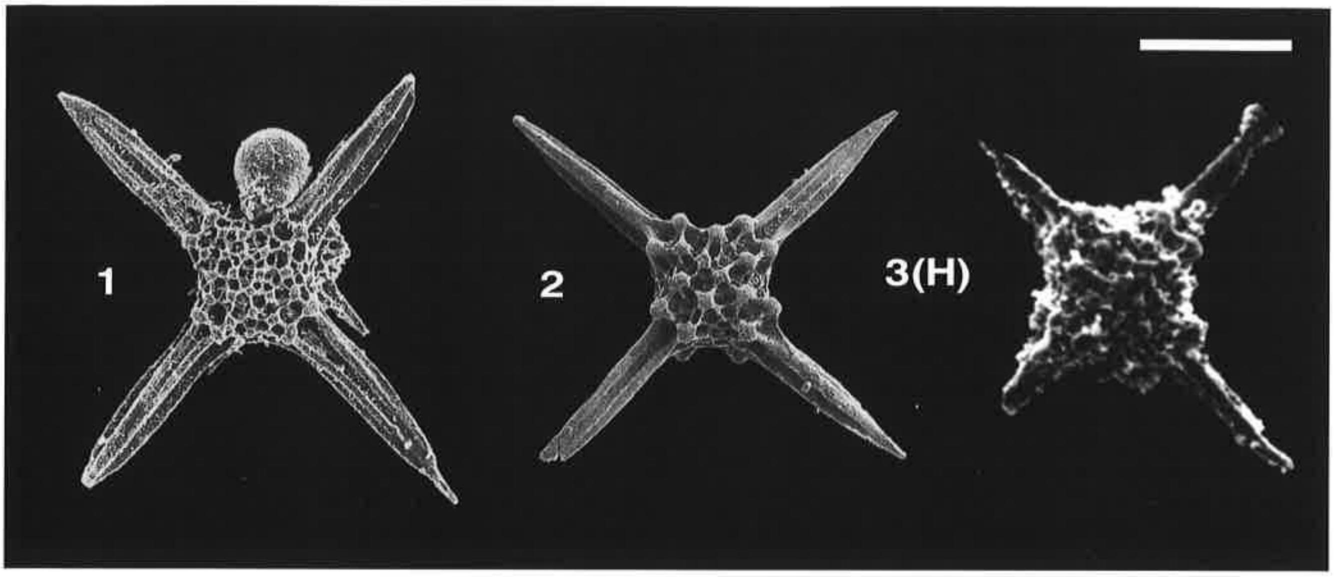


Plate 3213. *Emiluvia chica* s.l.FOREMAN. Magnification x150. **Fig. 1.** POB79/0384, POB899.60. **Fig. 2.** POB79/1629, POB79.4.**Fig. 3(H).** FOREMAN 1973b, pl. 8, fig. 7.

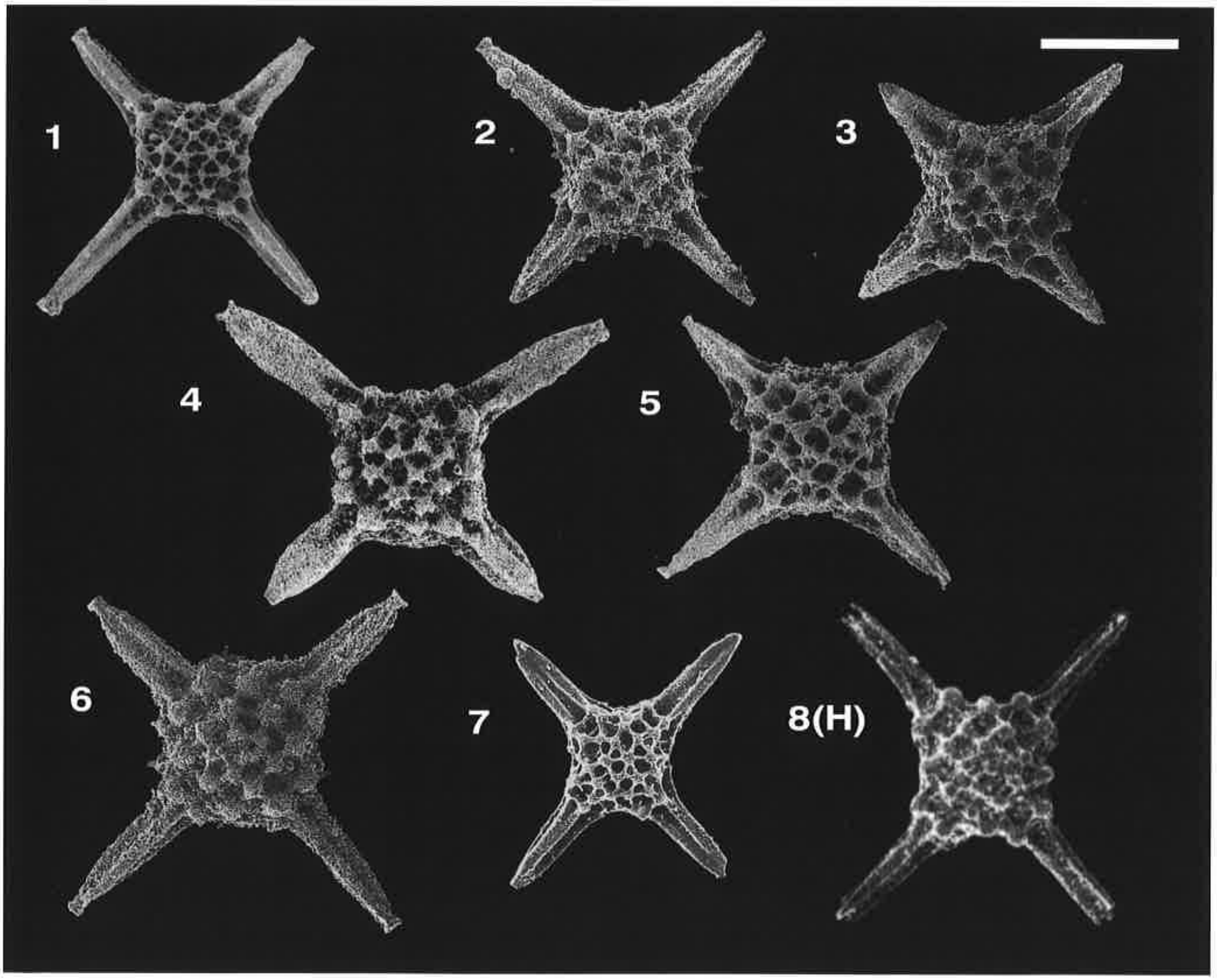


Plate 5132. *Emiluvia chica decussata* STEIGER. Magnification x150. **Fig. 1.** RJ118, Br28.85. **Fig. 2.** RJ84, Br1330. **Fig. 3.** RJ221, Br1330. **Fig. 4.** RJ114, Br28.85. **Fig. 5.** RJ242, Br1330. **Fig. 6.** RJ299, Br1330. **Fig. 7.** POB79/387, POB899.6. **Fig. 8(H).** STEIGER 1992, pl. 15, fig. 3.

EMILUVIA HOPSONI 3225

Emiluvia hopsoni PESSAGNO

Synonymy.-
Emiluvia hopsoni PESSAGNO
PESSAGNO 1977a, p. 76, pl. 4, figs. 14-16; pl. 5, figs. 1-7; pl. 12, figs. 15-16.
FOREMAN 1978, p. 744, pl. 1, fig. 3.
BAUMGARTNER et al. 1980, pl. 1, fig. 9.
KOCHER 1981, p. 64, pl. 13, figs. 6-7.
BAUMGARTNER 1984, p. 762, pl. 3, fig. 1.
DE WEVER & MICONNET 1985, p. 385.
SCHAAF 1985, p. 266.
DE WEVER et al., 1986, pl. 6, fig. 22.
AITA 1987, p. 63.
OZVOLDOVA & PETERCAKOVA 1987, pl. 32, fig. 5.
CONTI & MARCUCCI 1991, pl. 1, figs. 20-21.
WIDZ 1991, p. 246, pl. 1, fig. 25.
MATSUOKA 1992, pl. 4, fig. 11.
STEIGER 1992, p. 58, pl. 15, fig. 11.
JUD 1994, p. 77, pl. 9, fig. 15.
PESSAGNO et al. 1993, p. 131, pl. 4, fig. 21.
Emiluvia cf. *hopsoni* PESSAGNO
KATO & IWATA 1989, pl. 3, fig. 10.

Original Definition.- Test surface with outer layer comprised of square to triangular pore frames having nodes at vertices interconnected by bars; nodes usually massive, often merging. Four massive spines of medium length, triradiate in axial section; spines with three longitudinal grooves alternating with three longitudinal ridges. Terminal portions of spines with a crownlike structure aligned with one of three ridges of spine.

Original Remarks.- *Emiluvia hopsoni* differs from *E. chica* FOREMAN by virtue of the branched and more massive nature of its spines.

Etymology.- This species is named for Dr. C. A. Hopson (University of California at Santa Barbara) in honor of his contributions to the understanding of Coast Range ophiolites.

Measurements (in μm).-
Based on 10 specimens. Length of test: 110- 140; width of test: 110-140; length of spines: 140-190.

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 6-15, mid Bath. to late Berr.-earliest Val.

EMILUVIA LOMBARDENSIS 3253

Emiluvia lombardensis n.sp. BAUMGARTNER

Synonymy.-
Emiluvia sp. 2
KITO 1989, p. 115, pl. 6, figs. 14-16, 18-19.

Type Designation.- 81/2898, POB1341.

Original Definition.- *Emiluvia* with small central area and stout spines that almost engulf the central area.

Cortical shell relatively small, with planar or slightly convex upper and lower surface. Pores and nodes on vertices of central area are approximately equal in size and rather irregularly placed. Some specimens show delicate bars that bridge between primary beams at the base of spines giving the impression of a porous spine base.

Four sturdy distally tapering spines extend from central area. Spines are hexaradiate proximally and triradiate distally. The bases of spines have a tendency to join around the central area. Spines bear three primary and three almost equally developed secondary longitudinal grooves separated by narrow ridges. Spine tips consist of a glove-like structure composed of a central spine and 3 (sometimes 6) lateral protrusions or spines placed on the end of the primary (and sometimes on the secondary) ridges.

Original Remarks.- This species differs from other *Emiluvia* spp. by its very stout spines that taper distally. Secondary longitudinal grooves are more developed and central area is smaller than with *Emiluvia splendida* CARTER (1988, p. 35, pl. 16, figs. 5, 11).

Etymology.- Named after the type area, Lombardy.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Diameter of centreal area:	136	115	104	136
Length of spines:	212	205	198	221
Width of spine base:	55	59	54	62

Type Locality.- Sample POB 1341, near the top of the Sogno Formation, Colle di Sogno, Lombardy, Northern Italy.

UAZones.- 1-4, early-mid Aal. to late Baj.

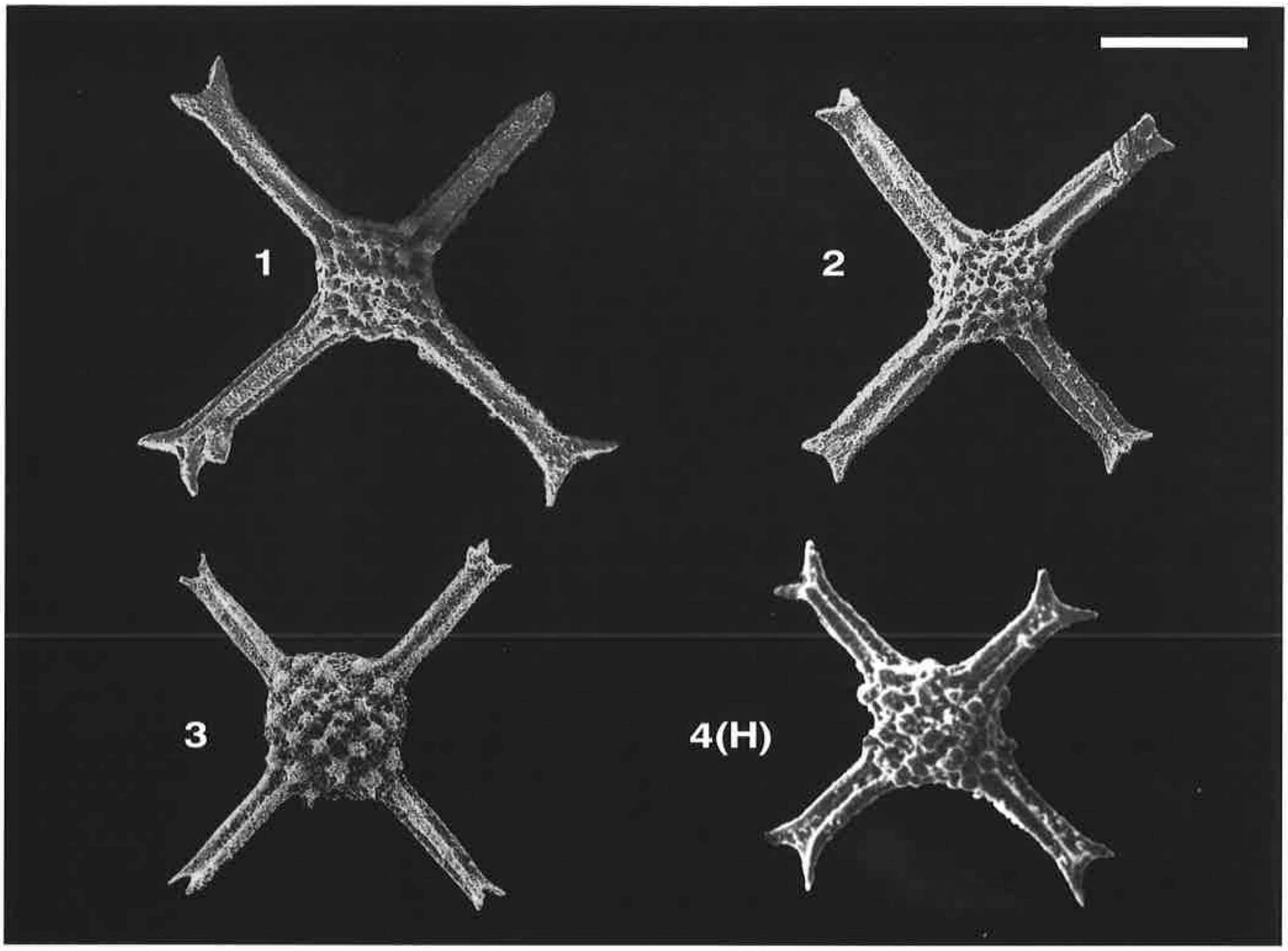


Plate 3225. *Emiluvia hopsoni* PESSAGNO. Magnification x150. **Fig. 1.** POB79/1656, POB79.5 899. **Fig. 2.** POB78/6136, POB899.51. **Fig. 3.** RJ115, Br28.85. **Fig. 4(H).** PESSAGNO 1977a, pl. 4, fig. 14.

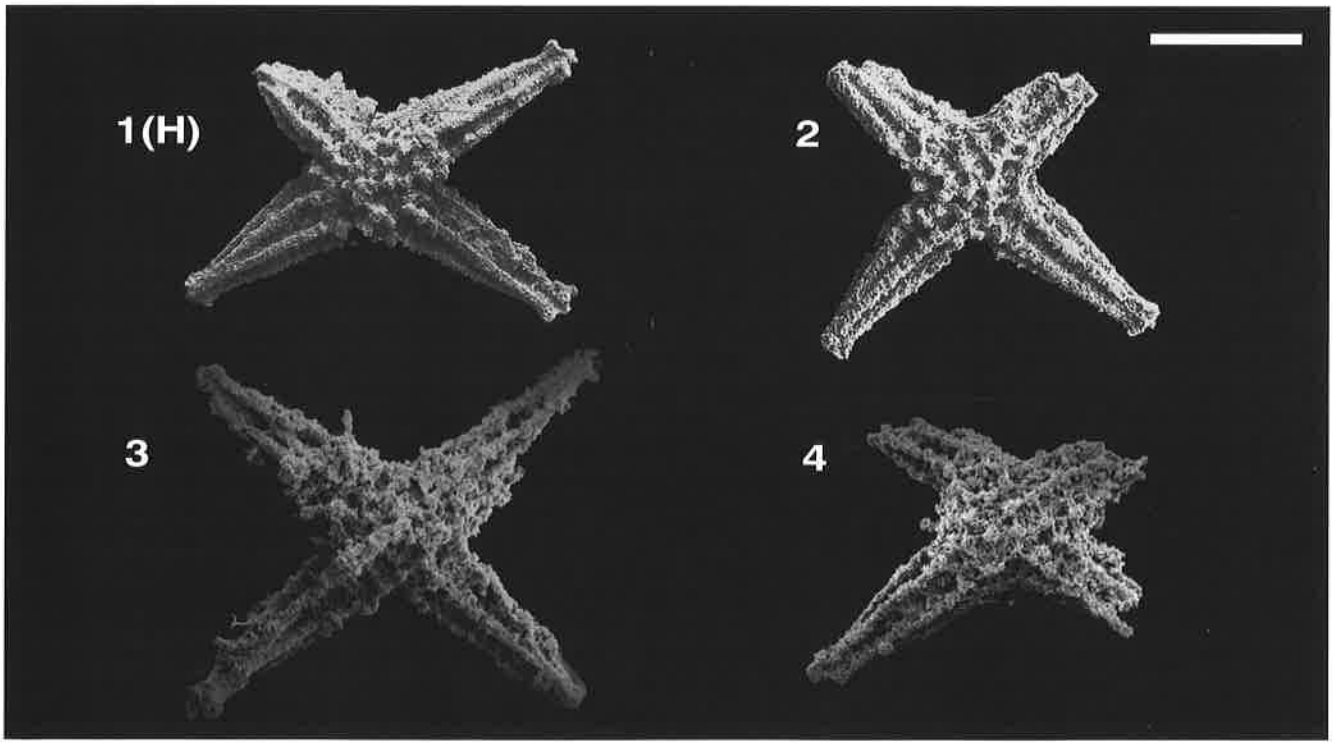


Plate 3253. *Emiluvia lombardensis* n.sp. BAUMGARTNER. Magnification x150. **Fig. 1(H).** POB 81/2898, POB1341. **Fig. 2.** POB 81/2877, POB1341. **Fig. 3.** AB TM90.32-a30.612 **Fig. 4.** AB TM90.32.618

EMILUVIA NANA 3212

Emiluvia nana n.sp. BAUMGARTNER

Synonymy.-
Emiluvia cf. *premyogii* BAUMGARTNER
? DE WEVER & MICONNET 1985, pl. 1, fig. 11.

Type Designation.- 81/2195, 534.122.1.43.

Original Definition.- Small *Emiluvia* with the 4 short spines at right angle. About 5-6 nodes on a line between opposed spines. Nodes small, sometimes coalescent, especially in the center. Rectangular to irregular pore frames, pores small, circular. Spines three-bladed, without significant secondary grooves.

Original Remarks.- This species differs from other *Emiluvia* by its small size.

Etymology.- *Nanus, -a, -um,* Latin for dwarfed.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Length of spines:	65	70	62	78
Width of central area :	72	75	70	88
Width of base of spines:	37	39	35	42

Type Locality.- DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 122, Section 1, 43 cm (Baumgartner 1984, loc. 30).

UAZones.- 6-9, mid Bath. to mid-late Oxf.

EMILUVIA ORDINARIA 4015

Emiluvia ordinaria OZVOLDOVA

Synonymy.-
Emiluvia sp. A
KOCHER 1981, p. 65, pl. 13, fig. 11.
Emiluvia sp. A in KOCHER
ORIGLIA-DEVOS 1983, p. 110, pl. 14, figs. 19-20.
Emiluvia sp. A KOCHER
DE WEVER & CORDEY 1986, pl. 1, fig. 13.
Emiluvia sp. cf *C. septemporatus* (PARONA)
EL KADIRI 1984, p. 36, pl. 5, fig. 10.
Emiluvia sedecimporata salensis PESSAGNO
DE WEVER et al. 1986, pl. 6, fig. 25.
Emiluvia ordinaria OZVOLDOVA
OZVOLDOVA & SYKORA 1984, p. 265, pl. 4, figs. 6-8; pl. 5, figs. 1-4; pl. 16, fig. 4.
OZVOLDOVA 1988, pl. 3, fig. 9.
DANELIAN 1989, p. 149, pl. 4, fig. 5-6.

Original Definition.- The test is of a shape of a quadrangle of strongly concave sides. A long, stout, three-ridged spine arises from each tip. The top and the bottom side of the test is strongly convex, lateral sides are concave.
The meshwork of the outer layer of the cortical shell is formed by regular rows of large pores parallel with the spines. A triangle pore at the spine base, a quadrangle pore and two pairs of quadrangle pores occur in each line from the spine base to the test centre. Nodes of the meshwork are thickened and prominent. The inner layer of the cortical shell is of a polygonal meshwork. The spine ridges are separated by deep grooves. The spines are of about the same lengths.

Etymology.- Latin, *ordinarius* - regular; after the regular arrangement of pores.

Measurements (in μm).-
Based on 3 specimens.

	HT	max.	min.
Width of test:	133	122	153
Maximum thickness of test:	130	125	160
Length of spines:	222	200	233
Maximum size of pores:	22	15	25

Type Locality.- The Sipkovsky Haj, Western Carpathians.

UAZones.- 9-11, mid-late Oxf. to late Kimm.-early Tith.

EMILUVIA OREA S.L. 4069

Emiluvia orea s.l. BAUMGARTNER

Synonymy.-
Emiluvia orea BAUMGARTNER
EL KADIRI 1984, p. 26, pl. 5, figs. 2, 5; pl. 26, fig. 7.
AITA & OKADA 1986, p. 108.
AITA 1987, p. 63, pl. 13, fig. 8.
OZVOLDOVA 1988, pl. 8, figs. 1-2.
DANELIAN 1989, p. 150, pl. 4, figs. 7-9.
See also subspecies

Included Taxa.-
3224 *Emiluvia orea orea* BAUMGARTNER
4070 *Emiluvia orea ultima* n.ssp. BAUMGARTNER & DUMITRICA

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

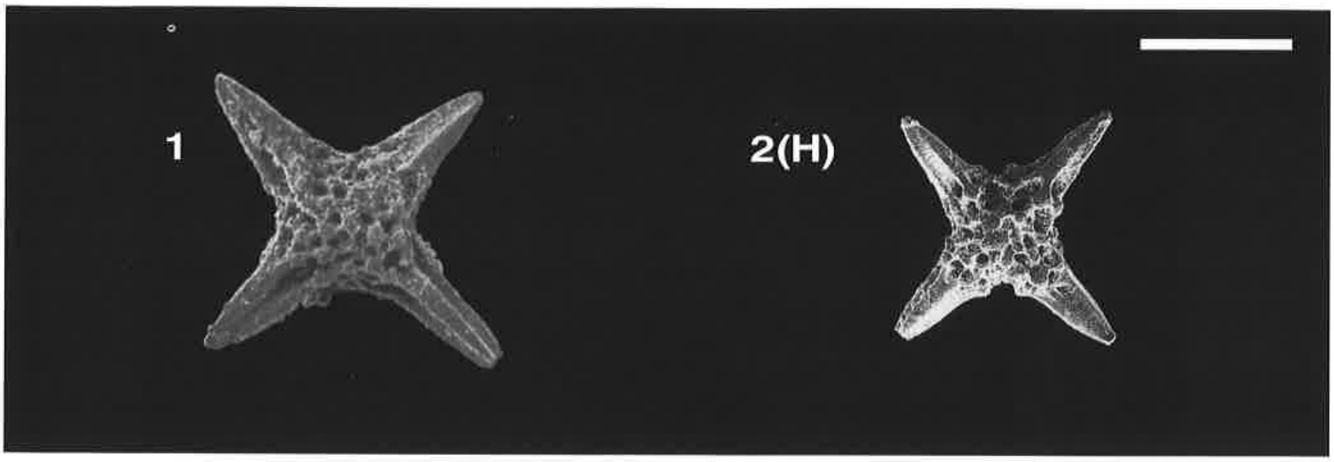


Plate 3212. *Emiluvia nana* n.sp. BAUMGARTNER. Magnification x200. **Fig. 1.** POB77/0519, POB28.51. **Fig. 2(H).** POB81/2195, 534.122.1.43.

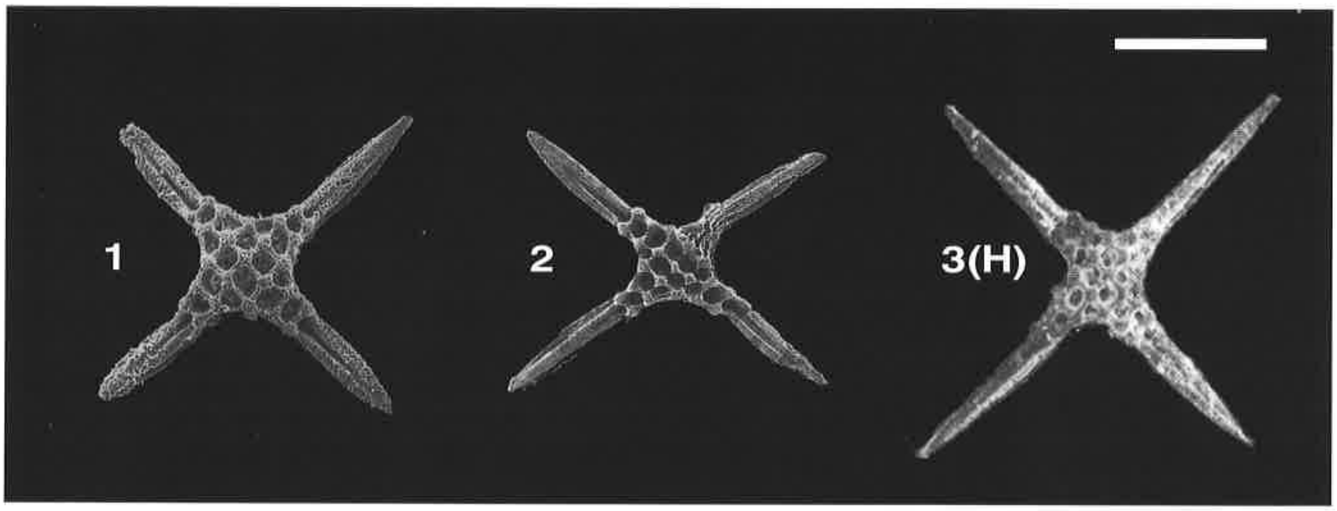


Plate 4015. *Emiluvia ordinaria* OZVOLDOVA. Magnification x100. **Fig. 1.** DW8119-16, ID200. **Fig. 2.** POB78/8109. **Fig. 3(H).** OZVOLDOVA & SYKORA 1984, pl. 4, fig. 7.

EMILUVIA OREA OREA 3224

Emiluvia orea orea BAUMGARTNER

Synonymy.-
Emiluvia orea BAUMGARTNER
BAUMGARTNER et al. 1980, p. 52, pl. 1, figs. 1-7.
KOCHER 1981, p. 64, pl. 13, fig. 8.
BAUMGARTNER 1984, p. 762, pl. 3, fig. 5
DE WEVER et al. 1986, pl. 7, figs. 3, 9.
ORIGLIA-DEVOS 1983, p. 107, pl. 14, figs. 11-12.

Original Definition.- Large form with stout spines and thick nodes. Cortical shell square in vertical view, discoidal to rectangular in lateral view. Top and bottom sides of cortical shell convex to planiform, lateral sides planiform, depressed due to lateral prominence of thick nodes of the outer layer. Outer layer composed of thick nodes connected by thin bars forming coarse tri- to tetragonal pore frames. Pores rounded, of equal or smaller size than nodes, or sometimes nearly covered by very thick nodes. Nodes placed irregularly or in faint diagonal (spine to spine) rows, with six to nine nodes per diagonal. The stout four spines are lanceolate with three broad ridges separated by narrow primary grooves. Internal structure: outer layer (see pl. 1, fig.7); the nodes are conical columns standing with their narrow end on the inner layer and continuing inwards as secondary radial beams. The bars are septae standing vertically between the nodes on the bars of the inner layer. Inner layer: the inner layer forms an overall discoidal cortical shell composed of uniform small meshwork as exposed on lateral sides. Primary radial beams in continuity with the spines, and secondary radial beams (see above) connect to the discoidal first medullary shell. It encloses a slightly smaller, fragile, second medullary shell, which is suspended by the continuing radial beams (see pl. 1, fig. 6).

Original Remarks.- This species differs from *E. pessagnoi* (to which it compares in size) by its much coarser and thicker developed outer layer with less nodes and by stouter spines. This species further differs from *E. chica* by its larger size and thicker outer layer.

Etymology.- *Orea* is a phonetical transcription of *oraios, -aia* = beautiful, very good in modern Greek.

Measurements (in μm).
Based on 13 specimens.

	HT	av.	min.	max.
Spine to spine with nodes:	203	209	186	265
Width between sides :	173	187	165	226
Width medullary shell:	-	57	50	70
Length of spines:	240-285	265	222	327
Width spines at the base:	53	55	44	68
No. nodes per diagonal:	6	7	6	9

Type Locality.- Angelokastron, Korinthos, Greece.

UAZones.- 8-11, mid Call.-early Oxf. to late Kimm.-early Tith.

EMILUVIA OREA ULTIMA 4070

Emiluvia orea ultima n. ssp. BAUMGARTNER & DUMITRICA

Synonymy.-
Emiluvia orea BAUMGARTNER
? AITA 1987, p. 63, pl. 13, fig. 8.

Type Designation.- DU1672, SV1635.

Original Definition.- Shell relatively large, drum-shaped, with concave lateral sides. Top and bottom sides of cortical shell convex to planiform, circular in axial view, commonly with 19 strong nodes arranged as follows: a central node surrounded by a circle of 6 nodes which in its turn is surrounded by a peripheral circle of 12 nodes forming the border of top and bottom sides. Of the last 12 nodes 2 are at the base of each primary spine and one in the bisector plane of the right angles made by the 4 spines. Nodes interconnected by thin bars forming triangular to quadrandular meshes which constitute the external layer of cortical shell. Inner layer, visible on lateral sides, has small pores in a more or less regular quincuncial disposition. Lateral sides free or covered with a patagium which gives to the entire shell a lenticular aspect. Spines three-bladed, lanceolate, co-planar, those disposed in an axis rotated 180° around this axis relative to those disposed in the perpendicular axis, so that if the former show on a face a groove the others show a blade. Medullary shell double, connected to cortical shell of top and bottom faces by a bunch of commonly 7 radial bars the distal ends of which correspond to externals nodes.

Original Remarks.- *Emiluvia orea ultima* n.ssp. differs from *E. orea orea* BAUMGARTNER in having a smaller number of nodes, in having very strong nodes concentrically arranged in two circles around a central node, in having a rather advanced cylindrical shape with concave lateral sides, and in having sometimes a patagium. It seems that the patagium is a later acquisiton of the subspecies as it is missing with older specimens (Upper Oxfordian-? Lower Kimmeridgian, sample SV.16) and always present with younger specimens (Kimmeridgian of sample Car. 19). The number and disposition of nodes as described under definition are rarely disturbed, a diagram constructed for a population of sample Car. 19 proving that they inscribe perfectly in a Gauss curve.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Diam. of shell:	220	217	200	237
Height of shell:	240	245	240	250
Length of spines:	140	192	140	235

Type Locality .- Svinita, West Carpathians, Romania.

UAZones.- 10-11, late Oxf.-early Kimm. to late Kimm.-early Tith.

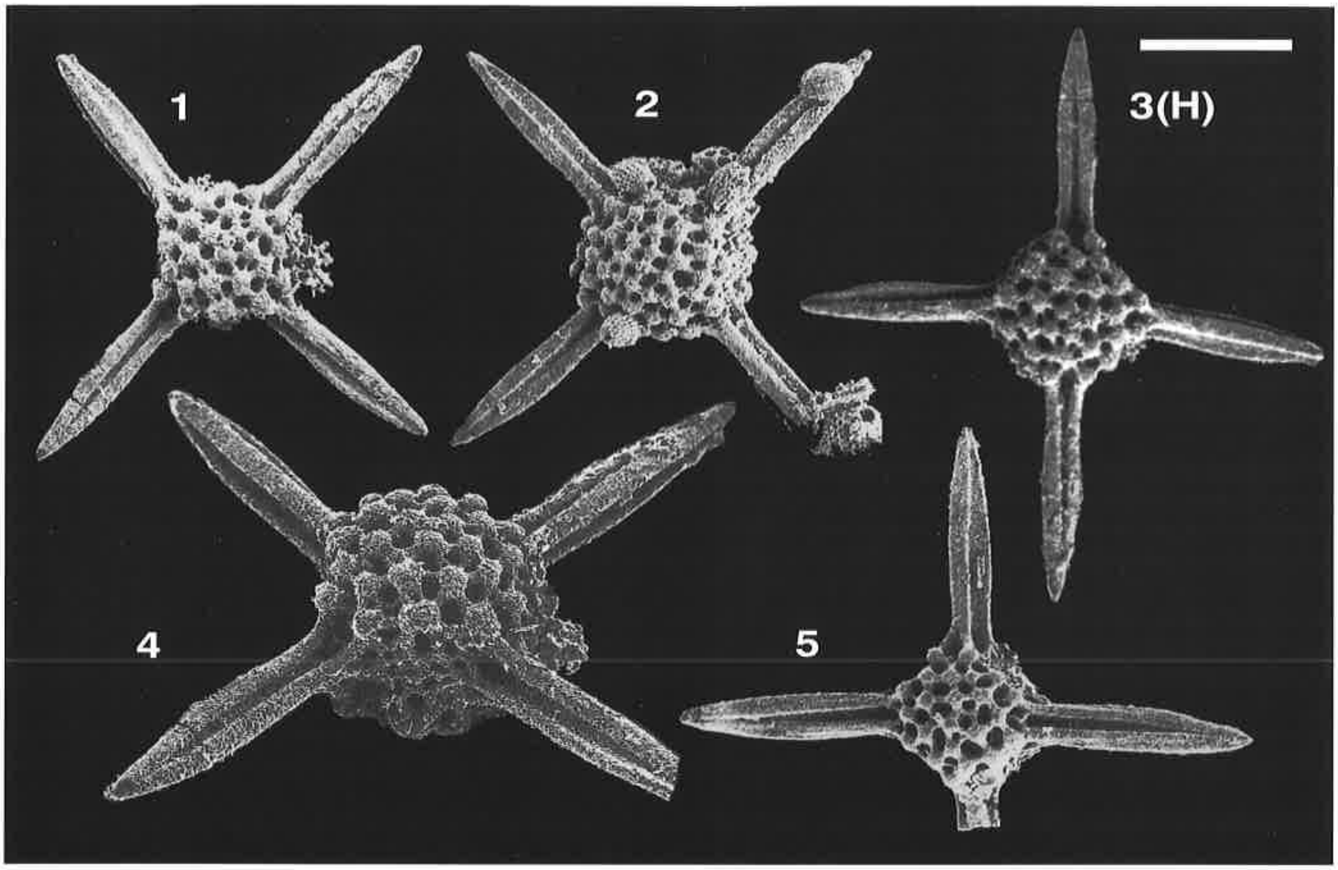


Plate 3224. *Emiluvia orea orea* BAUMGARTNER. Magnification x100, except Fig. 4 x150. **Fig. 1.** POB78/6107, POB899.50. **Fig. 2.** POB78/6104, POB899.50. **Fig. 3(H)**. POB78/6521, POB899.50. **Fig. 4.** POB78/6105, POB899.50. **Fig. 5.** POB78/6258, POB899.

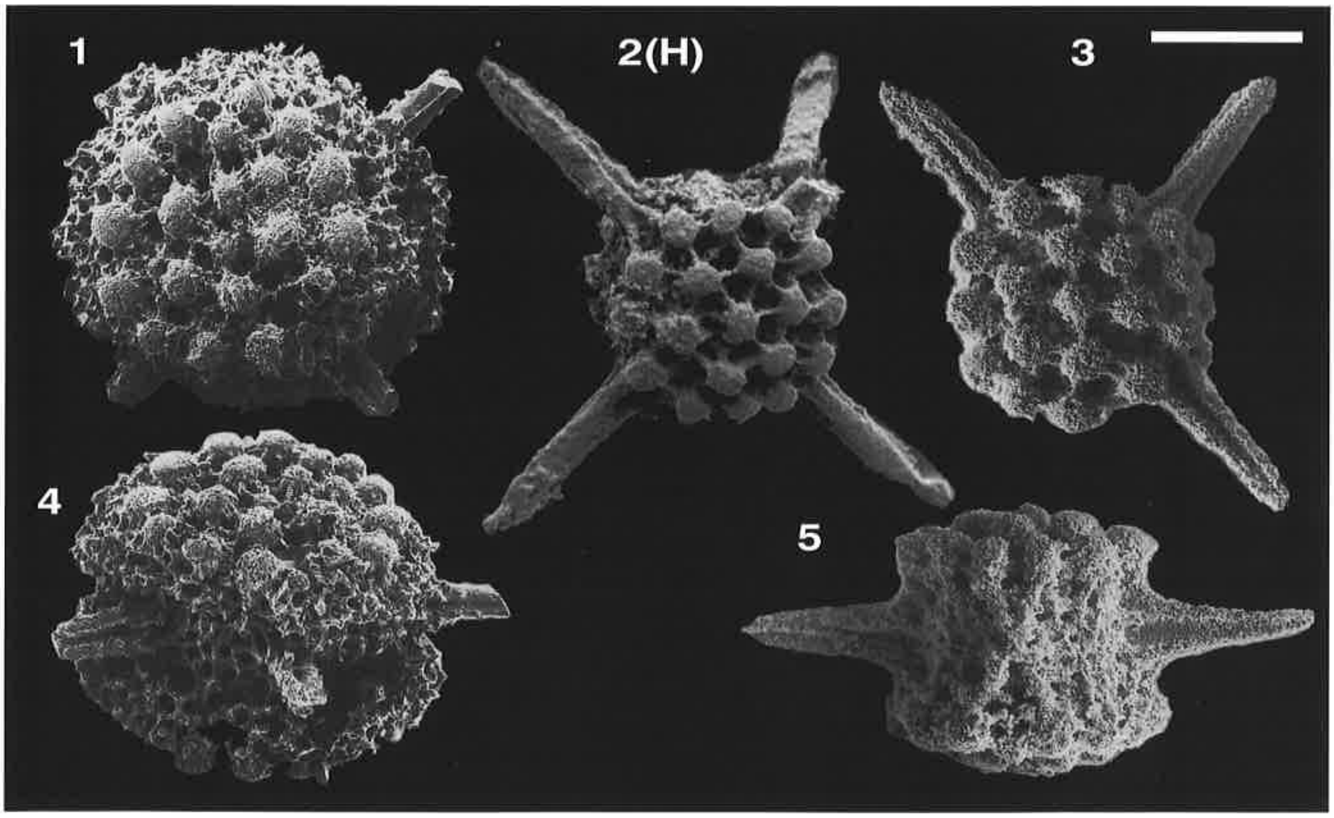


Plate 4070. *Emiluvia orea ultima* n.ssp. BAUMGARTNER & DUMITRICA. Magnification x150. **Fig. 1.** POB81/9044.76.534A.106.1.29 **Fig. 2(H)** DU1672, SV1635. **Fig. 3.** DU1671-2, SV1635. **Fig.4.** POB81/9059.76.534A.106.1.29 **Fig. 5.** DU1673, SV1635.

EMILUVIA PESSAGNOI S.L. 3066

Emiluvia pessagnoi s.l. FOREMAN

Synonymy.-
Emiluvia pessagnoi FOREMAN
FOREMAN 1973b, p. 262, pl. 8, fig. 6.
FOREMAN 1975, p. 612.
PESSAGNO 1977a, p. 76, pl. 5, fig. 8.
FOREMAN 1978, p. 744, pl. 1, figs. 1-2.
BAUMGARTNER et al. 1980, p. 53, pl. 1, fig. 10.
BAUMGARTNER 1984, p. 762, pl. 3, fig. 3.
JUD 1994, p. 77, pl. 10, figs. 1-2.
See also subspecies.

UAZones.- 4-17, late Baj. to late Val.

EMILUVIA PESSAGNOI MULTIPORA 3226

Emiluvia pessagnoi multipora STEIGER

Synonymy.-
Emiluvia pessagnoi FOREMAN
not FOREMAN 1973b, p. 262, pl. 8, fig. 6.
PESSAGNO 1977a, p. 76, pl. 5, fig. 8.
not FOREMAN 1978, p. 744, pl. 1, figs. 1-2.
BAUMGARTNER et al. 1980, p. 53, pl. 1, fig. 10.
AITA & OKADA 1986, p. 109, pl. 1, fig. 8.
DE WEVER et al. 1986, pl. 7, figs. 8, 10.
OZVOLDOVA 1988, pl. 3, fig. 4.
Emiluvia pessagnoi s.l. FOREMAN
BAUMGARTNER 1984, p. 762, pl. 3, fig. 3.
Emiluvia pessagnoi multipora STEIGER
STEIGER 1992, p. 54, pl. 15, figs. 1-2.

Original Definition.- "Quadranguar pillow shaped test with four triradiate primary spines and an irregular pore-pattern.

Large quadrangular pillow-shaped test with four long triradiate primary spines. The spines are located at the corners of the square. The pore pattern of the cortical shell is composed of irregularly distributed polygonal pore frames. A weak linear arrangement of pores can be recognized on some specimens. Nodes develop on the vertices of pore frames. Lateral sides of the shell show a meshwork of fine pores."

Original Remarks.- "This subspecies differs from *Emiluvia pessagnoi pessagnoi* FOREMAN by the irregular arrangement of pore frames. A comparison with a very similar species *Halodictya hojnosi* RIEDEL & SANFILIPPO (1974) is problematical. According to the diagnosis this species has a spongy patagium-like meshwork in the area of the arms. The morphotype with stronger spines assigned to *Halodictya* (?) *hojnosi* RIEDEL & SANFILIPPO by Baumgartner (1984) lacks a patagium and is probably closely related to the above described subspecies. The examined specimens doubtlessly allow recognition of transitions between both subspecies (E. *pessagnoi pessagnoi* and *E. pessagnoi multipora*). An initial trend to a regular arrangement of pores is observed especially with *Emiluvia pessagnoi multipora.*"

Remarks.- Specimens assigned herein to *Haliodictya hojnosi* have much weaker spines and are less than half the size of *Emiluvia pessagnoi multipora.*

Etymology.- *Multus*, numerous, *poros*, pore, referring to numerous pores on the cortical shell.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Diameter of shell:	240	250	220	280
Length of spines:	180	217	177	244

Type locality.- Gartenau, Ga39, quarry near St. Leonhard (Salzburg, Austria).

UAZones.- 8-14, mid Call.-early Oxf. to early-early late Berr.

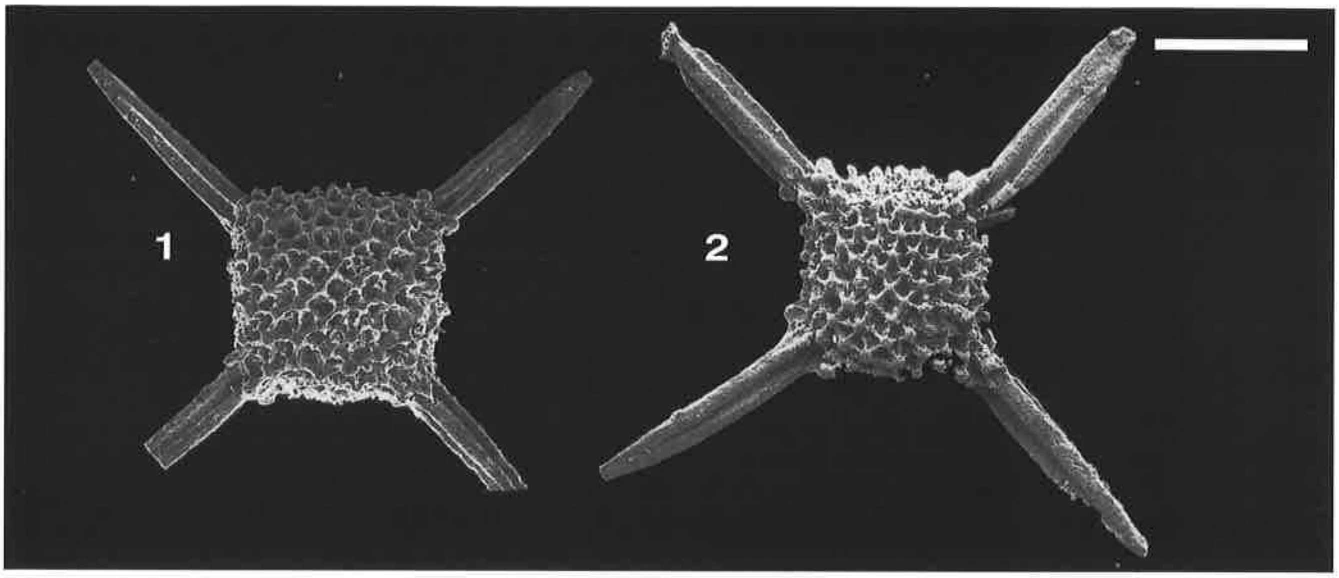


Plate 3066. *Emiluvia pessagnoi* s.l. FOREMAN. Magnification x150. **Fig. 1.** POB78/7611, POB986.51. **Fig. 2.** POB78/8201, POB986.51.

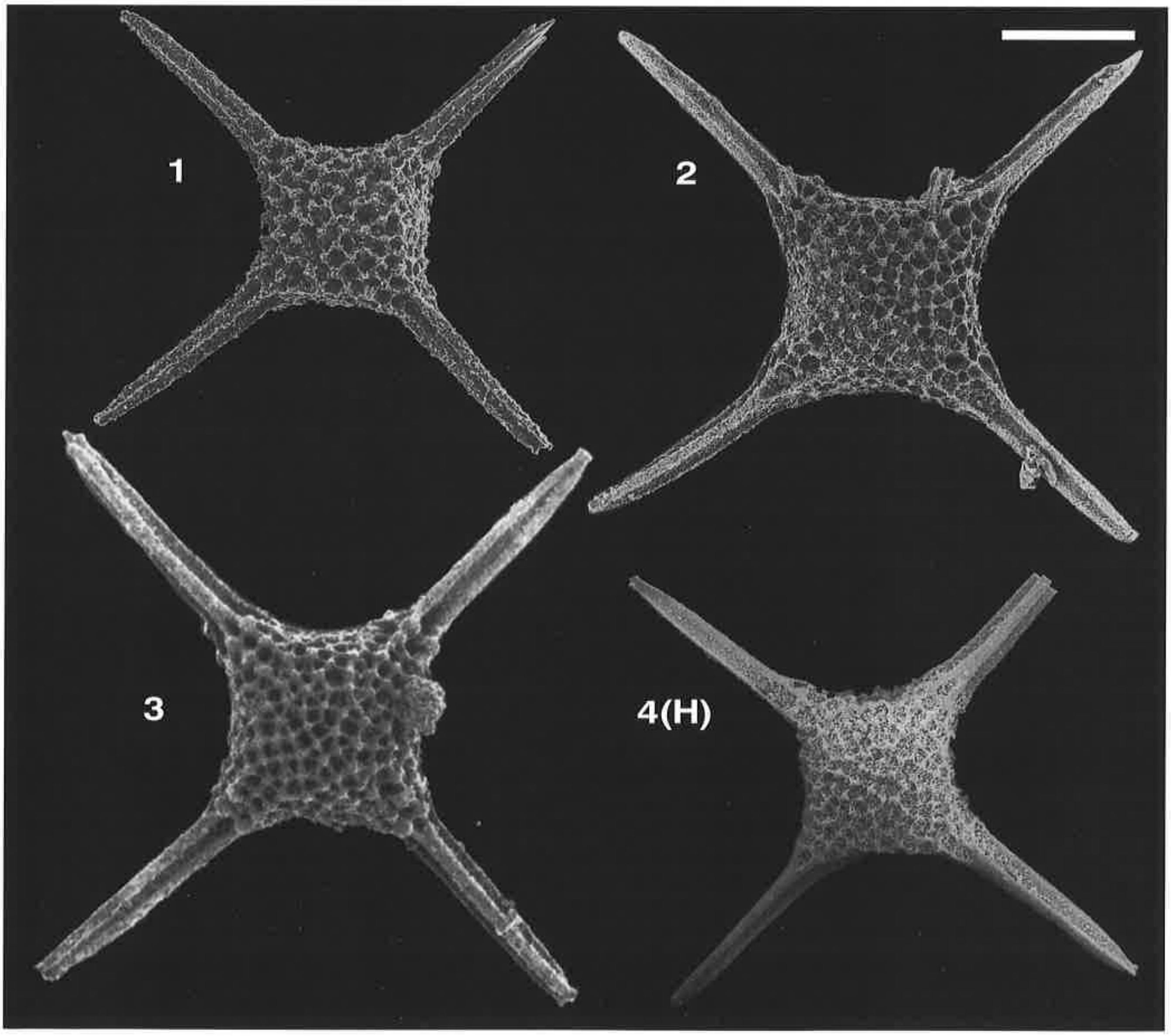


Plate 3226. *Emiluvia pessagnoi multipora* STEIGER. Magnification x150. **Fig. 1.** TS25, Ka31/2. **Fig. 2.** RJ82, Br28.85. **Fig. 3.** RJ37, Br1330. **Fig. 4(H).** TS35, Ga39/1.

EMILUVIA PESSAGNOI PESSAGNOI 4017

Emiluvia pessagnoi pessagnoi FOREMAN

Synonymy.-
Emiluvia pessagnoi FOREMAN
FOREMAN 1973b, p. 262, pl. 8, fig. 6.
not PESSAGNO 1977a, p. 76, pl. 5, fig. 8.
FOREMAN 1978, p. 744, pl. 1, figs. 1-2.
not BAUMGARTNER et al. 1980, p. 53, pl. 1, fig. 10.
not AITA & OKADA 1986, p. 109, pl. 1, fig. 8.
not DE WEVER et al. 1986, pl. 7, figs. 8, 10.
not OZVOLDOVA 1988, pl. 3, fig. 4.
Emiluvia pessagnoi s.l. FOREMAN
not BAUMGARTNER 1984, p. 762, pl. 3, fig. 3.

Original Definition.- The shell is large, rectangular with concave sides in transverse section, elliptical in vertical section. It bears a three-bladed spine at each corner of the rectangle, the four spines oriented as in a cross. All specimens observed had their spines broken so it is not known whether they are equal in length. The surface is covered with nodes which extend in two approximately parallel rows from each spine toward the center where they are less regularly arranged. Parallel bars connect the nodes near the spines to form triangles as in the pseudoaulophacidae. Nodes near the bases of the spines tend to be larger than those near the center of the shell.

Etymology.- This species is named for Emile Pessagno, Jr. in recognition of his work with the Pseudoaulophacidae of California.

Measurements (in μm).-
Based on 10 specimens. Width of shell from point midway beteeen spines to opposite side, 155-215 (185-215); approximate number of nodes from one spine to the opposite spine, 10-14.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 9-13, mid-late Oxf. to latest Tith.

EMILUVIA PREMYOGII 3210

Emiluvia premyogii BAUMGARTNER

Synonymy.-
Emiluvia chica FOREMAN
? SATO et al. 1982, pl. 3, fig. 14.
Emiluvia sp. B
WAKITA 1982, pl. 6, fig. 8.
EL KADIRI 1984, p. 34, pl. 5, fig. 9; pl. 6, figs. 1-2; pl. 26, fig. 9; not pl. 24, fig.1.
Emiluvia premyogii BAUMGARTNER
BAUMGARTNER 1984, p.762, pl. 3, figs. 6, 8-9, 11-12.
not DE WEVER & MICONNET 1985, p. 386, pl. 1, figs. 3-6.
AITA 1987, p. 63, pl. 1, fig. 3.
GORICAN 1987, p. 182, pl. 3, fig. 8.
DE WEVER et al. 1987, pl. A, fig. 1.
OZVOLDOVA 1988, pl. 6, fig. 2; pl. 8, fig. 4.
DANELIAN 1989, p. 150, pl. 4, figs. 10-11.
KITO 1989, p. 112, pl. 6, fig. 8.
KITO et al. 1990, pl. 1, fig. 9.
OZVOLDOVA 1990a, pl. 1, fig. 3.
CONTI & MARCUCCI 1991, pl. 1, fig. 18.
WIDZ 1991, p. 246, pl. 1, fig. 18.
PESSAGNO et al. 1993, p. 132, pl. 4, figs. 7, 12.
Emiluvia aff. *premyogii* BAUMGARTNER
DE WEVER & MICONNET 1985, pl. 1, fig. 8.

Original Definition.- Small *Emiluvia* with the 4 spines at right or slightly oblique angle (X-shaped). Opposed spines generally of unequal, adjacent spines of similar length. Nodes of central body placed on bars distinctly aligned with spines, forming 2 rows that meet in the center to form a cross. About 6 pairs of nodes between opposed spines. Center of cross forms a raised polygonal structure often with a central node. 4 large pores are placed around center, between the branches of cross. Additional lateral meshwork without significant nodes.

Original Remarks.- This species differs from other *Emiluvia* by having nodes distinctly aligned in the shape of a cross. *Emiluvia* sp. A of Kocher 1981 (p. 65, pl. 13, fig. 11) is not included, as it lacks the regular cross-shape of the central area.

Etymology.- Named in honour of Swami Prem Yogi alias Rudolph Kocher, for his contribution to Jurassic radiolarian stratigraphy.

Measurements (in μm).-
Based on 8 specimens.

	HT	spec.	min.	max.
Length of long spines AX:	130	148	95	218
Length of long spines BX:	127	-	-	-
Length of short spines CX:	120	129	92	165
Between base of spines :	95	114	95	139
Between concave sides :	77	83	71	111
Width of base of spines:	36	36	30	47

Type Locality.- Locality no.30 of locality descriptions (Baumgartner, 1984).

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

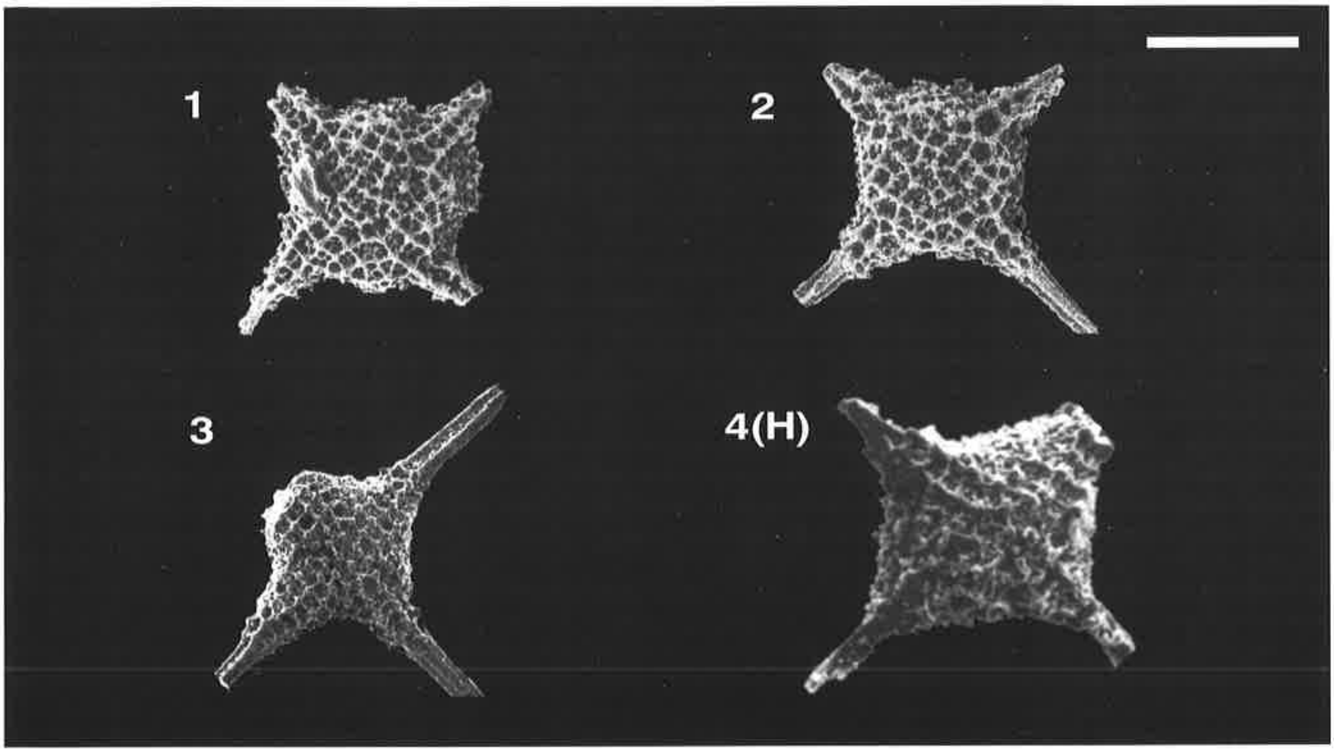


Plate 4017. ***Emiluvia pessagnoi pessagnoi*** **FOREMAN.** Magnification x100 **Fig. 1.** TS5312, KA63, **Fig. 2.** TS5311, Ka 63. **Fig. 3.** TS5310, GA39. **Fig. 4(H).** FOREMAN 1973b, pl. 8, fig. 6.

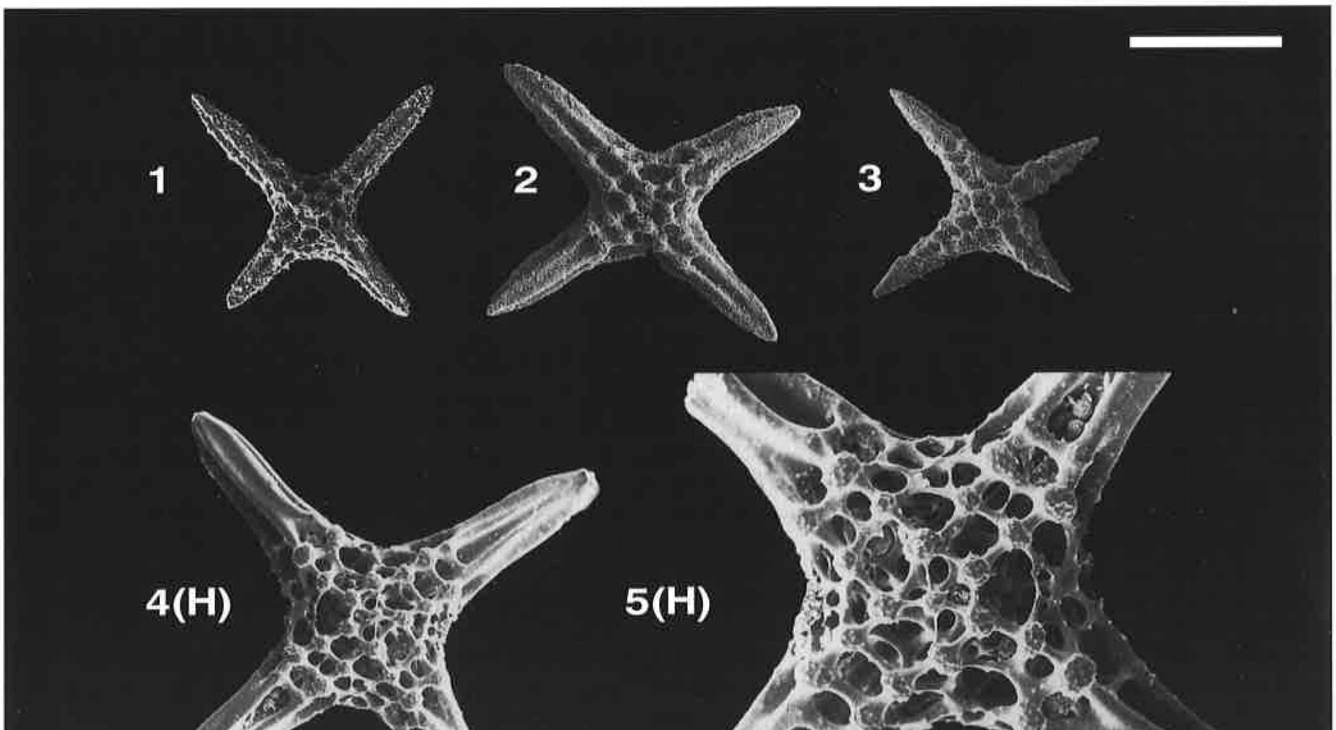


Plate 3210. ***Emiluvia premyogii*** **BAUMGARTNER.** Magnification x150, unless otherwise indicated. **Fig. 1.** POB78/6190, POB899.52. **Fig. 2.** DU 1807, R102. **Fig. 3.** DU1870, R102. **Fig. 4(H).** POB81/2424, 534.124.1.52, x300. **Fig. 5(H).** POB81/2425, 534.124.1.52, x500.

EMILUVIA SALENSIS 3215

Emiluvia salensis PESSAGNO

Synonymy.-
Emiluvia salensis PESSAGNO
PESSAGNO 1977a, p. 77, pl. 5, figs. 9-11.
KOCHER 1981, p. 65, pl. 13, fig. 10.
Emiluvia chica s.l. FOREMAN
ORIGLIA-DEVOS 1983, p. 106, pl. 14, fig. 5, not fig. 8.
Emiluvia sedecimporata salensis PESSAGNO
BAUMGARTNER 1984, p. 763, pl. 3, figs. 4, 7.
DE WEVER et al. 1986, pl. 6, figs. 21, 25- 26; pl. 7, fig. 5.
OZVOLDOVA 1990, pl. 3, fig. 5.
WIDZ 1991, p. 246, pl. 1, fig. 22.
Emiluvia salensis PESSAGNO groupe
DANELIAN 1989, p. 152, pl. 4, fig. 13.
Emiluvia sp.
CONTI & MARCUCCI 1991, pl. 1, fig. 19.

Original Definition.- Test with very massive nodes interconnected by bars to form square to triangular pore frames; pore frames predominantly square. Nodes extending onto base of spines. Four primary spines long, triradiate in axial section.

Original Remarks.- *Emiluvia salensis* n.sp. differs from *E. chica* FOREMAN by virtue of its extremely long spines and more massive, uniformly sized nodes.

Remarks.- This form is characterized by its totally flat surface of the central area.

Measurements (in μm).-
Based on 7 specimens. Length of test: 80 to 100. Width of test: 80 to 100. Length of spines: 150 to 220.

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 4-13, late Baj. to latest Tith.

EMILUVIA SEDECIMPORATA 3216

Emiluvia sedecimporata (RÜST)

Synonymy.-
Staurosphaera sedecimporata RÜST
RÜST 1885, p. 288, pl. 28(3), fig. 1.
Staurosphaera sedecimporata RÜST var. *elegans*
WISNIOWSKI 1889, p. 683, pl. 13, fig. 48.
Emiluvia sedecimporata elegans (WISNIOWSKI)
BAUMGARTNER 1984, p. 763, pl. 3, fig. 2.
OZVOLDOVA 1988, pl. 1, fig. 7.
WIDZ 1991, p. 246, pl. 1, fig. 26.
Emiluvia sedecimporata (RÜST)
ORIGLIA-DEVOS 1983, p. 110, pl. 14, figs. 13-14.
OZVOLDOVA & SYKORA 1984, pl. 3, figs. 5, 7.
SCHAAF 1984, p. 152-153, fig. 8.
DE WEVER et al. 1986, pl. 6, fig. 20.
DANELIAN 1989, p. 152, pl. 4, figs. 14-15.

Original Definition.- "Instead of a sphere almost a square, with corners extending into four strong spines"

Actualized Remarks.- (BAUMGARTNER, 1984) This name is used to denominate forms with a clearly square pore pattern of 16 similar pores as illustrated by Rüst (1885) and Wisniowski (1889). Nodes on quadruple junctions are moderately developed, a pair of nodes sits at the base of each spine.

Measurements (in μm).-
Diameter of square: 156, length of spines: 16.

Type Locality.- Aptychus Beds, Urshau, Germany.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

EMILUVIA SPLENDIDA 2002

Emiluvia splendida CARTER

Synonymy.-
Emiluvia splendida CARTER
CARTER et al. 1988, p. 35, pl. 16, figs. 5, 11.

Original Definition.- Test square and inflated with four massive corner spines. Upper and lower surfaces of test slightly convex and covered with well developed nodes connected by thin bars. Nodes much smaller on vertical sides of test. Pore frames square to triangular: inner pore frames small, subtriangular to irregularly polygonal. Spines sturdy with alternating longitudinal ridges and grooves. Ridges flattened, grooves wide, approximately 1.5 times width of ridges; ridges enlarge slightly at tips, extensions blunt-ended; central axis of spine extends to a fine point.

Original Remarks.- This species has affinity with *Emiluvia hopsoni* PESSAGNO, but differs in having more convex surfaces, less massive nodes and much smaller crown-like structures on spine tips.

Etymology.- Latin, *splendidus* (adj.), bright, shining.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Diameter of test:	124	118	110	110
Length of longest spine:	133	114	100	133

Type Locality.- GSC locality C-080595. Graham Island, British Colombia.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

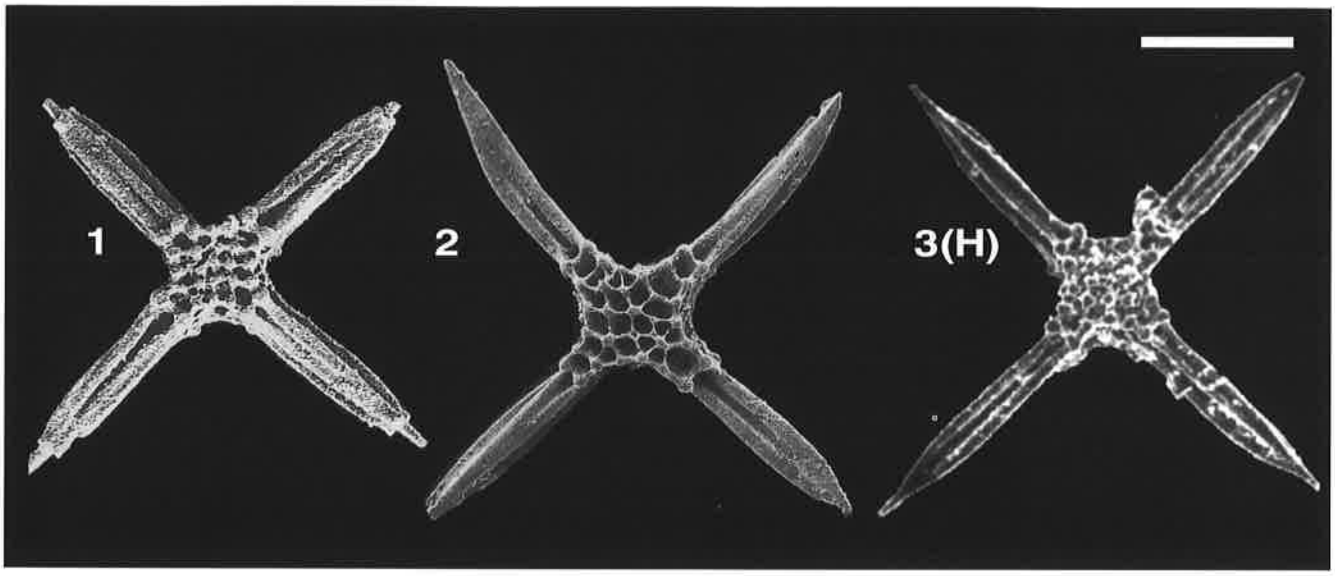


Plate 3215. ***Emiluvia salensis*** **PESSAGNO.** Magnification x150. **Fig. 1.** POB78/6143, POB899.51. **Fig. 2.** POB78/8204, POB986.51. **Fig. 3(H).** PESSAGNO 1977a, pl. 5, fig. 9.

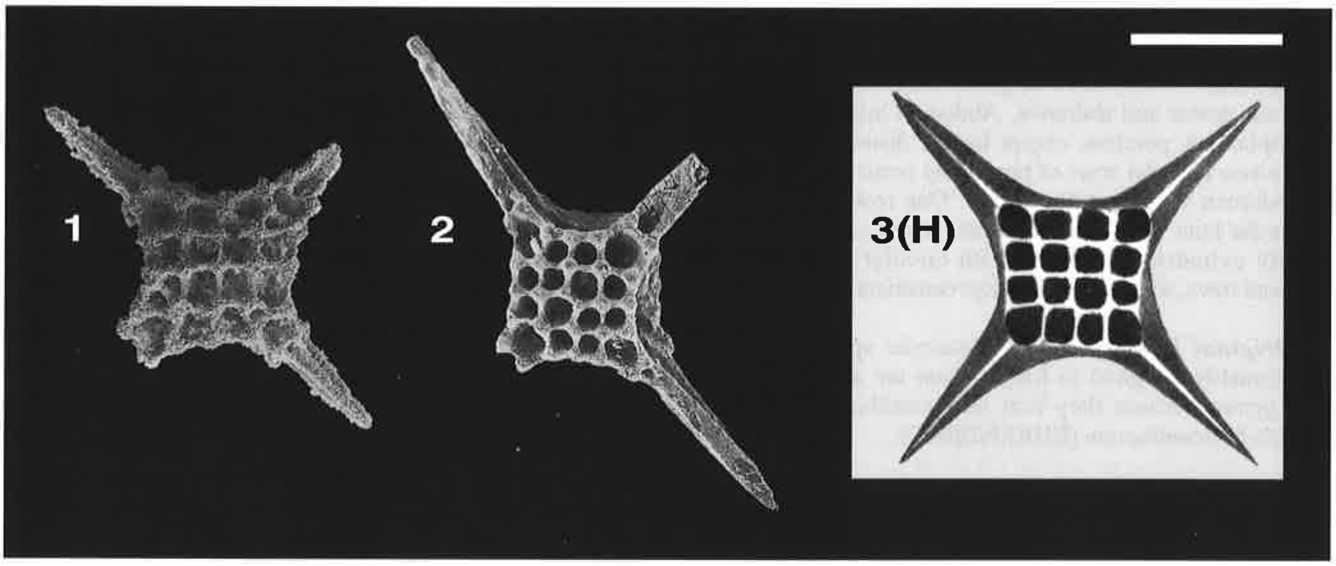


Plate 3216. ***Emiluvia sedecimporata*** **(RÜST).** Magnification x150. **Fig. 1.** DU1692, SV1635. **Fig. 2.** POB78/8107, POB986.52. **Fig. 3(H).** RÜST 1885, pl. 28(3), fig. 1.

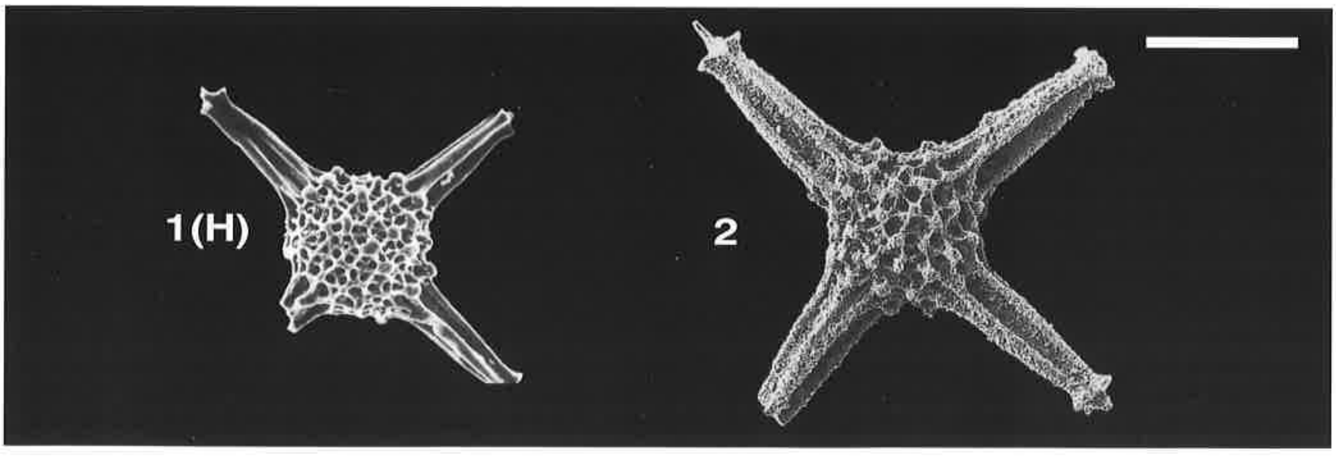


Plate 2002. ***Emiluvia splendida*** **CARTER**. Magnification x200. **Fig. 1(H).** CARTER et al. 1988, pl. 16, fig. 5. **Fig. 2.** POB 81/0000, POB 1341.

espartoensis >> *CRUCELLA ESPARTOENSIS AFF.* 5196

EUCYRTIDIELLUM 3632

Genus: *Eucyrtidiellum* BAUMGARTNER

Synonymy.-
Eucyrtidiellum BAUMGARTNER
BAUMGARTNER 1984, p. 764.
TAKEMURA 1986, p. 66.
NAGAI & MIZUTANI 1990, p. 593.
Monosera TAKEMURA & NAKASEKO
TAKEMURA & NAKASEKO 1986, p. 1021.

Type Species.- *Eucyrtidium* (?) *unumaensis* YAO 1979.

Original Definition.- Test composed of four segments. Cephalis small, spherical, poreless with variably developed straight or slightly oblique apical horn, rare forms with apical and vertical horn. A sutural pore is present at collar stricture or on proximal portion of thorax. Thorax dome-shaped, poreless, with irregular ornamentation consisting of ridges and nodes leaving depressions ("closed pores" of some authors) or with plicae. One or two rows of pores may occur at stricture between thorax and abdomen. Abdomen inflated annular to hemispherical, poreless, except for the distal quarter, where one to two irregular rows of pores may occur. Ornamentation of abdomen varying with species. One row of large pores marks the joint with fourth segment. Fourth segment delicate, mostly cylindrical, covered with circular pores in loose diagonal rows, with a distal poreless constriction.

Original Remarks.- The Mesozoic species hitherto questionably assigned to *Eucyrtidium* are assigned to this new genus, because they bear no resemblance to the type species *E. acuminatum* (EHRENBERG).

Actualized Remarks.- (NAGAI & MIZUNATI, 1990). Before *Eucyrtidiellum* was defined by Baumgartner (1984), the Mesozoic species belonging to this genus had been questionably regarded and denoted as *Eucyrtidium* (?), because they bear no exact resemblance to the type species, *Eucyrtidium acuminatum* EHRENBERG. According to the original description of *Eucyrtidium* (Foreman & Riedel, 1972), its test has segments with two or more strictures, and the type species *Eucyrtidium acuminatum* has eight segments. Contrary to this morphological definition, most, if not all, of Mesozoic species have only three or four segments. The first segment, cephalis, is small, spherical or subspherical and poreless with an apical horn that is either straight or slightly curved and mostly small in size. The 2nd segment, thorax, is dome-shaped and poreless in almost all species, and has ornamentation consisting of irregular ridges with depressions, nodes or plicae. There are many pores at the stricture between the second and third segments. The third segment, abdomen, is inflated annular to hemispherical. Surface of the abdomen is generally smooth, but varies according to species; it is, for instance, pored or plicate. Post-abdominal segment is mostly cylindrical and may have a row of large pores on the stricture. There are only a few extant examples of the post-abdominal structure, because this segment is extremely delicate and easily disrupted.

Included Taxa.-
3014 *Eucyrtidiellum nodosum* WAKITA
3017 *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)
3019 *Eucyrtidiellum pyramis* (AITA)
3048 *Eucyrtidiellum* (?) *quinatum* TAKEMURA
3016 *Eucyrtidiellum semifactum* NAGAI & MIZUTANI
3052 *Eucyrtidiellum unumaense* s.l. (YAO)
3015 *Eucyrtidiellum unumaense dentatum* n.ssp. BAUMGARTNER
3013 *Eucyrtidiellum unumaense pustulatum* BAUMGARTNER
3012 *Eucyrtidiellum unumaense unumaense* (YAO)

EUCYRTIDIELLUM NODOSUM 3014

Eucyrtidiellum nodosum WAKITA

Synonymy.-
Eucyrtidium ? sp. B
? ISHIDA 1983, pl. 9, fig. 8.
Eucyrtidiellum sp.
BAUMGARTNER 1985, fig. 38.m.
Eucyrtidiellum sp. aff. *E. unumaense* (YAO)
MATSUOKA 1986a, pl. 2, fig. 9; pl. 3, fig. 10.
Eucyrtidiellum nodosum WAKITA
WAKITA 1988, p. 408, pl. 4, fig. 29; pl. 5, fig. 16.
NAGAI 1988, pl. 1, fig. 5, pl. 2, fig. 6.
MATSUOKA 1990, pl. 2, fig. 8.
MATSUOKA 1992, pl. 4, fig. 10.

Original Definition.- Cephalis small, spherical with a small apical horn. Thorax with irregular small nodes. Whole portion of abdomen with relatively regular ornamentation consisting of larger nodes than those of thorax.

Original Remarks.- This species differs from *E. unumaensis* (YAO) by having a nodose abdomen and from *E. pustulatum* BAUMGARTNER by having larger and more regular nodes which cover the whole abdomen.

Remarks.- This species is similar to *Eucyrtidiellum gujoense* (TAKEMURA & NAKASEKO) (1986, pl. 1022, figs. 4.10-11; 5.1-3). It differs from the latter by having closed pores and regularly aranged well-pronounced small spines on the surface of the thorax and abdomen. Smaller spines can be observed even on the cephalis. The cephalis of *E. gujoense* is completely smooth.

Etymology.- *Nodosus* (Latin) = nodose.

Measurements (in μm).-
Based on 9 specimens. Total height, 93-120 (108); H/W of thorax, 27-45 (34)/37-53 (47); H/W of abdomen, 53-80 (66)/80-100 (92).

Type Locality.- Hida-Kanayama area, central Japan.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

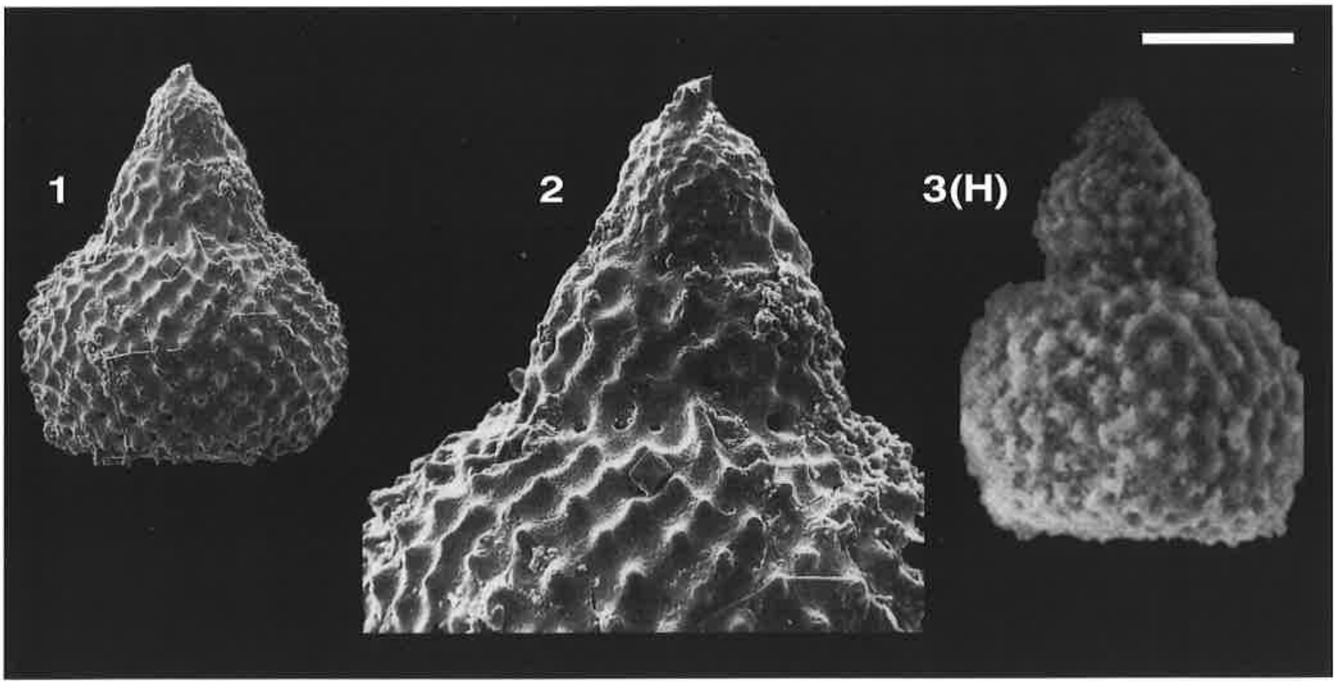


Plate 3014. *Eucyrtidiellum nodosum* WAKITA. Magnification x450, except Fig. 2 x900. **Fig. 1.** POB81/2218, 534.122.1.43. **Fig. 2.** POB81/2219, 534.122.1.43. **Fig. 3(H).** WAKITA 1988a, pl. 4, fig. 29.

EUCYRTIDIELLUM PTYCTUM 3017

Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)

Synonymy.-

Eucyrtidium ptyctum RIEDEL & SANFILIPPO
RIEDEL & SANFILIPPO 1974, p. 778, pl. 5, fig. 7; pl. 12, fig. 14, not fig. 15.
BAUMGARTNER & BERNOULLI 1976, p. 617, pl. 11e, g, not f.
BAUMGARTNER et al. 1980, p. 53, pl. 3, fig. 13.
AITA 1982, pl. 2, figs. 8, 9a-b, not fig. 10.
NISHIZONO et al. 1982, pl. 2, fig. 12.
YAO 1984, pl. 2, fig. 30.
SANFILIPPO & RIEDEL 1985, p. 618, figs. 4 b, d, ? 4 a, c.

Eucyrtidium (?) *ptyctum* RIEDEL & SANFILIPPO
PESSAGNO 1977a, p. 94, pl. 12, fig. 7.
FOREMAN 1978, pl. 2, fig. 5.
MIZUTANI 1981, p. 182, pl. 64, figs. 1a-b, 2.
ADACHI 1982, pl. 3, figs. 7-8.
AOKI & TASHIRO 1982, pl. 3, figs. 1-3; pl. 4, fig. 10.
OKAMURA & UTO 1982, pl. 6, fig. 18.
MIZUTANI et al. 1982, p. 57, pl. 4, fig. 5.
ISHIDA 1983, pl. 9, fig. 4.
NAKASEKO et al. 1983, fig. 2.12
YAMAMOTO 1983, pl. 1, fig. 4.
TAKASHIMA & KOIKE 1984, pl. 2, fig. 5.
AITA 1985, fig. 7.14.
MATSUOKA & YAO 1985, pl. 2, fig. 8.
TANAKA et al. 1985, pl. 1, fig. 16.
AITA & OKADA 1986, p. 109, pl. 6, figs. 14-17; pl. 7, figs. 3a-b.
MATSUOKA & YAO 1986, pl. 2, fig. 10.
IWATA & TAJIKA 1989, pl. 5, fig. 1.
MATSUOKA 1992, pl. 4, fig. 9.

Eucyrtidium ? ptyctum RIEDEL & SANFILIPPO
DUMITRICA & MELLO 1982, pl. 3, fig. 10, not fig. 9.
NISHIZONO & MURATA 1983, pl. 4, fig. 7.
ISHIDA 1985, pl. 3, fig. 15.

"*Eucyrtidium* "*ptyctum* RIEDEL & SANFILIPPO
PESSAGNO et al. 1984, p. 30, pl. 4, figs. 12-14.

Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
BAUMGARTNER 1984, p. 764, pl. 4, figs. 1-3.
BAUMGARTNER 1985, fig. 38.l.
MATSUOKA 1986a, pl. 2, fig. 10.
NAGAI 1986, p. 14, pl. 2, fig. 7.
AITA 1987, p. 65, pl. 4, figs. 12a-b; pl. 10, fig. 14; pl. 14, fig. 3.
KOJIMA & MIZUTANI 1987, p. 260, pl. 4, figs. 12-13.
NAGAI 1987, pl. 3, figs. 5a-c, 6.
KAWABATA 1988, pl. 2, fig. 12.
NAGAI 1988, pl. 2, figs. 4a-b.
WAKITA 1988, pl. 4, fig. 28, pl. 5, fig. 17.
KOJIMA 1989, pl. 2, figs. 7a-b.
NAGAI & MIZUTANI 1990, p. 595, pl. 3, figs. 5a-b.
YAO 1991, pl. 4, fig. 15.

Eucyrtidiellum cf. *ozaiense* (AITA)
WIDZ 1991, p. 246, pl. 1, fig. 23.

Eucyrtidiellum sp. aff. *E. ptyctum* (RIEDEL & SANFILIPPO)
PESSAGNO et al. 1993, p. 135, pl. 5, fig. 9.

Original Definition.- Form usually of three segments, with only a trace of a fourth preserved. Cephalis subspherical, in some specimens with an apical horn and thorax inflated-hemispherical-these two segments poreless, hyaline. Third segment inflated-annular, usually with broad longitudinal plicae, hyaline, poreless, or with irregularly arranged small pores in the distal quarter. Some specimens have fragments of delicate shell wall indicating the presence of a fourth segment.

Original Remarks.- This species is distinguished by the third segment being broadly costate, and/or having small pores grouped in its distal part.

Actualized Definition.- (BAUMGARTNER, 1984) Under this name are included only forms with tiny, short horn (if preserved) and abdomen with regular, well developed broad vertical plicae (about 7 to 12 visible per half circumference), which tend to terminate near the irregular row of pores at the base of abdomen. Kocher (1981), instead, included also forms with less distinct plicae (transitional forms to *E. unumaensis*) and forms with plicae originating on thorax possibly belonging to another genus. The narrower definition explains the later first occurence of *E. ptyctum* in this paper, compared to Kocher's (1981) data.

Etymology.- The specific name is derived from the Greek adjective *ptyctos*.

Measurements (in μm).-
Based on 20 specimens. Total length of three segments (excluding horn) 75-110, maximum breadth 65-90.

Type Locality.- Point Sal, California.

UAZones.- 5-11, latest Baj.-early Bath. to late Kimm.-early Tith.

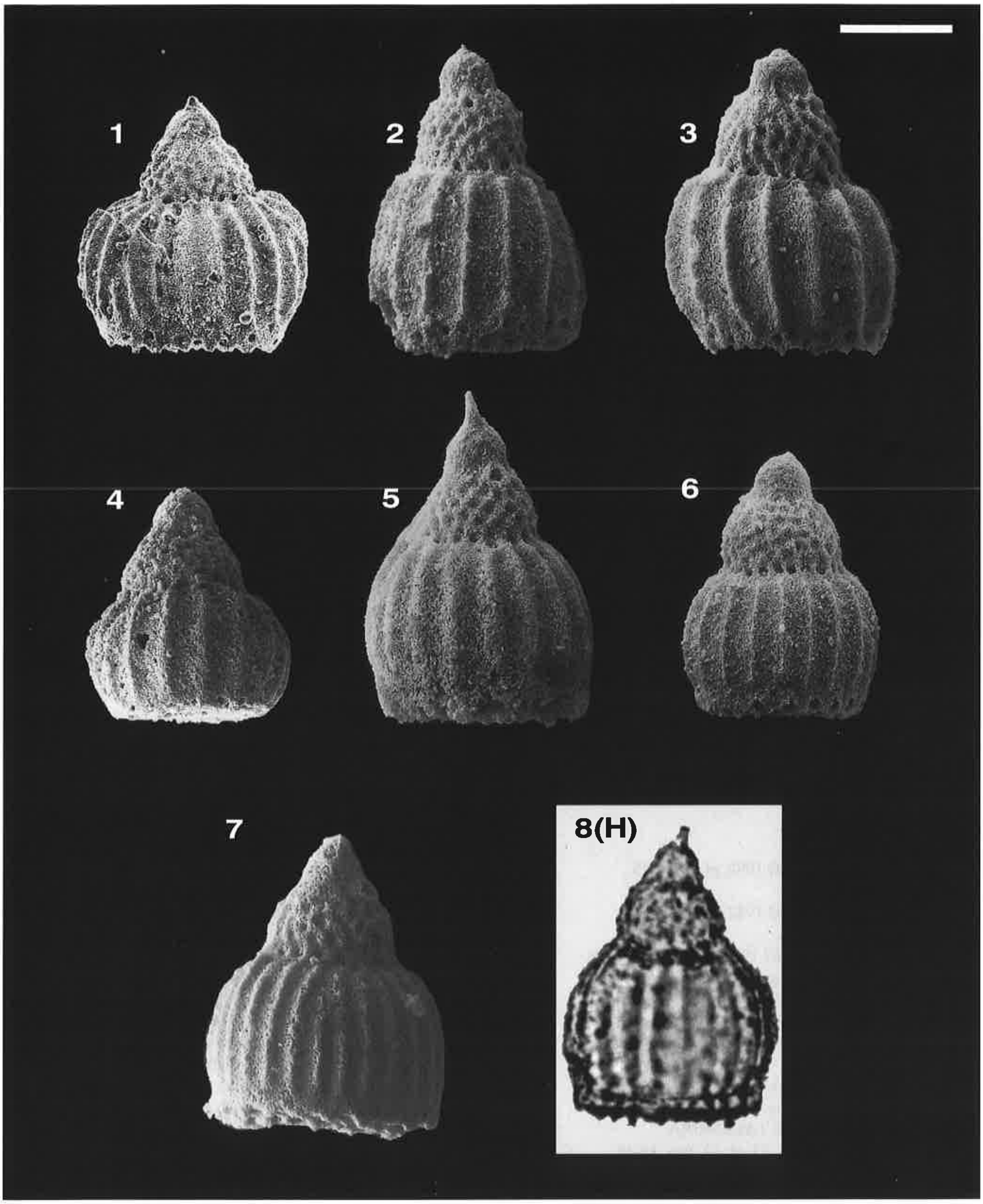


Plate 3017. ***Eucyrtidiellum ptyctum*** **(RIEDEL & SANFILIPPO).** Magnification x450. **Fig. 1.** POB80/3798, POB325. **Fig. 2.** DU1951, R102. **Fig. 3.** DU2459, PJ25. **Fig. 4.** GO901915, Bj15/1. **Fig. 5.** DU2977, PJ12. **Fig. 6.** DU1925, R102. **Fig. 7.** GO900516, UPC18. **Fig. 8(H).** RIEDEL & SANFILIPPO 1974, pl. 12, fig. 14.

EUCYRTIDIELLUM PYRAMIS 3019

Eucyrtidiellum pyramis (AITA)

Synonymy.-
Eucyrtidium sp.
NISHIZONO et al. 1982, pl. 2, fig. 11.
Eucyrtidium (?) sp.
AOKI 1982, pl. 2, fig. 20.
Eucyrtidium (?) *ptyctum* RIEDEL & SANFILIPPO
OKAMURA 1980, pl. 20, fig. 10.
MATSUYAMA et al. 1982, pl. 1, fig. 4.
Eucyrtidium sp. C
NISHIZONO & MURATA 1983, pl. 4, fig. 12.
Eucyrtidium (?) *pyramis* AITA
AITA & OKADA 1986, p. 109, pl. 6, figs. 8-13; pl. 7, figs. 1a-b.
Eucyrtidium (?) *ozaiense* AITA
AITA & OKADA 1986, p. 109, pl. 6, figs. 1-5; pl. 7, figs. 2a-b.
Eucyrtidiellum ozaiense (AITA)
NAGAI 1986, pl. 2, fig. 8.
AITA 1987, p. 65, pl. 14, fig. 1.
KAWABATA 1988, pl. 2, fig. 13.
YASUDA 1989, pl. 1, fig. 18.
Eucyrtidiellum pyramis (AITA)
AITA 1987, p. 65, pl. 14, fig. 2.
WAKITA 1987, pl. 1, figs. 13, 15-16.
WAKITA 1988, pl. 6, figs. 21-23.
Eucyrtidiellum sp. aff. *E. pyramis* (AITA)
WAKITA 1987, pl. 1, fig. 14.
WAKITA 1988, pl. 6, fig. 24.
Eucyrtidiellum cf. *pyramis* (AITA)
YAMAGATA 1989, pl. 2, figs. 14-15.

Original Definition.- Shell of three segments; cephalo-thorax forming short, smooth cone. Cephalis conical, poreless, smooth, without apical horn, and with type of internal spicular similar to that of *E. ozaiense,* with two large collar pores. Collar stricture indistinct, with small circular, sutural pore. Thorax truncate-conical to hemispherical, poreless, with longitudinal plicae. Lumber stricture distinct. Abdomen inflated-annular, poreless, and with 9 to 11 longitudinal plicae.

Remarks.- Specimens with a nodose thorax are included under this species. *Eucyrtidiellum ozaiense* (AITA) is treated as a synonym of *E. pyramis* (AITA). These two forms can be separated at the subspecies level. *E. pyramis* differs from *E. ptyctum* in being larger, and having a smoother cone of the cephalo-thorax with longitudinal plicae or a nodose thorax.

Etymology.- The specific name is derived from the Latin *pyramis*, noun meaning a pyramid or a cone.

Type Locality.- Komikuchi Formation, Kochi Prefecture, southwest Japan.

UAZones.- 12-13, early-early late Tith. to latest Tith.

EUCYRTIDIELLUM (?) QUINATUM 3048

Eucyrtidiellum (?) *quinatum* TAKEMURA

Synonymy.-
Eucyrtidium (?) sp. A
KISHIDA & SUGANO 1982, pl. 7, fig. 13.
Eucyrtidium (?) sp. C
KISHIDA & SUGANO 1982, pl. 8, fig. 20.
Eostichomitra ? sp.
KISHIDA & SUGANO 1982, pl. 10, figs. 15-16.
Stichocapsa sp. aff. *S. japonica* YAO
BAUMGARTNER 1984, p. 786, pl. 8, fig. 20.
BAUMGARTNER 1985, fig. 37.k.
not CARTER et al. 1988, p. 62, pl. 15, fig. 7.
HORI 1990, fig. 9.50.
Stichomitra japonica YAO
ISHIDA 1985, pl. 1, fig. 7.
Eucyrtidiellum quinatum TAKEMURA
TAKEMURA 1986, p. 67, pl. 12, figs. 16-18.
HATTORI 1988a, pl. 9, fig. A.
HATTORI & SAKAMOTO 1989, pl. 9, figs. L- M; pl. 10, fig. A.
KITO et al. 1990, pl. 1, fig. 1.
Eucyrtidiellum ? sp.
TAKEMURA 1986, p. 68, pl. 12, fig. 19.
Eucyrtidielllum aff. *quinatum* TAKEMURA
HATTORI 1987, pl. 12, figs. 18-19.
Eucyrtidiellum sp.
YAO 1991, pl. 2, fig. 21.

Original Definition.- Shell with five segments, with distinct strictures at joints. Cephalis small, spherical and poreless, without an apical horn. Thorax truncate-conical with relict pores. Abdomen truncate-conical to barrel-shaped, without pores. The fourth and widest segment barrel shaped, with irregularly distributed small pores and with small nodes, pore frames or ridges on its surface. The fifth and terminal segment barrel-shaped to ellipsoid shaped, with irregularly distributed pores, thinner wall possessing smooth or somewhat rough surface, and circular aperture on its base. In some specimens, the fifth segment broken off.

Original Remarks.- The cephalic skeletal structure and the shell structure of the proximal three segments of *Eucyrtidiellum quinatum* n.sp. is almost the same like those of *E. unumaensis* (YAO). However, this new species differs from the other species of *Eucyrtidiellum* in the possession of the widest fourth segment and the terminal fifth segment.

Remarks.- Included are also specimens with only 4 segments, if the 4th segment has a regularly nodose surface.

Etymology.- Latin *quinatum*, meaning five.

Measurements (in μm).-
Based on 7 specimens. Length of shell, 170-225; Length of proximal 4 segments, 120-165; Max. width of shell, 110-125.

Type Locality.- Maganese carbonate ore deposit, TKN-105. Gujo-Hachiman area, Mino Terrane, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

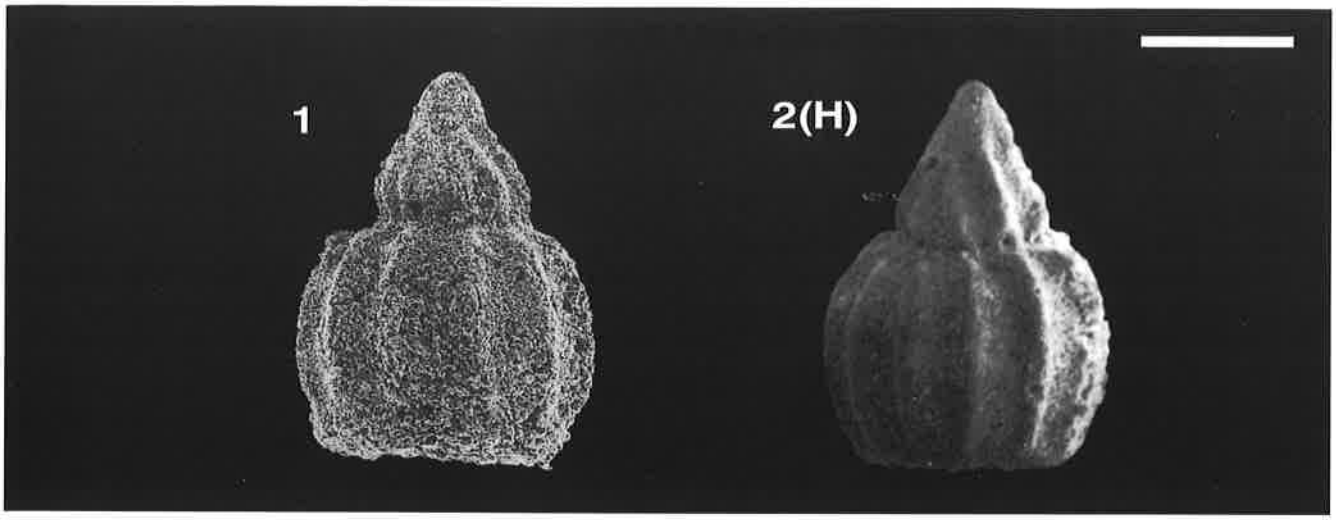


Plate 3019. ***Eucyrtidiellum pyramis*** **(AITA).** Magnification x450. **Fig. 1.** GO892021, GL142. **Fig. 2(H).** AITA & OKADA 1986, pl. 6, fig. 10.

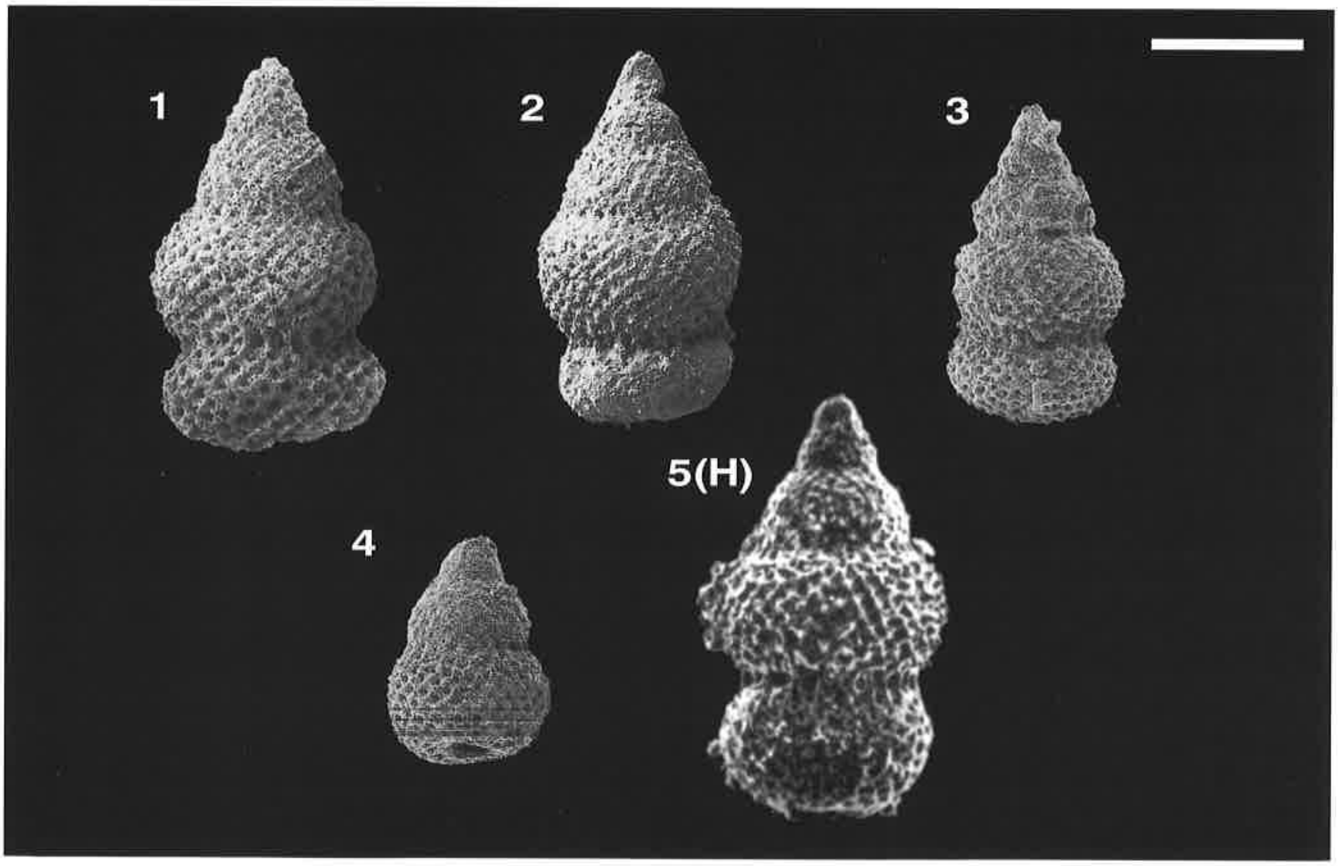


Plate 3048. ***Eucyrtidiellum*** **(?)** ***quinatum*** **TAKEMURA.** Magnification x250. **Fig. 1.** POB81/2970, POB1341. **Fig. 2.** POB80/2150, POB1263. **Fig. 3.** GO890428, GL127. **Fig. 4.** GO890429, GL127. **Fig. 5(H).** TAKEMURA 1986, pl. 12, fig. 18.

EUCYRTIDIELLUM SEMIFACTUM 3016

Eucyrtidiellum semifactum NAGAI & MIZUTANI

***Synonymy*.-**
Eucyrtidiellum sp. cf. *E. ptyctum* RIEDEL & SANFILIPPO
BAUMGARTNER 1985, fig. 43.d.
Eucyrtidiellum semifactum NAGAI & MIZUTANI
NAGAI & MIZUTANI 1990, p. 595, pl. 3, figs. 1-4a-b.

***Original Definition*.-** Abdomen has sixteen longitudinal but short plicae on the upper one-fifth to two-thirds of the surface.

Test usually composed of cephalis, thorax and abdomen. Cephalis is small, spherical with a small or medium-sized apical horn. Thorax truncated-conical with closed pores on the whole surface. Sutured pores are arranged at a collar stricture between thorax and abdomen. Third segment, abdomen, is poreless having sixteen longitudinal but short plicae on the upper one-fifth to two-thirds of the segment. The plicae gradually die out downward leaving a smooth surface, with a few very small pores at distal portion.

***Original Remarks*.-** This species resembles *E. ptyctum,* but differs in having shorter plicae on its abdominal surface. *E. semifactum* is found not infrequently in the Jurassic of the Japanese Islands.

***Etymology*.-** Named after Latin adjective *semifactus, a, um* meaning half-done or half-finished.

Measurements (in μm).-
Based on 10 specimens. Height of apical horn, 5-18 (av. 9), height of entire body including cephalis, thorax and abdomen, 56-82 (av. 72); height/width of cephalis, 8-15 (av. 11)/ 10-21 (av. 15); height/ width of thorax, 13-21 (av. 16)/ 26-33 (av. 29); height/width of abdomen, 36-49 (av. 46)/ 62-69 (av. 67).

***Type Locality*.-** Siliceous shale of Middle Jurassic age of Kutsuwano, Gifu Prefecture.

***UAZones*.-** 5-7, latest Baj.-early Bath. to late Bath.-early Call.

EUCYRTIDIELLUM UNUMAENSE S.L. 3052

Eucyrtidiellum unumaense s.l. (YAO)

***Synonymy*.-**
See subspecies.

***Included Taxa*.-**
3015 *Eucyrtidiellum unumaense dentatum* n.ssp.
BAUMGARTNER
3013 *Eucyrtidiellum unumaense pustulatum*
BAUMGARTNER
3012 *Eucyrtidiellum unumaense unumaense* (YAO)

***UAZones*.-** 3-8, early-mid Baj. to mid Call.-early Oxf.

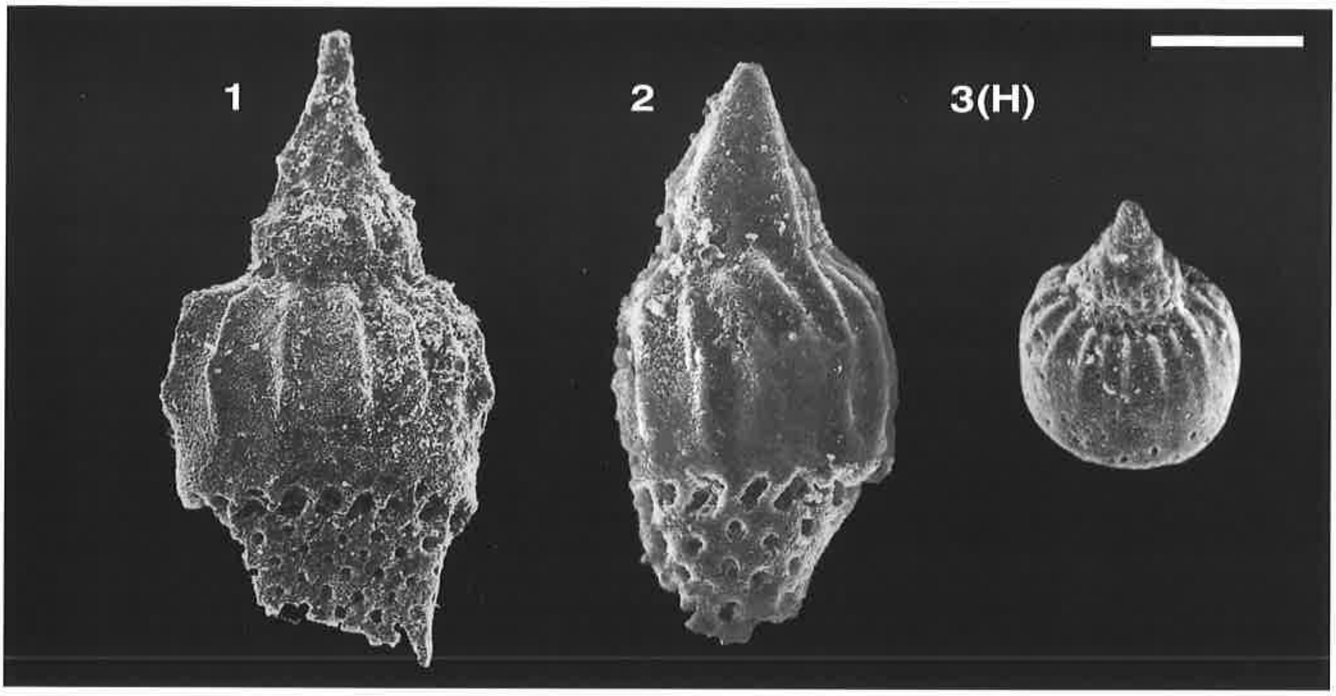


Plate 3016. ***Eucyrtidiellum semifactum*** **NAGAI & MIZUTANI.** Magnification x450. **Fig. 1.** POB80/3913, POB926. **Fig. 2.** GO891715, ZR683. **Fig. 3(H).** NAGAI & MIZUTANI 1990, pl. 3, fig. 1a.

EUCYRTIDIELLUM UNUMAENSE DENTATUM 3015

***Eucyrtidiell unumaense dentatum* n.ssp. BAUMGARTNER**

Synonymy.-
Eucyrtidiellum sp. A
BAUMGARTNER 1985, fig. 43.c.

Type Designation.- 80/3942, POB 926.

Original Definition.- Cephalis smooth, poreless with a long straight or slightly inclined or curved horn. Thorax distinctly nodose with sutural pore at stricture to cephalis and one row of pores at stricture to abdomen. Abdomen trapezoidal, with a sharp proximal edge covered with one row of nodes (8-10 per half circumference). Distal portion of abdomen smooth, with few very small pores placed distally. One row of large, elongated pores at stricture to fragile fourth segment which shows abundant circular pores.

Remarks.- This species differs from *E. pustulatum* by the presence of a flat terrace at the top of abdomen and a sharp edge with nodes in a regular row. It is regarded as a predecessor species of *E. ptyctum.*

Etymology.- *Dentatus, -a, -um,* Latin for equipped with teeth.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min	max
Height/width of cep.:	12/21	12/25	10/20	14/28
Height/width of th.: :	34/46	32/45	30/44	35/49
Height/width of ab. :	55/82	55/85	53/80	58/91
Height of 4th seg.	-	34	32	38
Length of apical horn :	49	35	32	54

Type Locality.- Sample POB 926, red chert overlying pillow basalt, Migdhalitsa Unit, near Trakhia, Central Argolis Peninsula, Greece (Baumgartner, 1985, figs. 40, 42b, 43c).

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

EUCYRTIDIELLUM UNUMAENSE PUSTULATUM 3013

***Eucyrtidiellum unumaense pustulatum* BAUMGARTNER**

Synonymy.-
Eucyrtidium sp.
SASHIDA et al. 1982, pl. 1, fig. 3.
Eucyrtidiellum pustulatum BAUMGARTNER
BAUMGARTNER 1984, p. 765, pl. 4, figs. 4-5.
BAUMGARTNER 1985, fig. 43.b.
YAMAMOTO et al. 1985, p. 35, pl. 4, figs. 4-5.
NAGAI 1986, p. 14, pl. 2, fig. 2.
AITA 1987, p. 65, pl. 4, figs. 13a-14b; pl. 10, figs. 15-16.
NAGAI 1987, pl. 2, figs. 2a-c, 3a-b, 4a-b.
NAGAI 1988, pl. 2, figs. 2a-b.
WAKITA 1988, pl. 4, figs. 26-27.
NAGAI & MIZUTANI 1990, p. 597, figs. 4. 1-5c.
Eucyrtidium (?) *unumaense* YAO
AITA 1985, figs.7. 15-16.

Original Definition.- Cephalis covered with small nodes and variably developed horn. Thorax distinctly nodose and proximal portion of abdomen with irregular coalescent nodes (short ridges) and pustules. Distal portion of abdomen smooth, with few very small pores placed in an irregular row.

Original Remarks.- This species differs from *E. unumaense* by having an irregularly nodose abdomen.

Etymology.- *Pustulatum,* pustulate (Latin).

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min	max
Height/width of cep.:	18/24	18/23	16/21	21/25
Height/width of th.: :	25/44	25/45	25/43	26/48
Height/width of ab. :	54/80	63/86	54/80	68/92
Height of 4th seg.	63	61	58	63
Length of apical horn :	16	18	12	27

Type Locality.- DSDP Leg 76, Site 534, Blake Bahama Basin, West Atlantic.

UAZones.- 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

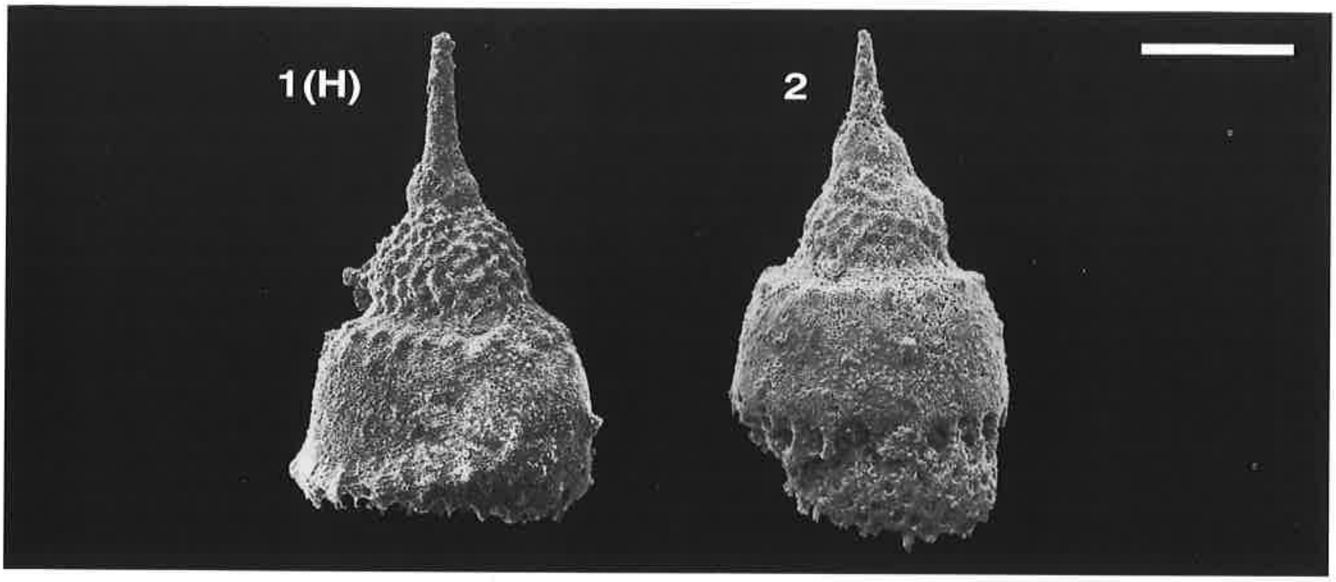


Plate 3015. ***Eucyrtidiellum unumaense dentatum*** **n.ssp. BAUMGARTNER.** Magnification x450. **Fig. 1(H).** POB80/3942, POB926. **Fig. 2.** POB81/1428, 534A.125.2.36.

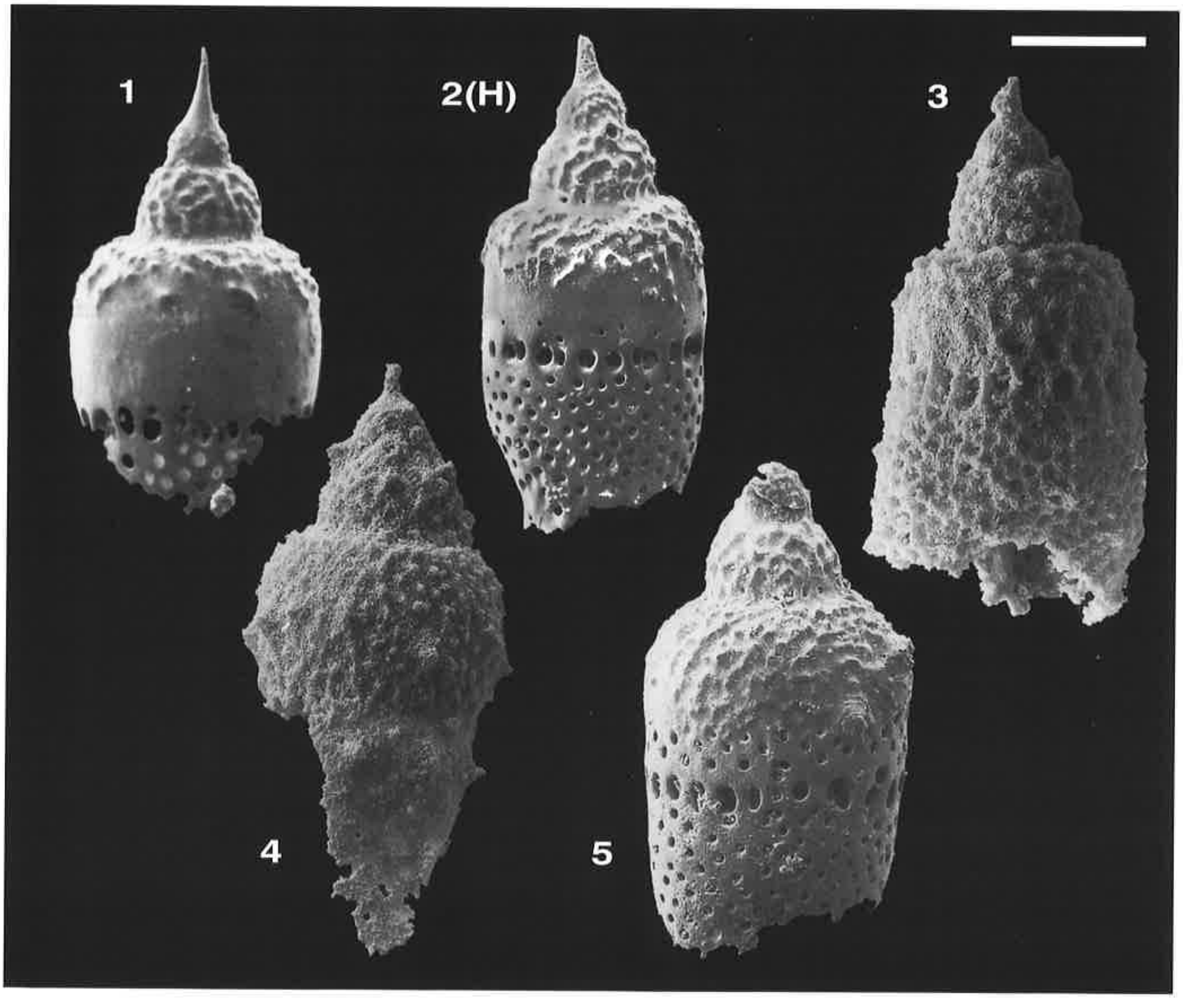


Plate 3013. ***Eucyrtidiellum unumaense pustulatum*** **BAUMGARTNER.** Magnification x450. **Fig. 1.** POB81/2429, 534.124.1.52. **Fig. 2(H).** POB81/2428, 534.124.1.52. **Fig. 3.** DU3136, PJ8. **Fig. 4.** POB81/2216, 534.122.1.43. **Fig. 5.** DU1942, R102.

EUCYRTIDIELLUM UNUMAENSE UNUMAENSE 3012

Eucyrtidiellum unumaense unumaense (YAO)

Synonymy.-
Eucyrtidium ptyctum RIEDEL & SANFILIPPO
RIEDEL & SANFILIPPO 1974, pl. 12, fig. 15 only.
BAUMGARTNER & BERNOULLI 1976, fig. 11f only.
Eucyrtidium (?) *unumaensis* YAO
YAO 1979, p. 39, pl. 9, figs. 1-11.
KOCHER 1981, p. 67, pl. 13, fig. 15.
HATTORI & YOSHIMURA 1982, pl. 4, fig. 1.
KIDO et al. 1982, pl. 4, fig. 9.
KOJIMA 1982, pl. 1, fig. 11.
MATSUOKA 1982a, pl. 1, fig. 15.
SASHIDA et al. 1982, pl. 2, fig. 3.
WAKITA 1982, pl. 3, fig. 1.
YAO et al. 1982, pl. 3, fig. 7.
WAKITA & OKAMURA 1982, pl. 8, fig. 7.
SAKA 1983, pl. 5, figs. 6-7.
Eucyrtidiellum unumaensis (YAO)
BAUMGARTNER 1984, p. 765, pl. 4, fig. 6.
YAMAMOTO et al. 1985, p. 35, pl. 4, fig. 6.
NAGAI 1986, p. 13, pl. 1, fig. 1a-c; pl. 2, fig. 1.
TAKEMURA 1986, p. 67, pl. 12, figs. 10-12.
GORICAN 1987, p. 182, pl. 3, figs. 9-10.
NAGAI 1988, pl. 2, figs. 1a-b.
WAKITA 1988, pl. 3, fig. 15.
HATTORI 1987, pl. 12, fig. 7.
HATTORI 1988a, pl. 8, fig. I.
Eucyrtidium (?) *unumaense* YAO
MIZUTANI et al. 1984, pl. 1, fig. 8.
not AITA 1985, figs. 7.15-16.
MATSUOKA 1985, pl. 1, fig. 9.
MATSUOKA 1992, pl. 1, fig. 8; pl. 2, fig. 7.
YAO 1991, pl. 3, fig. 6.
Eucyrtidiellum unumaense (YAO)
NAGAI 1987, pl. 2, figs. 1a-c.
KOJIMA 1989, pl. 2, figs. 5a-b.
Monosera unumaensis (YAO)
TAKEMURA & NAKASEKO 1986, p. 1022, pl. 4, figs. 6-8, not figs. 1-5, 9.

Original Definition.- Shell of four segments. Cephalis small, spherical or subspherical, poreless with an apical horn; in some specimens with a vertical horn; internally, an apical spine and rarely a vertical spine present. Thorax truncate-conical with closed pores and irregular hexagonal meshworks on whole surface, and with a sutural pore at proximal part. Third segment large relatively, inflated-hemispherical, poreless with smooth surface; in some specimens circular pores arranged in transverse rows at joint with thorax and at distal part. Fourth segment cylindrical, slightly narrow distally with pores scattered. Large pores arranged in one transverse row at joint with third segment. Fourth segment with thin wall distally.

Original Remarks.- This species is similar in whole shape to *Eucyrtidium ptyctum* RIEDEL & SANFILIPPO (1974, p. 778. pl. 5, fig. 7), but is distinguished from it by having no longitudinal plicae on the third segment.

Etymology.- This species is named after Unuma, north of Inuyama, Central Japan.

Measurements (in μm).-
Based on 20 specimens. Height overall, 120-190 (148); of cephalis, 12-24 (17); of thorax, 17-37 (23); of abdomen, 33-72 (47); of fourth segment, 23-80 (42); of apical horn, 5-38 (20); maximum width of shell, 44-101 (74).

Type Locality.- Mino Belt in the Northern Part of the Inuyama Area, Central Japan.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

EUCYRTIS 3633

Genus: *Eucyrtis* HAECKEL

Synonymy.-
Eucyrtis HAECKEL
HAECKEL 1881, p. 438.
HAECKEL 1887, p. 1488.

Type Species.- *Eucyrtis conoidea* RÜST 1885.

Original Definition.- "Open eradiate Stichocyrtida. Girdled Stichocorida (with aperture smooth or truncate). Acute (cephalis spiny, not smooth). With smooth test."

Original Remarks.- "All joints of the shell nearly of the same length (excepting often the first.) Surface smooth or rough, without spines".

Remarks.- Specimens are distinguished on the general shape of the test, including the segmental characteristics and the absence or presence and degree of development of spines. The shape of the pores is also important in species determination but because of the complicated system of pores and wall structure it is sometimes difficult to distinguish the real pore shape from the apparent pore shape.

Etymology.- *Eucyrtidium* = nice small basket, Greek.

Included Taxa.-
5620 *Eucyrtis columbaria* RENZ

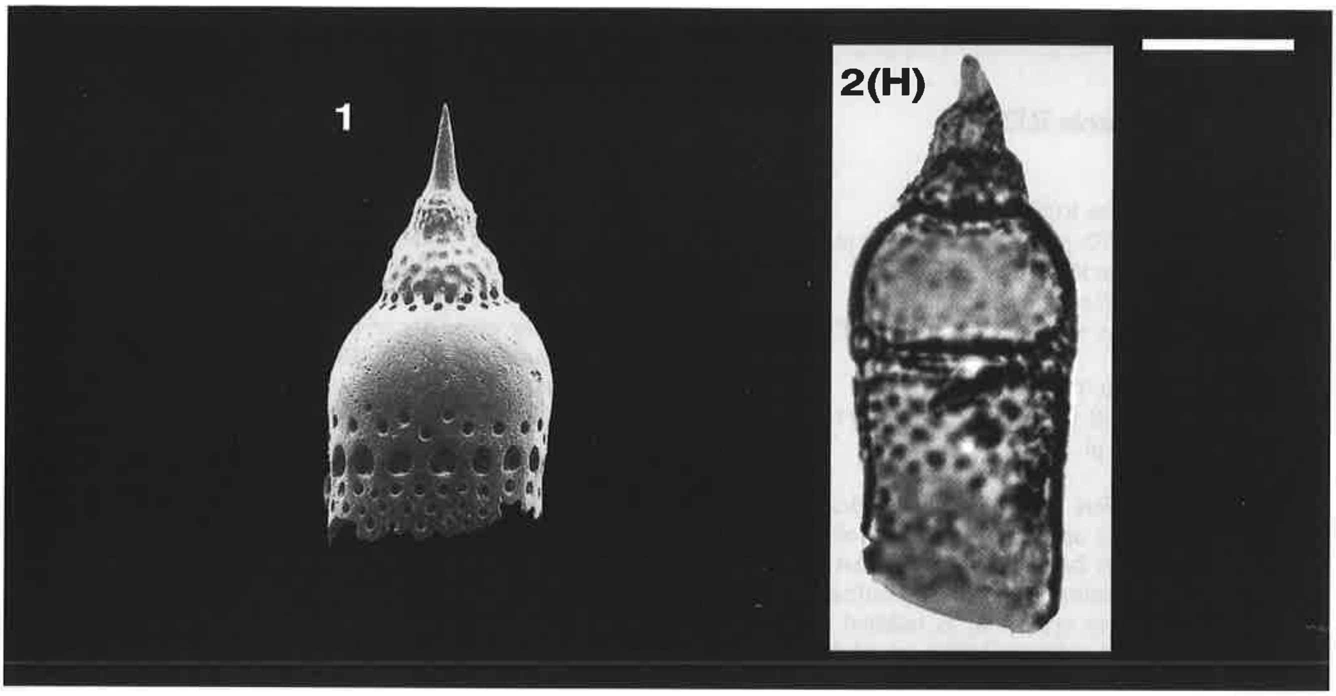


Plate 3012. *Eucyrtidiellum unumaense unumaense* (YAO). Magnification x450. **Fig. 1.** POB 81/9194, 76.534A.126.2.125. **Fig. 2(H).** YAO 1979, pl. 9, fig. 7a.

EUCYRTIS COLUMBARIA 5620

Eucyrtis columbaria RENZ

Synonymy.-

Eucyrtis columbarius RENZ

RENZ 1974, p. 792, pl. 12, figs. 13a-c; not pl. 7, figs. 14-20.

Eucyrtis columbaria RENZ

FOREMAN 1975, p. 615, pl. 2I, fig. 19

SCHAAF 1981, p. 434, pl. 5, figs. 1a-b; pl. 27, figs. 3a-b, not 2a-b.

SCHAAF 1984, p. 100, figs. 1-9b.

BAUMGARTNER 1992, p. 320, pl. 6, figs. 1-3.

JUD 1994, p. 77, pl. 10, figs. 3-6.

Original Definition.- Cephalis subspherical, sometimes enveloped in a stout apical horn usually offset, at other times simple with no horn; thorax somewhat rounded and hemispherical, abdominal segments, cylindrical or slightly conical with strictures appearing as internal rings; two or more slight lateral, internal ribs on abdomen occur randomly and sometimes protrude at the mouth as a tube; rarely the terminal segment appears bulbous and closed; often the lower segments curve out as if the axis is bent; pores round, regular, close set in rows or columns along the internal ribs; those not located on ribs tend to occur in checkerboard fashion.

Original Remarks.- This species is probably related to *Eucyrtidium thiensis* TAN 1927 (not Moore, 1973), a description based on one specimen. After studying topotypic material from Site 149, Rotti, two specimens plus fragments were found and considered to be *E. thiensis*. These differ from this species in being more conical in shape and in lacking a bent axis. There is also a similarity based on the character of the pores and internal septa with *Cyrtocapsa ovalis* RÜST, 1885. Whether this is conspecific with either of the other species can be decided only when topotypic material is available.

Remarks.- The specimens found in our material have numerous longitudinal ribs all over the one half of test opposite to the inflated part.

Etymology.- The specific name is Latin for dove-like.

Measurements (in μm).-
Based on 6 specimens. Height without apical horn 165-237; maximum width 72-105; number of segments 6-10.

Type Locality.- DSDP Leg 27, Site 261, eastern Indian Ocean.

UAZones.- 16-22, early Val. to late Barr.-early Apt.

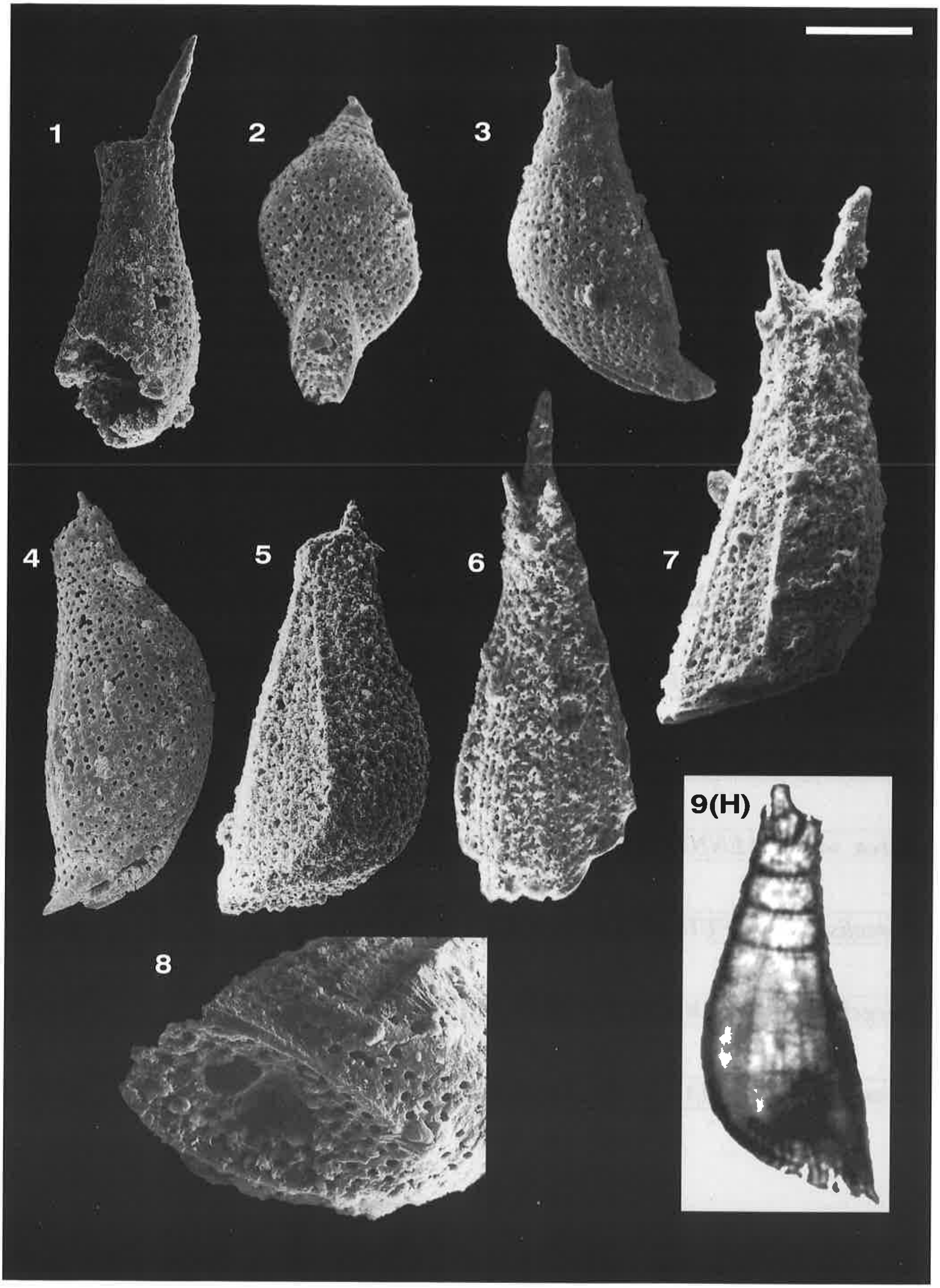


Plate 5620. ***Eucyrtis columbaria*** **RENZ.** Magnification x350, except Figs. 2,9 x700. **Fig. 1.** RJ117, Bo619.9. **Fig. 2.** DU299, Mo46. **Fig. 3.** DU297, Mo46. **Fig. 4.** DU3523, Mo46. **Fig. 5.** RJ69, GC887.0. **Fig. 6.** RJ1047, Bo169.9. **Fig. 7.** RJ1043, Bo619.90. **Fig. 8.** RJ1044, Bo619.90. **Fig. 9(H).** RENZ 1974, pl. 12, fig. 13c.

***euganea* >> STICHOMITRA (?) EUGANEA AFF.** **5550**

***ewingi* >> TRITRABS EWINGI WORZELI** **3115**

***ewingi* >> TRITRABS EWINGI S.L.** **3113**

***excellens* >> ARCHAEODICTYOMITRA EXCELLENS** **3287**

***exotica* >> TRITRABS EXOTICA** **3119**

***favosus* >> GONGYLOTHORAX FAVOSUS** **6131**

***favosus* >> GONGYLOTHORAX FAVOSUS AFF.** **3279**

***feliformis* >> HSUUM FELIFORMIS** **5824**

***flexa* >> TURANTA FLEXA** **2024**

***flexuosus* >> ARES CYLINDRICUS FLEXUOSUS** **4032**

***florea* >> ACAENIOTYLE (?) FLOREA** **5032**

***florealis* >> PSEUDOAULOPHACUS (?) FLOREALIS** **5334**

***fluegeli* >> PSEUDOCROLANIUM FLUEGELI** **5522**

***foremanae* >> TRIACTOMA FOREMANAE** **4068**

GODIA 3803

Genus: *Godia* WU

Synonymy.-
Godia WU
WU 1986, p. 356.

Type Species.- *Godia floreusa* WU 1986.

Original Definition.- Test circular, with short peripheral spines. Center of test weakly depressed, with large tubercle in center; central cavity surrounded by nodes.

Included Taxa.-
6125 *Godia coronata* (TUMANDA)
5287 *Godia lenticulata* JUD
5274 *Godia tecta* (TUMANDA)

GODIA CORONATA 6125

Godia coronata (TUMANDA)

Synonymy.-
Orbiculiforma coronata TUMANDA
TUMANDA 1989, p. 29, pl. 5, figs. 12-14; pl. 10, figs. 2, 5.

Original Definition.- *Orbiculiforma* with triangular pore frames and crown-like central portion. Test disk-shaped with a raised, rounded, central portion surrounded by concentrically arranged nodes. Periphery rounded; in places with imperforate and irregular equatorial extensions or short triradiate spines. Test of triangular pore frames with slightly raised vertices or sharp nodes. Central portion of irregular pore frames; with 11-15 surrounding nodes.

Original Remarks.- This species is similar to *Orbiculiforma igoi* n.sp. by having concentrically nodes around the raised central portion but differs in possessing triangular pore frames.

Etymology.- The specific name is derived from the Latin word "*corona*" meaning crown.

Measurements (in μm).-

	Holotype	Paratype 1	Paratype 2
Maximum diameter:	330	380	350
Diameter of central corona:	133	170	120

Type locality.- Furebira Formation, Usotan section.

UAZones.- 18-20, latest Val.-earliest Haut. to late Haut.

GODIA LENTICULATA 5287

Godia lenticulata JUD

Synonymy.-
Patellula planoconvexa (PESSAGNO)
? OKAMURA et al. 1982, p. 99, pl. 16, fig. 3.
Patellula sp.
THUROW 1987, pl. 7, fig. 20.
Godia (?) sp. C
THUROW 1988, p. 401, pl. 5, fig. 15.
Godia lenticulata JUD.
JUD 1994, p. 78, pl. 10, figs. 10-11.

Original Definition.- Test flat, circular, spongy with numerous small tubercles. Both faces as well as the rounded periphery may bear short, conical, pointed spines of approximately equal length.

Original Remarks.- This new species is herein assigned to the genus *Godia* WU although it lacks several characteristic structures of this genus such as a central tubercle and the central cavity. Since both faces of the test are equally developed it cannot be assigned to the genus *Patellula* PESSAGNO as Okamura et al. (1982) have done it.

Etymology.- Latin (adj.) *lenticulatus* = lens-shaped.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Diameter excl. spines:	241	293	241	333
Max. length of spines:	26	25	13	38

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

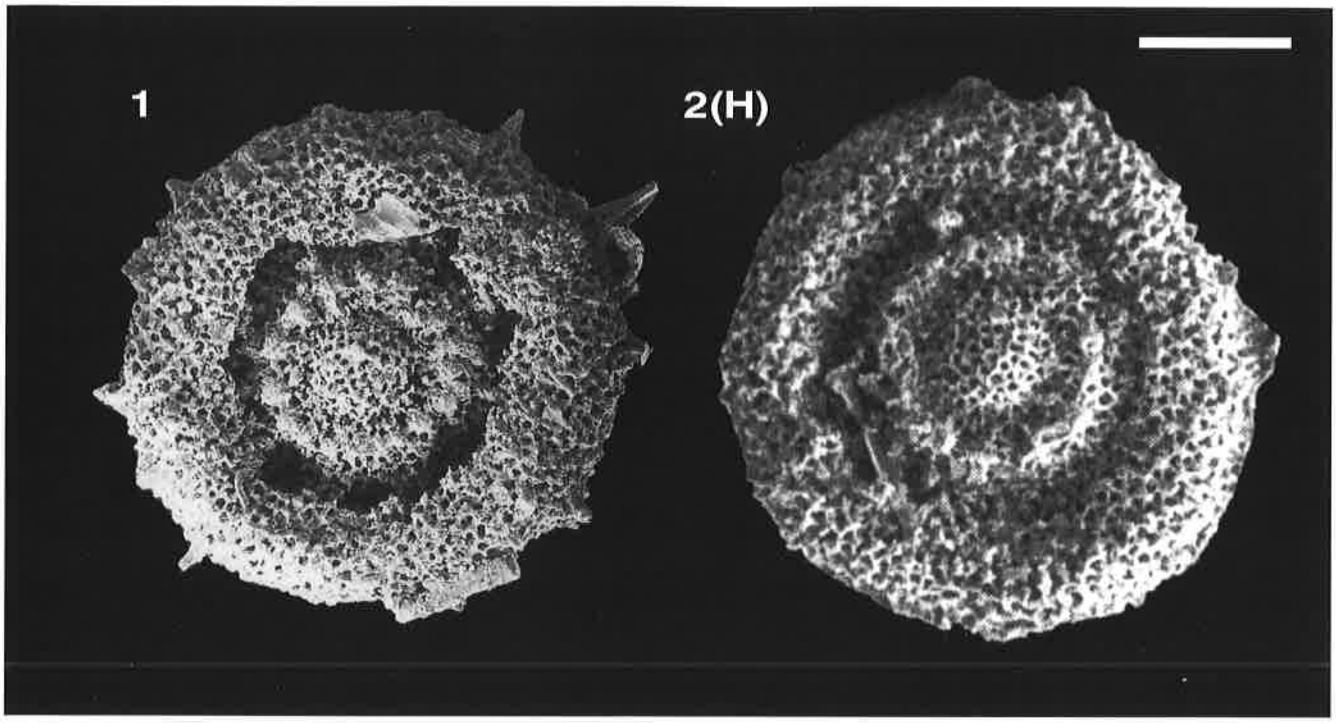


Plate 6125. *Godia coronata* (TUMANDA). Magnification x200. **Fig. 1.** POB79/3688, MO1 52. **Fig. 2(H).** TUMANDA 1989, pl. 5, fig. 14.

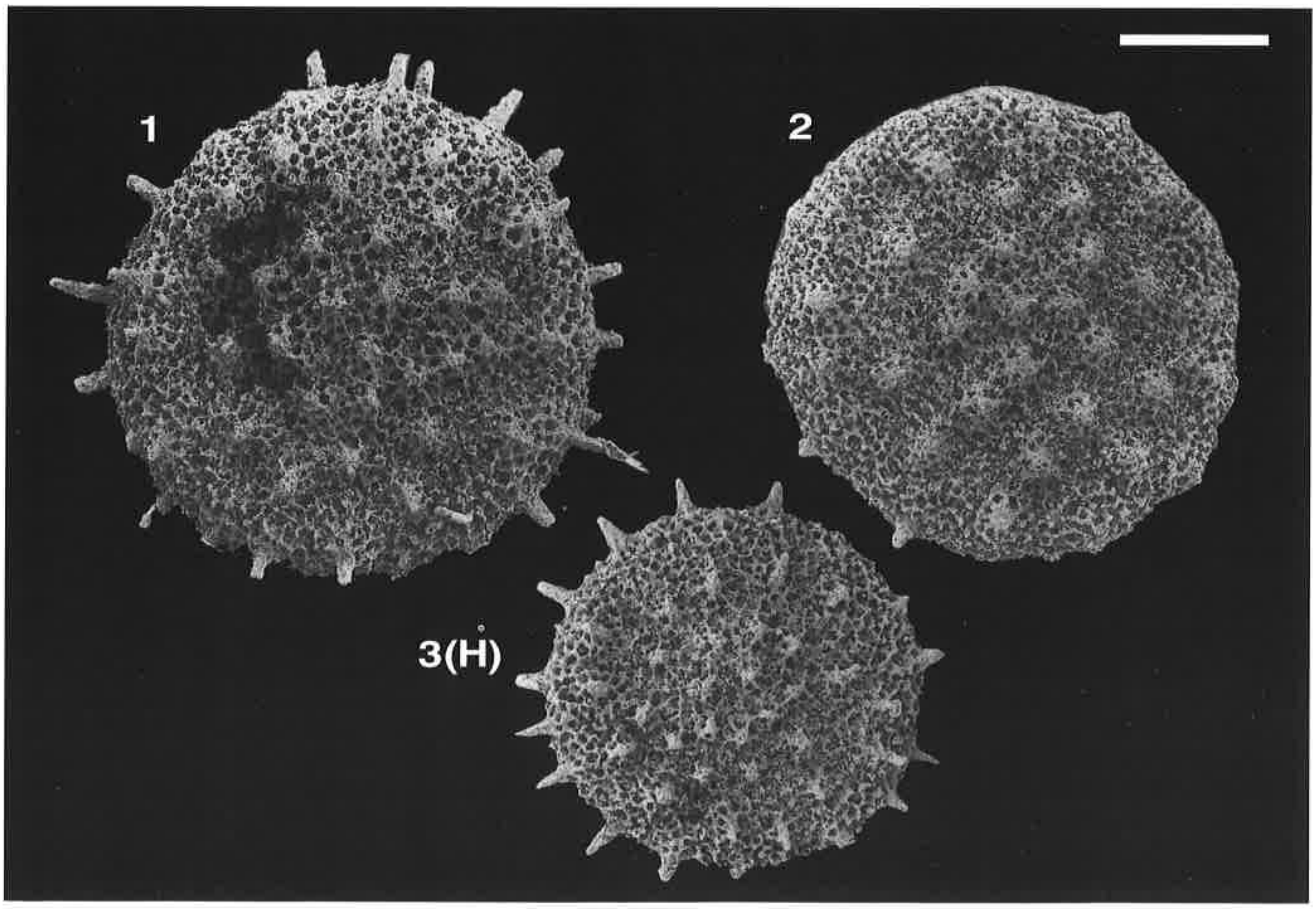


Plate 5287. *Godia lenticulata* JUD. Magnification x200. **Fig. 1.** RJ386, Bo566.5. **Fig. 2.** RJ252, Bo566.5. **Fig. 3(H).** RJ454, Bo566.5.

GODIA TECTA 5274

Godia tecta (TUMANDA)

Synonymy.-
Orbiculiforma tecta TUMANDA
TUMANDA 1989, p. 30, pl. 5, fig. 10.
OZVOLDOVA & PETERCAKOVA 1992, pl. 2, figs. 11-12.
Godia tecta (TUMANDA)
JUD 1994, p. 78, pl. 10, fig. 12.

Original Definition.- *Orbiculiforma* with a narrow and deep depression between the knob-like central portion and the peripheral part. Test disc-shaped. Periphery rounded with bladed spines invariably spaced. Meshwork of polygonal pore frames with rounded to subrounded pores. Central knob-like portion separated from peripheral concentric portion by narrow and steep depression.

Original Remarks.- This species differs from the other species of *Orbiculiforma* in having a narrow and deep depression between the knob-like central portion and the peripheral part.

Etymology.- Latin *tectus* meaning secretive, reserved.

Measurements (in μm).-
Holotype diameter 260, diameter of central portion 133.

Type Locality.-Furebira Formation, Usotan section.

UAZones.- 19-22, early Haut. to late Barr.-early Apt.

GONGYLOTHORAX 3635

Genus: *Gongylothorax* FOREMAN, emend. DUMITRICA

Synonymy.-
Gongylothorax FOREMAN
FOREMAN 1968, p. 19.
DUMITRICA 1970, p. 56.

Type Species.- *Dicolocapsa verbeeki* TAN 1927.

Original Definition.- Dicyrtid forms with large inflated spherical or subspherical thorax, the latter with a distinct relatively large pore or tube near its junction with the cephalis. Cephalis may or may not be partly depressed in thoracic cavity, thorax with or without aperture.

Actualized Definition.- (DUMITRICA, 1970) Dicyrtids with small, poreless cephalis, partly or completely depressed in a large inflated thorax, the latter compulsorily with constricted aperture and generally with more or less distinct sutural pore near its junction to the cephalis; collar plate with four collar pores.

Original Remarks.- *Stylocapsa* PRINCIPI (1909) differs in that it has a large well-developed spine, and probably no large pore or tube.

Actualized Remarks.- (DUMITRICA, 1970) According to the opinions unfolded in the first part of this study, we considered necessary emending the original diagnosis. The emendements concern mainly the taxonomical value of the aperture and sutural pore. This latter has been considered by Foreman as an important character, whereas the constricted aperture, existing at the type-species, would be taxonomically immaterial. The opportunity we had of searching several species of the same morphological type like *G.verbeeki* led us to opposite conclusions. The aperture was proved to be a distinctive character of first order. In exchange, the sutural pore has for this genus a relative value, sometimes being difficult if not impossible (*G. siphonofer*) to discern it from the ordinary pores of the collar suture. Another question to be settled remains the taxonomic value of the encasement degree. The type species, as well as other some species have a partly depressed cephalis, but there are also other ones whose cephalis is completely encased and whose belonging to this genus might be a most moot point. In this respect, a satisfactory answer might give, we believe, the species of *Heliocryptocapsa,* which positively have a partly or completely encased cephalis.

Gongylothorax is morphologically rather similar to *Heliocryptocapsa,* particularly by its discoidal forms, differing only by the presence of the aperture and the absence of the equatorial spines. *Cryptocapsa* is also or appears to be closely related to it.

Etymology.- The name is derived from the Greek *gongylos*, spherical and thorax (masculine).

Included Taxa.-
6131 *Gongylothorax favosus* DUMITRICA
3279 *Gongylothorax* sp. aff. *G. favosus* DUMITRICA
4022 *Gongylothorax oblongus* YAO
4023 *Gongylothorax sakawaensis* MATSUOKA
4024 *Gongylothorax* sp. aff. *G. siphonofer* DUMITRICA

GONGYLOTHORAX FAVOSUS 6131

Gongylothorax favosus DUMITRICA

Synonymy.-
Gongylothorax favosus DUMITRICA
DUMITRICA 1970, p. 56, pl. 1, figs. 1a-c, 2.

Original Definition.- Cephalis small, poreless, without apical horn and partly depressed in the thoracic cavity. Thorax large, spherical, with surface divided into large hexagonal areas by obvious ridges. In the middle of each hexagon there is a very narrow cylindrical pore with

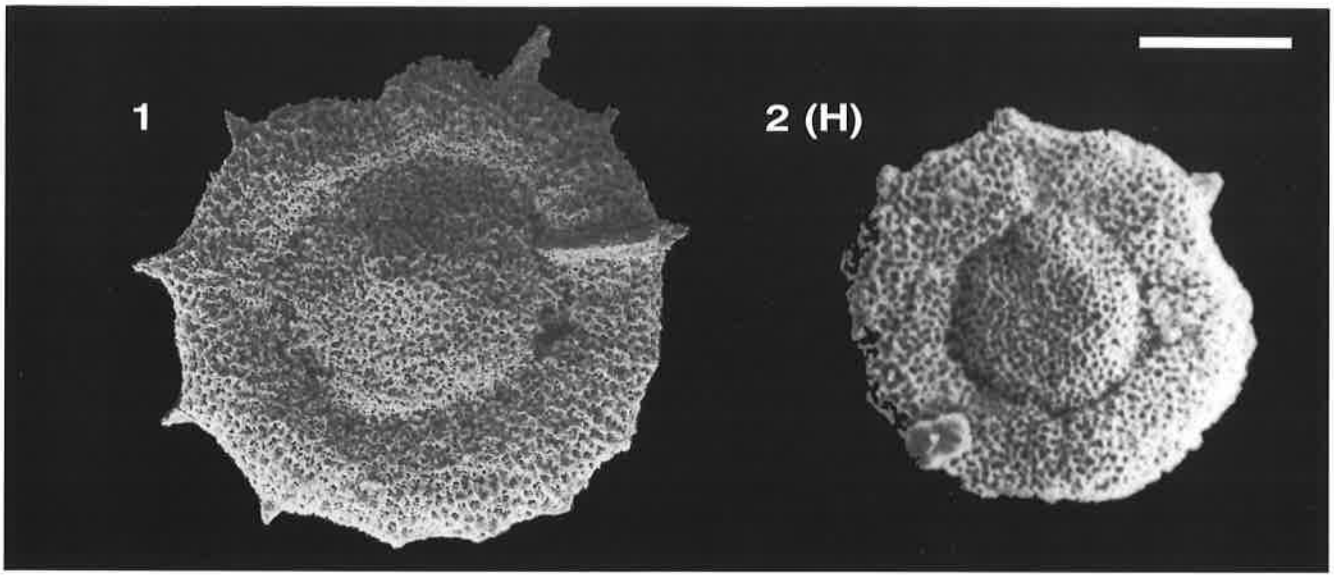


Plate 5274. *Godia tecta* (TUMANDA). Magnification x200. **Fig. 1.** RJ41, Bo581.65. **Fig. 2(H).** TUMANDA 1989, pl. 5, fig. 10.

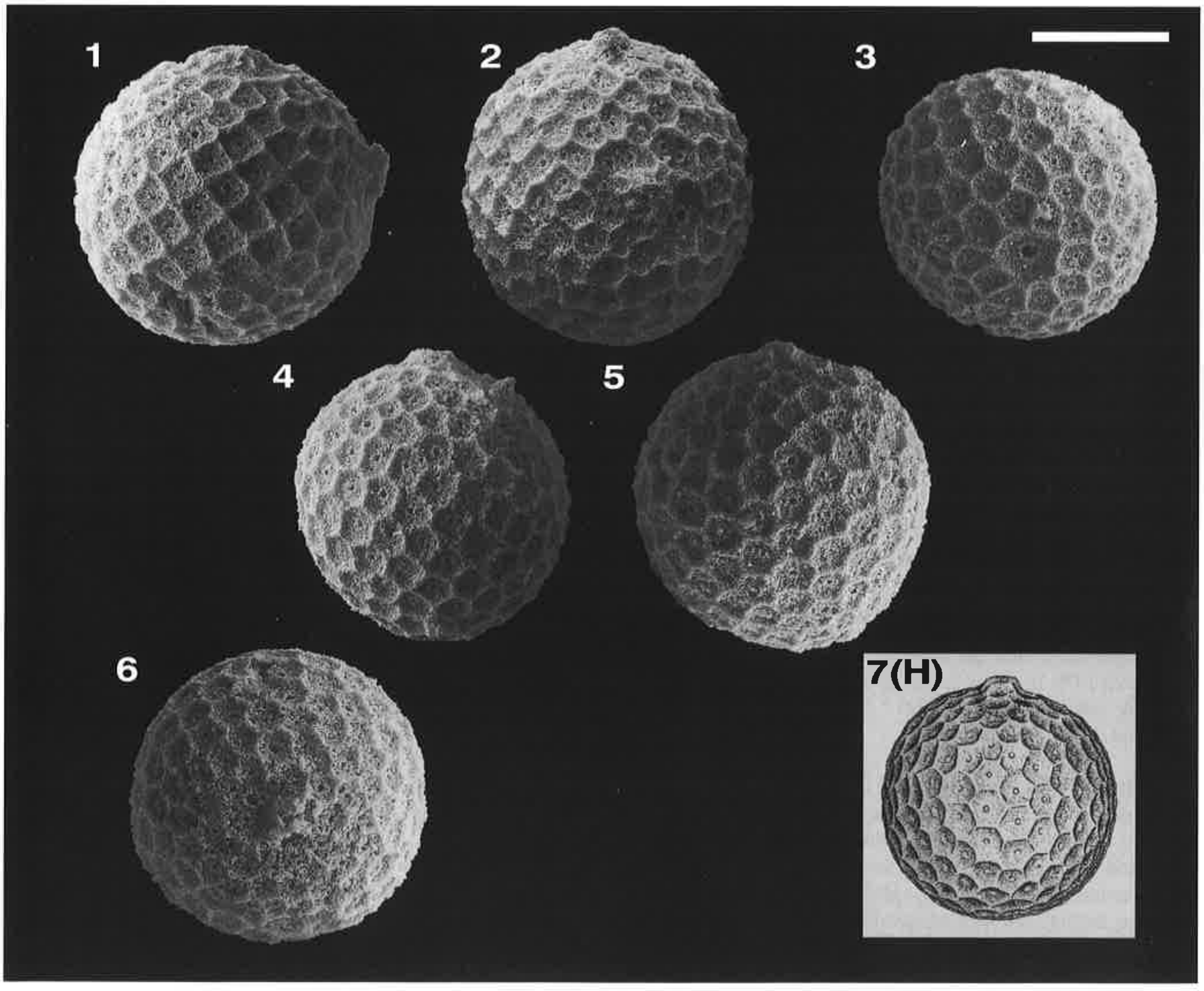


Plate 6131. *Gongylothorax favosus* DUMITRICA. Magnification x300. **Fig. 1.** DU2504, PJ25. **Fig. 2.** DU2505, PJ25. **Fig. 3.** DU1838, R102. **Fig. 4** DU1840, R102. **Fig. 5.** DU1921, R102. **Fig.6.** DU1922, R102. **Fig. 7(H).** DUMITRICA 1970, pl. 1, fig. 1b.

protruding rim. Thoracic aperture circular, with protruding rim, too. Sutural pore circular and narrow, located in the angle formed by the vertical and right lateral spine.

Measurements (in μm).-
Based on 4 specimens. Diameter of cephalis 22-25, of thorax 115-130.

Type Locality.- Pojorita, Suceava district, Moldova valley, Romania.

UAZones.- 8-10, mid Call.-early Oxf. to late Oxf.-early Kimm.

GONGYLOTHORAX FAVOSUS AFF. 3279

Gongylothorax sp. aff. *G. favosus* DUMITRICA

Synonymy.-
Gongylothorax favosus DUMITRICA
MATSUOKA 1986a, pl. 2, fig. 5, pl. 3, fig. 9.
ADACHI 1988, pl. 30, fig. 6.
Gongylothorax sp. aff. *G. favosus* DUMITRICA
MATSUOKA 1992, pl. 4, fig. 5.

Remarks.- In comparison with the type material of Dumitrica (1970) this species has a more elongated general shape with a larger depressed cephalis and an ellipsoidal thorax. This form differs from *G. oblong*us YAO by the presence of polygonal pore frames.

UAZones.- 7-8, late Bath.-early Call. to mid Call.-early Oxf.

GONGYLOTHORAX OBLONGUS 4022

Gongylothorax oblongus YAO

Synonymy.-
"Arecta" sp. B
ICHIKAWA & YAO 1973, pl. 4, figs. 5-6b.
Gongylothorax oblonga YAO
YAO 1979, p. 27, pl. 1, figs. 25-32.
Gongylothorax oblongus YAO
YAO et al. 1982, pl. 3, fig. 8.

Original Definition.- Shell of two segments, ellipsoidal. Cephalis spherical, poreless, partly encased in thoracic cavity. Internally, there are four collar pores, separated by a median bar, a vertical spine and primary lateral spines. A short axial spine comes downwards into thoracic cavity. Thorax ellipsoidal with circular, sparse pores which open in short projections or on smooth surface. Aperture narrow, circular. Sutural pore distinct at cephalis-thorax joint with short projection.

Original Remarks.- This species is distinguished from *Gongylothorax siphonofer* by the ellipsoidal thorax, and from Theoperid gen. and sp. indet. in FOREMAN 1971, (p. 1676, pl. 3, fig. 1) and *Dicolocapsa* sp. A in MOORE (1973, p. 826, pl 11, fig. 10) by having no longitudinal ridges on the shell surface.

Remarks.- This species differs from *G.* aff. *siphonofer* DUMITRICA by the ellipsoidal thorax and from *G.* aff. *favosus* DUMITRICA by the absence of polygonal pore frames.

Etymology.- This species named from the Latin adjective *oblongus*, meaning elliptical or elongate.

Measurements (in μm).-
Based on 16 specimens. Height overall, 88-126 (104); of cephalis, 20-27 (23); of thorax, 78-120 (96); maximum width of shell, 53-90 (70); diameter of aperture, 7-15 (9).

Type Locality.- Sample IN 7, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 4- 4, late Baj.

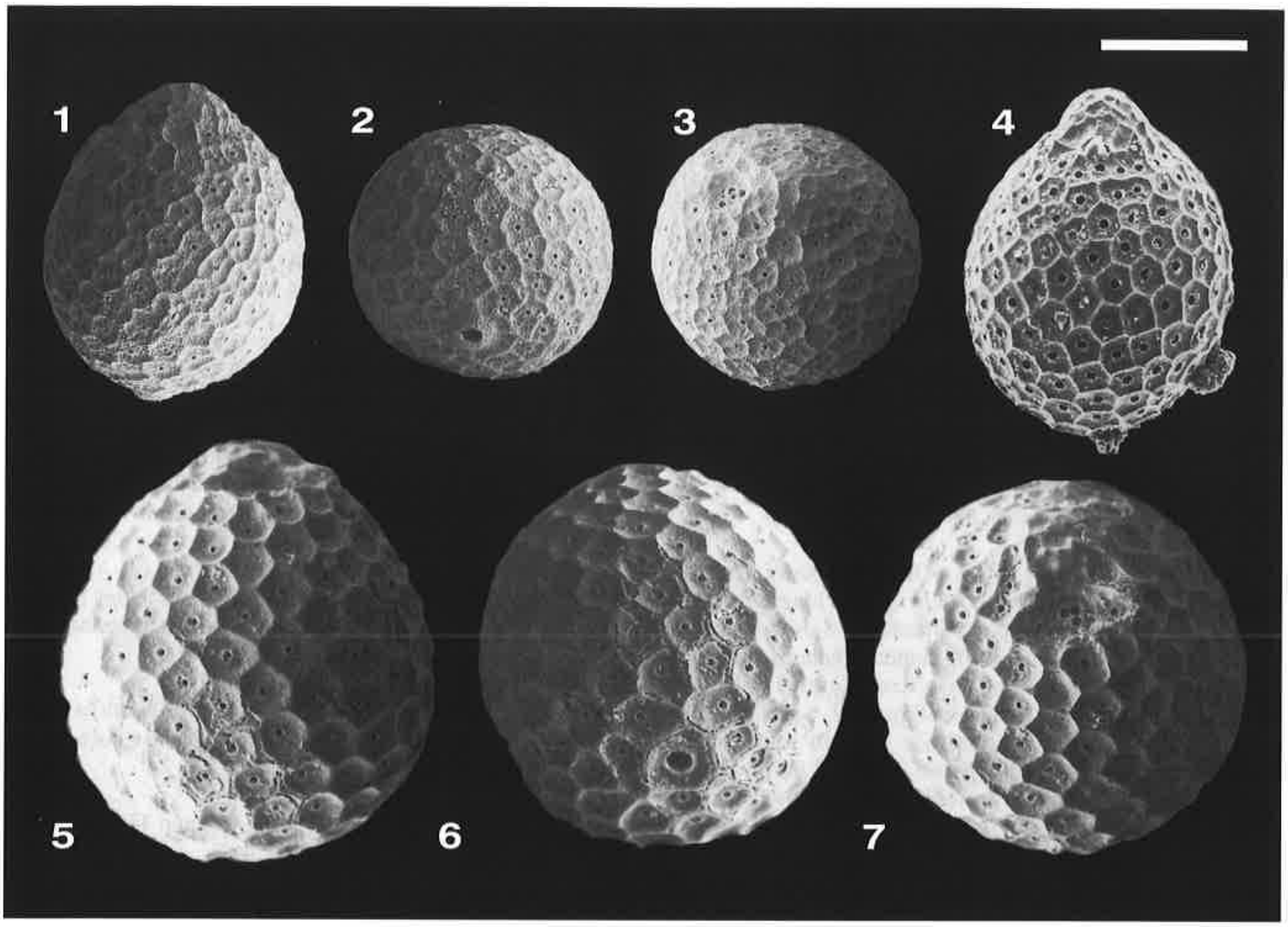


Plate 3279. *Gongylothorax* sp. aff. *G. favosus* DUMITRICA. Magnification x500. **Fig. 1.** GO903129, GL207. **Fig. 2.** GO903130, GL207. **Fig. 3.** GO903131, GL207. **Fig. 4.** POB82/9100, 76.534A.124.1.52. **Fig. 5.** GO900824, GL209. **Fig. 6.** GO900826, GL209. **Fig. 7.** GO900825, GL209.

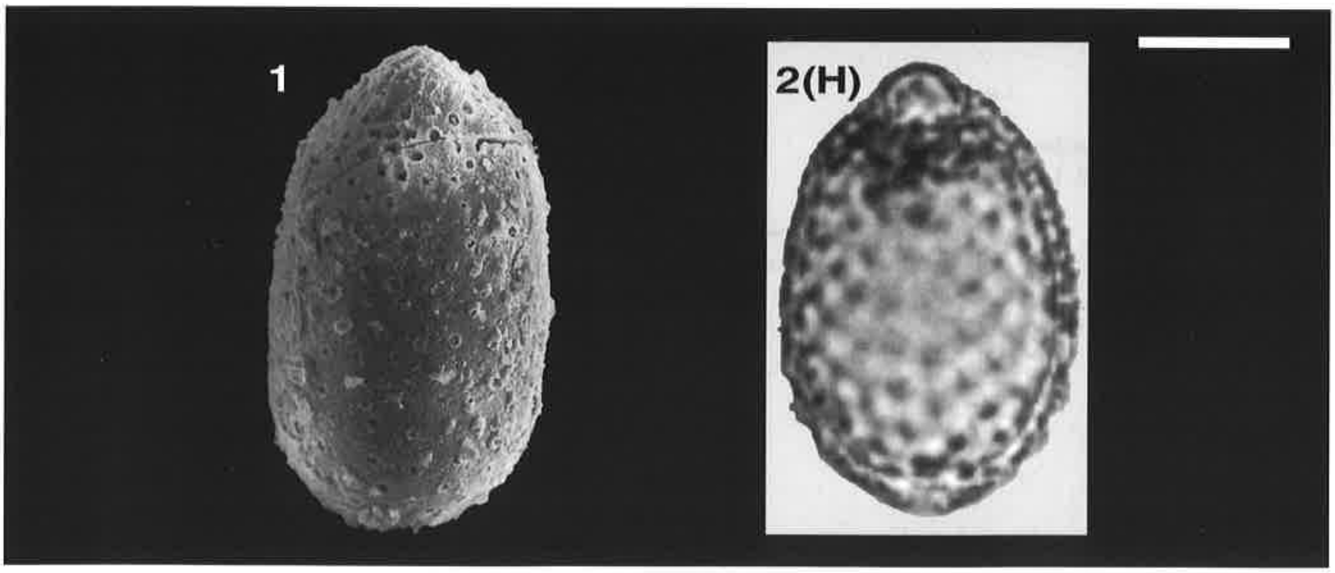


Plate 4022. *Gongylothorax oblongus* YAO. Magnification x600. **Fig. 1.** MA8845, MIN-1, CH-1-A. **Fig. 2(H).** YAO 1979, pl. 1, fig. 25a.

GONGYLOTHORAX SAKAWAENSIS 4023

Gongylothorax sakawaensis MATSUOKA

Synonymy.-
Gongylothorax sakawaensis MATSUOKA
MATSUOKA 1982b, p. 74, pl. 1, figs. 1-10.
MATSUOKA 1982a, pl. 3, figs. 1-2.
YAO et al. 1982, pl. 4, figs. 8-9.
MATSUOKA 1983a, p. 14, pl. 1, fig. 4; pl. 5, figs. 7a-b.
YAO 1983, fig. 3, 11.
YAO 1984, pl. 2, figs. 19-20, 23.
MATSUOKA & YAO 1986, pl. 2, fig. 4; pl. 3, fig. 10.
AITA 1987, p. 65, pl. 5, figs. 2a-3b.
WAKITA 1988, pl. 4, fig. 14.
YAO 1991, pl. 4, fig. 7.
MATSUOKA 1992, pl. 5, fig. 2.

Original Definition.- Shell of two segments, elongate ovoidal, widest at about 3/4 portion of total length from the proximal end. Proximal part somewhat flattened with a circular depression situated off-center. Cephalis spherical internally, completely (or nearly completely) hidden in thoracic wall and cavity. Thorax ellipsoidal, with a circular, constricted aperture. Outer surface of shell smooth with small, circular and widely spaced pores of uniform size, and inner surface of thorax with large narrowly spaced pores which taper externally. Pores on the depression of proximal part circular, larger than the pores on the outer surface of shell and comparatively densely spaced. Wall almost uniform in thickness, but slightly thicker around aperture.

Original Remarks.- Inner structure of cephalis was not observed. This species is assigned to *Gongylothorax* because shell consists of two segments, cephalis is hidden in thoracic wall and cavity, and aperture is constricted. Pores on the depression of proximal part may be homologous with sutural pore. Judging from externally tapering pores of the wall, it is presumed that the thicker the wall grows, the smaller the pores become during the ontogenetic development.This species differs from *Gongylothorax oblongus* (YAO, 1979, p. 27, pl. 1, figs. 25-32) in elongate ovoidal form of shell, in flattened proximal part with a depression and in smaller size of pores on the outer surface. This species looks similar to *Lithocampe* (?) *nudata* KOCHER (Baumgartner et al., 1980, p. 55, pl. 6, fig. 3) in the external shape, but differs from the latter in consisting of two segments.

Etymology.- This specific name comes from Sakawa Town, Kochi Prefecture, southwest Japan, its type locality.

Measurements (in μm).-
Based on 11 specimens. Total length, 160-210; Width of widest portion, 70-93; Diameter of cephalis, 20-25; Diameter of aperture, 4-9; Thickness of wall, 7-9.

Type Locality.- Sample 7-0503, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

GONGYLOTHORAX SIPHONOFER AFF. 4024

Gongylothorax sp. aff. *G. siphonofer* DUMITRICA

Synonymy.-
Gongylothorax siphonofer DUMITRICA
YAO 1979, p. 26, pl. 1, figs. 17-24.

Remarks.- (YAO, 1979) *Gongylothorax siphonofer* DUMITRICA 1970 was described from the Cenomanian deposits of Romania. The Japanese forms of this species have a smooth surface of shell in many specimens.

This form differs from *G. siphonofer* by the aperture having a protruding rim and from *G. oblongus* by its spherical outline.

Measurements (in μm).-
Based on 13 specimens. Height overall, 72-105 (87); of cephalis, 20-24 (22); of thorax, 65-99 (82); maximum width of shell, 66-90 (75); diameter of aperture, 6-7 (6).

UAZones.- 4- 4, late Baj.

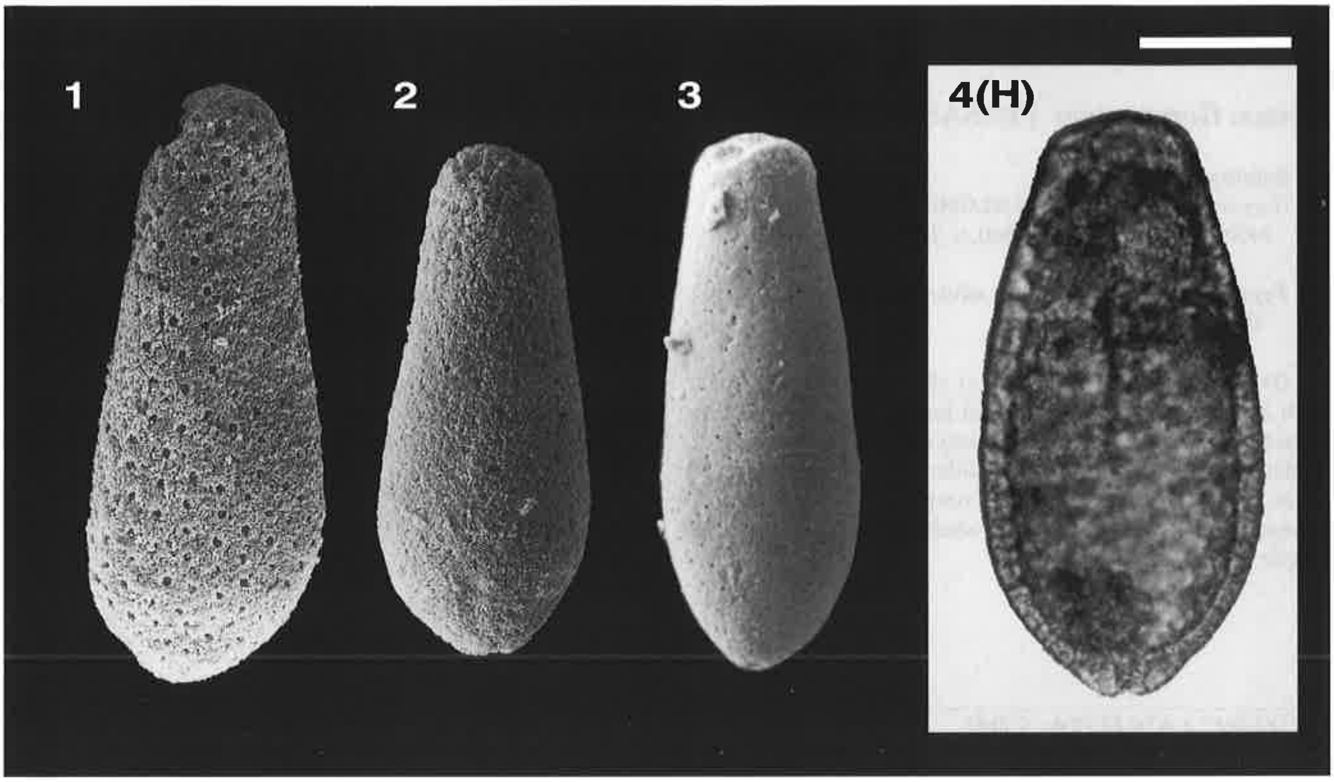


Plate 4023. *Gongylothorax sakawaensis* MATSUOKA. Magnification x400. **Fig. 1.** DU1959, R102. **Fig. 2.** DU2728, PJ14. **Fig. 3.** MA143, OCUMR2488, 7-0503. **Fig. 4(H).** MATSUOKA 1982b, pl. 1, fig. 1a.

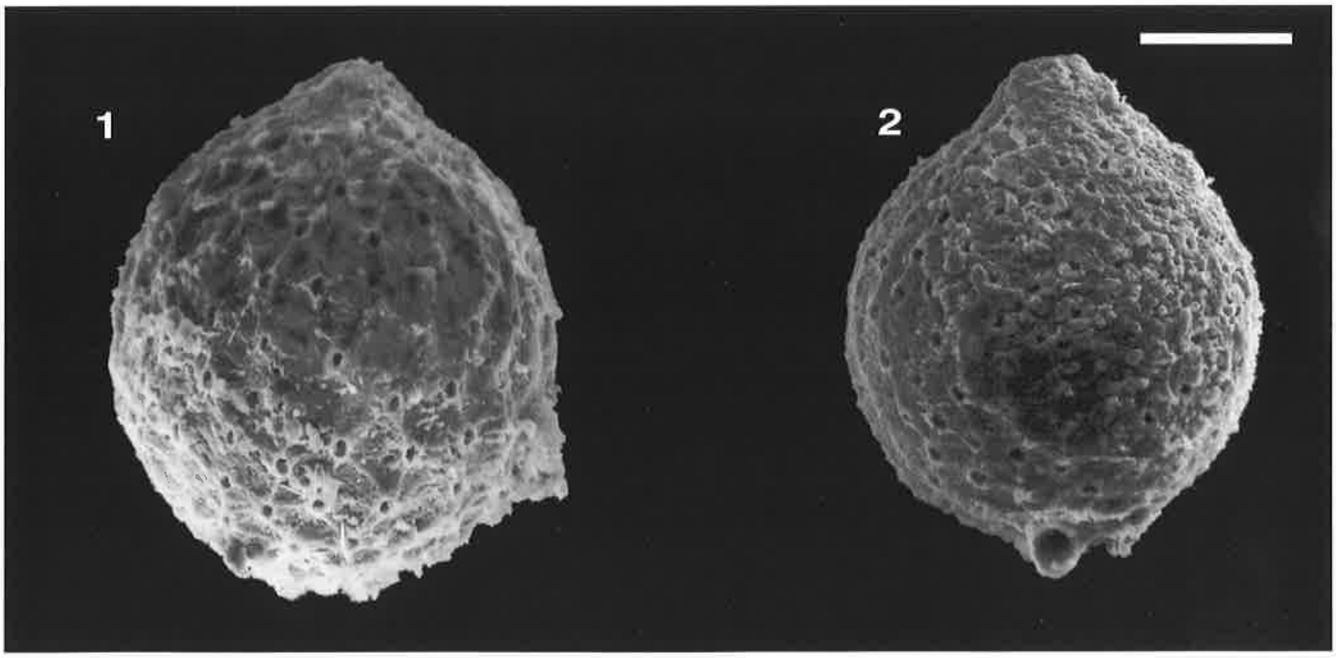


Plate 4024. *Gongylothorax* sp. aff. *G. siphonofer* DUMITRICA. Magnification x900. **Fig. 1.** MA9051, MIN-1, CH-1-A. **Fig. 2.** MA9089, MIN-1, CH-1-A.

GORGANSIUM 3636

Genus: *Gorgansium* PESSAGNO & BLOME

Synonymy.-
Gorgansium PESSAGNO & BLOME
PESSAGNO & BLOME 1980, p. 234.

Type Species.- *Gorgansium silviesense* PESSAGNO & BLOME 1980.

Original Definition.- Cortical shell typically elliptical with 3 primary spines of unequal length usually occurring in same plane. Primary spines assymetrically arranged; 2 spines closer together, often considerably shorter than third spine. Corticall shell usually compressed in plane of 3 primary spines. First medullary shell small, spherical with fragile pore frames.

Original Remarks.- *Gorgansium* n.gen. differs from *Betraccium* PESSAGNO 1979, in the assymetrical arrangement and unequal length of its primary spines. Whereas *Betraccium* has symmetrically arranged, more or less equidistant spines of equal length, *Gorgansium* has its 2 shorter spines situated close together.

The system of form analysis for species of *Gorgansium* is shown in plate 8, figure 16.

Etymology.- *Gorgansium* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D. pt. 6, recommendation 40, p. 113). The gender of this genus is neuter.

Included Taxa.-
3076 *Gorgansium* spp.

GORGANSIUM SPP. 3076

Gorgansium spp.

Remarks.- We include under this designation all Middle and Late Jurassic patanelliids with 3 spines of approximately equal importance at various angles.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

gracilis >> ARCHAEOTRITRABS GRACILIS 5913

grande >> PARAHSUUM (?) GRANDE 4031

gratiosa >> HIGUMASTRA GRATIOSA 3109

grutterinki >> CYRTOCAPSA (?) GRUTTERINKI 5506

guadalupensis >> MIRIFUSUS GUADALUPENSIS 3160

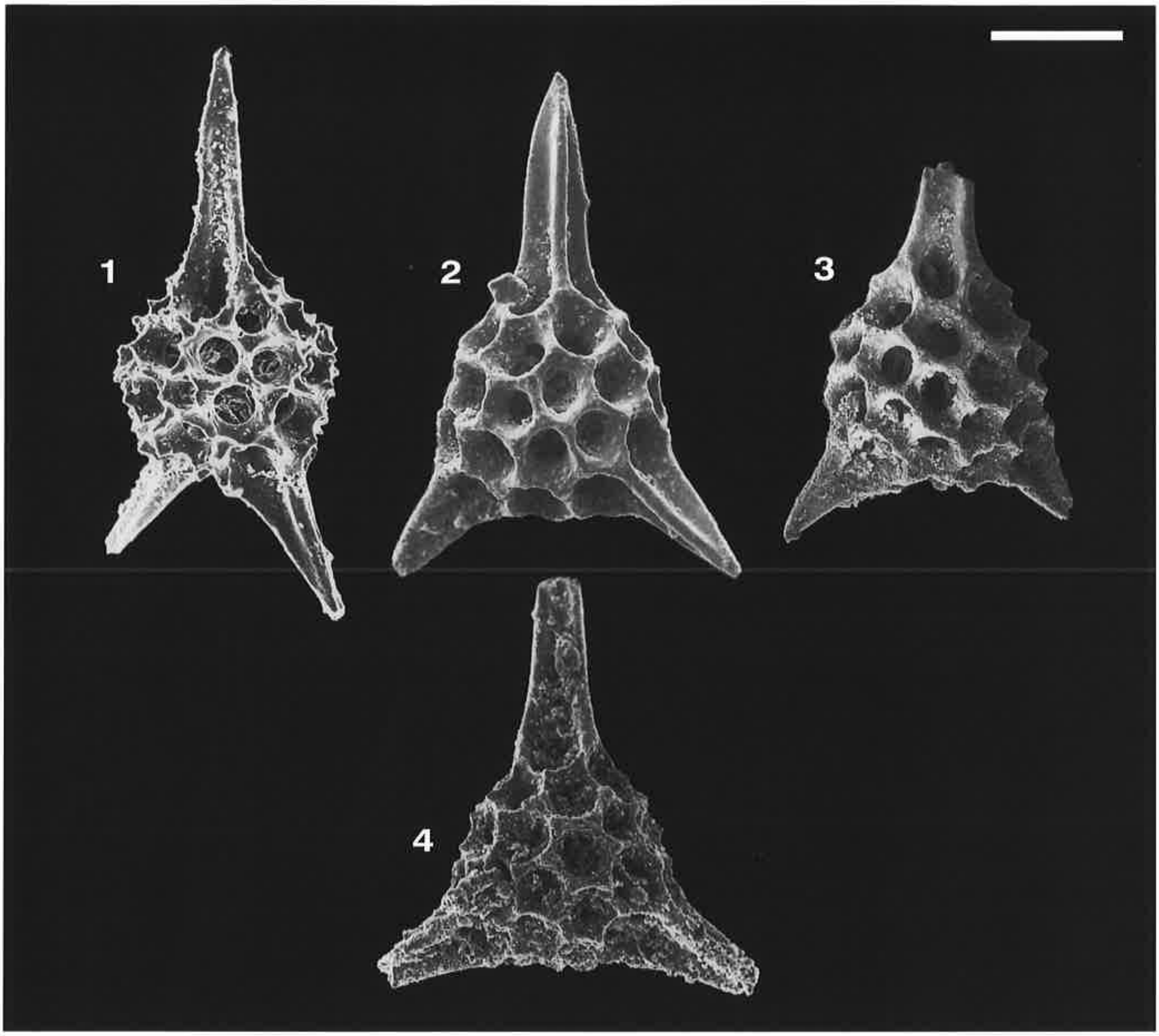


Plate 3076. *Gorgansium* spp. Magnification x500. **Fig. 1.** POB80/3947, IN7. **Fig. 2.** POB81/1446, 534A.125.2.36. **Fig. 3.** POB81/1475, 534A.125.2.36. **Fig. 4.** POB81/1393, 534A.125.2.36.

GUEXELLA 3637

Genus: *Guexella* BAUMGARTNER

Synonymy.-
Guexella BAUMGARTNER
BAUMGARTNER 1984, p. 766.

Type Species.- *Lithocampe nudata* KOCHER 1981

Original Definition.- Test ellipsoidal or spindle-shaped, composed of 2 or more (usually 4) segments. Cephalis hemispherical, poreless or with few basal pores, internally smooth with wide, undivided basal aperture to thorax. No cephalic spines have been observed. Thorax and postthoracic segments form together a thinwalled body without external strictures, covered with small circular pores. Thorax at least 2 times as wide as cephalis, trapezoidal, with a sharp proximal edge. Variable ornamentation (spines, ridges) may cover the planiform top of thorax and completely obscure the cephalis. The last segment (usually 4th) delicate, cup-shaped or constricted, with small basal aperture without tubular extension.

Original Remarks.- This genus differs from *Theocapsomma* HAECKEL, emend. FOREMAN 1968, from *Novodiacanthocapsa* EMPSON-MORIN 1981 and from *Gongylothorax* FOREMAN 1968, emend DUMITRICA 1970, by a cephalis which is not partly immersed in the thorax and by the peculiar sharp-edged thorax. This genus is erected to include several forms related to *G. nudata* now used in biostratigraphy of the Jurassic (e.g. *Lithocampe* (?) sp. aff. *L. nudata* KOCHER, MATSUOKA 1983, p. 27, pl. 4, fig. 12-13, pl. 9, fig. 15).

Etymology.- Dedicated to Jean Guex, Lausanne, in honour of his contribution to the fundamentals of biostratigraphy.

Included Taxa.-
3061 *Guexella nudata* KOCHER

GUEXELLA NUDATA 3061

Guexella nudata (KOCHER)

Synonymy.-
Lithocampe nudata KOCHER
BAUMGARTNER et al. 1980, p. 55, pl. 6, fig. 3.
KOCHER 1981, p. 75, pl. 14, figs. 18-19.
Lithocampe (?) *nudata* KOCHER
YAO et al. 1982, pl. 4, figs. 1-2.
MATSUOKA 1982a, pl. 2, figs. 1-2.
AITA 1982, pl. 1, figs. 19a-c.
MATSUOKA 1983a, p. 27, pl. 9, figs. 12-14.
YAO 1984, pl. 2, fig. 1.
AITA 1985, fig. 7.17.
ISHIDA 1985, pl. 2, fig. 2; pl. 3, fig. 13.
MATSUOKA & YAO 1986, pl. 2, fig. 3, pl. 3, fig. 17.
Guexella nudata (KOCHER)
BAUMGARTNER 1984, p. 766, pl. 5, figs. 5-7.
YAMAMOTO et al. 1985, p. 35, pl. 4, fig. 7.
MATSUOKA 1986a, pl. 3, figs. 15a-b.
KISHIDA & HISADA 1986, fig. 8. 3.
MIZUTANI et al. 1986, fig. 2. 11.
AITA 1987, p. 65, pl. 5, figs. 5a-6b; pl. 10, fig. 17.
MATSUOKA 1988, pl. 1, fig. 9.
DANELIAN 1989, p. 156, pl. 5, fig. 3.
MATSUOKA 1990, pl. 1, fig. 9.
YAO 1991, pl. 3, fig. 1.

Original Definition.- Test formed by a spindle-shaped three-chambered tube with hemisperical cephalis causing an abrupt change in contour. The last segment is the longest and widest and terminates in a small aperture. All specimens are broken distally, but it seems that they end in a small tube. The wall is thin, with small pores in diagonal rows forming an hexagonal pattern; cephalis poreless.

Etymology.- *Nudatus, a, um* = Latin, uncovered.

Measurements **(in μm).-**
Based on 33 specimens.

	HT	av.	min.	max.
Height:	150	151	130	185
Width (4th segment):	64	71	60	86
Height of ephalis:	12	-	-	-
Height of thorax:	33	-	-	-
Height of abdomen :	47	-	-	-
Height (4th segment):	58	-	-	-
Height of mouth:	13	-	-	-

Type Locality.- Saltrio (Roadcut N of Saltrio), Italy.

UAZones.- 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

guexi >> *SAVARYELLA GUEXI* 5193

gutta >> *THANARLA GUTTA* 5904

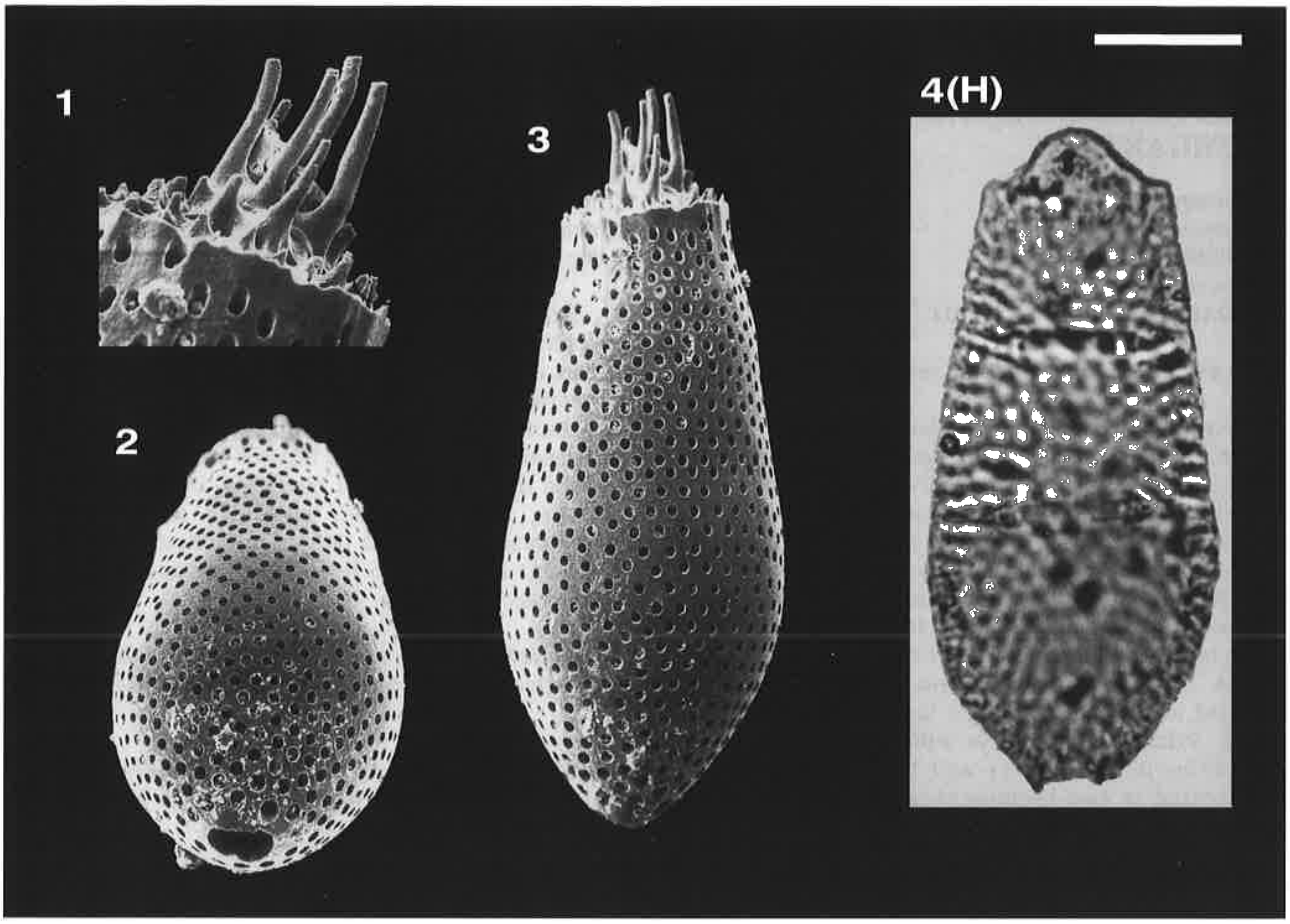


Plate 3061. ***Guexella nudata*** **(KOCHER).** Magnification x500, except Fig. 1 x1000. **Fig. 1.** POB81/2668, 534.124.1.52. **Fig. 2.** POB81/2667, 534.124.1.52. **Fig. 3.** POB81/2670, 534.124.1.52. **Fig. 4(H).** BAUMGARTNER et al. 1980, pl. 6, fig. 3.

HALESIUM 3639

Genus: *Halesium* PESSAGNO, emend. BAUMGARTNER

Synonymy.-
Halesium PESSAGNO
PESSAGNO 1971a, p. 207.
Halesium PESSAGNO emend.
BAUMGARTNER 1980, p. 314.

Type designation.- Halesium sexangulum PESSAGNO.

Original Definition.- Test in horizontal view with rays comprised of triangular to rectangular/square pore frames always arranged in two markedly linear rows. Marked linearity of meshwork due to three prominent vertical parallel tabulae (central and lateral tabulae) which merge in central area. Tabulae with massive nodes which intersect with bars to form either triangular or square frames. Meshwork in central area. Tabulae with massive nodes which intersect with bars to form either triangular or square frames. Meshwork in central area triangular. Meshwork arranged in horizontal, parallel layers. Rays subequal in length. Primary rays always with massive, cylindrical bracchiopyle. Secondary and tertiary rays usually terminating in two prominent lateral spines and one prominent central spine.

Original Remarks.- *Halesium* n.gen. differs from *Patulibracchium* n.gen. (1) in having pore frames always arranged in two parallel rows on its rays (exclusive of ray tips); (2) by having pore frames comprised of tabulae as well as bars; (3) by the uniform character of its meshwork; and (4) by the arrangement of its meshwork in parallel, horizontal layers. Both genera share bracchiopyles on their primary rays. The triangular meshwork of *Halesium* differs from that of *Pseudoaulophacus* PESSAGNO by being comprised of bars and tabulae instead of just bars and by being arranged in parallel instead of concentric layers.

Actualized Definition.- (BAUMGARTNER, 1980) Test as with subfamily, composed of 3 rays at equal interradial angles, 1 ray (primary ray of Pessagno, 1971) always with cylindrical hollow bracchiopyle. Well-developed central and lateral spines. Patagium may be present. The examination of the topotypic material (Pessagno collection) showed that all species of *Halesium*, including the type species, have an inner structure of rays as all Angulobracchiinae. The definition of Kozur & Mostler, 1978 (p. 142) is not followed. See remarks under *Patulibracchium* herein.

Remarks.- This genus differs from *Angulobracchia* by regular meshwork of cortical shell, shorter rays and thicker test.

Etymology.- This genus is named for Dr. Anton L. Hales, University of Texas at Dallas, in honor of his contributions to deep earth studies.

Included Taxa.-
5166 *Halesium biscutum* JUD
5243 *Halesium* (?) *lineatum* JUD
5223 *Halesium medium* (STEIGER)

HALESIUM BISCUTUM 5166

Halesium biscutum JUD

Synonymy.-
? *Homoeoparonaella* sp. D
STEIGER 1992, p. 43, pl. 9, fig. 12.
Halesium biscutum JUD
JUD 1994, p. 78, pl. 10, figs. 13-14.

Original Definition.- Flat, three-rayed test. Rays of equal length, having on both faces one thick central and two thinner external longitudinal beams connected by small delicate bars forming irregular or sometimes also triangular or quadrangular meshes with small nodes at junctions. Intersection of beams in central area forming irregular pore-frames. Tips of rays enlarged, with nodose, irregular pore-frames. Ray tips, when well preserved, armed with several small spines. Interradial space filled with dense patagium.

Original Remarks.- Halesium biscutum n.sp. differs from *Halesium* (?) *lineatum* n.sp. by having an irregular arrangement of pore frames on the surface of rays, and by having a larger patagium in the interradial space and laterally enlarged tips. Poorly preserved specimens of *H. biscutum* n.sp. lacking all interradial patagium are difficult to distinguish from *Halesium* (?) *lineatum* n.sp. under binocular. A bracchiopyle, characteristic of the genus, was never observed.

Etymology.- Latinized from the Italian *biscottum* = biscuit.

Measurements (in um).-
Based on 10 specimens.

	HT	av.	min.	max.
Maximum length of rays:	280	276	245	333

Type Locality.- Fiume Bosso, Umbria-Marche Italy.

UAZones.- 14-22, early-early late Berr. to late Barr.-early Apt.

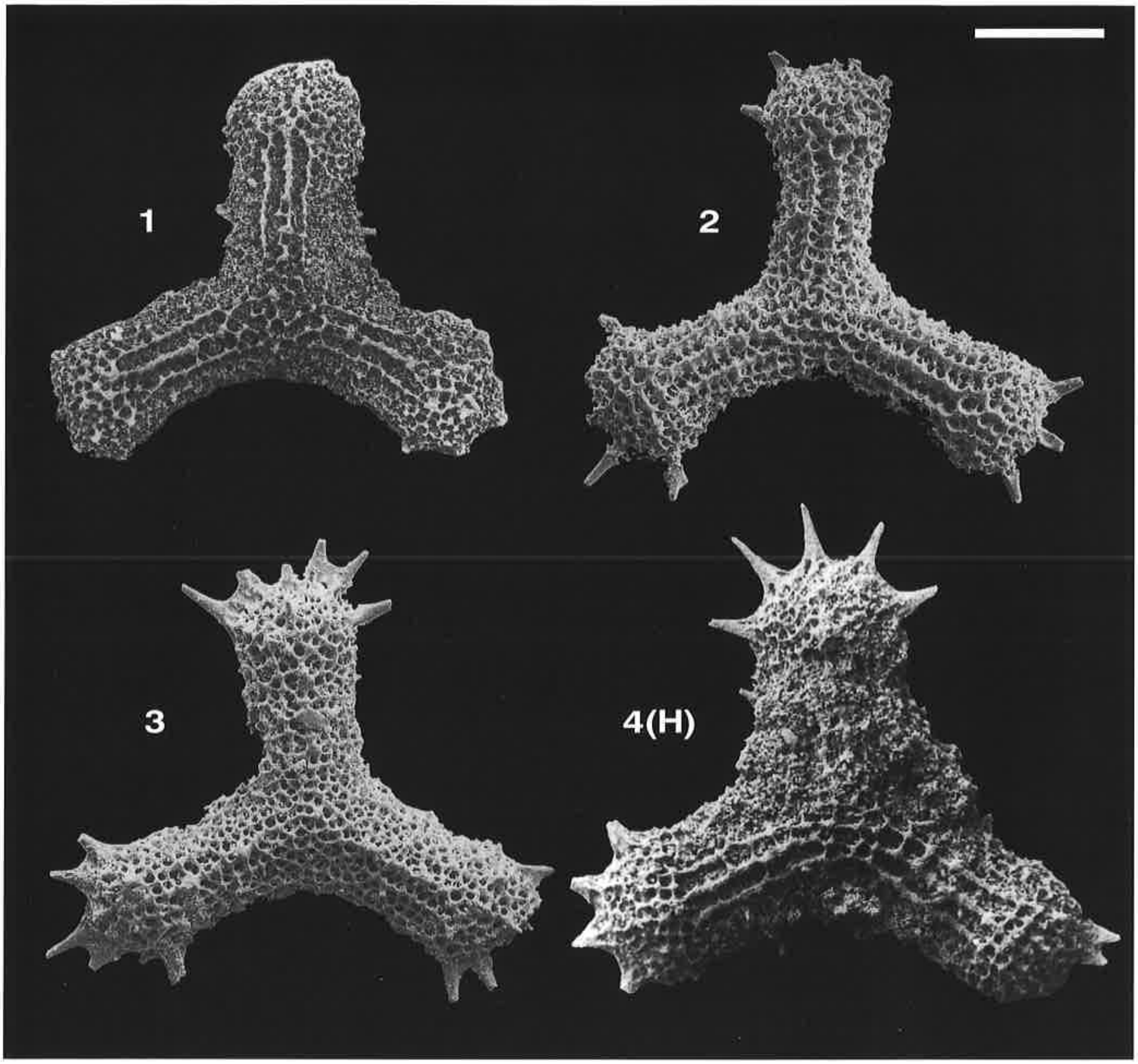


Plate 5166. *Halesium biscutum* JUD. Magnification x150. **Fig. 1.** RJ333, Bo566.5. **Fig. 2.** DU1335, V40. **Fig. 3.** DU3492, Mo46. **Fig. 4(H).** RJ1676, Bo566.50.

HALESIUM (?) LINEATUM 5243

Halesium (?) *lineatum* JUD

Synonymy.-
Homoeoparonaella sp. B
STEIGER 1992, p. 42, pl. 9, fig. 9.
Halesium (?) *lineatum* JUD
JUD 1994, p. 79, pl. 11, figs. 1-3.

Original Definition.- Three-rayed test with bulbous, spiny tips. Rays of equal length, composed of 6 beams, 3 on upper and 3 on lower surface of test. Central beam on each side of the test is largest. Beams connected by regularly spaced small bars forming two rows of alternate triangular pore-frames. Intersection of beams in central area of test characterized by meshwork of irregular pore-frames, sometimes with small nodes at junctions of bars. Sides of rays covered with a variably wide meshwork, on well preserved specimens bearing short conical spines in the equatorial plane of the test. Rays terminating with bulbous tips. Surface with nodose pore-frames. Rim of tips with generally 5 equal spines disposed radially in the equatorial plane.

Original Remarks.- *Halesium* (?) *lineatum* n.sp. was compared with *Halesium biscutum* n.sp. under the latter species.

Etymology.- From the Latin *lineatus* = linear.

Measurements (in um).-
Based on 4 specimens.

	HT	av.	min.	max.
Maximum length of rays:	284	271	284	400
Width of rays:	61	65	81	84
Width of tips:	122	93	125	200

Type Locality.- Breggia Gorge, Ticino, Southern Switzerland.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

HALESIUM MEDIUM 5223

Halesium medium (STEIGER)

Synonymy Species.-
Hagiastridae gen. et sp. indet.
FOREMAN 1973b, p. 261, pl. 6, figs. 5-6.
Paronaella bronnimanni PESSAGNO
HOLZER 1980, p. 159, pl. 1, fig. 14; not pl. 2, fig. 12.
Hagiastridae gen. et sp. indet.
HOLZER 1980, pl. 2, figs. 13-14.
Angulobracchia media STEIGER
STEIGER 1992, p. 49, pl.11, figs. 12-13.

Original Definition.- "Three armed patulibracchiid. Arms rectangular in cross section. Cortical shell of the arms characterized by longitudinal ribs strictly limited to the centre. Arm laterally limited by nodulous ribs. Central area shows an irregular pattern of nodes and irregularly developed pores. In the area of the arms two longitudinal double rows of alternating triangular pore frames occur. Arms terminating undistinctly with step-like edges which form the transition to the arm prolongations. The arm prolongations are developed on each arm and may occur with two variations: (1) rectangular prolongation with irregular pore pattern and directional change and (2) ribbed cylinder with single row of rectangular pores between longitudinal ribs. In the equatorial plain always two lateral spines occur in the area of the arm ends. Occasionally at the contact of the arm ends to arm prolongations two shorter spines can be developed."

Original Remarks.- "*Angulobracchia media* differs from all other species of *Angulobracchia* by the stucture of the cortical shell of the arms: three longitudinal ribs and two double rows of alternating triangular pore frames; partly rectangular and partly cylindrical arm prolongations and two lateral spines in the area of the arm ends."

Etymology.- *Media* Latin, in the middle. The longitudinal ribs in the centre of the arms should be characteristic.

Measurements (in um).-
Based on 7 specimens.

	HT	av.	min.	max.
Length of rays:	217	189	163	220
Width of rays:	50	45	38	60
Width rays prolongation:	67	72	67	86

Type Locality.- Gartenau, Steinbruch quarry, St. Leonhard, Salzburg.

UAZones.- 16-21, early Val. to early Barr.

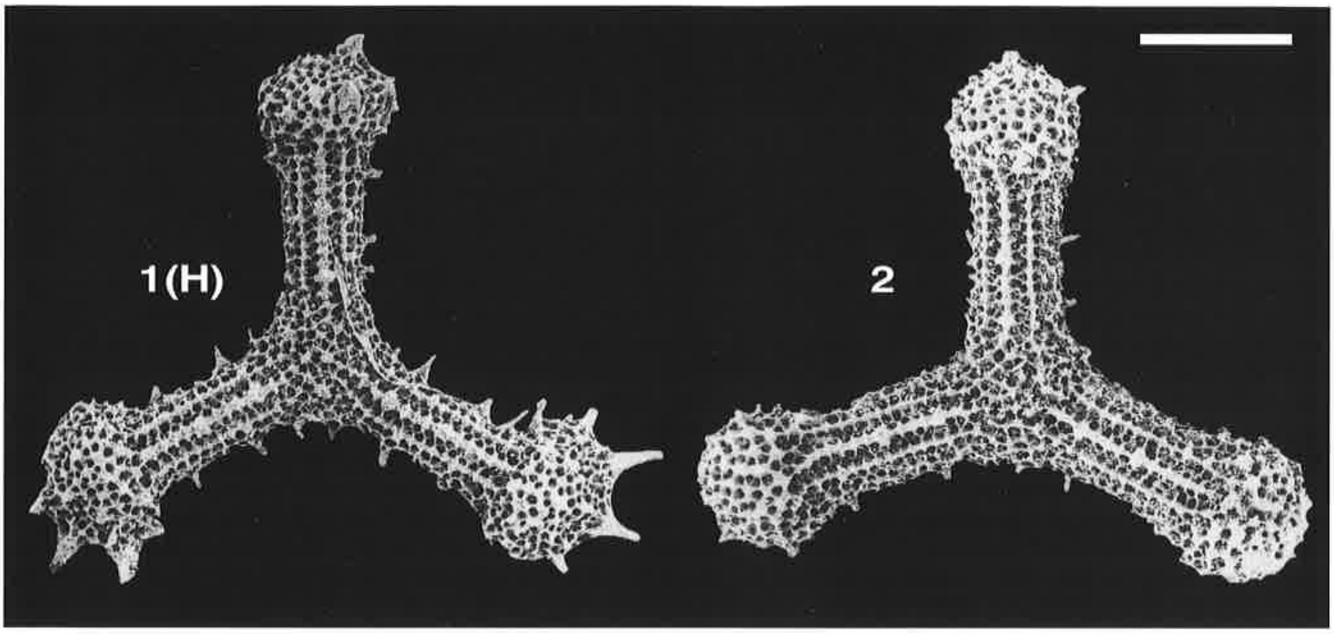


Plate 5243. *Halesium* (?) *lineatum* JUD. Magnification x150. **Fig. 1(H).** RJ49, Br28.85. **Fig. 2.** RJ47, Br28.85.

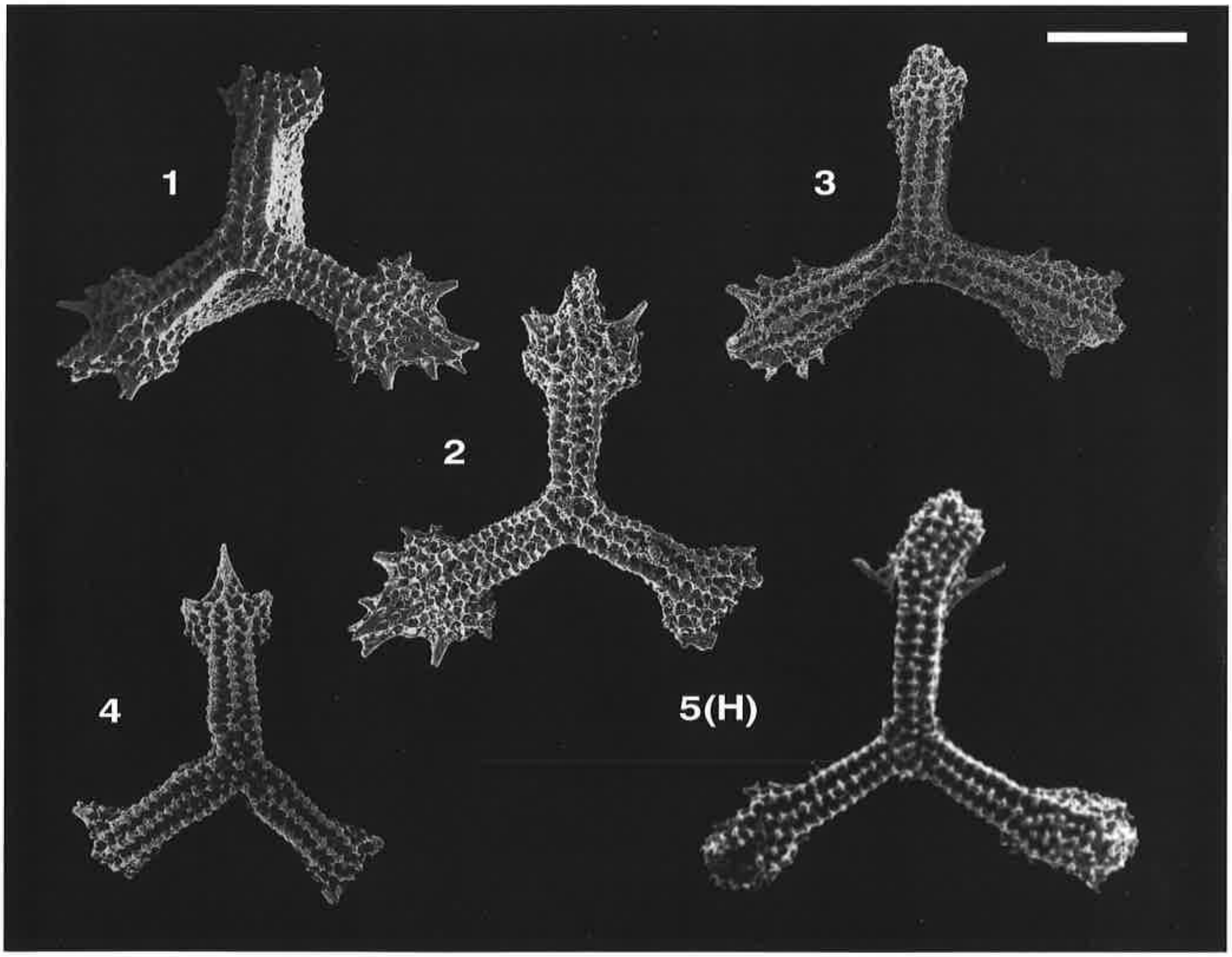


Plate 5223. *Halesium medium* (STEIGER). Magnification x150. **Fig. 1.** POB79/3132, MO1 46. **Fig. 2.** POB79/3131, MO1 46. **Fig. 3.** RJ78, Br28.85. **Fig. 4.** RJ99, Br141.55. **Fig. 5(H).** STEIGER 1992, pl. 11, fig. 12.

HALIODICTYA 3640

Genus: *Haliodictya* HOJNOS

Synonymy.-
Haliodictya HOJNOS
HOJNOS 1916, p. 349.

Type Species.- *Haliodictya loerentheyi* HOJNOS 1916.

Original Definition.- "Skeleton is square and latticed, with four latticed elongated prolongations at corners."

Remarks.- The following species are questionably included with this genus, because they bear imperforate, sometimes stout spines at the four corners of the central area.

Included Taxa.-
3243 *Haliodictya* (?) *antiqua* s.l. RÜST
3218 *Haliodictya* (?) *antiqua antiqua* (RÜST) sensu PESSAGNO
3217 *Haliodictya* (?) *antiqua* ssp. B
3254 *Haliodictya* (?) *hojnosi* RIEDEL & SANFILIPPO

HALIODICTYA (?) ANTIQUA S.L. 3243

Haliodictya (?) *antiqua* s.l. (RÜST)

Synonymy.-
Staurospahera antiqua RÜST
not MUZAVOR 1977, p. 52 pl. 1, fig. 8.
EL KADIRI 1984, p. 22.
DANELIAN 1989, p. 192.
Emiluvia antiqua (RÜST)
not ORIGLIA-DEVOS 1983, p. 105, pl. 14, fig. 4.
Emiluvia (?) *antiqua* (RÜST)
BAUMGARTNER 1985, fig. 38.g.
See also subspecies

Included Taxa.-
3218 *Haliodictya* (?) *antiqua antiqua* (RÜST) sensu PESSAGNO
3217 *Haliodictya* (?) *antiqua* ssp. B

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

HALIODICTYA (?) ANTIQUA ANTIQUA 3218

Haliodictya (?) *antiqua antiqua* (RÜST) sensu PESSAGNO

Synonymy.-
Staurosphaera antiqua RÜST
RÜST 1885, p. 289, pl. 28, fig. 2.
BAUMGARTNER 1984, p. 785, pl. 8, fig. 18.
OZVOLDOVA 1990, pl. 3, fig. 8.
CONTI & MARCUCI 1991, pl. 4, fig. 3.
WIDZ 1991, p. 254, pl. 4, fig. 5.
Emiluvia antiqua (RÜST)
PESSAGNO 1977a, p. 76, pl. 4, figs. 9-10.
KOCHER 1981, p. 63, pl. 13, fig. 4.
Emiluvia (?) *antiqua* (RÜST)
? BAUMGARTNER 1985, fig. 38.g.

Original Definition.- Form very similar to the species described above (see *Emiluvia sedecimporata*), differing by having 24 irregularly large and irregularly polygonal meshes.

Actualized Remarks.- (PESSAGNO, 1977a). Rüst's illustration of his type specimen is surprisingly accurate for its day and can be easily correlated with the electron micrographs of Tithonian specimens from California.

S. antiqua antiqua differs from other subspecies included under this species by the presence of large oval-shaped openings at the base of each spine.

Measurements (in μm).-
Diameter of test: 175. Length of spines: 150.

Type Locality.- Aptychus Beds, Urseblau, Germany.

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

HALIODICTYA (?) ANTIQUA | B 3217

Haliodictya (?) *antiqua* ssp. B

Synonymy.-
Staurosphaera sp. A
WIDZ 1991, p. 254, pl. 4, fig. 4.

Definition.- This species is characterized by a square to subcircular central area with large oval to circular openings set in loose, concentric or spiral rows. Openings are usually largest in the center.

UAZones.- 6-11, mid Bath. to late Kimm.-early Tith.

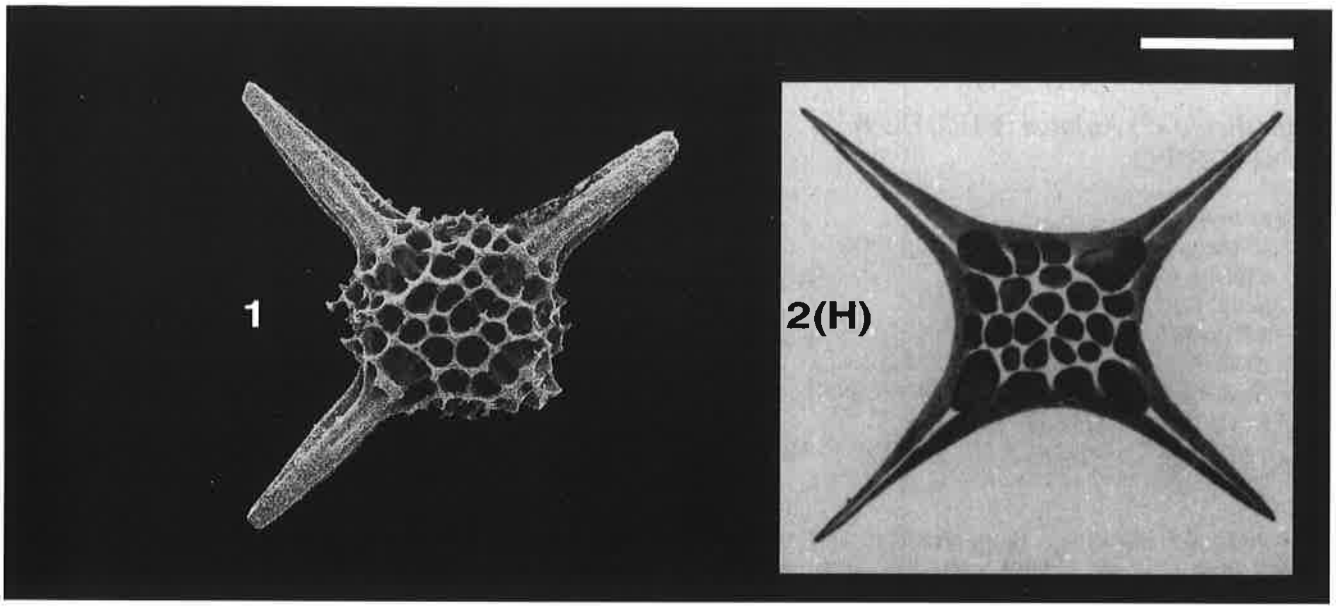


Plate 3218. *Haliodictya* (?) *antiqua antiqua* (RÜST) sensu PESSAGNO. Magnification x150. **Fig. 1.** POB78/6730, POB899.55. **Fig. 2(H).** RÜST 1885, pl. 28, fig. 2.

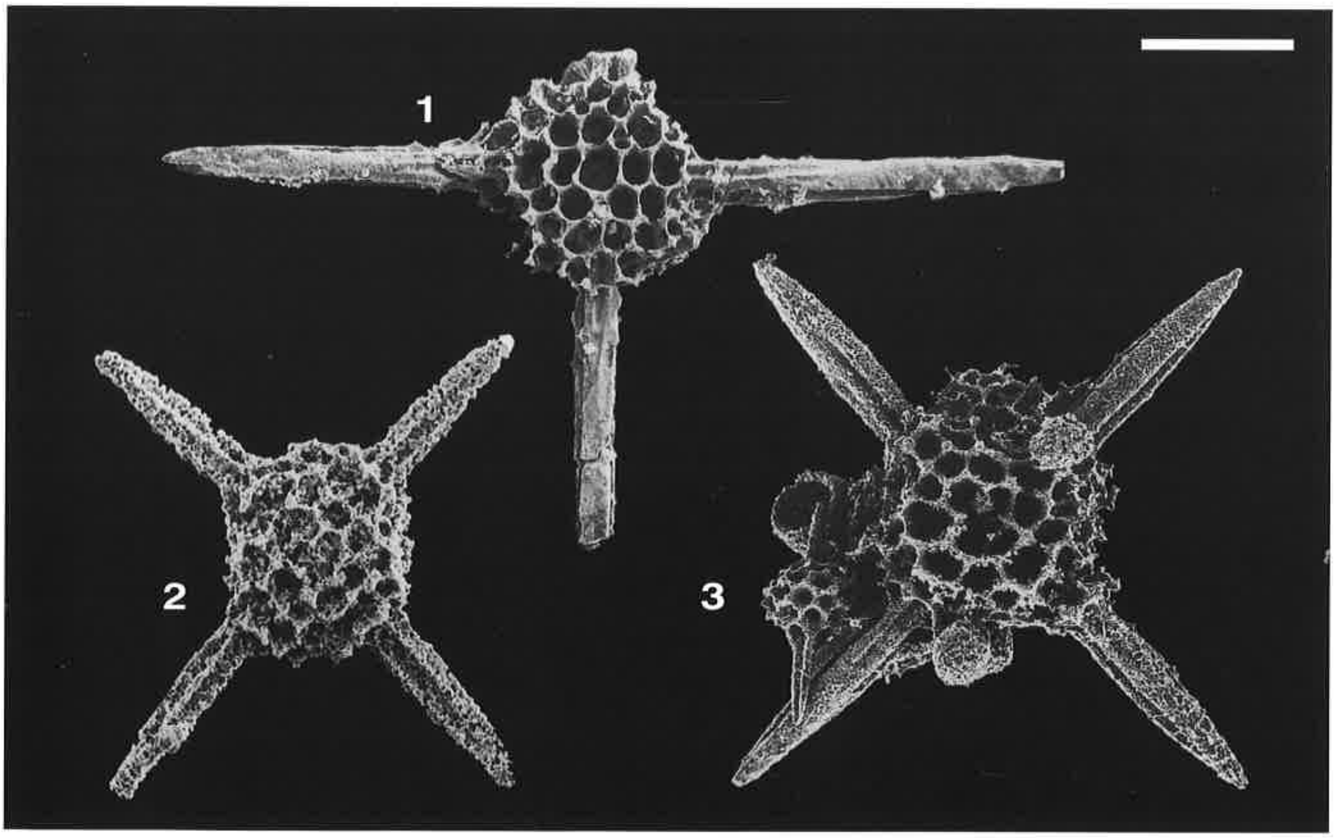


Plate 3217. *Haliodictya* (?) *antiqua* ssp. B. Magnification x150. **Fig. 1.** POB78/8112, POB986.52. **Fig. 2.** DU3827, SV19. **Fig. 3.** POB78/6137, POB899.51.

HALIODICTYA (?) HOJNOSI 3254

Haliodictya (?) *hojnosi* RIEDEL & SANFILIPPO

Synonymy.-
Haliodictya hojnosi RIEDEL & SANFILIPPO
RIEDEL & SANFILIPPO 1974, p. 779, pl. 2, fig. 6; pl. 12, fig. 2, not 3.
AITA 1982, pl. 3, fig. 13.
AITA 1987, p. 64, pl. 1, fig. 6; pl. 8, fig. 4.
Haliodictya (?) *hojnosi* RIEDEL & SANFILIPPO
KOCHER 1981, p. 70, pl. 14, fig. 7.
BAUMGARTNER 1984, p. 767, pl. 4, figs. 10-11.
DANELIAN 1989, p. 157, pl. 5, fig. 5.

Original Definition.- Four-armed to approximately square form with the central body composed, at least in part, of very small, regular, square meshes. Some small specimens consist only of the finely-squared central body with very short bladed spines at the corners, some have an irregularly spongy zone surrounding the finely-squared central body, and in still others the irregularly spongy material is extended as four arms passing into the bladed spines. The finely-squared central structure may be covered in some specimens by irregularly spongy material.

Original Remarks.- This species is distinguished from other, superficially similar forms by the regularly and finely squared central body. It is assigned to Hojnos' genus with some reservations, since the type species (*H. loerentheyi* HOJNOS, 1916 p. 349, pl. 3, fig. 10) appears to have concentric structure in the central body. *Spongolonche inaequispinata* PARONA 1890 (p. 32, pl. 4, fig. 7) has much larger spines, but may be related. Another possibly related form is *Staurosphaera sedecimporata elegans* WISNIOWSKI 1889, (p. 683, pl. 13, fig. 48), in which the squared meshes are coarser.

Actualized Remarks.- (BAUMGARTNER, 1984) Riedel & Sanfilippo (1974) illustrated several morphotypes under this name. The forms included herein lack a preserved spongy meshwork and have, like the holotype, well-defined, solid spines at the corners of the square central body. These forms have been recorded throughout the studied interval, thus the name does not appear in the range chart.

Measurements (in μm).-
Based on 12 specimens. Minimum diameter of skeleton 90-125. Its maximum diameter (including arms and spines) 160-275.

Type Locality.- WR 67-74 Roadcut on northwest side of the road approximately 0.8 km. northeast of Santa Anna (near Caltabellota, Sicily).

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

hanni >> *PSEUDOEUCYRTIS HANNI CF.* 5407

hayi >> *TRITRABS HAYI* 3116

helenae >> *ALIEVIUM HELENAE* 3228

heliotropica >> *ORBICULIFORMA (?) HELIOTROPICA* 3204

helvetica >> *PODOBURSA HELVETICA* 3169

hemicostata >> *STYLOCAPSA (?) HEMICOSTATA* 4045

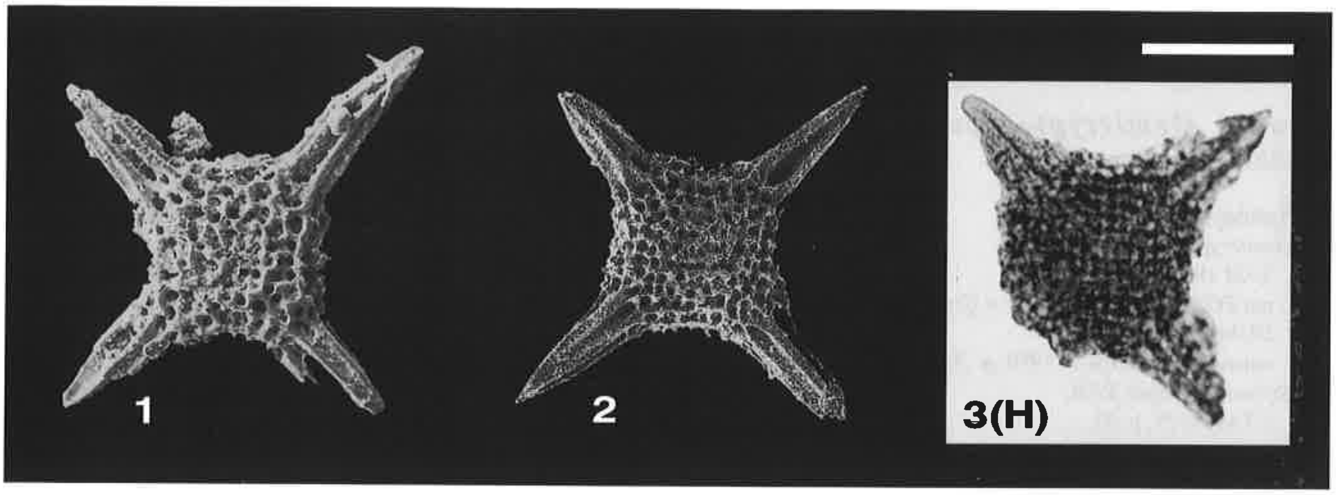


Plate 3254. ***Haliodictya* (?) *hojnosi* RIEDEL & SANFILIPPO.** Magnification x250. **Fig. 1.** POB81/2382, 534.121.1.26. **Fig. 2.** POB78/6147, POB899.51. **Fig. 3(H).** RIEDEL & SANFILIPPO 1974, pl. 12, fig. 2.

HEMICRYPTOCAPSA 3641

Genus: *Hemicryptocapsa* TAN, emend. DUMITRICA

Synonymy.-
Hemicryptocapsa TAN
TAN 1927, p. 50.
not FOREMAN 1968, p. 35 = *Cryptamphorella* DUMITRICA
emend. DUMITRICA 1970, p. 70.
Stylocryptocapsa TAN
? TAN 1927, p. 51.

Type Species.- *Hemicryptocapsa capita* TAN 1927.

Original Definition.- "One Tricyrtida eradiata, clausa, without apical horn, where the thorax is hidden in the abdomen. This feature becomes gradational with the other end member *Tricolocapsa.* In transitional species the identification should rely on the “systematic” interpretation of the individual author. It belongs to the subfamily Theocapsida HAECKEL. *T. pilula* HINDE could be included in this group (Molukkenverslag, p. 712, VII-3. Appendix Molengraaff. Borneo, p. 33, IV-22).”

Actualized Definition.- (DUMITRICA, 1970) Cryptothoracic tricyrtids with large inflated abdomen having a strongly constricted aperture and a simple sutural pore; cephalis simple, poreless, with four collar pores, usually without apical horn; thorax campanulate, porous, partly to almost completely depressed into the abdominal cavity and armed with three descending spines.

Remarks.- It is not surely proven that the species here assigned to *Hemicryptocapsa* belong really to it. Tan's diagnosis is too large and may be confusing because several cryptothoracic genera may hide behind it. Being established that Tan’s species are upper Cretaceous and that the species we described under the name of *Hemicryptocapsa* are of rather similar age, that some characters such as the aperture and the thorax encasing are common to our and Tan’s species, it is possible that the thorax structure be similar too.

Hemicryptocapsa appears to be an intermediate evolutive term between *Williriedellum* and *Holocryptocapsa.* From the first one it differs in having the three characteristic descending thoracic spines and a simple sutural pore. It is inferior to the last one by its less depressed thorax.

Species are distinguished by the configuration of abdominal surface features, i.e. the configuration of pores and ridges.

Included Taxa.-
4026 *Hemicryptocapsa capita* TAN

HEMICRYPTOCAPSA CAPITA 4026

Hemicryptocapsa capita TAN

Synonymy.-
Hemicryptocapsa capita TAN
TAN 1927, p. 50, pl. 9, fig. 67.
not DUMITRICA & MELLO 1982, pl. 3, fig. 3.
OKAMURA & UTO 1982, pl. 2, fig. 20.
IGO et al. 1987, fig. 2.12.
KITO 1987, pl. 2, fig. 7.
TUMANDA 1989, p. 37, pl. 6, fig. 8; pl. 10, fig. 9.
AGUADO et al. 1991, figs. 7.16, 20.
MATSUOKA 1992, pl. 1, fig. 3.
Hemicryptocapsa spp. cf. *H. capita* TAN
RIEDEL & SANFILIPPO, 1974, p. 779, pl. 6, figs. 1-4.
FOREMAN 1975, p. 618, pl. 2I, figs. 18, 20.
NAKASEKO et al. 1979, pl. 2, figs. 8-9.
NAKASEKO & NISHIMURA 1981, p. 153, pl. 4, fig. 5; pl. 14, fig. 7.
KIMINAMI et al. 1985, pl. 2, fig. 2.
Hemicryptocapsa cf. *capita* TAN
SUYARI 1986b, pl. 4, fig. 3.
Hemicryptocapsa sp. B
TUMANDA 1989, p. 37, pl. 6, fig. 9.

Original Definition.- "Spherical, with two septa. thorax encased in the thick wall of the abdomen. Cephalis poreless, with irregularly disposed costae. Abdomen spherical, made of big round pores, disposed in hexagonal frames because of which the wall becomes rough. Pylome visible, overgrown by a hyaline thick-walled cap with four big openings through which the pylome-canal communicates with the external world. The same pylome-cap forms with *Cyrtocapsa grutterinki,* var. A pl. 13, fig. 111 and *Artocapsa bicornis* pl. 16, fig. 142".

Measurements (in μm).-
Length: 203, maximum width: 155, thickness of the wall: 22, diametre of pores: 5, length of pylome-cap: 15, ratio of length of segments: 7:7:40.

Type Locality.- Rotti Island, Moluccas Archipelago, East Indian Ocean.

UAZones.- 17-18, late Val. to latest Val.-earliest Haut.

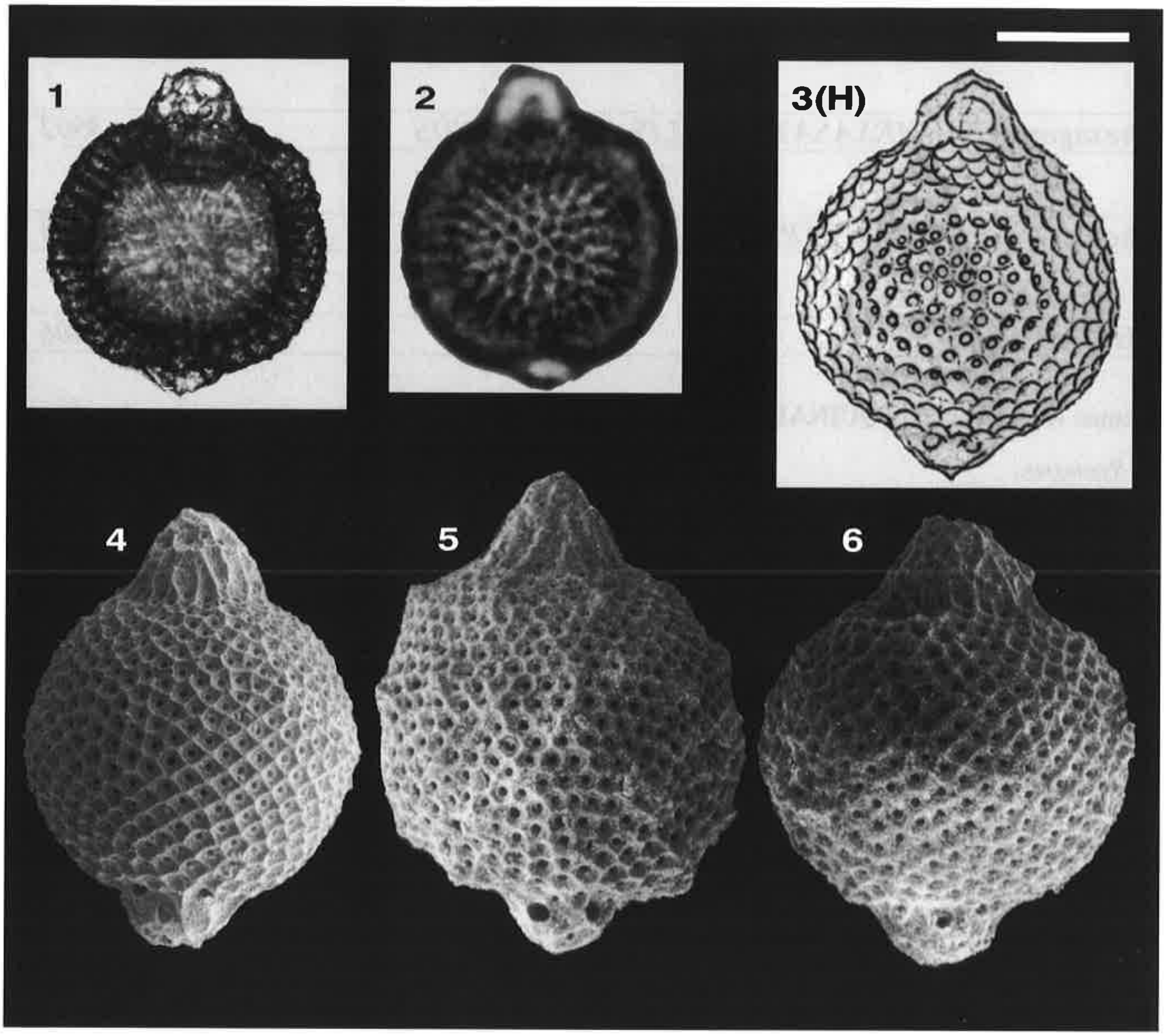


Plate 4026. ***Hemicryptocapsa capita*** **TAN.** Magnification x300. **Fig. 1.** KI6-19(35), NK82090406. **Fig. 2.** KI6-20(35), NK82090406. **Fig. 3(H).** TAN 1927, pl. 9, fig. 67. **Fig. 4.** KI30-6, NK81062827. **Fig. 5.** KI97-16, NK81072501. **Fig. 6.** KI102-4, NK81091809.

hexacubicus >> *LEUGEO HEXACUBICUS* 3244

hexagonus >> *HEXASATURNALIS HEXAGONUS* 3502

hexaptera >> *PODOCAPSA (?) HEXAPTERA* 4033

HEXAPYRAMIS 6006

Genus: *Hexapyramis* SQUINABOL

***Synonymy*.-**
Hexapyramis SQUINABOL
SQUINABOL 1903, p. 113.

***Type Designation*.-** *Hexapyramis pantanellii* SQUINABOL 1903.

***Original Definition*.-** "I am obliged to create this genus for a form that is neither very frequent nor too rare among radiolarians. It consists of six pyramids with very rounded corners that apparently are rather similar to cones connected by their bases according to the faces of a cube, or, that is the same thing, disposed on a sphere in three equal orthogonal axes. All specimens observed are unfortunately so opaque that they did not permit me to see the continuation of these axes inside the test; it was not possible therefore to decipher whether they are also or not inside the sphere. The probability is that they certainly are not but being not sure it is better for the moment to ignore this. The body of each pyramid is formed of a meshwork with irregular meshes, almost always polygonal in outline and very large, resembling rather well the type drawn by Haeckel for *Hexacromyum octahedrum*".

***Included Taxa*.-**
5069 *Hexapyramis* (?) *precedis* JUD

HEXAPYRAMIS (?) PRECEDIS 5069

Hexapyramis (?) *precedis* JUD

***Synonymy*.-**
Hexapyramis (?) *precedis* JUD
JUD 1994, p. 79, pl. 11, figs. 4-6.

***Original Definition*.-** Central test latticed, globular, with 6 equal, three-bladed pointed robust spines. Base of spines with wide lattice. Pores polygonal, variable in size and shape. Internal structures not observable because of the poor state of preservation.

***Original Remarks*.-** *Hexapyramis* (?) *precedis* n.sp. differs from *Hexapyramis pantanellii* SQUINABOL (1903) by its smaller size, by having shorter spines and by lacking well developed latticed pyramids. Younger forms show a passage to *Hexapyramis pantanellii. Hexapyramis* (?) *precedis* n.sp. could therefore be the ancestor of *H. pantanellii.*

***Etymology*.-** From the Latin *precedere* = precede.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total height:	313	332	246	435
Height central part:	136	172	133	247
Width central part:	135	143	112	206
Maximum Length spines:	77	90	72	112

***Type Locality*.-** Fiume Bosso, Umbria-Marche, Italy.

***UAZones*.-** 17-22, late Val. to late Barr.-early Apt.

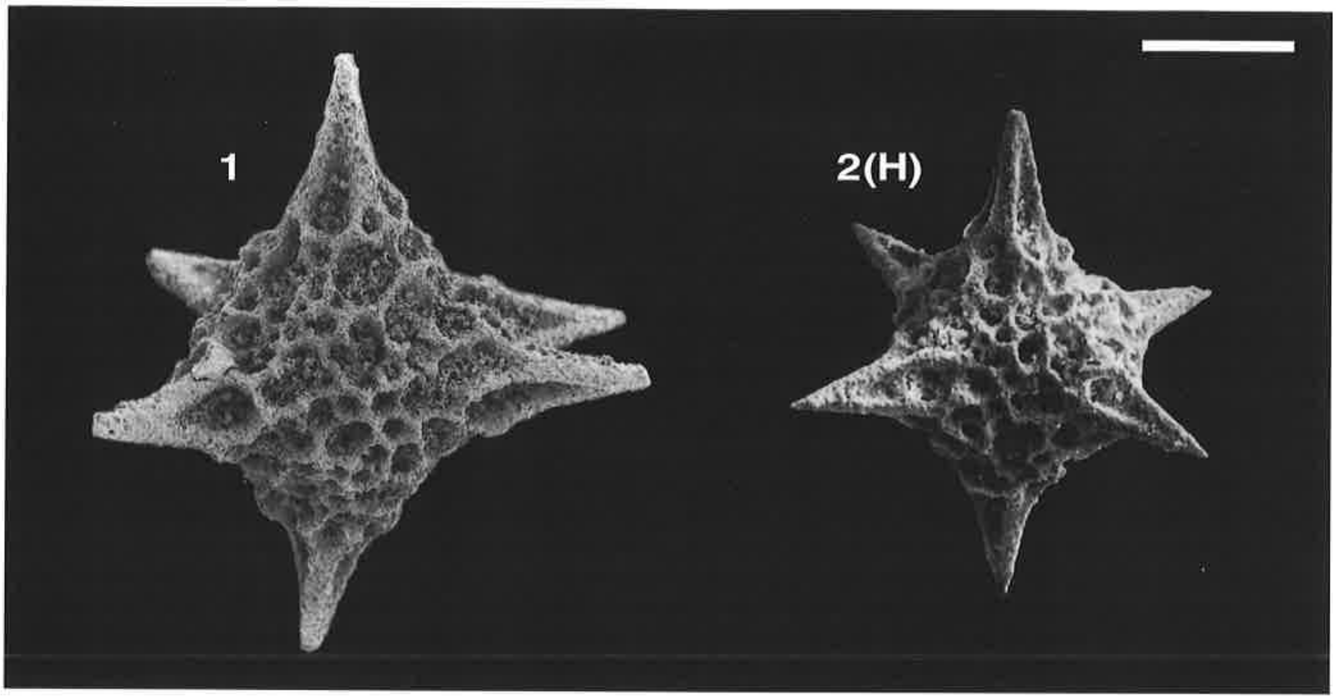


Plate 5069. *Hexapyramis* (?) *precedis* JUD. Magnification x300. **Fig. 1.** RJ187, Bo566.50. **Fig. 2(H).** RJ1111, Bo561.50.

HEXASATURNALIS 3656

Genus: *Hexasaturnalis* KOZUR & MOSTLER

Synonymy.-
Hexasaturnalis KOZUR & MOSTLER
KOZUR & MOSTLER 1983, p. 28.

Type Designation.- *Spongosaturnalis ? hexagonus* YAO, 1972.

Original Definition.- Ring and outer spines strongly bladed. Outline of ring hexagonal to octogonal or subquadratically rounded. 4-6 very strong outer spines. Two massive polar spines opposite to interspine spaces on the outer margin of the ring. No auxiliary spines. Ring often a little constricted in the polar spine attachment region. Cortical shelles spongy, widely separated from the inner margin of the ring. Medullary shell latticed.

Original Remarks.- By increase of the number of marginal spines the hexagonal to octogonal outline of the ring is transformed to a polygonal to subcircular one. In this manner the genus *Spongosaturnalis* CAMPBELL & CLARK, 1944, evolved in the Cretaceous from *Hexasaturnalis* n.gen.

Praehexasaturnalis n.gen. from the Norian has the same outline of ring, but the polar spines are still situated opposite to the marginal spines and the narrow ring is still flat to shallow oval in cross section. *Yaosaturnalis* n.gen. has the same outline and structure of ring as *Hexasaturnalis* n.gen. but auxiliary spines are present.

Remarks.- We herein follow the definition by Kozur & Mostler (1983) which permits to avoid, for the following two species, the delicate problem of the generic systematics of Post-Triassic saturnalids.

Etymology.- According to the outline.

Included Taxa.-
3502 *Hexasaturnalis hexagonus* (YAO)
3089 *Hexasaturnalis tetraspinus* (YAO)

HEXASATURNALIS HEXAGONUS 3502

Hexasaturnalis hexagonus (YAO)

Synonymy.-
Spongosaturnalis ? hexagonus YAO
YAO 1972, p. 31, pl. 6, figs 1-3; pl. 11, figs. 3a-c.
WAKITA & OKAMURA 1982, pl. 5, fig. 2.
MATSUDA & ISOZAKI 1982, pl. 1, fig. 20.
WAKITA 1982, pl. 4, fig. 11.
Spongosaturnalis (?) *tetraspinus* YAO
KISHIDA & SUGANO 1982, pl. 6, fig. 9, not 10.
Acanthocircus hexagonus (YAO)
KIDO 1982, pl. 3, fig. 10.
HATTORI 1987, pl. 1, fig. 2.
HATTORI 1988a, pl. 1, fig. K.
Hexasaturnalis hexagonus (YAO)
not GRILL & KOZUR 1986, pl. 2, fig. 5.
Mesosaturnalis hexagonus (YAO)
not CARTER et al. 1988, pl. 47, pl. 9, figs. 11-12.
CARTER & JAKOBS 1991, p. 343, pl. 2, fig. 15.

Original Definition.- Spongosaturnalid with subhexagonal ring, and with six strong spines on ring.

Shell not preserved, but believed to be wholly spongy because numerous fragmentary thorns, which may be connected with spongy shell, are clearly observed on sturdy spines. Polar spines short, thick, with no ridge. Ring bilaterally symmetrical, subhexagonal, strong, with clear ridge on outer edge. Inner edge of ring curves rather smoothly, while outer edge is subhexagonal, with spine at each vertex. Ring which joins with polar spine bends slightly toward inside. Spines, situated diagonally on ring, strong, somewhat long, of sharp tip, with clear ridges which continue to one on outer edge of ring.

Original Remarks.- This species differs from *Spongosaturnalis ? septispinus* (described below) in the number of spine, and from *S. ? minoensis* (described below) in lacking auxiliary spines on the inner margin of the saturnalin ring. *Spongosaturnalis* ? sp. FOREMAN 1971, (pl. 1, fig. 4; Cretaceous sediments core, Site 61, west margin of East Mariana Basin, through the Deep Sea Drilling Project), is similar to this species, but the former has slender spines on which there is no ridge.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Diameter of ring longit.:	243	198	156	243
Diameter of ring trans.:	278	245	188	282
Diameter of shell :	136	104	75	136
Lenght of polar spine:	23	19	10	25
Lenght of spine:	126	101	62	130
Breadth of ring:	36	27	17	39

Type Locality.- Inuyama area, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

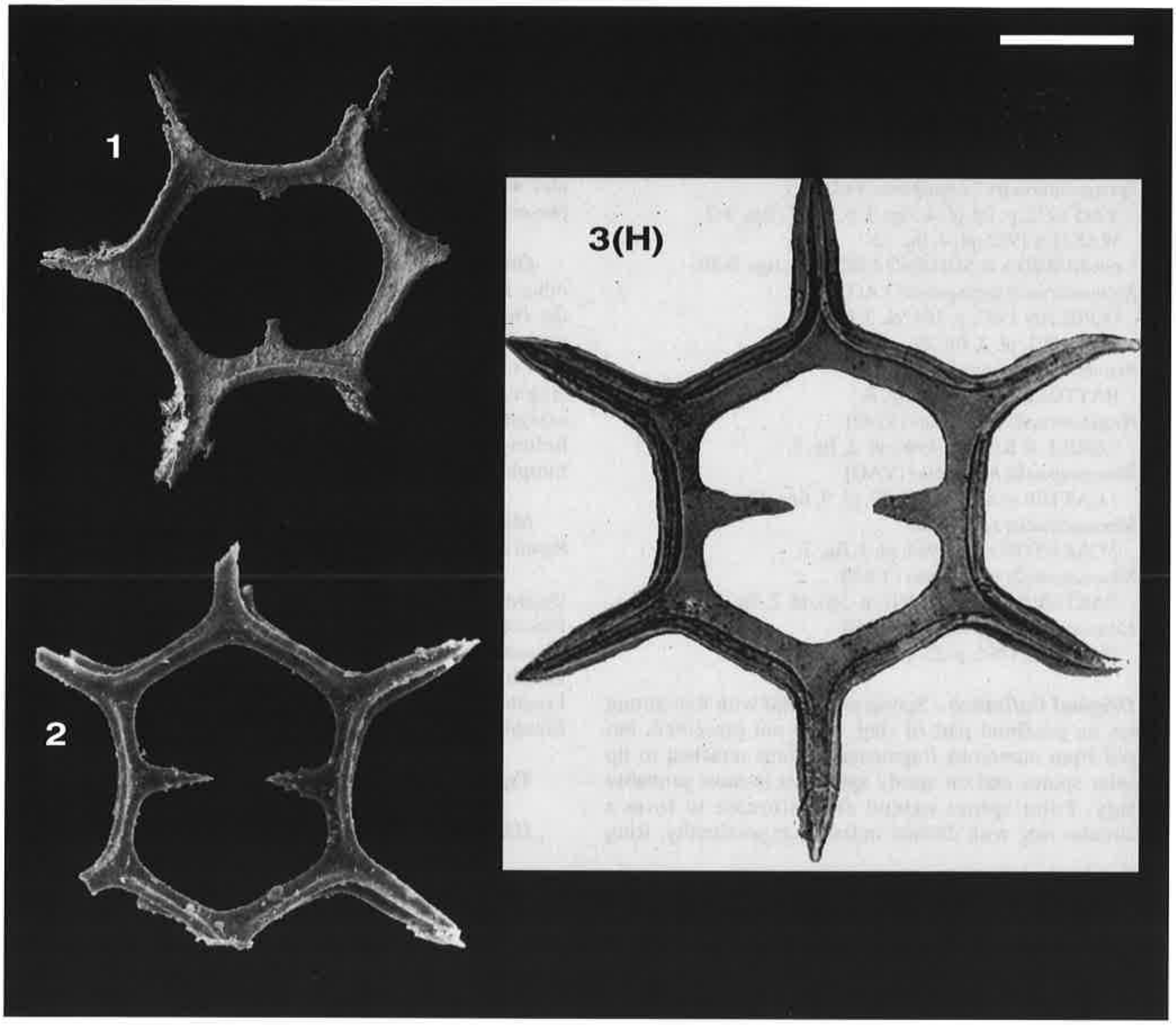


Plate 3502. *Hexasaturnalis hexagonus* (YAO). Magnification x 200. **Fig. 1.** KI8835-1581, S70. **Fig. 2.** MA9828, MIN-1, CH-1-A. **Fig. 3(H).** YAO 1972, pl. 6, fig. 2.

HEXASATURNALIS TETRASPINUS 3089

Hexasaturnalis tetraspinus (YAO)

Synonymy.-
Spongosaturnalis ? tetraspinus YAO
YAO 1972, p. 29, pl. 4, figs. 1-6; pl. 11, figs. 1-2.
WAKITA 1982, pl. 4, fig. 12.
not KISHIDA & SUGANO 1982, pl. 6, figs. 9-10.
Mesosaturnalis tetraspinus (YAO)
GORICAN 1987, p. 184, pl. 3, fig. 1.
YAO 1991, pl. 3, fig. 24.
Acanthocircus tetraspinus YAO
HATTORI 1988a, pl. 2, fig. B.
Hexasaturnalis hexagonus (YAO)
? GRILL & KOZUR 1986, pl. 2, fig. 5.
Mesosaturnalis hexagonus (YAO)
? CARTER et al. 1988, pl. 47, pl. 9, figs. 11-12.
Mesosaturnalis squinaboli
? CARAYON et al. 1984, pl. 1, fig. 2.
Mesosaturnalis tetraspinus (YAO)
CARTER & JAKOBS 1991, p. 343, pl. 2, fig. 16.
Hexasaturnalis tetraspinus (YAO)
TONIELLI 1991, p. 23, pl. 1, fig. 5.

Original Definition.- Spongosaturnalid with four strong spines on proximal part of ring. Shell not preserved, but judged from numerous fragmentary thorns attached to tip of polar spines and on sturdy spines, it is most probably spongy. Polar spines extend and bifurcate to form a subcircular ring with distinct indentation proximally. Ring bilaterally symmetrical, strong, with clear ridge on outer edge. Four spines are present symmetrically on proximal part of ring. Spines strong, slightly curved, with sharp tip, and with clear ridges. In some specimens, short spine is present on terminal end of ring.

Original Remarks.- This species is distinguished from other species by the strong spines on the proximal part of the ring. There is little variation in the shape of the ring, excluding the presence of a short spine at the terminal end.

Complete specimen with the shell was not found and fragmentary rings are common. Although the generic assignment of this species is slightly doubtful, it may belong to the genus *Spongosaturnalis* because of its morphological feature.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Diameter of ring longit.:	360	294	220	360
Diameter of ring; trans.:	485	374	220	485
Diameter of shell :	105	102	80	120
Length of polar spine:	95	63	40	95
Length of spine:	90	75	58	100
Breadth of ring:	37	30	16	37

Type Locality.- Inuyama area, central Japan.

UAZones.- 1-6, early-mid Aal. to mid Bath.

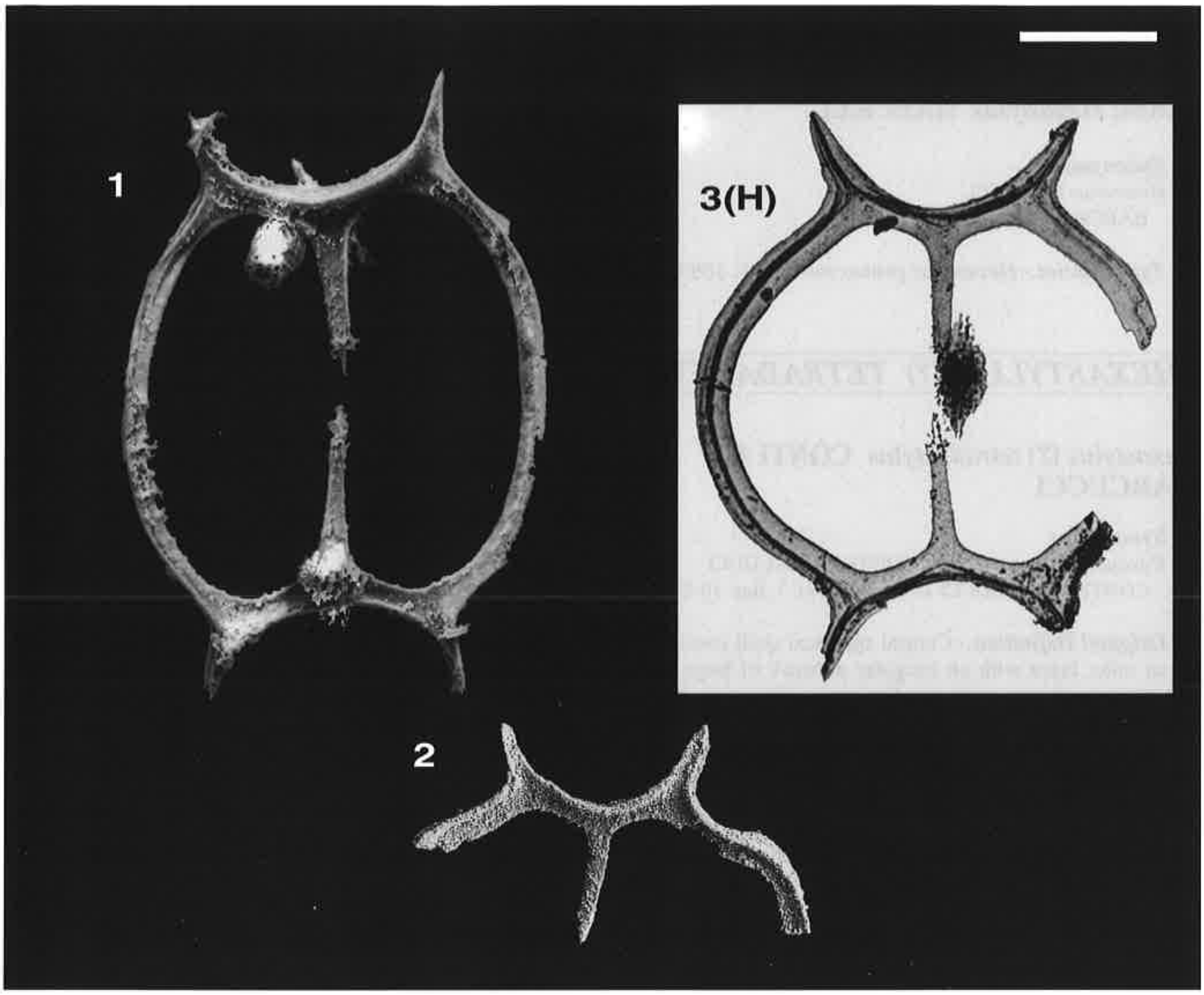


Plate 3089. *Hexasaturnalis tetraspinus* (YAO). Magnification x150. **Fig. 1.** KI8849-1902, S63, x145. **Fig. 2.** POB81/2900, POB1341. **Fig. 3(H).** YAO 1972, pl. 4, fig. 6.

HEXASTYLUS 3643

Genus: *Hexastylus* HAECKEL

Synonymy.-
Hexastylus HAECKEL
HAECKEL 1881, p. 450

Type Species.- *Hexastylus primaevus* RÜST, 1885.

Original Definition.- "Monosphaeria with six spines (the six spines situated in three mutually perpendicular axes). Without secondary spines."

Included Taxa.-
4027 *Hexastylus* (?) *tetradactylus* CONTI & MARCUCCI

HEXASTYLUS (?) TETRADACTYLUS 4027

Hexastylus (?) *tetradactylus* CONTI & MARCUCCI

Synonymy.-
Hexastylus (?) *tetradactylus* CONTI & MARCUCCI
CONTI & MARCUCCI 1991, p. 801, pl. 3, figs. 10-11.

Original Definition.- Central spherical shell constituted by an outer layer with an irregular network of large pores and an inner layer with smaller pores; these are visible through the larger pores of the outer layer. The test bears six large radial spines with logitudinal grooves and ridges; these principal spines terminate with three thinner lateral secondary spines and a still shorter axial one.

Original Remarks.- The double-layer pore meshwork of *Hexastylus* (?) *tetradactylus* distinguishes this species from *H. grandiporus* SQUINABOL 1903, in which a simple meshwork of pores is present. The termination of spines in these two species cannot be compared since they are not preserved in the specimen of *H. grandiporus* described by Squinabol 1903. *Hexastylus* (?) *tetradactylus* is comparable with *H. ombonii* SQUINABOL for the double layer pore meshwork, but it differs from this species in the length and shape of spines. The assignment to genus *Hexastylus* is provisional, since most species of this genus show a simple meshwork of pores.

Etymology.- Greek, *tetra* (prefix from tetteres = four) + *dacktylos* = finger.

Measurements (in μm).-
Based on 3 specimens.

	HT	min.	max.
Diameter of shell:	215	200	230
Length principal spine:	140	125	150
Length lateral spines:	130	60	130

Type Locality.- Sample GR 6, Ponte di Lagoscuro (Eastern Liguria - Italy).

UAZones.- 1-4, early-mid Aal. to late Baj.

hichisoense >> LAXTORUM (?) HICHISOENSE 4028

hiconocosta >> PARAHSUUM (?) HICONOCOSTA 3011

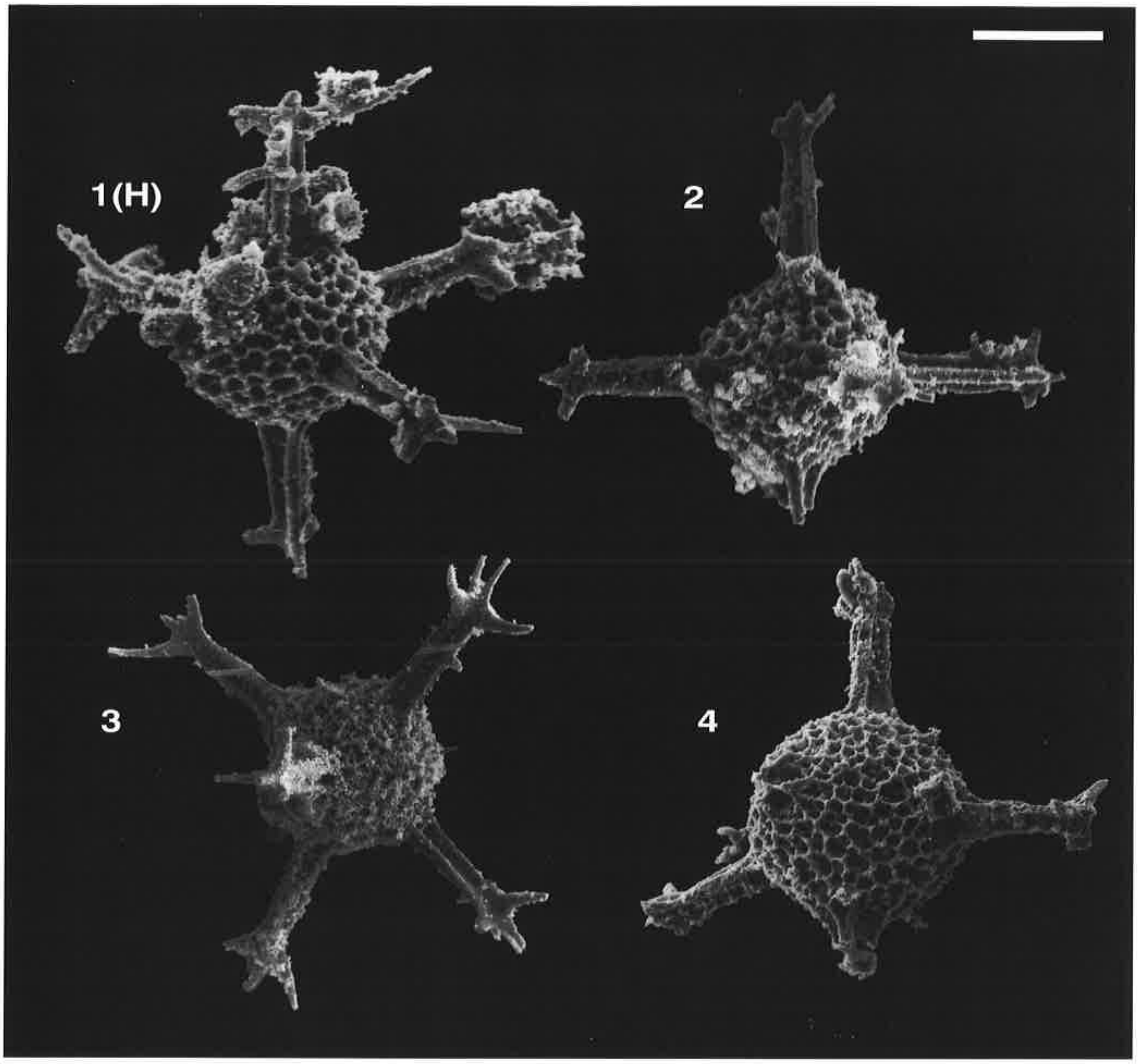


Plate 4027. ***Hexastylus* (?) *tetradactylus* CONTI & MARCUCCI.** Magnification x150. **Fig. 1(H).** MC45/87, GR6. **Fig. 2.** MC44/87, GR6. **Fig. 3.** MA10317, MIN-1, Ch-1-A. **Fig. 4.** MC09/87, GR6.

HEXASTYLUS (?) \ A 2009

Hexastylus (?) sp. A

Synonymy.-
Hexastylus (?) sp. 1
KITO 1987 , p. 181, pl. 1, fig. 18.
Hexastylus (?) sp. A
TONIELLI 1991, p. 120, pl. 2, fig. 6.

Remarks.- Test composed of a sphaerical cortical shell with six radial spines arranged at right angles. Cortical shell made of hexagonal or pentagonal pore frames with vertices that bear little nodes. Three radiate, straight and long spines with three primary and three secondary grooves. We have not observed the internal structure , the species is, therefore, doubtfully assigned to the genus *Hexastylus.*

UAZones.- 1-4, early-mid Aal. to late Baj.

HIGUMASTRA 3644

Genus: *Higumastra* BAUMGARTNER

Synonymy.-
Higumastra BAUMGARTNER
BAUMGARTNER 1980, p. 290.

Type Species.- *Higumastra inflata* BAUMGARTNER 1980.

Original Definition.- Test composed of 4 rays at right angles. Cortical rays composed of thin external beams connected by regular bars forming large circular pores in longitudinal rows. Ray tips with central or 2 lateral and central spines. Inner structure in rays and medullary shells always visible in transmitted light observation. Centrally placed shells (1 or 2) are on both sides joined to the cortical shell. Vertical septae lying below the median pore row extend from the innermost medullary shell and divide the inner space of the rays into 2 main canals of semicircular cross section. Vertical septum composed of primary beam and primary lamellae penetrated by large lamellae pores. Vertical septum with 1 or 2 channels belows the median pore row on each side. Patagium may be well developed, present as remnants, or absent.

Original Remarks.- *Higumastra* n.gen. differs from all other four-armed hagiastrids by the easily visible inner structure and in having large pore frames in longitudinal rows with a distinct median pore row.

Etymology.- *Higumastra* is an anagram of *Hagiastrum.*

Included Taxa.-
3108 *Higumastra coronaria* OZVOLDOVA.
3109 *Higumastra gratiosa* n.sp. BAUMGARTNER
3110 *Higumastra imbricata* (OZVOLDOVA)
3106 *Higumastra inflata* BAUMGARTNER
3148 *Higumastra wintereri* n.sp. BAUMGARTNER & KITO

HIGUMASTRA CORONARIA 3108

Higumastra coronaria OZVOLDOVA

Synonymy.-
Higumastra sp. C
BAUMGARTNER 1980, p. 291, pl. 3, figs. 10, 12; pl. 11, figs. 1-2.
Higumastra coronaria OZVOLDOVA
OZVOLDOVA & SYKORA 1984, p. 266, pl. 7, figs. 2-5; pl. 8, fig. 1; pl. 16, fig. 3.

Original Definition.- Four rays arise from a small central area; they are arranged in a cross and connected by a thick patagium protruding like a garland over flat, axially compressed rays. The garland is of a subquadrangle shape and extends to about half the distance between the beginnings of the spines and the test centre. There are four large circular to oval openings in the angles between the rays. The meshwork of the rays is formed by five longitudinal rows of oval pores, the size of which increases towards the tips. The patagium meshwork is spongy, the size of its pores equals to the size of the pores at the ray tips. The patagium surface is ragged. The central area pores are small, arranged irregularly. In the test centre, two concentrical medullary shells are placed.

Etymology.- Latin *corona* - the garland; after the patagium in the shape of a garland.

Measurements (in μm).-
Based on 3 specimens.

	HT	min.	max.
Width of test:	625	562	625
Length of spines:	91	62	166
Diameter of aperture:	75	60	75
Diameter of pores:	16	14	18

Type Locality.- The Sipkovsky Haj, the Cachticke Karpaty Mts.

UAZones.- 8-9, mid Call.-early Oxf. to mid-late Oxf.

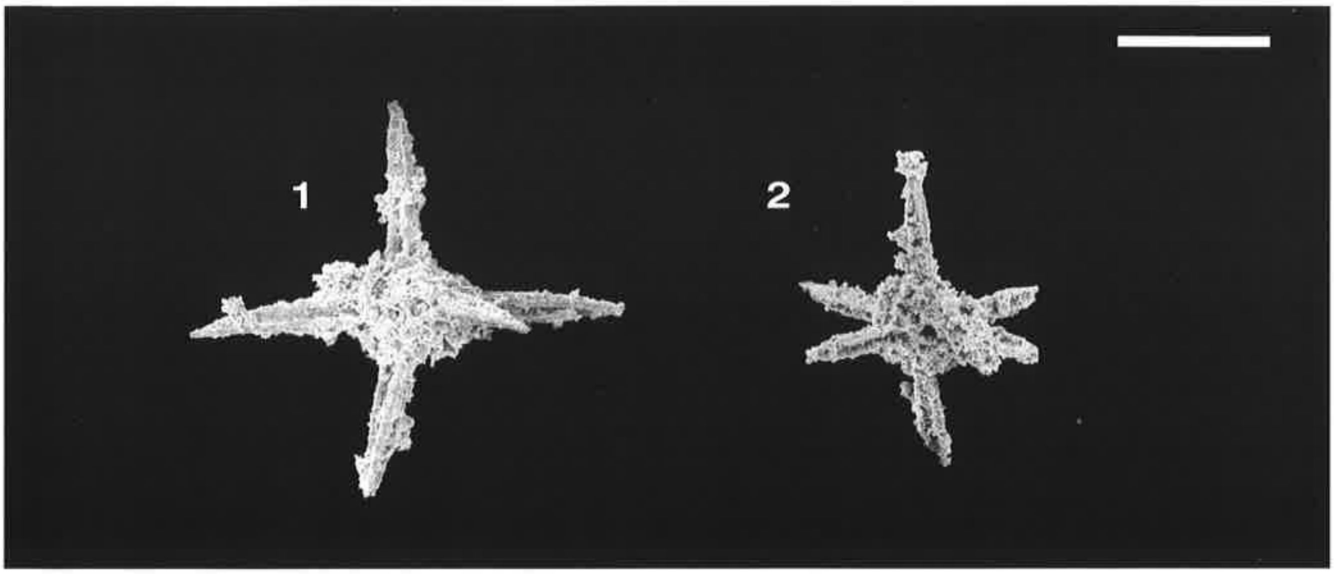


Plate 2009 *Hexastylus* (?) sp. A. Magnification x100. **Fig. 1.** AB6404, TM40.15a1. **Fig. 2.** AB53, TM48.35.a78.

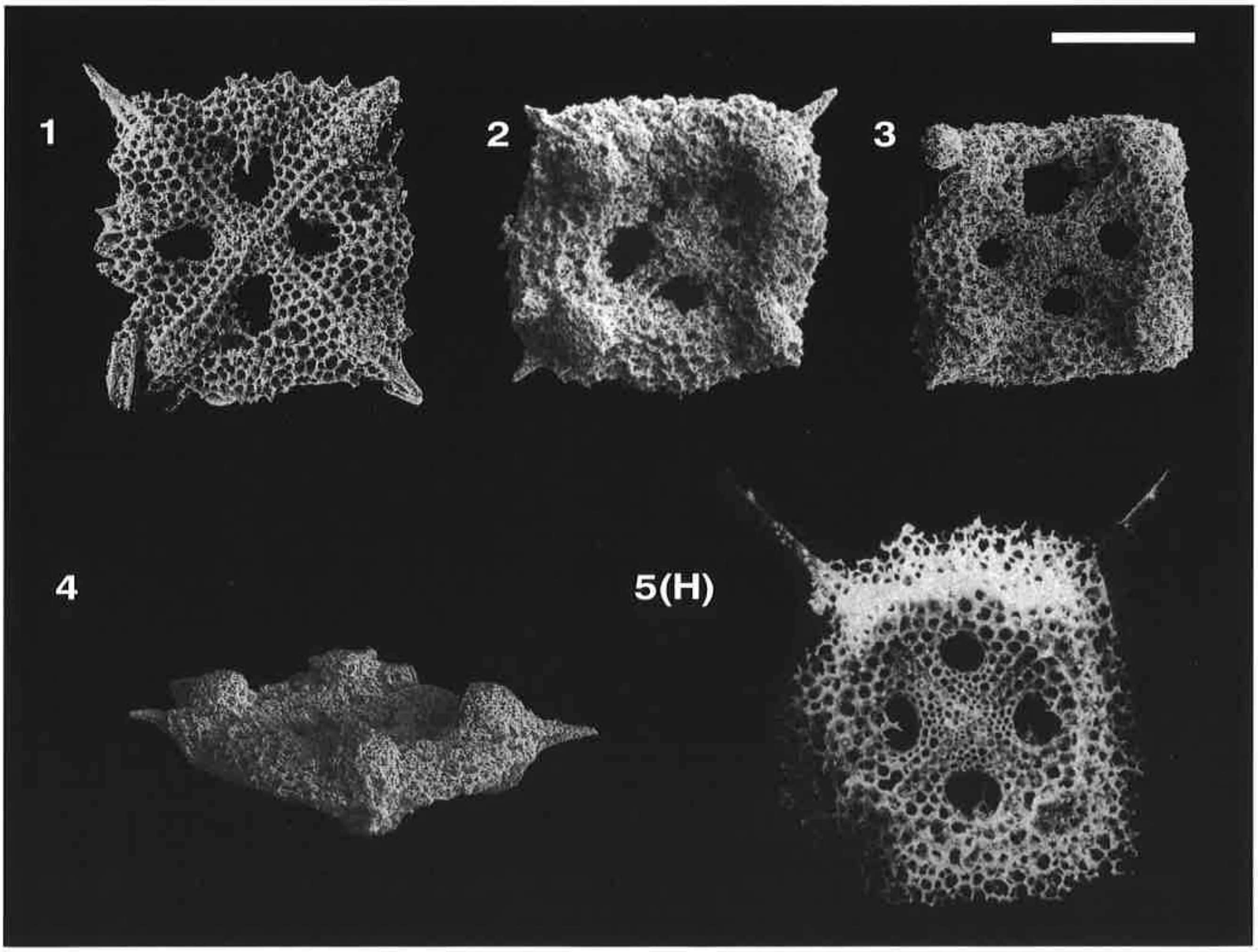


Plate 3108. *Higumastra coronaria* OZVOLDOVA. Magnification x100. **Fig. 1.** POB78/6111, POB899.51. **Fig. 2.** DU3838, SV16. **Fig. 3.** DU3837, SV16. **Fig. 4.** DU3835, SV16. **Fig. 5(H).** OZVOLDOVA & SYKORA 1984, pl. 7, fig. 2.

HIGUMASTRA GRATIOSA 3109

Higumastra gratiosa n.sp. BAUMGARTNER

Synonymy.-
Higumastra sp. aff. *H. inflata* BAUMGARTNER
not BAUMGARTNER 1980, p. 290, pl. 3, fig. 4.
not KOCHER 1981, p. 71, pl. 14, fig. 9.
BAUMGARTNER 1984, p. 768, pl. 4, fig. 12.
DE WEVER et al. 1986, pl. 8, fig. 2.
Higumastra imbricta OZVOLDOVA
PESSAGNO et al. 1993, p.125, pl. 3, figs. 23-24.

Type Designation.- POB 81/9183, 76.534A.126.2.125.

Original Definition.- Small, fragile form with depressed central area and variably developed patagium. Rays almost of equal length, rapidly broadening to join central area, normally bearing sharp spines. Central row of pores on each ray very distinct and framed by raised beams. Central area depressed. Apparently, the absence of cortical material in the central area uncovers the medullary shell. A fragile patagium usually fills the space between rays.

Original Remarks.- This species is distinguished from other *Higumastra* by its small size and the presence of a delicate patagium between rays. This species differs from *H. devilsgapensis* PESSAGNO, BLOME & HULL 1993, in Pessagno et al. 1993 by a less inflated test and by a raised median row of pore frames. The external beams on both side of the median pore row merge into the blades of the central spines.

Etymology.- *Gratiosa*, (f.) from Latin = graceful.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Length of rays:	150	152	135	185
Width of central area:	160	166	152	175

Type Locality.- Leg 76, Site 534, Blake Bahama Basin, Central Atlantic.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

HIGUMASTRA IMBRICATA 3110

Higumastra imbricata (OZVOLDOVA)

Synonymy.-
Crucella (?) *imbricata* OZVOLDOVA
OZVOLDOVA 1979, p. 254, pl. 3, figs. 1, 4.
Higumastra imbricata (OZVOLDOVA)
KOCHER 1981, p. 71, pl. 14, fig. 8.
BAUMGARTNER 1984, p. 767, pl. 4, fig. 13.
DE WEVER & MICONNET 1985, p. 387, pl. 1, fig. 10.
AITA 1987, p. 64, pl. 8, fig. 10.
OZVOLDOVA & PETERCAKOVA 1987, p. 119, pl. 32, figs. 6, 8.
DANELIAN 1989, p. 157, pl. 5, fig. 6.
KITO 1989, p. 134, pl. 13, fig. 1.
DANELIAN & BAUDIN 1990, pl. IIB, fig. 1.
KITO et al. 1990, pl. 1, fig. 7.
CONTI & MARCUCCI 1991, pl. 2, fig. 8.
not STEIGER 1992, p. 43, pl. 10, fig. 4.
not PESSAGNO et al. 1993, pl. 3, figs. 23-24.
Higumastra sp. A
ISHIDA 1983, pl. 11, fig. 1.
Higumastra sp.
YAMAMOTO et al. 1985, pl. 4, figs. 8a-b.
Higumastra aff. *imbricata* OZVOLDOVA
KISHIDA & HISADA 1986, fig. 2.24.

Original Definition.- Test is cross-shaped. Central area contains a small cell surrounded by three concentrical rows of cells separated by radial bars. This central area of test is of a flat, discoid shape. From it, four massive flat rays diverge crosswise. They expand in width in about 3/5 of their length and terminate in a roof shape. At the end of the rays, there is a massive short spine. Cross section of the rays is elliptical. The rays are of approximately the same length. Meshwork of the rays is formed by 4-5 longitudinal rows of square pore frames. Their number is 7-10 in each row. 2-3 longitudinal rows of pores join in an expanded part of the rays.

Etymology.- After termination of rays; Latin *imbricatus* - arranged tile-like.

Measurements (in μm).-
Based on 3 specimens.

	HT	min.	max.
Width of test:	160	155	200
Length of rays:	150	140	190
Length of spines	25	25	75
Diameter of pores:	8	8	12

Type Locality.- Podbiel, Orava, Slovakia.

UAZones.- 4-8, late Baj. to mid Call.-early Oxf.

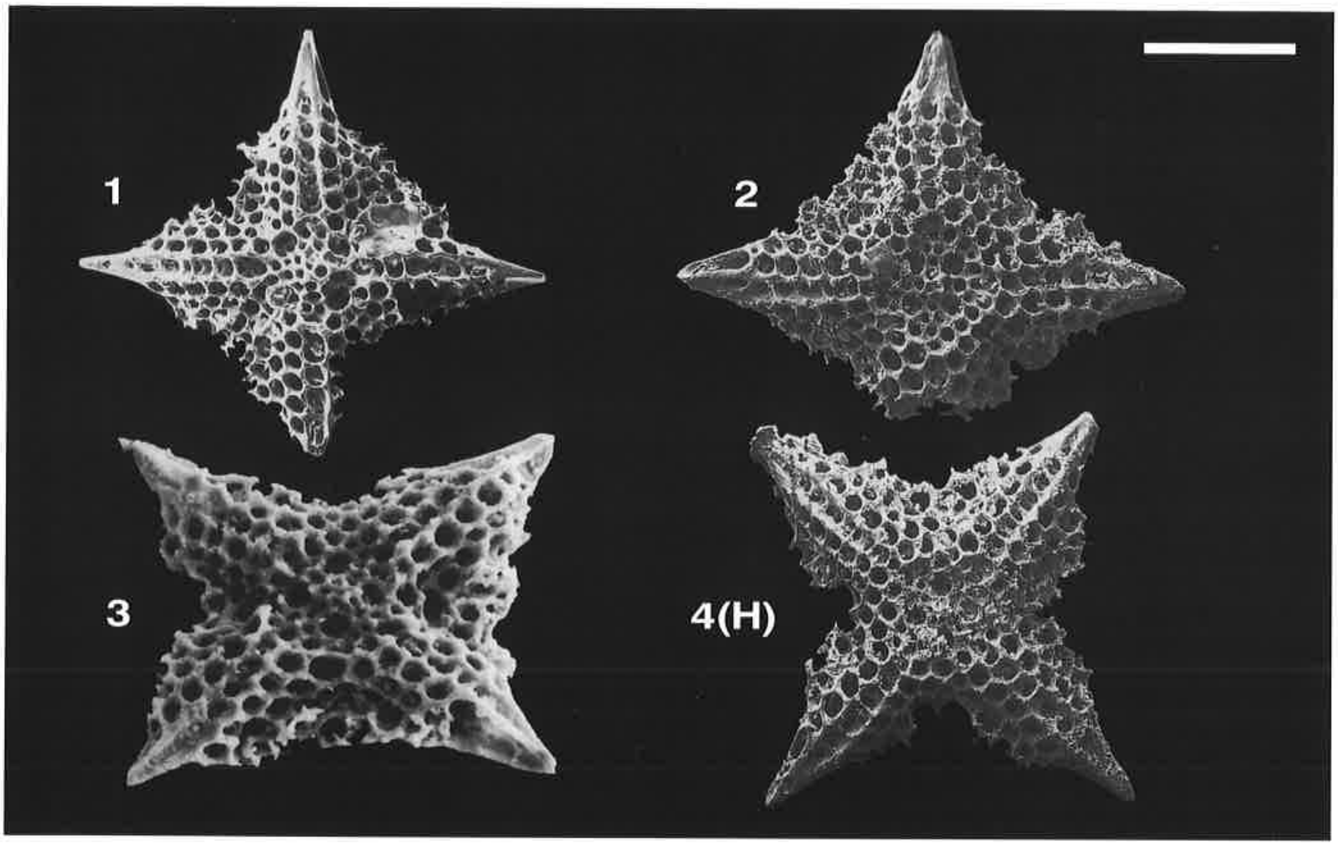


Plate 3109. *Higumastra gratiosa* n.sp. BAUMGARTNER. Magnification x200. **Fig. 1.** POB79/4435, IN7. **Fig. 2.** POB79/4434, IN7. **Fig. 3.** GO852677, ZB28. **Fig. 4(H).** POB81/9183, 76.534A.126.2.125.

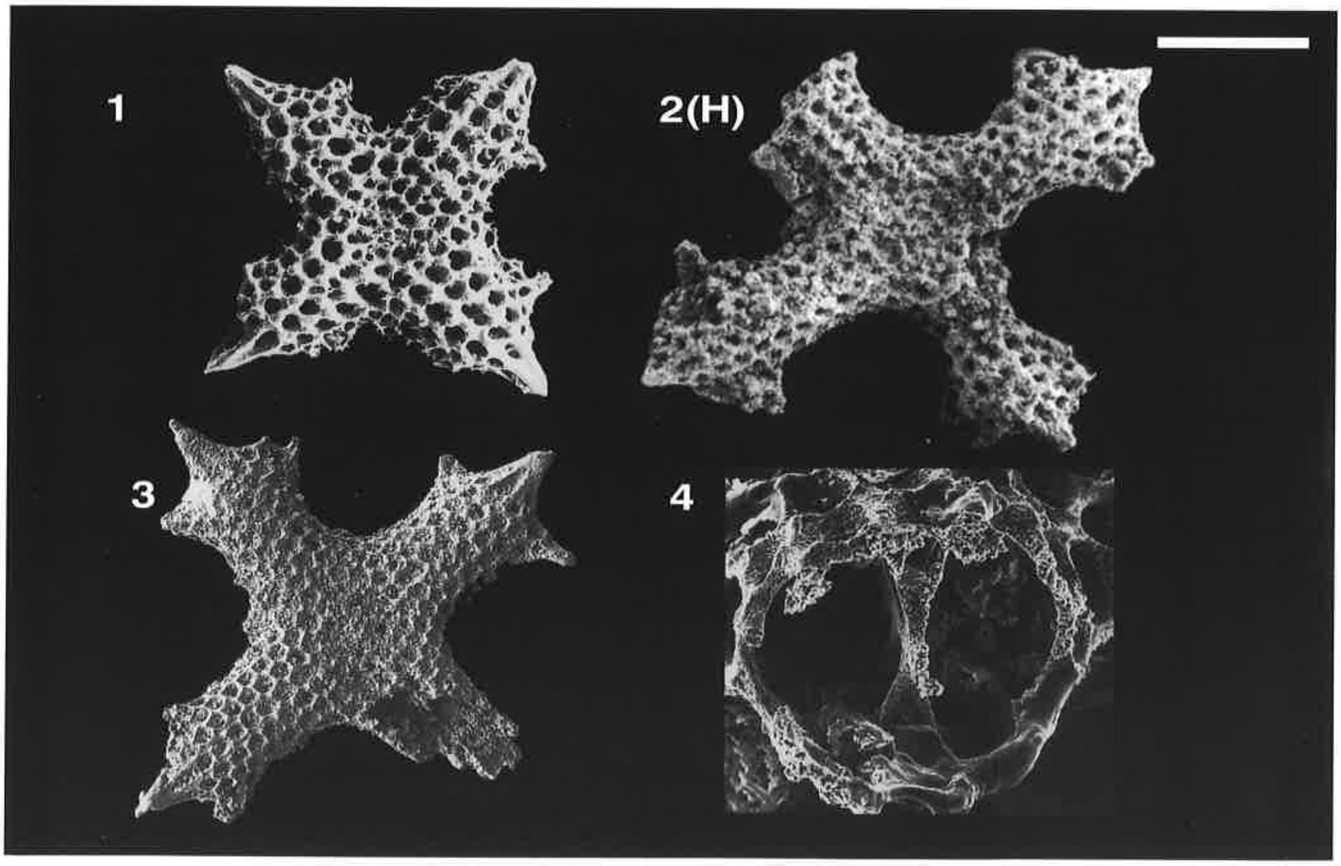


Plate 3110. *Higumastra imbricata* (OZVOLDOVA). Magnification x150 except Fig. 4 x600. **Fig. 1.** POB81/9210, 76.534A.126.2.125. **Fig. 2(H).** OZVOLDOVA 1979b, pl. 3, fig. 4. **Fig. 3.** POB79/4831, QC1. **Fig. 4.** POB81/2825, 534.125.6.13.

HIGUMASTRA INFLATA 3106

Higumastra inflata BAUMGARTNER

Synonymy.-
Higumastra inflata BAUMGARTNER
BAUMGARTNER 1980, p. 290, pl. 3, figs. 1, 2, 5-9, 11.

Original Definition.- Test as with genus, rays usually slightly longer along one axis than the other, terminating in a short, massive central spine of circular cross section. Rays inflated, usually thickest in proximal half. Five to six pore rows visible on upper or lower half of ray. Central area of cortical shell covered with dense meshwork of bars with small, irregular pore frames. Some specimens show remnants of a patagium in the angles between the rays. Medullary shells as with genus.

Original Remarks.- This species differs from others in lacking a well-developed patagium and in its size and inflated rays.

Etymology.- Latin: *inflatus, a, um*,-inflated.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of short rays AX:	275	283	200	323
Length of short rays CX:	280	-	-	-
Length of long rays BX:	300	295	286	358
Length of long rays DX:	300	-	-	-
Width of rays:	105	92	75	13
Length of longest spine:	60	89	60	125
Width of largest pores:	14	13	10	14

Type Locality.- Locality B of Baumgartner (1980); Argolis Peninsula (Peloponnesus, Greece).

UAZones.- 7-10, late Bath.-early Call. to late Oxf.-early Kimm.

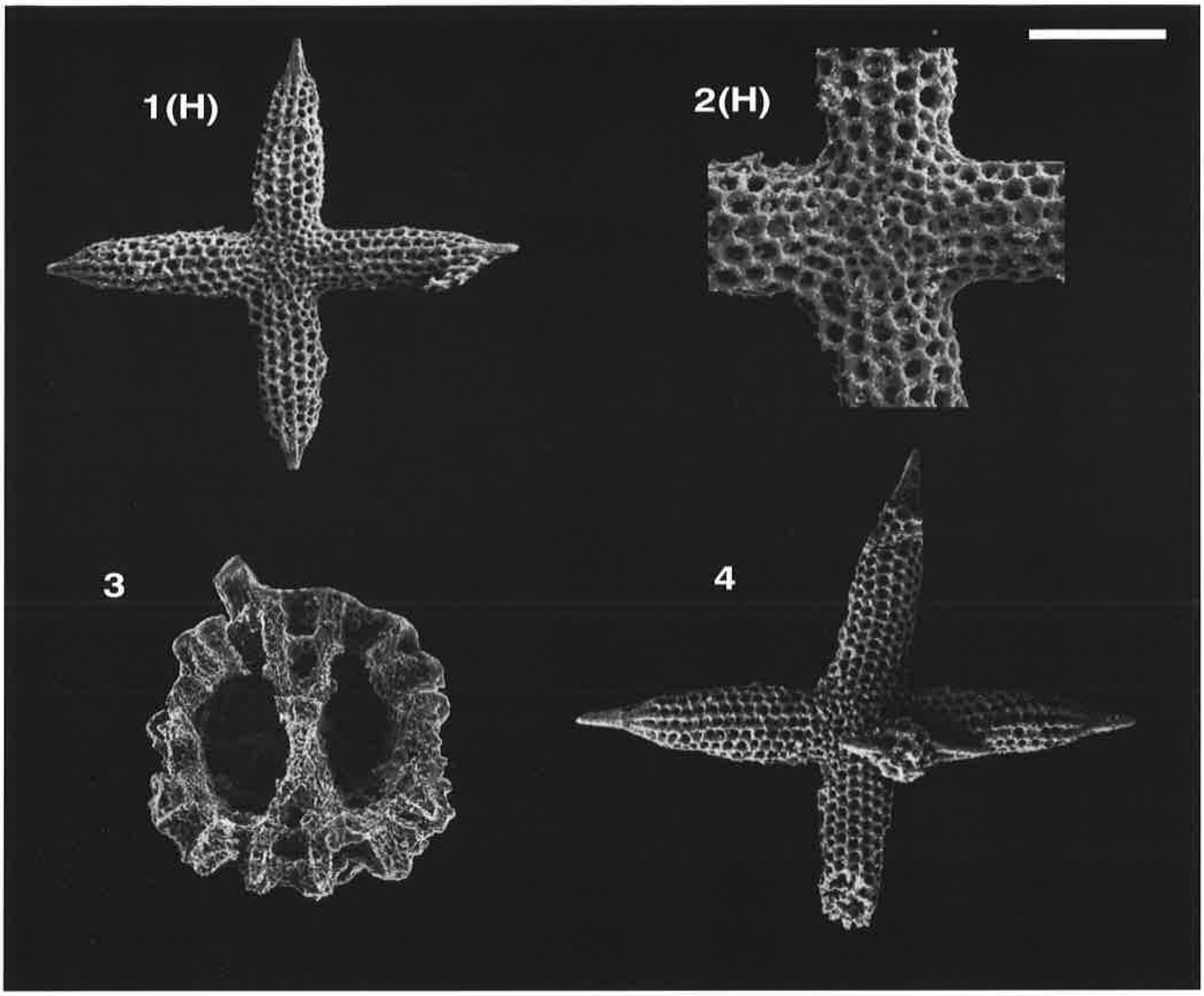


Plate 3106. ***Higumastra inflata*** **BAUMGARTNER.** Magnification x100, unless otherwise indicated. **Fig. 1(H).** POB78/6082, POB899.50. **Fig. 2(H).** POB78/6083, POB899.50, x200. **Fig. 3.** POB79/614, POB 899, x500. **Fig. 4.** POB78/6084, POB899.50.

HIGUMASTRA WINTERERI 3148

Higumastra wintereri n.sp. BAUMGARTNER & KITO

Synonymy.
Higumastra sp.
WAKITA 1982, pl. 5, figs. 6-8.
Higumastra sp. A, C, D
HATTORI 1988a, pl. 5, figs. C, E, F.
? *Pseudocrucella sanfilippoae* (PESSAGNO)
CARTER et al. 1988, p. 29, pl. 7, figs. 1, 4.
Higumastra aff. *inflata*
DE WEVER et al. 1986, pl. 8, fig. 2.
? *Higumastra* sp. A
CARTER et al. 1988, p. 29, pl. 10, fig. 6.

Type Designation.- POB 81/2897, POB1341.

Original Definition.- Test with 4 tapering rays of subequal length. Rays relatively thin and terminating by a strong, basaly triradiate central spine. Transversal section of ray rounded square to subrectangular. A central and two lateral rows of pores are visible on upper or lower surface of rays. Pores are framed by prominent ridges bearing nodes at vertices. Central area having a square depression exposing small pores. Some specimens have remnants of patagium.

Original Remarks.- This species differs from *H. inflata* BAUMGARTNER by having a smaller size, shorter rays that are square in cross section, and by only three rows of pores. The species also differs from *H. imbricata* (OZVOLDOVA) by the absence of lateral spines on ray tips.

Etymology.- Named in honour of Professor E.L. Winterer, Scripps Institution of Oceanography, La Jolla, California, for his contibution to the understanding of Tethyan radiolarites, and his support to radiolarian work.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Diam. of central part:	135	123	106	138
Length of ray AX:	211	-	-	-
Length of ray BX:	221	-	-	-
Length of ray CX:	248	190	157	248
Length of ray DX:	221	-	-	-
Width of ray:	81	70	66	81

Type Locality.- POB 1341, Colle di Sogno, Northern Italy.

UAZones.- 1-8, early-mid Aal. to mid Call.-early Oxf.

HILARISIREX 3645

Genus: *Hilarisirex* TAKEMURA & NAKASEKO, emend. PESSAGNO et al.

Synonymy.-
Hilarisirex TAKEMURA & NAKASEKO
TAKEMURA & NAKASEKO 1982b, p. 458.
emend. PESSAGNO et al. 1986, p. 30

Type Species.- *Hilarisirex quadrangularis* TAKEMURA & NAKASEKO, 1982b.

Original Definition.- Cephalis posessing two equal triradiate apical spines. Thorax, in shape a frustum of a quadrangular pyramid, having thin and irregularly scattered walls between feet. Four triradiate feet according with edges of the thoracic frustum and protruding below aperture.

Original Remarks.- This genus is distinguished from *Diceratigalea* TAKEMURA & NAKASEKO n.gen. by its shapes of both two apical spines and thorax.

Actualized Remarks.- (PESSAGNO et al. 1986) The test of *Hilarisirex* TAKEMURA & NAKASEKO 1982b, is clearly tricyrtid and not dicyrtid as claimed by Takemura and Nakaseko, it includes a well-defined thorax, and a well-defined abdomen (pl. 1, fig. 17). The cephalis and thorax (= cephalis of Takemura and Nakaseko, 1982b) consists of a latticed, perforate inner layer, which on well-preserved specimens is covered by an outer layer of microgranular silica. It is likely that the microgranular outer layer was formed at a late stage in ontogeny; immature specimens probably possess a perforate, latticed cephalis and thorax. On some specimens the rims of polygonal pore frames can be seen projecting through the thin veneer of microgranular silica (pl. 8, figs. 6, 14). The abdominal wall of the type genus *Hilarisirex* possesses two latticed layers whereas that of *Diceratigalea* TAKEMURA & NAKASEKO, 1982b, possesses a single latticed layer.

Etymology.- The generic name means Hilarious king.

Type Locality.- Sample TKN-105, Yamato Village, Gifu Prefecture, central Japan.

Included Taxa.-
3002 *Hilarisirex quadrangularis* TAKEMURA & NAKASEKO

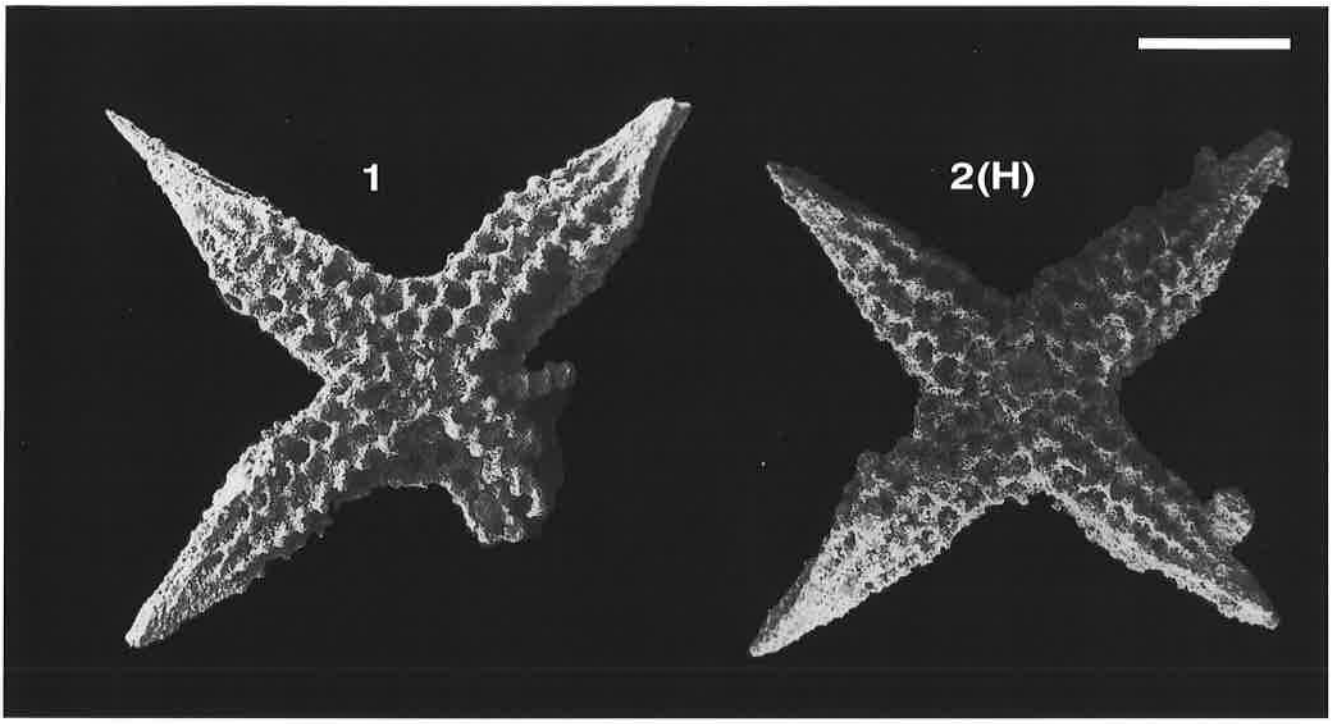


Plate 3148. ***Higumastra wintereri*** **n.sp. BAUMGARTNER & KITO.** Magnification x200. **Fig. 1.** POB81/2872, POB1341. **Fig. 2(H).** POB81/2897, POB1341.

HILARISIREX QUADRANGULARIS 3002

Hilarisirex quadrangularis TAKEMURA & NAKASEKO

Synonymy.-
Type A.
TAKEMURA & NAKASEKO 1982a, pl. 1, figs. 1a-f, 2a-c.
Hilarisirex quadrangularis TAKEMURA & NAKASEKO
TAKEMURA & NAKASEKO 1982b, p. 458-461, pl. 70, figs. 1-2; pl. 71, figs. 1-2.
TAKEMURA 1986, p. 43, pl. 2, fig. 1.

Original Definition.- Test quadrangularly pyramidal with two apical spines and four feet. Cephalis spherical, poreless with uneven surface, from which two strong and triradiate apical spines arise obliquely. Each spine possessing three ridges, of which two are on the apical side and the other one arise from near collar portion. On the lower surface of cephalis, four ridges arising at the terminal point of inner four basal spines, and lying obliquely downward to terminate at four vertices of thoracic frustum. In some specimens, (pl. 70, fig. 2a), many cephalic ridges lying on cephalic surface of collar portion.

Thorax in shape of a frustum of quandrangular pyramid of which four ridges accord with four feet. At the apical end of thorax, near collar portion, four transverse ridges lying with small nodes at each end, from which four feet arise below. Four feet triradiate, possessing three ridges of which the outer one accords with the edge of thoracic frustum. The outer two inner ridges on the inner side of the thoracic wall, are connected with those of adjacent feet in arch-shape at the upper part of thorax (pl. 71, figs. 2-b,c) At the lowermost part of thorax, inner ridges extend transversely to be connected with the adjacent ridges, forming a square framework in which aperture is enclosed with a circular skeleton. A thin wall scattered with circular pores connects both the square frame and the circular skeleton around aperture.

Four lateral sides of thoracic frustum, where is surrounded by inner ridges of four feet, are covered by generally thin, swelled walls with irregularly distributed, circular or elliptical pores. Four triradiate feet protrude below aperture.

Cephalis possess seven skeletal elements, a median bar two weaker apical spines and four stronger basal spines (Text-fig. 5). The median bar is shifted slightly from the center of collar plate. Two apical spines arise obliquely upward from both ends of median bar, terminating at cephalic wall to be connected with outer triradiate spines of cephalis. Four basal spines run laterally to cephalic wall, jointed with four cephalic ridges on the wall surface and connected with four feet.

Original Remarks.- Because the median bar is shifted from the center of the collar plate, one of two apical spines of inner cephalic skeletal elements is longer than the other. Longer apical spine may correspond to vertical spine (V) of Nassellaria, and shorter one to apical spine (A) of Nassellaria. Then, a pair of basal spines on the side of vertical spine (V) are lateral spines (L), and another pair on the opposite side (side of apical spine (A)) are secondary lateral spines (1) (text-fig. 4-5).

Total shape of this new species is similar to Paleozoic *Palaeoscenidium*. Probably, this new species may have been evolved from Paleozoic spicule-form palaeoscenidiids, by complication of skeletons and formation of cephalo-thorax.

Measurements (in μm).-
Length of shell (exclusive of apical spines and feet), 100-200 maximum width of thorax, 90-100.

Type Locality.- Jurassic mangenese ore deposits in the Mino Belt.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

himedaruma >> *STICHOCAPSA HIMEDARUMA* 4038

hipposidericus >> *DEVIATUS DIAMPHIDIUS HIPPOSIDERICUS* 3111

hisuikyoense >> *TRANSHSUUM HISUIKYOENSE* 3194

hojnosi >> *HALIODICTYA (?) HOJNOSI* 3254

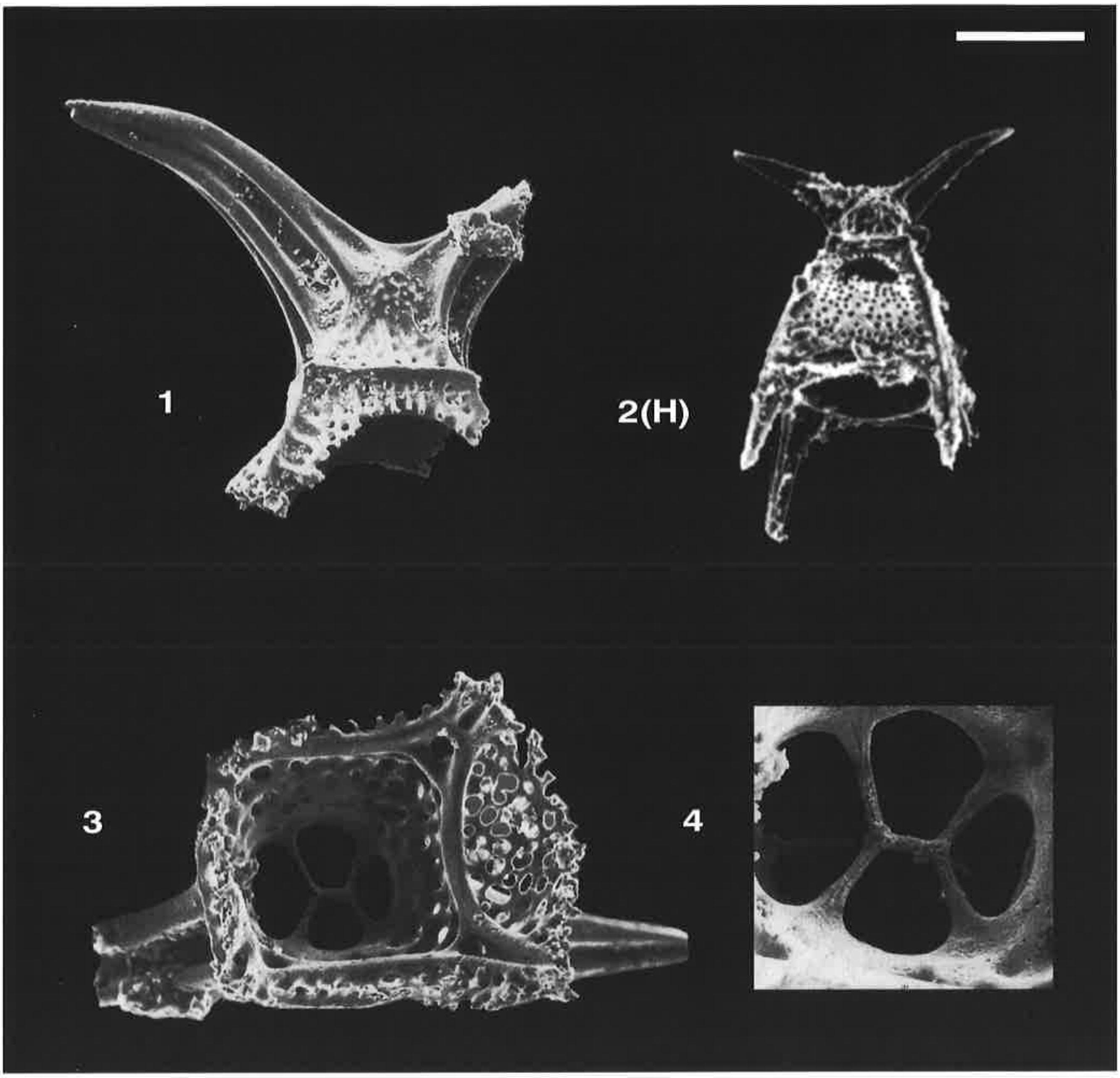


Plate 3002. ***Hilarisirex quadrangularis*** **TAKEMURA & NAKASEKO.** Magnification x600, unless otherwise indicated. **Fig. 1.** POB81/2799, 534.124.1.52. . **Fig. 2(H).** TAKEMURA & NAKASEKO 1982c, pl. 70, fig. 1a, x300. **Fig. 3.** POB81/2798, 534.124.1.52. **Fig. 4.** POB81/2797, 534.124.1.52, x1200

HOLOCRYPTOCANIUM 6007

Genus: *Holocryptocanium* DUMITRICA

Synonymy.-
Holocryptocanium DUMITRICA
DUMITRICA 1970, p. 75.

Type Species.- *Holocryptocanium tuberculatum* DUMITRICA 1970.

Original Definition.- Tricyrtids of usually spherical shape, formed of a simple, poreless cephalis, partly to almost completely depressed into the abdominal cavity; thorax porous, armed with three descending spines and completely depressed into the abdominal cavity; abdomen large, with strongly constricted aperture and a sutural pore closed inner side by a porous plate.

Original Remarks.- This new genus is rather similar to *Holocryptocapsa* (in our meaning), by the encasing degree of the cephalo-thorax. It is distinguished from it by the number of the thoracic descending spines, the structure of its sutural pore and, at least at present, by generally larger size of its species. It might be considered as a descendant of *Hemicryptocapsa*, which has the same number of thoracic spines, but is distinguished by the structure of its sutural pore. *Holocryptocanium* has a sutural pore similar to *Willliriedellum*, so that it is possible for the latter to be its direct ancestor.

Remarks.- In species determination the size, shape and distribution of the pores and the presence/absence of mammae and the nature of the mammae can be important diagnostic features.

Included Taxa.-
6107 *Holocryptocanium barbui* DUMITRICA

HOLOCRYPTOCANIUM BARBUI 6107

Holocryptocanium barbui DUMITRICA

Synonymy.-
Holocryptocanium barbui DUMITRICA
DUMITRICA 1970, p. 76, pl. 17, figs. 105-108b; pl. 21, fig. 136.
NAKASEKO et. al. 1979, p. 23, pl. 5, fig. 6.
SCHAAF 1981, p. 435, pl. 2, fig. 1; pl. 10, fig. 6.
MATSUYAMA et al. 1982, pl. 2, fig. 5.
TAKETANI 1982b, pl. 1, fig. 5.
YAMAUCHI 1982, pl. 1, fig. 1.
BAUMGARTNER 1984, p. 768, pl. 4, fig. 14.
YAO 1984, pl. 5, fig. 1.
OKAMURA & MATSUGI 1986, pl. 3, fig. 3.
IGO et al. 1987, text-fig. 2.18.
KITO 1987, pl. 2, fig. 11.
VISHNEVSKAYA 1988, pl. 11, figs. 1-3.
KATO & IWATA 1989, pl. 4, fig. 10.
TUMANDA 1989, p. 37, pl. 7, figs. 20-21.
OZVOLDOVA 1990, p. 142, pl. 6, figs. 1-6.
TAKETANI & KANIE 1992, fig. 3.16.
Holocryptocanium barbui (DUMITRICA)
MURATA et al. 1982, pl. 2, fig. 5.
Holocryptocanium barbui barbui DUMITRICA
NAKASEKO & NISHIMURA 1981, p. 153, pl. 3, figs. 1-4.
SUYARI 1986a, pl. 9, fig. 8.
Holocryptocanium japonicum NAKASEKO & NISHIMURA
NAKASEKO et al. 1979, p. 23, pl. 5, figs. 8, 10.
OKAMURA 1980, pl. 21, fig. 5.
TAKETANI 1982a, p. 67, pl. 13, fig. 21.
YAMAUCHI 1982, pl. 1, fig. 2.
Holocryptocanium barbui japonicum NAKASEKO & NISHIMURA
NAKASEKO & NISHIMURA 1981, p. 154, pl. 3, figs. 5-7b; pl. 14, fig. 10.
SUYARI 1986a, pl. 5, fig. 6; pl. 9, fig. 9.
SUYARI & KUWANO 1986, pl. 3, figs. 2-4.
Holocryptocanium sp.
? SCHAAF 1981, pl. 2, fig. 8.
OKAMURA & UTO 1982, pl. 4, figs. 3- 4.
SUYARI 1986a, pl. 5, fig. 7.
SUYARI 1986b, pl. 4, fig. 9.
TERAOKA & KURIMOTO 1986, pl. 1, fig. 1.

Original Definition.- Shell externally spherical or very slightly oval. Cephalis spherical, smooth, porelesss, completely hidden in abdomen, from which it is sustained by its apical end. At the outside, the cephalic zone is marked on abdomen by an evident depression. Thorax campanulate, porous, completely depressed into abdomen, from the wall of which it anchors by slender spines originating in the angles of the intermediate bars of the thoracic pores. Thoracic opening triangular, armed with three descending spines. Abdomen very large, spherical, rarely slightly oval, with a pronounced depression in the cephalic zone. Its surface smooth, rarely with more or less marked hexagonal frames. Abdominal wall thick-walled, pierced by pores of challengerian structure (lamp chimney-like) and set usually in regular rows. The route of such a pore shows an internal narrow collar, a median large, oval space and an external narrow cylindrical or tronconical zone. As a consequence, the pores of the very young, thin-walled specimens, when the growing of the shell reached the median zone, have large external openings, whereas the pores of the mature specimens have very narrow external openings. The same peculiarity of these pores gives rise in optical section to several concentric strips of different luminosity and thickness : an inner dark, narrow strip, followed by a light strip a little larger, a second dark, narrow strip and an external large light strip. Aperture axial, strongly constricted, without protruding rim, but surrounded by a poreless zone. Sutural pore circular to subcircular, large, located on the ventral side of the cephalis. It is joined to thorax by a porous plate.

Original Remarks.- This species is closely related to *H. tuberculatum* by the peculiarity of its thorax, encasing degree of its cephalis and the structure of its sutural pore, but is clearly distinguished by its abdomen.

Remarks.- Under this species are herein included both morphotypes with smooth surface and with well marked polygonal pore frames.

Etymology.- The species is dedicated to Prof. I.Z. Barbu, to whom I owe the discovery of the very interesting assemblage of Cenomanian Nassellaria from Podu Dimbovitel.

Measurements (in μm).-
Based on 30 specimens. Diameter of cephalis 20-23, of thorax 35-40, of abdomen 110-190.

Type Locality.- Podu Dîmbovitei, Arges district, Romania.

UAZones.- 13 - 22, latest Tith. to late Barr.-early Apt.

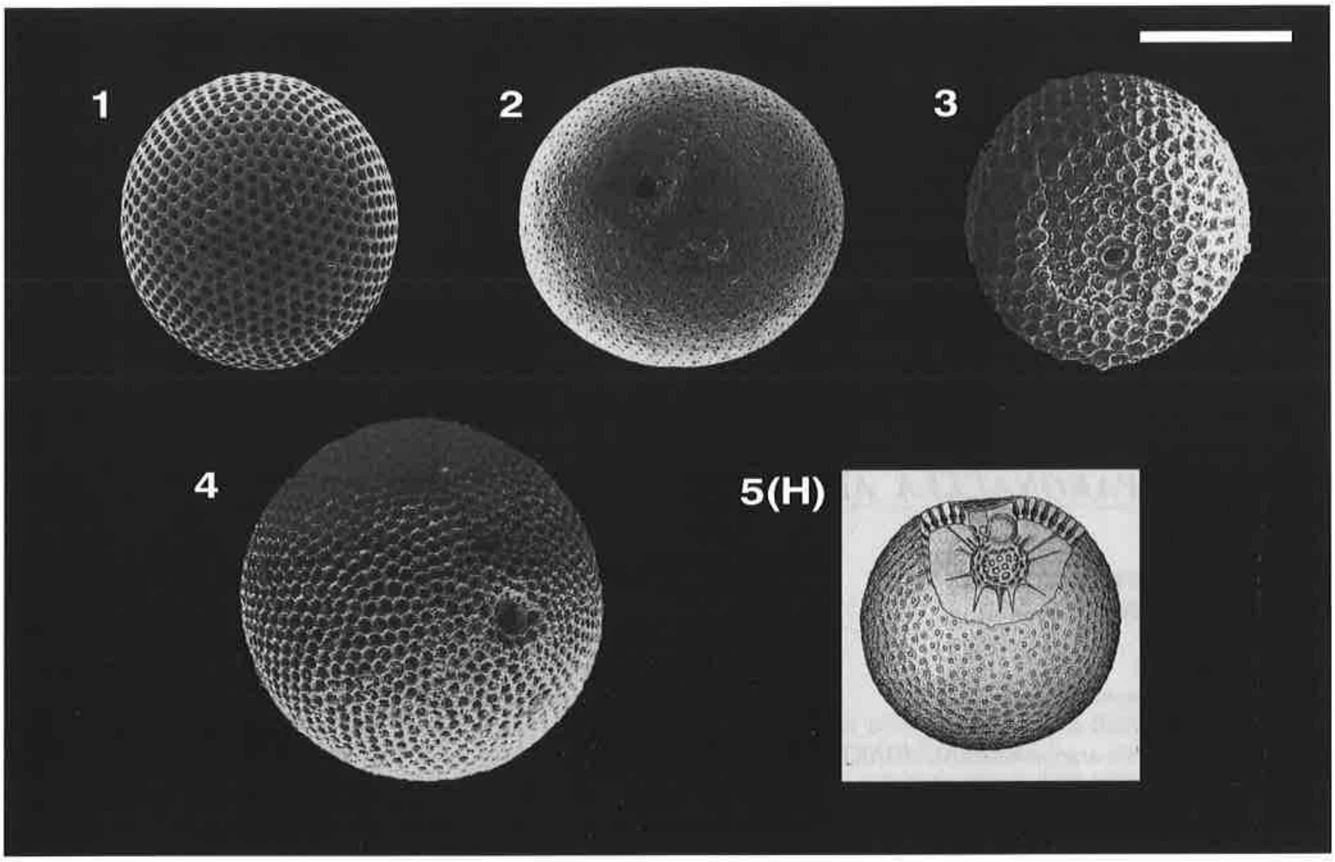


Plate 6107. *Holocryptocanium barbui* DUMITRICA. Magnification Figs. 1, 4 x100, Figs. 2, 3, 5(H) x200. **Fig. 1.** POB82/9010. **Fig. 2.** POB82/9013. **Fig. 3.** POB80/1962, POBMO25. **Fig. 4.** RJ108, Bo569.6. **Fig. 5(H).** DUMITRICA 1970, pl. 17, fig. 8a.

HOMOEOPARONAELLA 3648

Genus: *Homoeoparonaella* BAUMGARTNER

Synonymy.-
Homoeoparonaella BAUMGARTNER
BAUMGARTNER 1980, p. 288.

Type Species.- *Paronaella elegans* PESSAGNO, 1977a.

Original Definition.- Test as with subfamily, composed of 3 rays with equal to subequal interradial angles lacking a bracchiopyle and a patagium. Cortical rays composed of numerous longitudinal external beams connected by short bars in transverse rows forming small pore frames. Nodes well developed. Ray tips bulbous with or without central spine. Medullary shell composed of centrally placed medullary rays merging in central area. Medullary shell composed of 3 (sometimes 5) primary canals arranged around primary beams. Medullary shell connected by numerous radially arranged subsidiary beams to cortical shell.

Original Remarks.- *Homoeoparonaella* n.gen. differs from *Paronaella* PESSAGNO 1971 (placed in Patulibracchiidae herein) by its regular linear arrangement of pores and external beams and by its differentiation into cortical and medullary shells. It is distinguished from all other three-armed hagiastrid genera in having numerous external beams and in lacking a bracchiopyle.

Etymology.- *Homoeoparonaella* is named for its external homeomorphy with *Paronaella* PESSAGNO.

Included Taxa.-
3103 *Homoeoparonaella argolidensis* BAUMGARTNER
2003 *Homoeoparonaella* sp. aff. *H. argolidensis* BAUMGARTNER
3104 *Homoeoparonaella elegans* (PESSAGNO)
2004 *Homoeoparonaella* sp. aff. *H. elegans* (PESSAGNO)
3105 *Homoeoparonaella* (?) *giganthea* BAUMGARTNER
5253 *Homoeoparonaella* sp. aff. *H. irregularis* (SQUINABOL)
5267 *Homoeoparonaella peteri* JUD
3150 *Homoeoparonaella* (?) *pseudoewingi* n.sp. BAUMGARTNER
5163 *Homoeoparonaella speciosa* (PARONA)

HOMOEOPARONAELLA ARGOLIDENSIS 3103

Homoeoparonaella argolidensis BAUMGARTNER

Synonymy.-
Hagiastrid cf. *Amphibracchium* sp.
BAUMGARTNER & BERNOULLI 1976, fig. 10h.
Homoeoparonaella argolidensis BAUMGARTNER
BAUMGARTNER 1980, p. 288, pl. 2, figs. 1, 8-12; pl. 11, fig. 4.
KOCHER 1981, p. 72, pl. 14, fig. 10.
ORIGLIA-DEVOS 1983, p. 72, pl. 8, figs. 1-3, 6-7.
BAUMGARTNER 1984, p. 768, pl. 4, fig. 15.
EL KADIRI 1984, p. 90, pl. 9, figs. 1.
DE WEVER et al. 1986, pl. 8, figs. 5-7.
DANELIAN 1989, p. 158, pl. 5, figs. 7-8.
KITO 1989, p. 125, pl. 8, fig. 15.
OZVOLDOVA 1990, pl. 4, fig. 2.
WIDZ 1991, p. 247, pl. 2, fig. 5.
STEIGER 1992, p. 41, pl. 9, figs. 3-4.
Tritrabs ewingi (PESSAGNO)
CONTI & MARCUCCI 1991, pl. 4, fig. 9.

Original Definition.- Test with slender elongate rays of equal length, having expanded ellipsoidal tips. Cortical rays composed of 8-10 longitudinal beams and bars placed in oblique transverse rows, forming rectangular to parallelogram-shaped pore frames. Nodes moderately developed. Longitudinal beams tend to be oriented obliquely with respect to the ray axis, rays therefore appear to be twisted as a left-handed screw. Rays circular in cross section, about 5 beams visible vertically. Longitudinal beams merge in central area; a centrally placed porous hump equipped with a raised central tip is surrounded by a depression with widely spaced small pores. Ray tips composed of polygonal pore frames with circular pores; numerous tiny spines are placed on ray tips and on nodes of external beams, where preserved. Some specimens show longer, but still weakly developed central or lateral spines. Medullary rays as with genus.

Original Remarks.- *H. argolidensis* differs from all other species in having distinct, obliquely-running longitudinal beams producing left-twisted rays, and seems to be related to *H. elegans* (PESSAGNO) which has shorter rays, elongated ray tips and well-developed central spines.

Etymology.- Named for the Argolis Peninsula (Peloponnesus, Greece), sample locality.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
Length of rays AX:	335	341	245	420
Length of rays BX:	330	-	-	-
Length of rays CX:	340	-	-	-
Width of rays:	55	63	50	75
Width of ray tips:	100	118	85	143
Length of longest spine:	50	39	25	50

Type Locality.- Angelokastron (Greece).

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

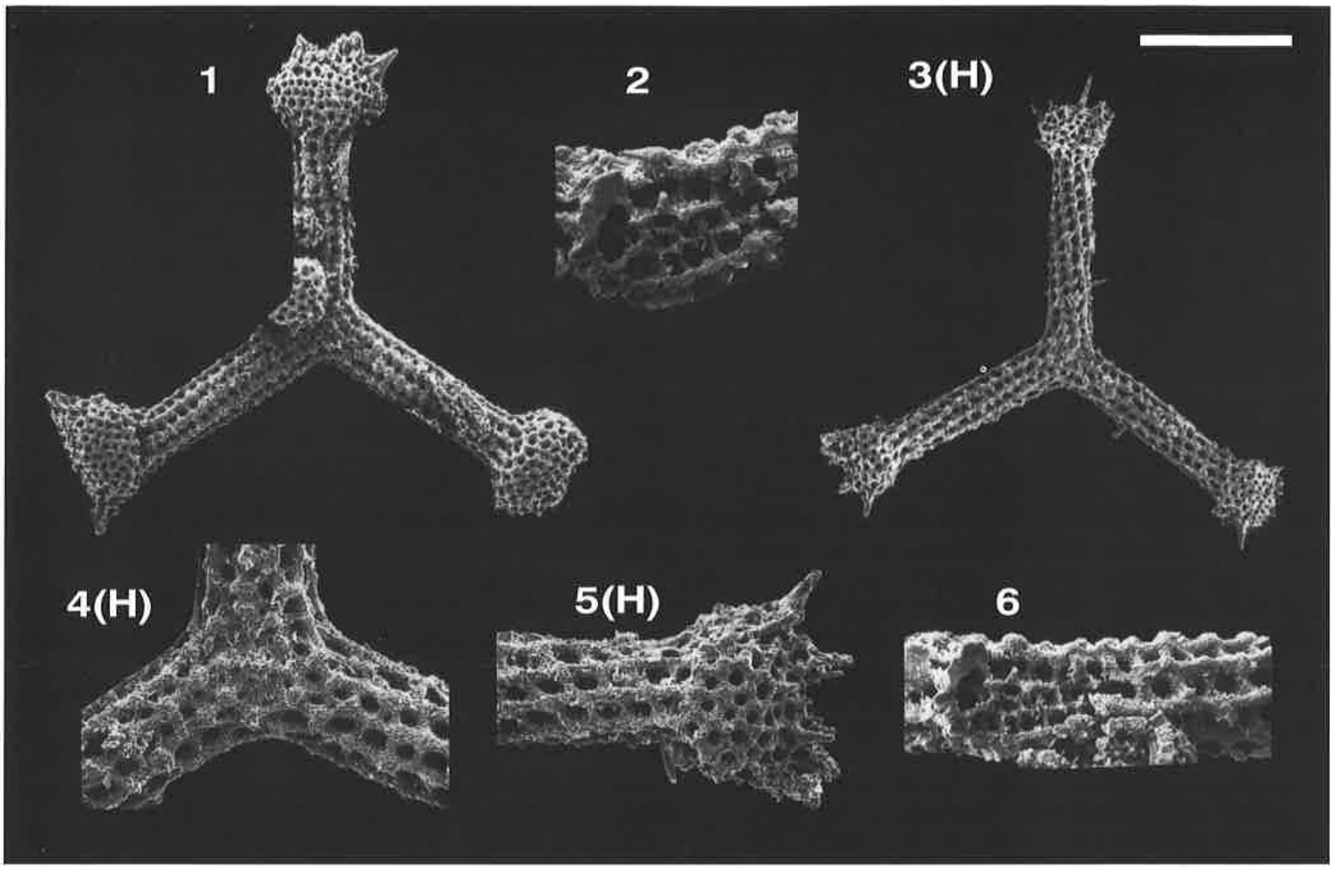


Plate 3103. ***Homoeoparonaella argolidensis*** **BAUMGARTNER.** Magnification x100, unless otherwise indicated. **Fig. 1.** POB78/6200, POB899.52. **Fig. 2.** POB79/408, POB899.52, x500. **Fig. 3(H).** POB78/6204, POB899.52. **Fig. 4(H).** POB78/6205, POB899.52, x250. **Fig. 5(H).** POB78/6206, POB899.52, x250. **Fig. 6.** POB79/410, POB899.60, x250.

HOMOEOPARONAELLA ARGOLIDENSIS AFF. 2003

Homoeoparonaella sp. aff. *H. argolidensis* BAUMGARTNER

Synonymy.-
Homoeoparonaella sp. aff. *H. argolidensis* BAUMGARTNER
CARTER et al. 1988, p. 28, pl. 7, figs. 5-6.

Remarks.- This species appears to be closely related to *Homeoparonaella argolidensis* and differs only by lacking a porous hump (with raised central tip) in the central area. If further study eventually proves this species to be *H. argolidensis*, then Baumgartner's quoted range of late Bathonian - early Callovian to Tithonian must be lowered considerably.

UAZones.- 1-2, early-mid Aal. to late Aal.

HOMOEOPARONAELLA ELEGANS 3104

Homoeoparonaella elegans (PESSAGNO)

Synonymy.-
Paronaella elegans PESSAGNO
PESSAGNO 1977a, p. 70, pl. 1, figs. 10-11.
? DE WEVER et al. 1979, p. 88, pl. 5, fig. 9.
Homoeoparonaella elegans (PESSAGNO)
BAUMGARTNER 1980, p. 289, pl. 2, figs. 2-6; pl. 11, fig. 6.
KOCHER 1981, p. 72, pl. 14, fig. 11.
ORIGLIA-DEVOS 1983, p. 73.
BAUMGARTNER 1984, p. 768, pl. 4, fig. 16.
EL KADIRI 1984, p. 93, pl. 9, figs. 6, 11, not 7, 10.
DANELIAN 1989, p. 159, pl. 5, figs. 9-10.
KITO 1989, p. 126, pl. 9, figs. 12-16.
WIDZ 1991, p. 247, pl. 2, fig. 6.
STEIGER 1992, p. 42, pl. 9, figs. 5-6.

Original Definition.- Meshwork fine with predominance of tetragonal (usually square) pore frames. Pore frames becoming pentagonal on ray tips. Each ray with moderately long, central spine.

Actualized Definition.- (BAUMGARTNER, 1980) Internal structure as with genus. The forms herein included may possess longer and stouter triradiate central spines. Three grooves on each spine mark the prolongation of the primary canals beyond the shell.

Etymology.- This species is named from the Latin adjective *elegans*, meaning choice, fine neat.

Measurements (in μm).-
Based on 8 specimens. Length of rays: 120 to 220, width of rays: 60 to 80; length of spines: 50 to 65.

Type Locality.- Point Sal (California, USA).

UAZones.- 4-10, late Baj. to late Oxf.-early Kimm.

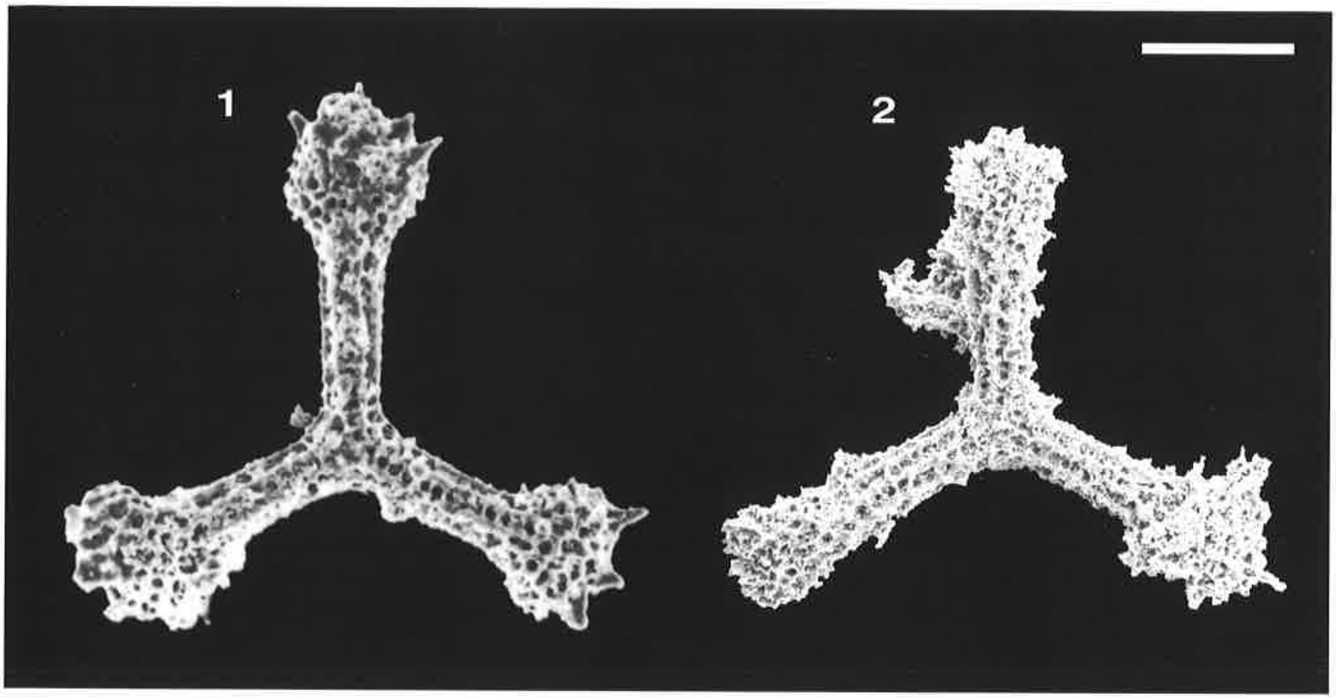


Plate 2003. *Homoeoparonaella* sp. aff. *H. argolidensis* BAUMGARTNER. Magnification x200. **Fig. 1.** CARTER et al. 1988, pl. 7, fig. 5. **Fig. 2.** AB414. TM40.15.b35.

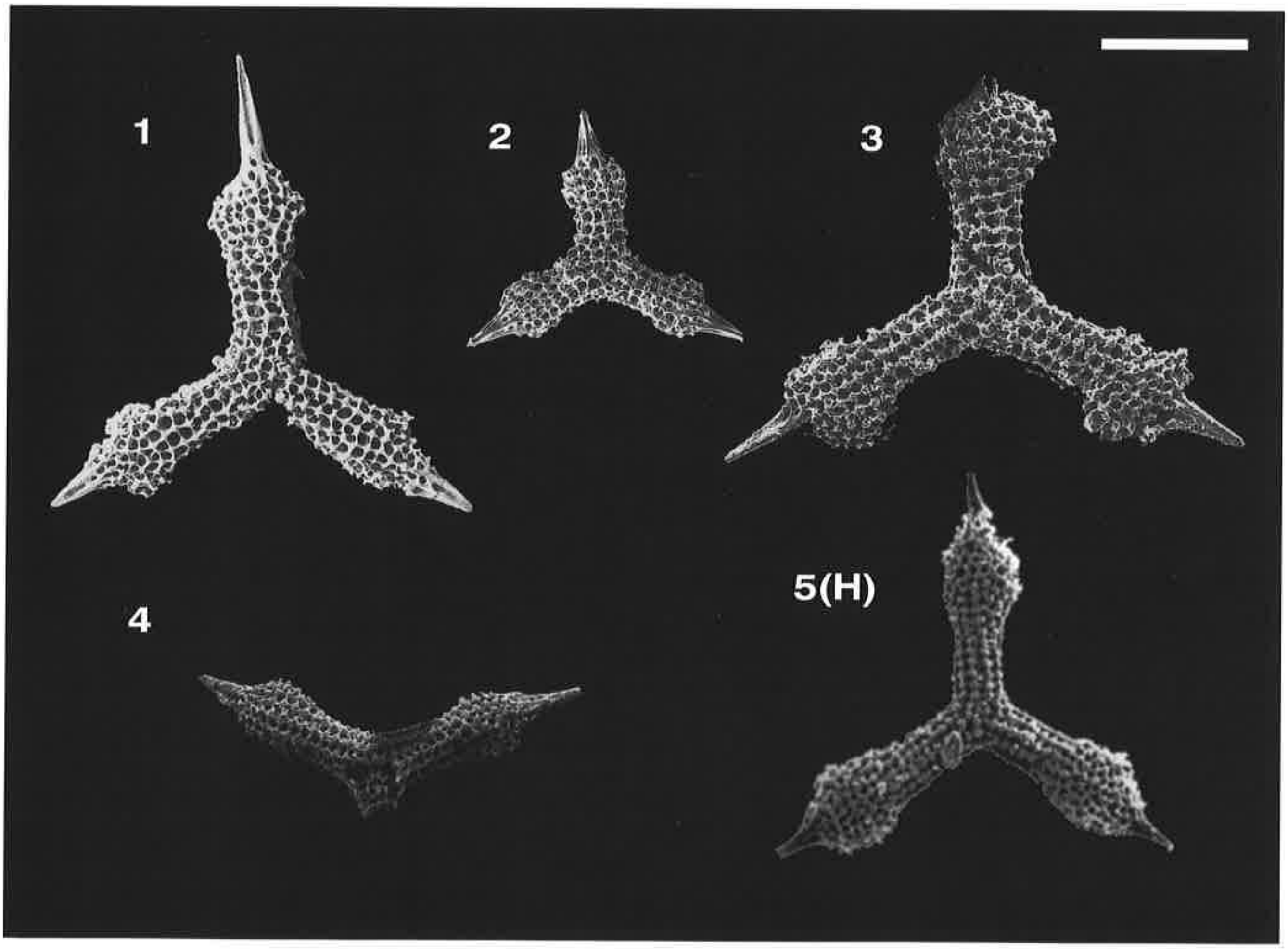


Plate 3104. *Homoeoparonaella elegans* (PESSAGNO). Magnification x150. **Fig. 1.** POB78/8148, POB986.52. **Fig. 2.** POB81/2417, 534.122.1.52. **Fig. 3.** POB78/6570, POB899.54. **Fig. 4.** POB79/610, POB899. **Fig. 5(H).** PESSAGNO 1977a, pl. 1, fig. 10.

HOMOEOPARONAELLA ELEGANS AFF. 2004

Homoeoparonaella sp. aff. *H. elegans* (PESSAGNO)

Synonymy.-
Homoeoparonaella sp. aff. *H. elegans* (PESSAGNO)
PESSAGNO 1977a, p. 70, pl. 1, figs. 10-11.
DE WEVER et al. 1979, p. 88, pl. 5, fig. 9.
BAUMGARTNER 1980, p. 289, pl. 1, fig. 15; pl. 2, figs. 2-6; pl. 11, fig. 6.
CARTER et al. 1988, p. 28, pl. 16, fig. 7.

Remarks.- This form differs from *Homoeoparonaella elegans* PESSAGNO 1977a by having less expanded ray tips, subaligned and tetragonal pore frames on almost all test surfaces, and by having less prominent nodes at pore frame vertices.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

HOMOEOPARONAELLA (?) GIGANTEA 3105

Homoeoparonaella (?) *gigantea* BAUMGARTNER

Synonymy.-
Homoeoparonaella gigantea BAUMGARTNER
BAUMGARTNER 1980, p. 289, pl. 2, figs. 13-16; pl. 11, fig. 5.
KOCHER 1981, p. 72, pl. 14, fig. 12.
BAUMGARTNER 1984, p. 768, pl. 4, fig. 17.

Original Definition.- Test with sturdy short rays and large club-shaped ray tips with a single central spine. Cortical rays composed of 10-15 strongly nodose external beams connected by short bars forming rectangular or sometimes triangular pore frames. Pores small, sometimes interstitial between almost touching thick nodes.

Expanded bulbous ray tips and central area tend to have hexagonally (*Alievium*-like) arranged pores. The distal part of the tip is axially flattened leading to a bladelike porous structure bearing the single central spine. Three or more grooves on the proximal part of the spines mark the exit of the primary canals. Medullary shell as with genus, specimens with more than 3 primary canals have been observed.

Original Remarks.- *H. gigantea* differs from *H. elegans* PESSAGNO 1977a by its sturdy nature, strongly developed nodes and larger size.

Etymology.- Latin: *giganteus, a, um*, giant.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Length of rays AX:	250	288	250	336
Length of rays BX:	250	-	-	-
Length of rays CX:	260	-	-	-
Width of rays:	110	106	90	125
Width of ray tips:	170	169	165	172
Length longest spine:	130	97	60	130

Type Locality.- Angelokastron (Greece).

UAZones.- 8-10, mid Call.-early Oxf. to late Oxf.-early Kimm.

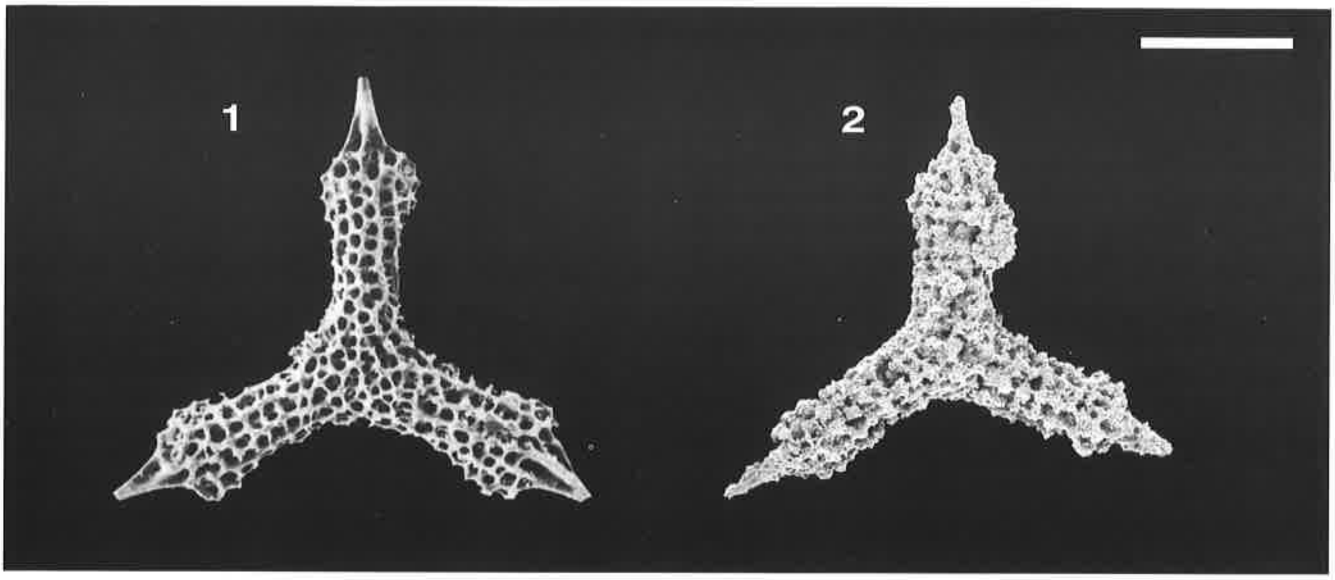


Plate 2004. ***Homoeoparonaella* sp. aff. *H. elegans* (PESSAGNO).** Magnification x200. **Fig. 1.** CARTER et al. 1988, pl. 16. fig. 7. **Fig. 2.** AB 414.TM40, 15b35

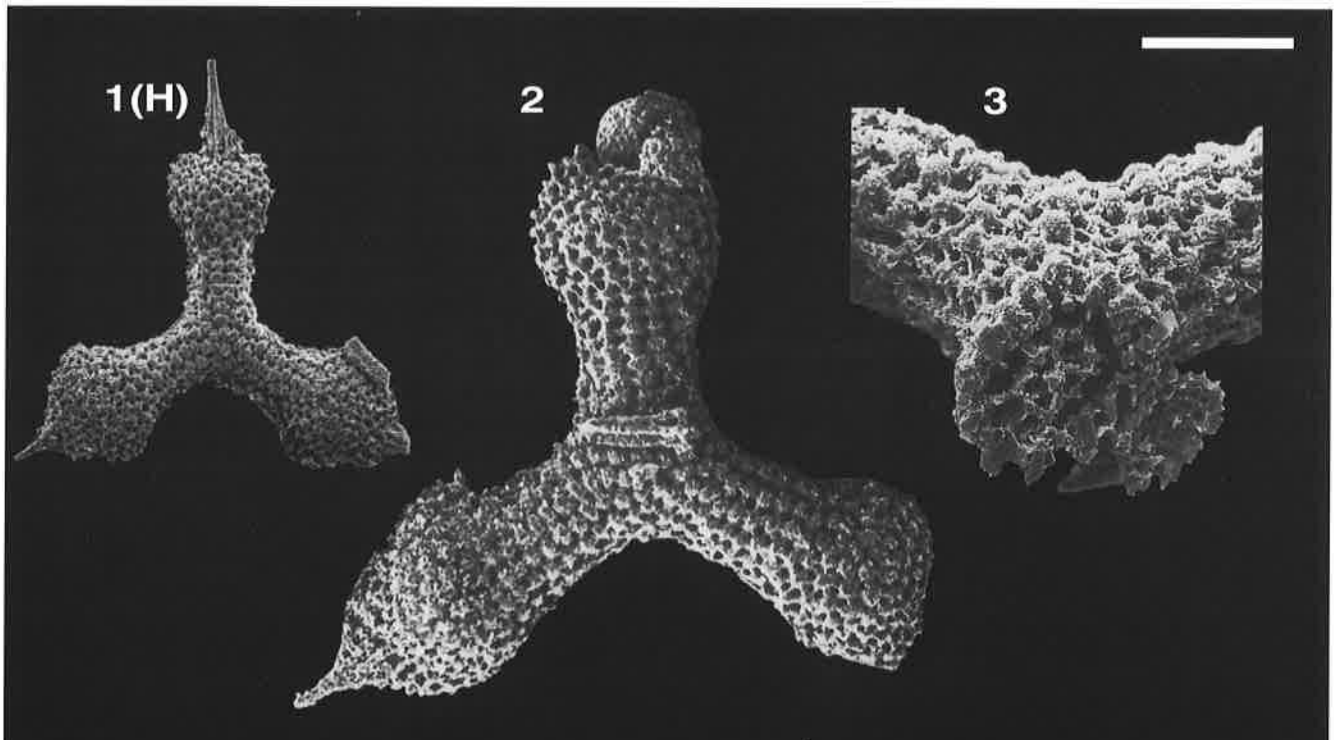


Plate 3105. ***Homoeoparonaella* (?) *gigantea* BAUMGARTNER.** Magnification x150, except Fig. 3 x400. **Fig. 1(H).** POB78/6557, POB899.54. **Fig. 2.** POB78/6216, POB899.52. **Fig. 3.** POB79/0403, POB899.60.

HOMOEOPARONAELLA IRREGULARIS AFF. 5253

Homoeoparonaella sp. aff. *H. irregularis* (SQUINABOL)

Synonymy.-
Rhopalastrum irregulare SQUINABOL
SQUINABOL 1903, p. 122, pl. 9, fig. 10.
Homoeoparonaella sp. aff. *H. irregularis* (SQUINABOL)
JUD 1994, p. 80, pl. 11, figs. 7-8.

Original Definition.- (JUD, 1994) Test of three rays of equal or subequal length. Rays composed of indeterminate number of longitudinal beams, of which 4-5 are visible on upper or lower sides. Longitudinal beams connected by transverse bars, forming a network of longitudinal and transverse rows of pores. Central part of test with irregular pore pattern. Longitudinal beams slightly oblique with respect to the ray axis, rays appearing to be twisted clockwise. Tips of rays slightly bulbous, composed of polygonal (usually tetragonal or pentagonal) pore frames, with rounded pores of unequal size.

Remarks.- Most specimens have rays of relatively equal length and have their terminal spines broken off. Specimens with unequal rays, as illustrated by Squinabol (1903), were very rare in our material. Our specimens (measurements based on 5 specimens) have an average length of the rays of 350 μm (min. 233, max. 444), an average thickness of the rays of 70 μm (min. 56, max. 81), an average width of tips of 121 μm (min. 100, max. 150), and are thus generally larger than those described by Squinabol.

Measurements (in μm).-
Length of the three rays 287, 275, 263, width 49, 52, 42. Width of the enlargements 82, 69, 80.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

HOMOEOPARONAELLA PETERI 5267

Homoeoparonaella peteri JUD

Synonymy.-
Homoeoparonaella peteri JUD
JUD 1994, p. 80, pl. 11, figs. 9-12.

Original Definition.- Test with three rays disposed at equal angles. Rays of approximately equal length, long, slender, with 5 longitudinal beams on the upper and lower faces. Beams connected by transverse bars, forming longitudinal and transverse rows of square pores with acute nodes on vertices. Intersection of beams in central area of test with irregular pore-frames. Lateral sides of rays convex, with one longitudinal bar developed in the depression, connected to the marginal beams of the upper and lower face of test by transverse bars, forming two rows of pores in alternate disposition. Tips of rays inflated, small with irregular polygonal pore frames, armed with several spines of variable length.

Original Remarks.- *Homoeoparonaella peteri* n.sp. differs from *Homoeoparonaella argolidensis* BAUMGARTNER and *Homoeoparonaella* sp. aff. *H. irregularis* (SQUINABOL), which are morphologically the closest forms, by the wide longitudinal depression on the lateral sides of the rays, by generally larger size and by having square pores arranged in both longitudinal and transverse rows.

Etymology.- This species is dedicated to Prof. Dr. Peter Oliver Baumgartner, Institute of Geology and Paleontology, University of Lausanne, Switzerland, honouring his contributions to the knowledge of Radiolaria and thanking him for introducing me into the fascinating world of radiolarians and for supervising my thesis.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Maximum length of rays:	487	532	350	700
Maximum width of rays:	75	75	71	83
Maximum width of tips:	143	146	120	181

Type Locality.- Gorgo a Cerbara, Umbria-Marche, Italy.

UAZones.- 19-22, early Haut. to late Barr.-early Apt.

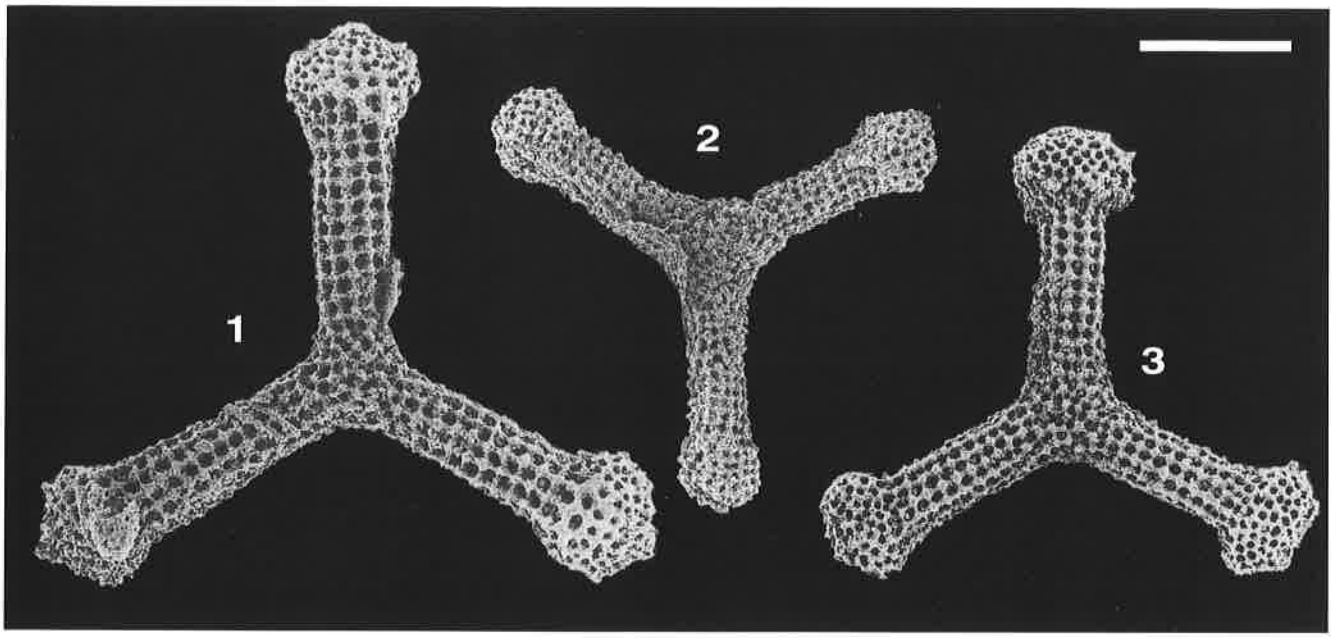


Plate 5253. ***Homoeoparonaella* sp. aff. *H. irregularis* (SQUINABOL).** Magnification x150. **Fig. 1.** RJ26, Br1330. **Fig. 2.** RJ260, Bo449.50. **Fig. 3.** RJ87, Br141.55.

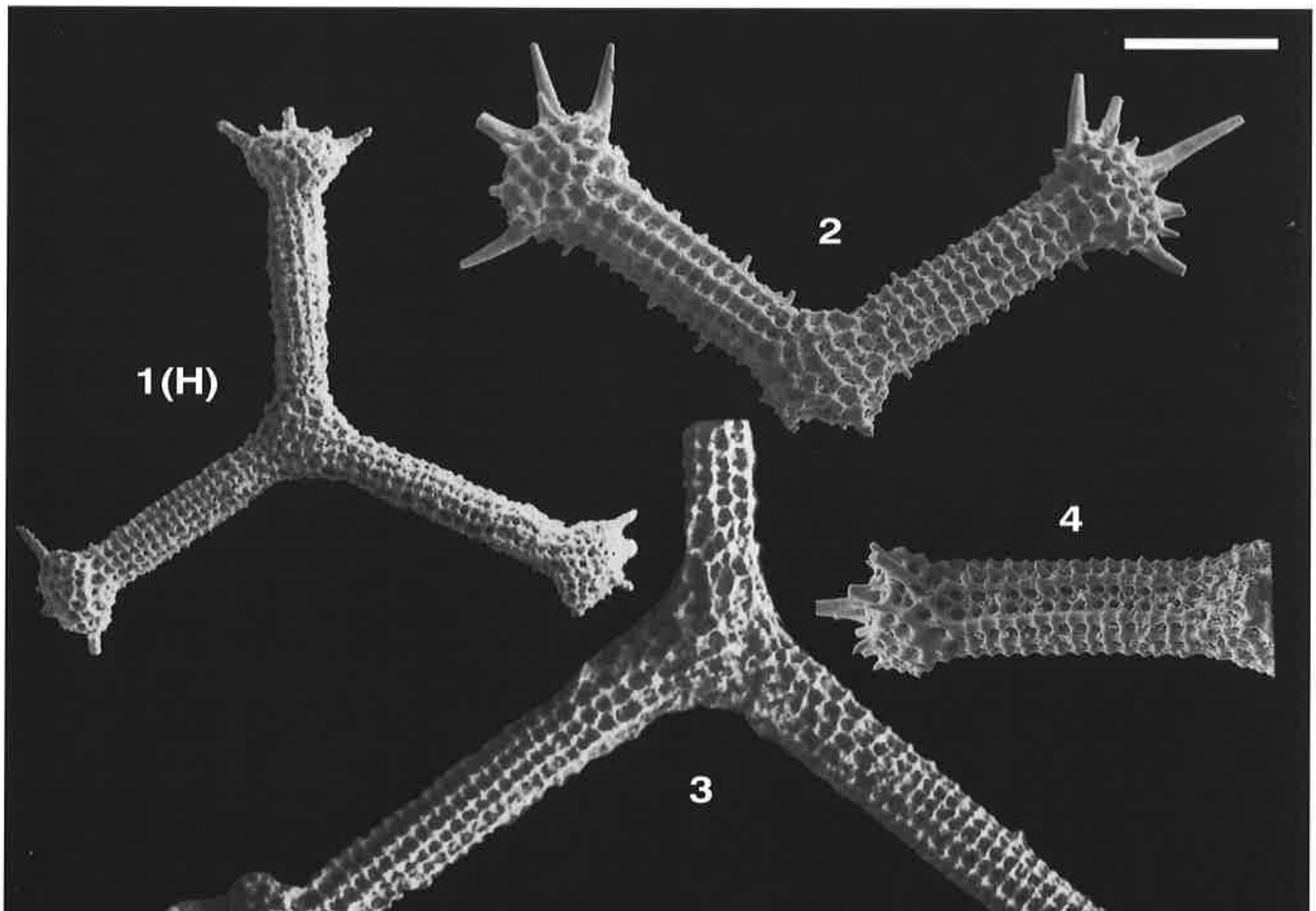


Plate 5267. ***Homoeoparonaella peteri* JUD.** Magnification x150, except Fig.1(H) x100. **Fig. 1(H).** RJ754, GC882.4. **Fig. 2.** DU672, Mo46. **Fig. 3.** RJ925, GC887.0. **Fig. 4.** DU673, Mo46.

HOMOEOPARONAELLA (?) PSEUDOEWINGI 3150

Homoeoparonaella (?) *pseudoewingi* n.sp. BAUMGARTNER

Synonymy.-
? *Tritrabs* sp. A cf. *T. ewingi* (PESSAGNO) WAKITA 1982, pl. 5, fig. 1.
? *Homoeoparonaella* sp. SATO et al. 1982, pl. 3, fig. 3.
? *Homoeoparonaella* sp. NAGAI 1985, pl. 1, figs. 3-3a, 4-4a.
? *Homoeoparonaella* sp. A YAMAMOTO et al. 1985, p. 35, pl. 5, figs. 1a-b.
? *Tritrabs* sp. aff. *Tritrabs exotica* (PESSAGNO) OZVOLDOVA & PETERCAKOVA 1987, p. 122, pl. 36, figs. 2, 4.
? *Homoeoparonaella* sp. aff. *H. argolidensis* BAUMGARTNER CARTER 1988, p. 28, pl. 7, figs. 5-6.
? *Homoeoparonaella* sp. B HATTORI 1988a, pl. 5, fig. H.

Type Designation.- 81/1411, 534A.125.2.36.

Original Definition.- Hagiastrid (?) with three stout rays arranged at slightly unequal angles bearing bulbous ray tips. Rays composed of 8 external beams arranged symmetrically such that the top and bottom central beams meet in the central area, whereas the adjacent lateral two as well as the two lateral central ones are continuous from one ray to another around the central area. External beams and central area smooth or slightly nodose, central area, small, with small irregular pores. Two rows of alternating pores are present between each pair of beams. The cortical space is formed by 8 tertiary canals which lie beneath each external beam. The medullary rays are complex: the quatriradiate central beam is surrounded by 4 primary canals, 4 secondary and 4 tertiary beams, which alternate with 8 secondary canals. The 4 primary canals are centered on the diagonals of a square, the corners of which are formed by the top and the bottom lateral external beams. The top and bottom central as well as the lateral central external beams are centered above the respective sides of that square. The bulbous ray tip has irregular circular pores and bears two stout lateral spines with a circular cross-section at a 90-120 degree angle with respect to the ray axis. Several more delicate spines are sometimes present in the central area of ray tip.

Original Remarks.- This species externally resembles *Tritrabs ewingi*, but is stouter and has usually shorter rays. It also differs from the latter by having 8 instead of 6 external beams. The species should be assigned to a new genus (and to a new subfamily) by virtue of its quatriradiate ray symmetry. It is included with *Homoeoparonaella* on a preliminary basis.

Etymology.- Named for its superficial resemblance with *T. ewingi* (PESSAGNO).

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of rays AX:	204	-	-	-
Length of rays BX:	-	-	-	-
Length of rays CX:	-	-	-	-
Width of rays:	61	68	58	70
Width of ray tips:	107	102	98	112
Length longest spine:	46	38	32	52

Type Locality.- DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 122, Section 1, 43 cm (Baumgartner 1984, loc. 30).

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

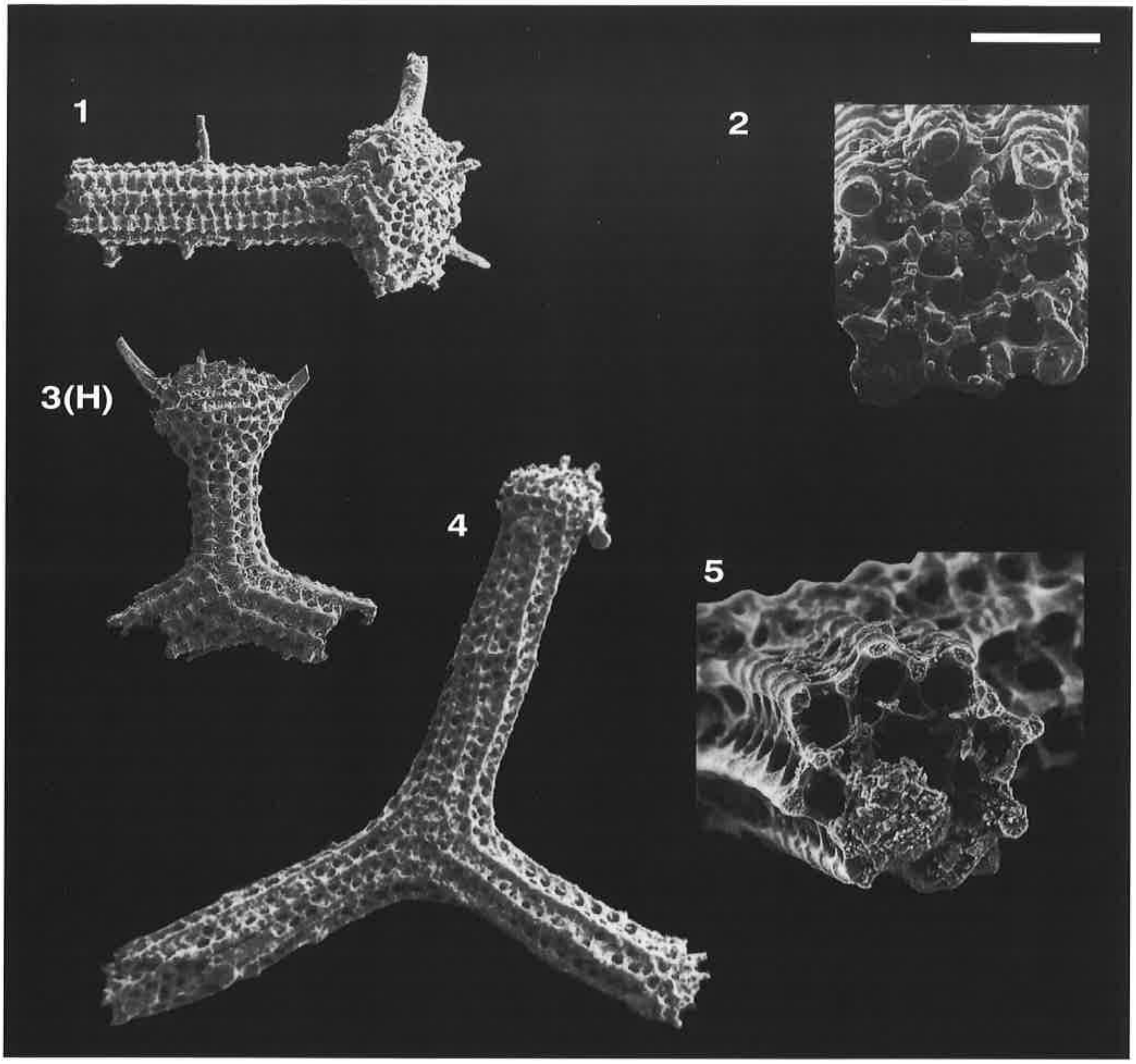


Plate 3150. ***Homoeoparonaella* (?) *pseudoewingi* n.sp. BAUMGARTNER.** Magnification x200, except Figs. 2, 5 x800. **Fig. 1.** POB81/2813, 534A.121.1.25. **Fig. 2.** POB81/2815, 534A.121.1.25. **Fig. 3(H).** POB81/1411, 534A.125.2.36. **Fig. 4.** POB81/2374, 534.121.1.26. **Fig. 5.** POB81/1419, 534.125.2.36.

HOMOEOPARONAELLA SPECIOSA 5163

Homoeoparonaella speciosa (PARONA)

Synonymy.-
Dictyastrum speciosum PARONA
PARONA 1890, p. 158, pl. 4, fig. 1.
HINDE 1900, p. 24, pl. 2, fig. 6.
Hymeniastrum ancora RÜST
RÜST 1898, p. 27, pl. 9, fig. 1.
Homoeoparonaella sp. A
THUROW 1988, p. 402, pl. 10, fig. 10.
Homoeoparonaella speciosa (PARONA)
JUD 1994, p. 80, pl. 11, figs. 13-14.

Original Definition.- "Form with three short, equal rays with large central trilateral area and with big globose enlargement on the extremities of each ray. Again 10 series of subsquare pores are observable on the enlargements and 4 others on the rays."

Actualized Definition.- (JUD, 1994) Test three-rayed with interradial patagium. Rays short, robust, with 4-5 longitudinal beams visible on each face of test, connected by transverse bars, forming longitudinal and transverse rows of square pores. Intersection of rays in central area with irregular pore frames. Longitudinal beams prolonged into tips of rays which are enlarged laterally and have the same pore pattern as the rays. Structure of lateral sides of rays unknown. Interradial space of rays filled with dense patagium, which may surround sometimes also the tips. Outline of patagium in interradial area concave. Thickness of patagium markedly thinner than rays. Spines have never been observed or were never preserved on the ends of the rays on our specimens.

Actualized Remarks.- (JUD, 1994) Taking in account the superficial structure *Hymeniastrum ancora* RÜST 1889, (p. 27, pl. 9, fig. 1) suggests that it could very well be *Dictyastrum speciosum* PARONA, surrounded by a patagium. Our specimens have an average length of rays (based on 6 specimens) of 244 μm and correspond perfectly to the specimen described by Parona. Badly preserved specimens of *Homoeoparonaella speciosa* PARONA and of *Cyclastrum* (?) *trigonum* (RÜST) may be difficult to distinguish. They differ clearly by the structure of the rays, *H. speciosa* having several transverse rows of pores on the enlarged tips and also lacking terminal spines on rays.

Measurements (in μm).-
Total length of rays (starting from the center) 244, their length starting from the intersection on the central area 183, their width 48, diameter of the globose enlargements 122-104, diameter of pores 12-9.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 13-21, latest Tith. to early Barr.

hopsoni >> *EMILUVIA HOPSONI* 3225

horridus >> *XITUS HORRIDUS* 5725

HSUUM 3649

Genus: *Hsuum* PESSAGNO, emend. TAKEMURA

Synonymy.-
Hsuum PESSAGNO
PESSAGNO 1977a, p. 81.
emend. TAKEMURA 1986, p. 49.

Type Species.- *Hsuum cuestaense* PESSAGNO 1977a.

Original Definition.- Test multicyrtoid, conical lacking strictures. Cephalis conical, with small horn and sparse irregularly dispersed pores. Thorax trapezoidal with sparse irregularly dispersed pores. Abdomen and post-abdominal chambers with massive, continuous to discontinuous diverging costae; three to six rows of small square pore frames with circular pores between costae. Costae of some species with irregular branches that link adjoining costae and obscure linearly arranged pore frames beneath. Pores of all post-thoracic chambers tending to remain open during ontogeny and to be primary pores.

Actualized Definition.- (TAKEMURA, 1986) Shell of multi-segments, conical, spindle shaped or cylindrical, with apical horn. Pores irregularly distributed in the proximal two or three segments, and regularly arranged in both longitudinal and lateral lines on the inner surface of more distal segments than abdomen or the fourth. Distinct longitudinal and continuous costae, between which there are one to four longitudinal lines of pores, covering almost all surface or the distal part of the shell. MB, A, V, D, two L and two I as cephalic skeletal elements.

Original Remarks.- *Hsuum* n.gen. appears to build its test by secreting costal projections each time a new chamber is formed; linearly arranged square pore frames are then secreted between costal projections. Because it shares the same mode of test building as the Archaeodictyomitridae PESSAGNO, it is tentatively placed in this family. *Hsuum* differs from *Archaeodictyomitra*

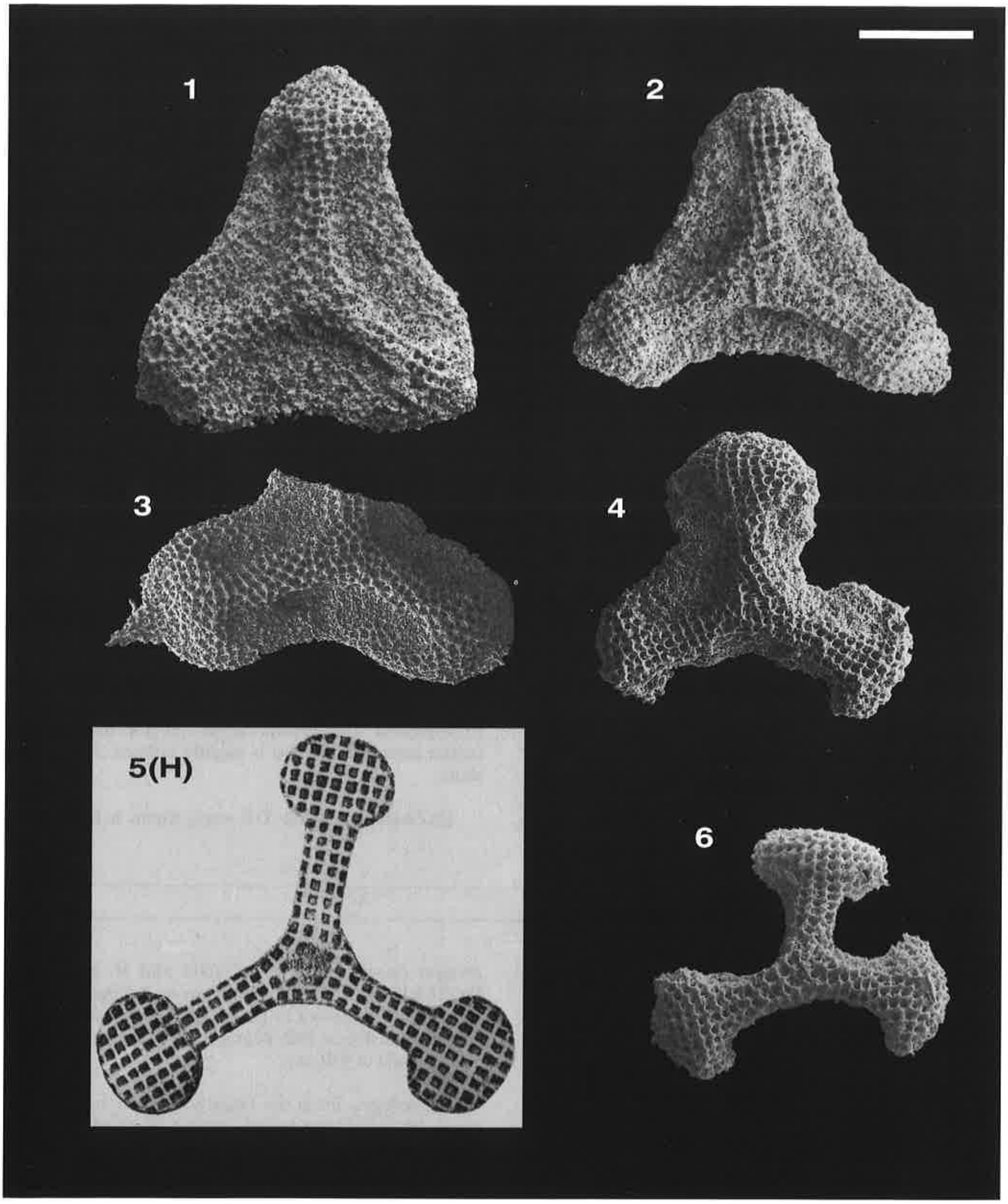


Plate 5163. ***Homoeoparonaella speciosa*** **(PARONA).** Magnification x150. **Fig. 1.** RJ96, Bo569.6. **Fig. 2.** RJ95, Bo569.6. **Fig. 3.** POB79/5256, POB1205.3. **Fig. 4.** DU1218, v40 **Fig. 5(H).** PARONA 1890, pl. 4, fig. 1 **Fig. 6.** DU896, MO46.

PESSAGNO in having several rows of pores between costae and by possessing primary rather than relict pores (cf. Pessagno 1976).

Actualized Remarks.- (TAKEMURA, 1986) Pessagno 1977a described four species belonging to the genus *Hsuum*, of which one (*H.* (?) *stanleyensis*) is questionably assigned. Among the remnant three species while *Hsuum maxwelli* possesses discontinuous costae, *H. cuestaensis* and *H. obispoensis* bear longitudinal contiuous costae on almost all of the surface. On the other hand, the species belonging to *Hsuum* s.s. from TKN-105 possess distinct longitudinal continuous costae only on the distal part of shell. The surface structure of the proximal part of these species resembles that of *Parashuum* of which the shell is composed of the proximal part with irregularly distributed pores and the distal part with rectangularly or squarely arranged pores. This fact indicates that these species from TKN-105 belong to the intermediate form between *Parashuum* and late Jurassic *Hsuum cuestaensis* and *Hsuum obispoensis*, and that the longitudinal continuous costae had been formed from the distal part to the proximal part through the evolution from the early Jurassic *Parahsuum* to late Jurassic *Hsuum,* quite the same like the discontinuous costae of *Transhsuum* n.gen. *Hsuum* s. s. is distinguished from genera *Parahsuum* YAO and *Transhsuum* TAKEMURA by the possession of distinct longitudinal continuous costae on its shell surface.

Remarks.- A full spectrum of species belonging to this genus are not included in this present catalogue. Forms that have been included are considered as a selection of characteristic index species. Species in this genus differ by slight modifications of overall shape and by the configuration of costae.

Etymology.- This genus is named for Dr. Kenneth J. Hsu (ETH, Zurich, Switzerland) to honor his contributions to the study of the Franciscan complex.

Included Taxa.-
3182 *Hsuum* sp. aff. *H. cuestaense* PESSAGNO
5824 *Hsuum feliformis* JUD
3195 *Hsuum matsuoaki* ISOZAKI & MATSUDA
2006 *Hsuum* sp. cf. *H. mirabundum* PESSAGNO & WHALEN
3591 *Hsuum raricostatum* JUD
2018 *Hsuum* (?) sp. 1

HSUUM CUESTAENSE AFF. 3182

Hsuum sp. aff. *H. cuestaense* PESSAGNO

Synonymy.-
aff. *Hsuum* cuestaensis PESSAGNO
PESSAGNO 1977a, p. 81, pl. 7, figs 12-13.

Remarks.- This species is caracterized by a thick irregular latticed structure on the proximal part which is different from that of the closely related *Hsumm cuestaense* PESSAGNO. Continuous costae develop distally. The costate portion of the test is slightly inflated. Apical horn short.

UAZones.- 10-13, late Oxf.-early Kimm. to latest Tith.

HSUUM FELIFORMIS 5824

Hsuum feliformis JUD

Synonymy.-
Protunuma sp. B.
STEIGER 1992, p. 90, pl. 27, fig. 8 only.
gen. et sp. indet.
TUMANDA 1989, pl. 6, fig. 17.
Hsuum feliformis JUD
JUD 1994, p. 81, pl. 12, figs. 1-2.

Original Definition.- Conical test, bearing 2 apical horns. Number of segments unknown. Proximal part of test with irregular, slightly nodose pore frames, without costae, bearing two short spines of which one corresponds probably to the apical and the other to the ventral spine. Middle and distal parts of test with longitudinal continuous and discontinuous costae enclosing several longitudinal rows of pores. Test slightly increasing in width from proximal to distal part, terminating with constriction and large aperture.

Original Remarks.- *Hsuum feliformis* n.sp. differs from *Hsuum cuestaense* PESSAGNO and *H. matsuokai* ISOZAKI & MATSUDA by possessing 2 horns instead of only one. There seem to be remarkable variations in the height of the test, as P.O. Baumgartner found one specimen with a height of 480 μm.

Etymology.- From the Latin *felis* = cat and *forma* = shape, because of the resemblance of the specimen to the shape of a sitting cat.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Total height:	229	223	217	229
Maximum width:	129	120	110	129
Length apical horns:	22	23	20	27
Width base apical horns:	51	55	51	62

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

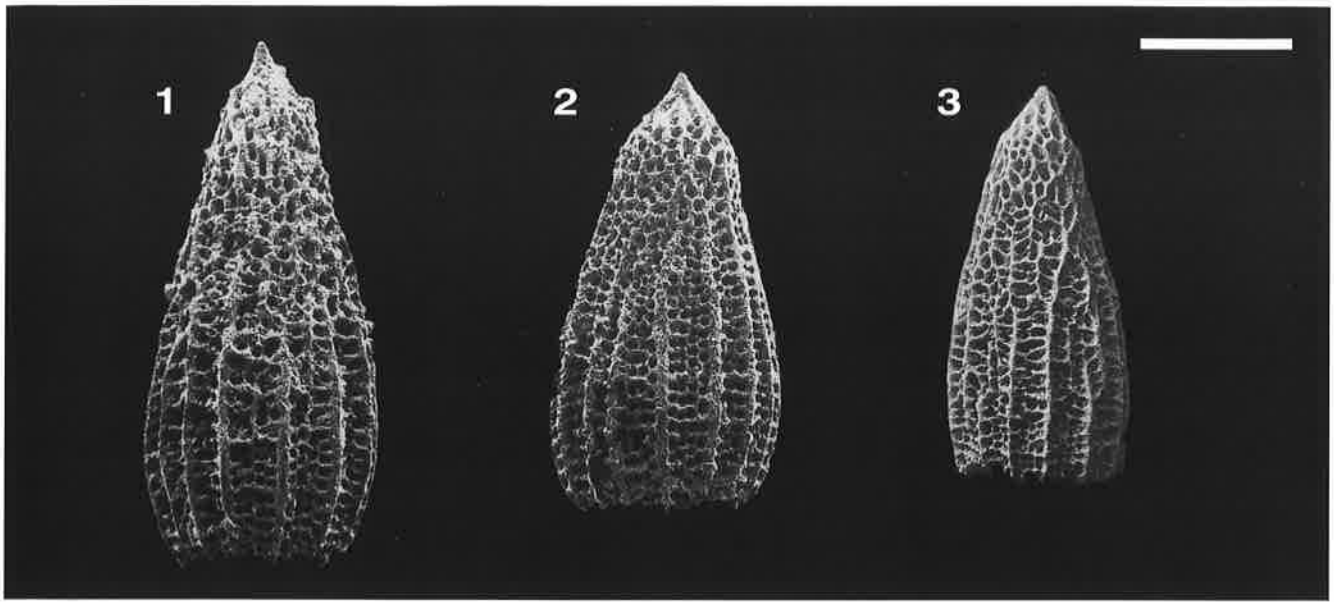


Plate 3182. *Hsuum* sp. aff. *H. cuestaense* PESSAGNO. Magnification x200. **Fig. 1.** POB81/9020, 76.534A.106.1.29. **Fig. 2.** POB81/9019, 76.534A.106.1.29. **Fig. 3.** DU2899, DR77.

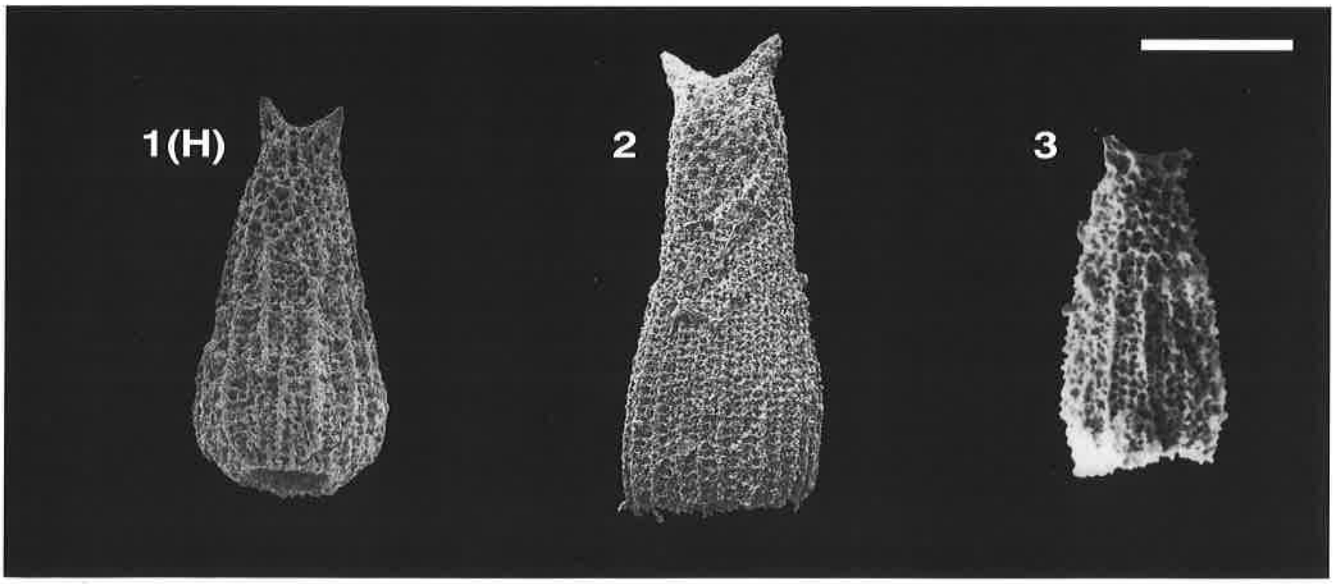


Plate 5824. *Hsuum feliformis* JUD. Magnification x200. **Fig. 1(H).** RJ292, Br1330. **Fig. 2.** POB79/5055, POB1205.1. **Fig. 3.** RJ856, Pi40.20.

HSUUM MATSUOKAI 3195

Hsuum matsuokai ISOZAKI & MATSUDA

Synonymy.-
Hsuum sp. C
HATTORI & YOSHIMURA 1982, pl. 3, fig. 8.
Hsuum sp. B
KISHIDA & SUGANO 1982, pl. 7, figs. 14-16.
unnamed nassellaria
WAKITA & OKAMURA 1982, pl. 7, fig. 3.
Hsuum sp.
YAO 1984, pl. 1, figs. 6-7.
ISHIDA 1985, pl. 1, fig. 3.
MATSUOKA 1986c, pl. 2, figs. 1-3.
Hsuum (?) *matsuokai* ISOZAKI & MATSUDA
ISOZAKI & MATSUDA 1985, p. 438, pl. 3, figs. 1-14.
SASHIDA 1988, p. 19, pl. 4, figs. 16-18.
not HATTORI 1988a, pl. 13, fig. E.
HATTORI & SAKAMOTO 1989, pl. 16, fig. I.
? *Hsuum maxwelli*
DE WEVER & MICONNET 1985, pl. 4, fig. 3.
Hsuum primum TAKEMURA
TAKEMURA 1986, p. 50, pl. 5, figs. 17-21.
HATTORI 1987, pl. 17, figs. 11-13, not figs. 8-9.
HATTORI & SAKAMOTO 1989, pl. 15, figs. I-J.
Hsuum aff. *mclaughlini* PESSAGNO & BLOME
GORICAN 1987, p. 183, pl. 2, fig. 11.
? *Hsuum* (?) *matsuokai*
not HATTORI 1988b, pl. 4, fig. E.
Hsuum matsuokai ISOZAKI & MATSUDA
SASHIDA 1988, p. 19, pl. 4, figs. 16-18.
DANELIAN 1989, p. 160, pl. 5, fig. 12.
KITO 1989, p.179, pl. 21, figs. 1-4, 18.
YAO 1991, pl. 2, fig. 18.
Ogivus falloti EL KADIRI
EL KADIRI 1992, p. 46, pl. 2, figs. 3-4.

Original Definition.- Shell of 7 segments, possibly more, long, spindle-shaped; slenderly conical in proximal 3 segments; broad, barrel-shaped in distal half. Cephalis conical with robust apical horn, coated by outer microgranular layer, on which sparse irregularly dispersed pores remain open. Apical horn variously ornamented with thick blades or narrow grooves, having transverse section typically of tetraradiate cruciform with 4 blades at base, almost circular at tip. Internally, 6 collar pores, divided by median bar, D-bar, V-bar, 2 L-bars and 2 l-bars. Post-cephalic segments, free from the outer microgranular layer, trapezoidal in longitudinal section; each segment becoming wide distally except for the distal-most one, which is reversely trapezoidal in longitudinal section. Average ratio of height to width of a single segment approximately 1:3 for thorax and abdomen, approximately 1:4 for post-abdominal segments. Wall of segment, thin; its longitudinal section flat in proximal half, slightly convex outward in distal half. Pores circular, uniform in size. Square pore frames aligned longitudinally and transversely; in 2 to 3 longitudinal rows of pores between every neighbouring pairs of costae, in 4 transverse rows for each segment. 16-19 continuous costae developing on post-abdominal segments. Weak irregular transverse bars rarely present, linking adjoining costae. Internal partitions rudimentary, circular in outline with a large centrally placed aperture.

Original Remarks.- Ornamentation on cephalis varies considerably from specimen to specimen. Generallly, larger specimens tend to have slenderer shell and apical horn of more completely tetraradiate cruciform section (pl. 3, figs. 1-2). Most of the specimens possess 4 rudimentary ornamenting blades around apical horn. This species is distinguished from other species of the genus *Hsuum* PESSAGNO by its extraordinarily conspicuous apical horn with various ornamentation and restricted development of thick costae within distal half of the shell. Furthermore, bifurcation of costae or distally widening silhouette of the shell can not be recognized in *H* (?). *matsuokai* n.sp. although they are common features among most of the species belonging to *Hsuum* PESSAGNO. Pessagno & Whalen (1982) established some new multicyrtoid nassellarian genera of Early to Middle Jurassic age, such as *Droltus* and *Canutus*, which are essentially characterized by linear arrangement of square pore frames. *H.* (?) *matsuokai* n.sp. is not referable to them in wall structure mentioned above. On the other hand, the proximal half of the shell of this species looks rather like that of genus *Parahsuum* YAO, except for its robust apical horn. In these circumstances, this species is here provisionally classified under genus *Hsuum* PESSAGNO.

Remarks.- This species differs from its ancestor *Hsuum altile* HORI & OTSUKA 1989 by having a robust massive apical horn which is tetraradiate cruciform in cross-section.

Etymology.- This species is named for Dr. Matsuoka in honor to his contribution to Jurassic radiolarian biostratigraphy in southwest Japan.

Measurements (in μm).-
Based on 13 specimens. Height, 240-410 (310). Max. width, 120-160 (140). Diameter aperture, 50-90 (80); No. costae, 15-19 (17).

Type Locality.- Sample 140, Hisuikyo, Kamiaso area, Gifu Prefecture, central Japan.

UAZones.- 1-5, early-mid Aal. to latest Baj.-early Bath.

HSUUM MIRABUNDUM CF. 2006

Hsuum sp. cf. *H. mirabundum* PESSAGNO & WHALEN

Synonymy.-
Hsuum sp. cf. *H. mirabundum* PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 131, pl. 7, figs. 9, 17, 21.
CARTER et al. 1988, p. 52, pl. 15, fig. 4.

Remarks.- Specimens compare well with *Hsuum mirabundum*, but are slimmer and more elongate. Some are one third as long again as the illustrated specimen. In addition, very few lateral costae have been noted.

UAZones.- 3-6 , early-mid Baj. to mid Bath.

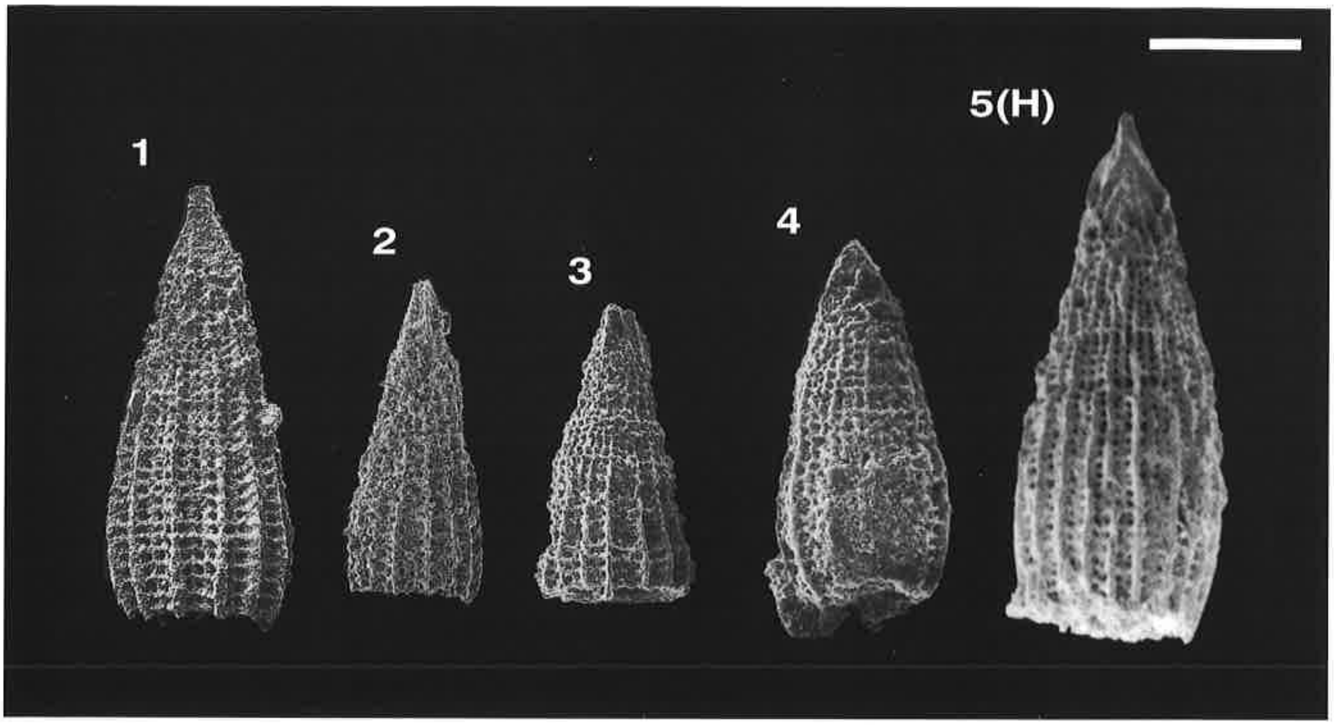


Plate 3195. *Hsuum matsuokai* ISOZAKI & MATSUDA. Magnification x200. **Fig. 1.** POB81/2850, POB1341. **Fig. 2.** GO892305, GL125. **Fig. 3.** GO892306, GL125. **Fig. 4.** GO892121, UPC13. **Fig. 5(H).** ISOZAKI & MATSUDA 1985, pl. 3, fig. 1.

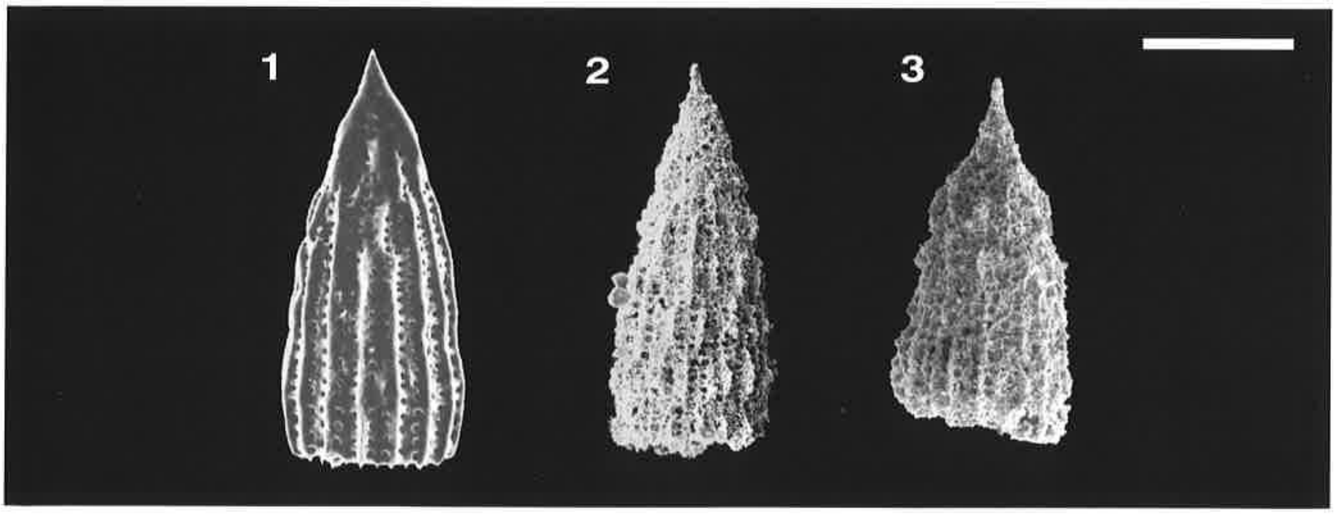


Plate 2006. *Hsuum* sp. cf. *H. mirabundum* PESSAGNO & WHALEN. Magnification x200. **Fig. 1.** CARTER et al. 1988, pl. 15, fig. 4. **Fig. 2.** AB 1258, TM105.50f69.**Fig. 3.** AB688, TM105.50.f25.

HSUUM RARICOSTATUM 3591

Hsuum raricostatum JUD

Synonymy.-
Hsuum cf. *rutogense* YANG & WANG
YANG & WANG 1990, p. 208, pl. 4, fig. 15
Protunuma sp. B
STEIGER 1992, p. 90, pl. 27, figs. 5-7, not 8.
Hsuum raricostatum JUD
JUD 1994, p. 81, pl. 12, figs. 3-5.

Original Definition.- Small, fusiform test with wide aperture. Number of segments unknown. Proximal part of test conical, when well preserved, bearing a very short horn. Surface with irregular pore-frames. Middle and distal parts of test inflated, with 6-8 wide-spaced longitudinal costae on half of diameter of the test, of which some are generally continuous, each intercostal space enclosing 2-4 longitudinally aligned rows of small pores. Terminal part of test constricted.

Original Remarks.- *Hsuum raricostatum* n.sp. differs clearly from *H. rutogense* YANG & WANG by being generally more inflated, by possessing a smaller number of longitudinal costae and also some shorter, discontinuous costae which may merge beneath the apical part, and by having also a short, pointed apical horn. The ratio between height and width of our specimens is 1.57 while of Yang & Wang specimens is 1.80.

Etymology.- From the Latin *rarus* = rare and *costatus* = with ribs.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Height:	274	263	247	275
Max. width:	184	167	153	184

Type Locality.- Pieia, Umbria-Marche, Italy.

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

HSUUM (?) \ 1 2018

Hsumm (?) sp. 1

Synonymy.-
Nassellaria gen et sp. indet X
HORI 1990, fig. 9.46.

Remarks.- This small form is characterized by a long, curved cephalic horn. It should be assigned to a new genus, rather than *Hsuum.* The general shape and the horn of our material compare well with the illustration by Hori (1990). The details of the test wall structure, difficult to study in our material, may differ slightly.

UAZones.- 1-2, early-mid Aal. to late Aal.

hybum >> SUNA HYBUM 5049

ichikawai >> SOLENOTRYMA ICHIKAWAI 4037

imbricata >> HIGUMASTRA IMBRICATA 3110

imlayi >> ZARTUS IMLAYI GR. 3040

imperialis >> PODOCAPSA (?) IMPERIALIS 5397

inflata >> HIGUMASTRA INFLATA 3106

inflexa >> CRUCELLA (?) INFLEXA 5902

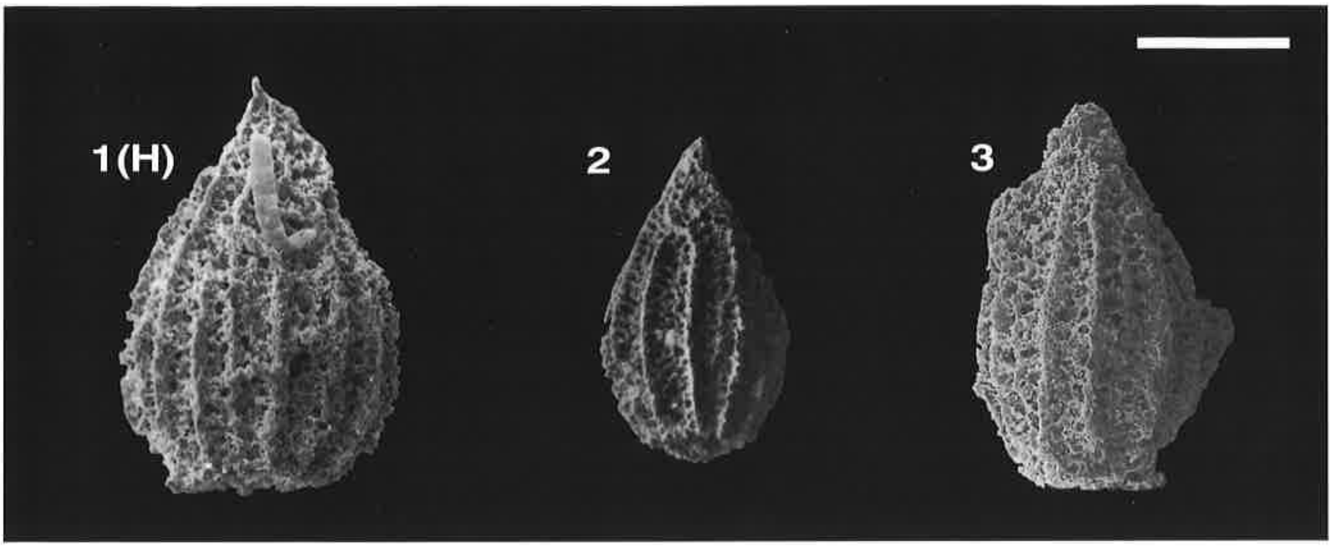


Plate 3591. ***Hsuum raricostatum*** **JUD.** Magnification x200. **Fig. 1(H).** RJ2, Pi10.0 1. **Fig. 2.** RJ839, Pi57.5. **Fig. 3.** RJ39, V -6.

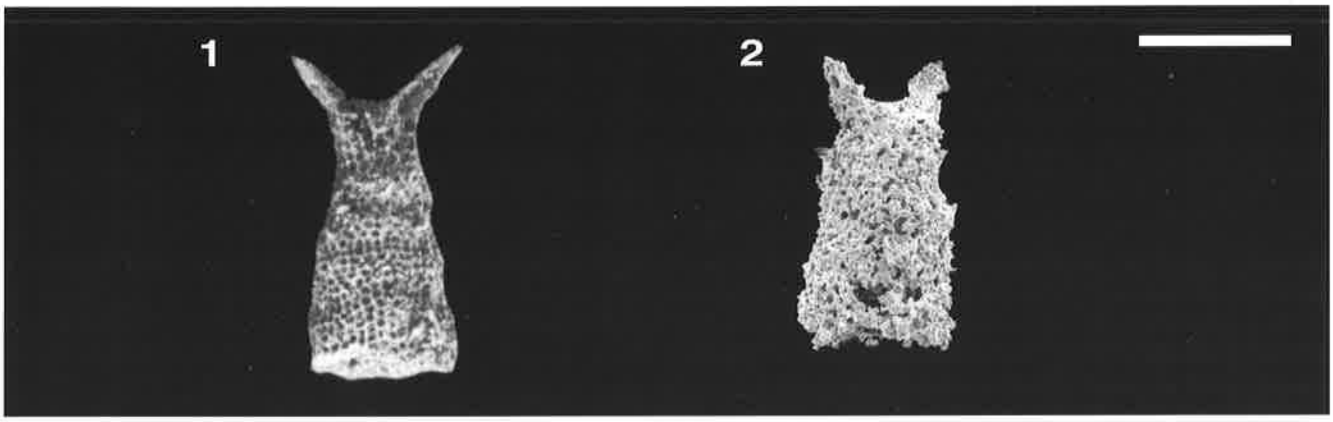


Plate 2018. ***Hsuum*** **(?) sp. 1.** Magnification x200. **Fig. 1.** HORI 1990, fig. 9.46. **Fig. 2.** AB6406, TM40.15.a5.

infundibuliforme >> CYCLASTRUM INFUNDIBULIFORME *5261*

irazuense >> BISTARKUM IRAZUENSE *5199*

irregularis >> HOMOEOPARONAELLA IRREGULARIS AFF. *5253*

italicus >> JACUS (?) ITALICUS *5371*

izeensis >> TETRATRABS IZEENSIS *3302*

izeensis >> PARAHSUUM IZEENSE *2012*

jacobsae >> TRIACTOMA JACOBSAE *3409*

JACUS 3651

Genus: *Jacus* DE WEVER

***Synonymy*.-**
Jacus DE WEVER
DE WEVER 1982a, p. 204.

***Type Species*.-** *Jacus coronatus* DE WEVER, 1982a.

***Original Definition*.-** Shell made of two segments, an apical horn and three feet. Apical horn, long and stout, is generally three-bladed. Thorax costulate, with a network of regular horizontal ribs and irregular vertical ribs. Thoracic wall of several superposed networks, the external most being the thickest. The three feet, usually three-bladed, correspond to L and D but seem prolongation of the thorax. Cephalic skeleton of 8 actines: A, V, MB, Ll,Lr, ll, lr and D. Actine A cross the cephalic cavity and prolonges outside cephalis into a very short horn outside shell wall. D, Lr and Ll prolonged into feet and their trace along thorax is usually marked by a keel.

***Original Remarks*.-** *Jacus* differs from *Napora* PESSAGNO and *Ultranapora* PESSAGNO by the structure of wall which is simple and pierced by large round pores in these two genera and composed of several reticulate layers in *Jacus*. Moreover, *Jacus* has no cephalocone as defined by Pessagno (1977b, p. 38) but has usually a velum in the prolongation of the thorax. *Jacus* differs from *Silicarmiger* DUMITRICA, KOZUR & MOSTLER 1980 by the well differentiated velum, which is thinner walled than thorax, and by its feet well distinct from velum.

***Etymology*.-** Arbitrary combination of letters.

***Included Taxa*.-**
5371 *Jacus* (?) *italicus* JUD

JACUS (?) ITALICUS 5371

Jacus (?) *italicus* JUD

***Synonymy*.-**
Jacus (?) *italicus* JUD
JUD 1994, p. 82, pl. 12, figs. 6-7.

***Original Definition*.-** "Conical test with open terminal velum and 3 distally curving feet. Cephalis conical with a stout bladed horn. Thorax inflated, with coarse polygonal pore frames, sometimes with visible transverse costae. Spines D and L of initial spicule extended as ribs on thorax and then prolonged into long, three-bladed, curved feet. Velum cylindrical, short, narrower than thorax, perforate, not connected to feet".

***Original Remarks*.-** "*Jacus* (?) *italicus* n.sp. differs from the other species of this genus so far known by its larger pores, a shorter apical horn and a relatively short velum".

***Etymology*.-** Named after its Italian provenance.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Height test:	200	220	200	246
Width test:	113	112	106	117
Length velum	20	40	20	57
Width velum:	58	77	58	95
Length feet:	83	84	70	100

***Type Locality*.-** Fiume Bosso, Umbria-Marche, Italy.

***UAZones*.-** 15-20, late Berr.-earliest Val. to late Haut.

japonica >> *STICHOCAPSA JAPONICA* 3049

japonicus >> *PROTUNUMA JAPONICUS* 3292

jonesi >> *TRIACTOMA JONESI* 3096

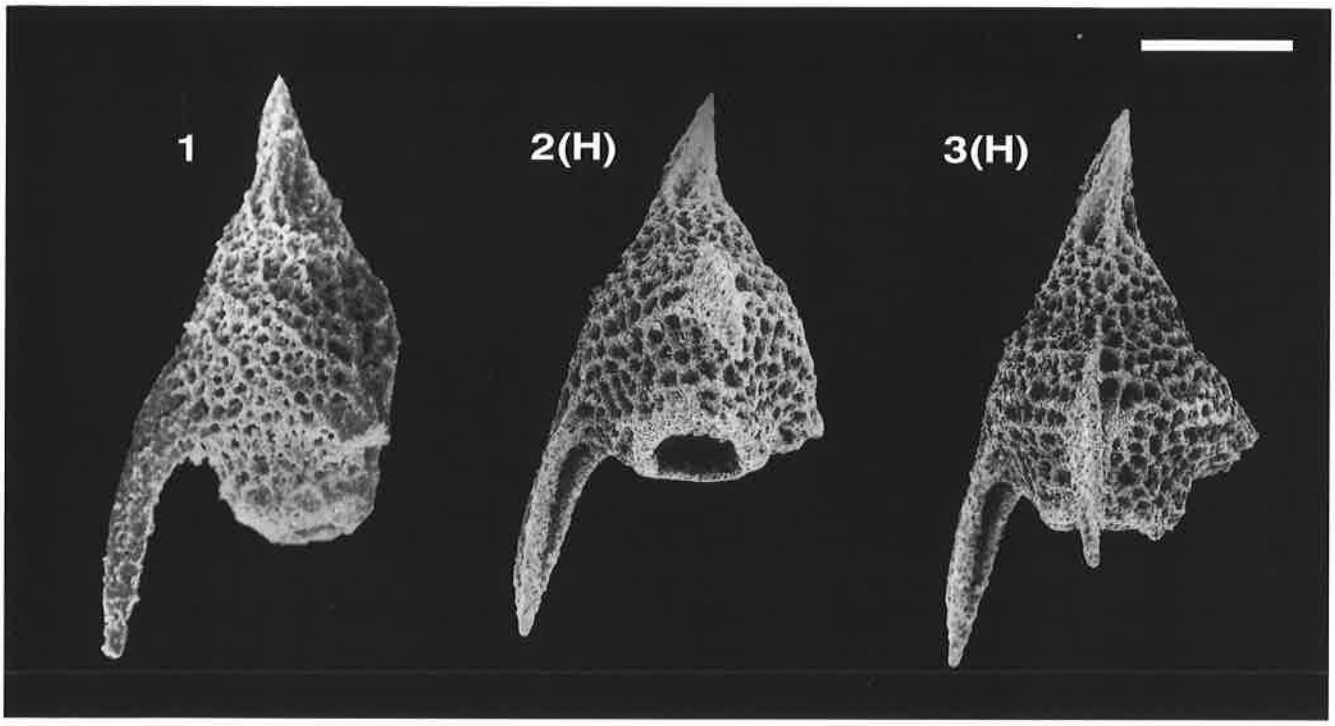


Plate 5371. *Jacus* (?) *italicus* JUD. Magnification x300. **Fig. 1.** RJ44, Bo581.65. **Fig. 2(H).** RJ213, Bo566.5. **Fig. 3(H).** RJ212, Bo566.5.

jurassicum >> LAXTORUM (?) JURASSICUM	*3151*

kaminogoensis >> SETHOCAPSA KAMINOGOENSIS AFF.	*5481*

kamoensis >> DICTYOMITRELLA (?) KAMOENSIS	*4014*

KATROMA 3652

Genus: *Katroma* PESSAGNO and POISSON, emend. DE WEVER

Synonymy.-
Katroma PESSAGNO & POISSON
PESSAGNO & POISSON 1979, p. 62.
Katroma PESSAGNO & POISSON
emend. DE WEVER 1982a, p. 193.

Type Species.- *Katroma neagui* PESSAGNO & POISSON 1979.

Original Definition.- Test multicyrtid, comprised of cephalis, thorax, abdomen, and with type species one post-abdominal chamber terminating in long, cylindrical, open, tubular extension. Cephalis hemispherical with horn; thorax and abdomen trapezoidal in outline. First post-abdominal chamber subspherical, considerably larger than previous chambers and with variable number of medially arranged circumferential spines.

Original Remarks.- *Katroma* differs from *Podobursa* WISNIOWSKI by having an open tube on its final post-abdominal chamber.

Actualized Definition.- (DE WEVER, 1982a) Shell spindle-shaped, tri- or multicyrtid. Cephalis, not separated from thorax by a stricture, has one or more apical horns and usually several small spines on lateral parts. Following segments increase in size to the last one which is inflated and prolonged by a long lattice tube closed distally. Last segment may bear spines on its inflated part.

Remarks.- *Katroma* differs from *Podobursa* WISNIOWSKI 1889, (p. 686, type species; *Podobursa dunikowskii* WISNIOWSKI 1889) by the general presence of three segments and particularly by the presence of several cephalic spines (apical and others).

Pessagno & Poisson (1979) considered as a distinctive character from *Podobursa* the open distal tube. Well preserved specimens have shown that the tube is generally distally closed. In this situation we consider as one of the distinctive character the presence of several horns emerging from the apical part.

Etymology.- The name *Katroma* is formed by an arbitrary combination of letters. Its gender is feminine.

Included Taxa.-
5436 *Katroma milloti* SCHAAF

KATROMA MILLOTI 5436

Katroma milloti SCHAAF

Synonymy.-
Katroma milloti SCHAAF
SCHAAF 1984, p. 124-125, figs. 1-4.
STEIGER 1992, p. 77, pl. 21, figs. 1-5.
JUD 1994, 82, pl. 12, fig. 8.

Original Definition.- The test is made up of three segments, the first two (cephalis and thorax) being very small. The abdomen is swollen and extended by a tube. The cephalis is lost in the base of two strong three-bladed cephalic horns, which are inequal in length. The thorax is slightly bigger than the cephalis. The abdomen is spherical and swollen, much bigger than the two first segments and shows 30 to 40 strong radiating spines with a circular section. The cylindrical post-abdominal tube is distally closed and terminates in a crown of little spines. The abdominal pores are circular and irregularly disposed, those of the tube show a tendency to be aligned.

Etymology.- This species is named in honor of Georges Millot, member of the institute, honoring his important contributions in geology and his passion for geology which he inoculated on me when I was a young student.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
Length of horn:	82	98	76	105
Diameter of cephalis:	33	31	26	35
Diameter of abdomen:	159	158	145	195
Length abdominal spines:	78	80	73	94
Length distal tube:	195	208	185	250

Type Locality.- CR 28, Schaaf's collection (1984).

UAZones.- 13-19, latest Tith. to early Haut.

kisoensis >> CYRTOCAPSA (?) KISOENSIS 3050

kitoi >> SETHOCAPSA KITOI 3264

komamiensis >> YAMATOUM KOMAMIENSIS 2020

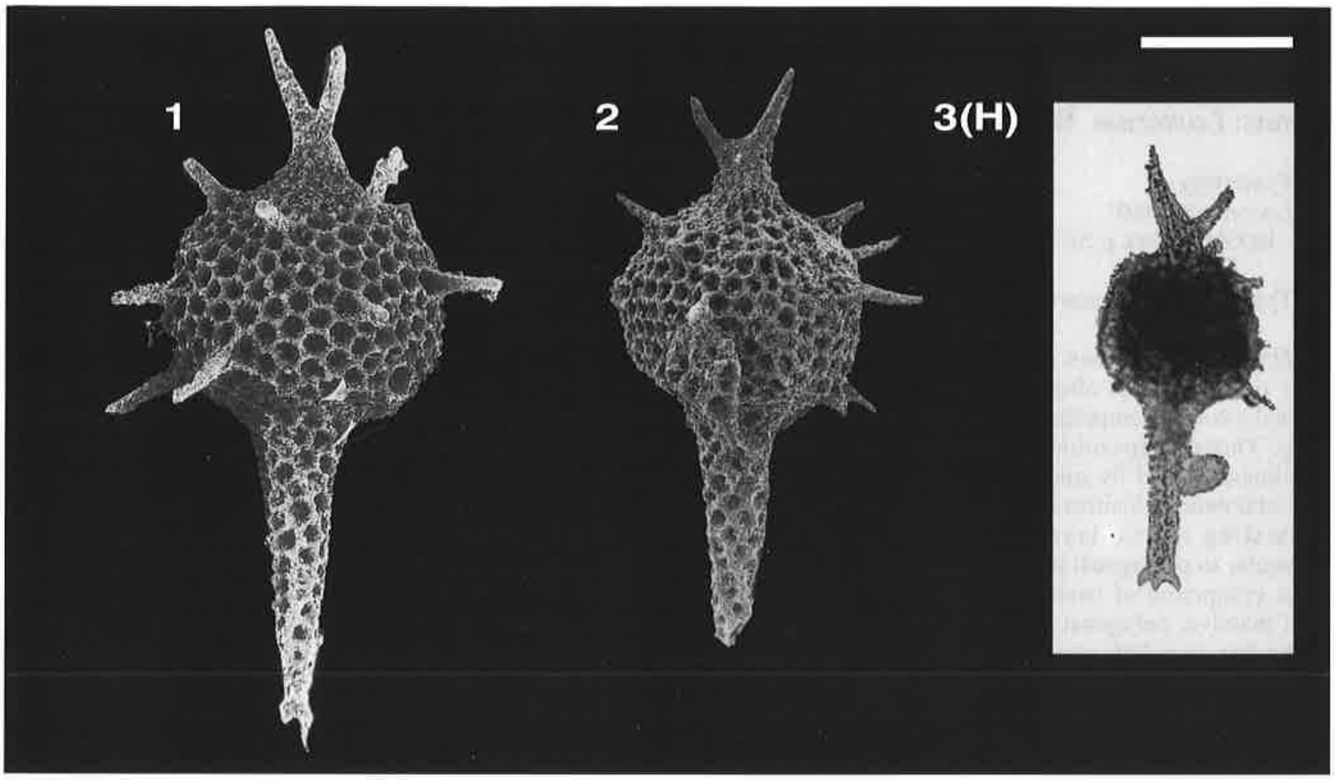


Plate 5436. ***Katroma milloti*** **SCHAAF.** Magnification x150. **Fig. 1.** RJ389, Br28.85. **Fig. 2.** RJ213, Br1330. **Fig. 3(H).** SCHAAF 1984, p. 125, fig. fig. 2b.

kotura >> PARONAELLA KOTURA **3140**

lacrimalis >> STYLOCAPSA LACRIMALIS **4046**

lacrimula >> ARCHAEODICTYOMITRA LACRIMULA **5595**

lanceloti >> PSEUDODICTYOMITRA LANCELOTI **5641**

lanceloti >> PSEUDODICTYOMITRA LANCELOTI AFF. **5642**

latissima >> NAPORA LATISSIMA **3031**

latusicostatus >> UNUMA LATUSICOSTATUS **4058**

LAXTORUM 3654

Genus: *Laxtorum* BLOME

Synonymy.-
Laxtorum BLOME
BLOME 1984a, p. 56.

Type Species.- *Laxtorum hindei* BLOME 1984a.

Original Definition.- Test multicyrtid, consisting of four or more post-abdominal chambers (segments). Cephalis conical, imperforate, with a large, well-developed horn. Thorax trapezoidal in outline, perforate, in some specimens buried by microgranular silica. Abdomen and post-abdominal chambers trapezoidal in outline. Test wall consisting of two layers: inner layer comprised of triangular to pentagonal pore frames that lack nodes ; outer layer comprised of triangular to hexagonal pore frames with massive, polygonal nodes at the pore frame vertices, nodes low in relief; pores of both layers of pore frames large, subcircular to polygonal in outline; pore frames of the outer layer generally restricted to the circumferential ridges, with the exception of the final post-abdominal chambers. Post-abdominal chambers commonly increasing more rapidly in width than in height.

Original Remarks.- *Laxtorum* new genus differs from *Canoptum* PESSAGNO et al., 1979, by having a test in which the pores are not buried by an outer layer of accreted microgranular silica.

Etymology.- *Laxtorum* is a name formed by an arbitrary combination of letters (ICZN, 1964, p.113, Appendix D, pt. IV, Recommendation 40).

Included Taxa.-
4028 *Laxtorum* (?) *hichisoense* ISOZAKI & MATSUDA
3151 *Laxtorum* (?) *jurassicum* ISOZAKI & MATSUDA

LAXTORUM (?) HICHISOENSE 4028

Laxtorum (?) *hichisoense* ISOZAKI & MATSUDA

Synonymy.-
Spongocapsula ? sp. B
KISHIDA & SUGANO 1982, pl. 9, figs. 14-15.
Spongocapsula sp. C
YAO 1984, pl. 1, figs. 4-5; not fig. 3.
Laxtorum (?) *hichisoense* ISOZAKI & MATSUDA
ISOZAKI & MATSUDA 1985, p. 436, pl. 2, figs. 1-9.

Original Definition.- Shell of 6 to 8 segments, possibly more, long, spindle-shaped, without external strictures or circumferential ridges. Cephalis conical, having thick wall which is apically even thickened to form a stout apical horn with deep, irregular, longitudinal grooves. Each groove becoming deep distally, terminated at rather large pore on cephalis. Internally, six collar pores divided by median bar, D-bar, V-bar, 2 L-bars and 2 l-bars. Post-cephalic segments, trapezoidal in longitudinal section. Each segment widening distally except for the distal-most one, which becomes narrow distally. Average ratio of height to width for a single post-abdominal segment approximately 1:3. Proximal part of shell covered with a spongy outer layer. Pores mostly circular, various in size, rather irregularly aligned, or roughly arranged longitudinally, and in 5 rows for each segment transversely. Inner surface of wall, flat to slightly convex outerward in longitudinal section. Internal planiform partitions between segments, imperforate, circular in outline, having a large centrally placed aperture.

Original Remarks.- Although it lacks externally visible circumferential ridges, *L.* (?) *hichisoense* n.sp. possesses wall structure and arrangement of pores on the inner wall similar to those of *L.* (?) *jurasssicum* n.sp. and other species of *Laxtorum* described by Blome (1984a). This species is here tentatively classified in genus *Laxtorum* BLOME as in the case of *L.* (?) *jurassicum* n.sp.

This species is distinguished from *L.* (?) *jurassicum* n.sp. by spindle-shaped silhouette, smooth outer surface without externally visible circumferential ridges, and rugged, stout apical horn.

Etymology.- The specific name comes from Hichiso Town, Gifu Prefecture, central Japan, where the type locality is located.

Measurements (in μm).-
Based on 7 specimens. Height: 280-400 (average: 320); Maximum width, 120-140 (average:130); Diameter of aperture at distal end, 70-80 (average: 80).

Type Locality.- Sample 140, Hisuikyo, Kamiaso area, Gifu Prefecture, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

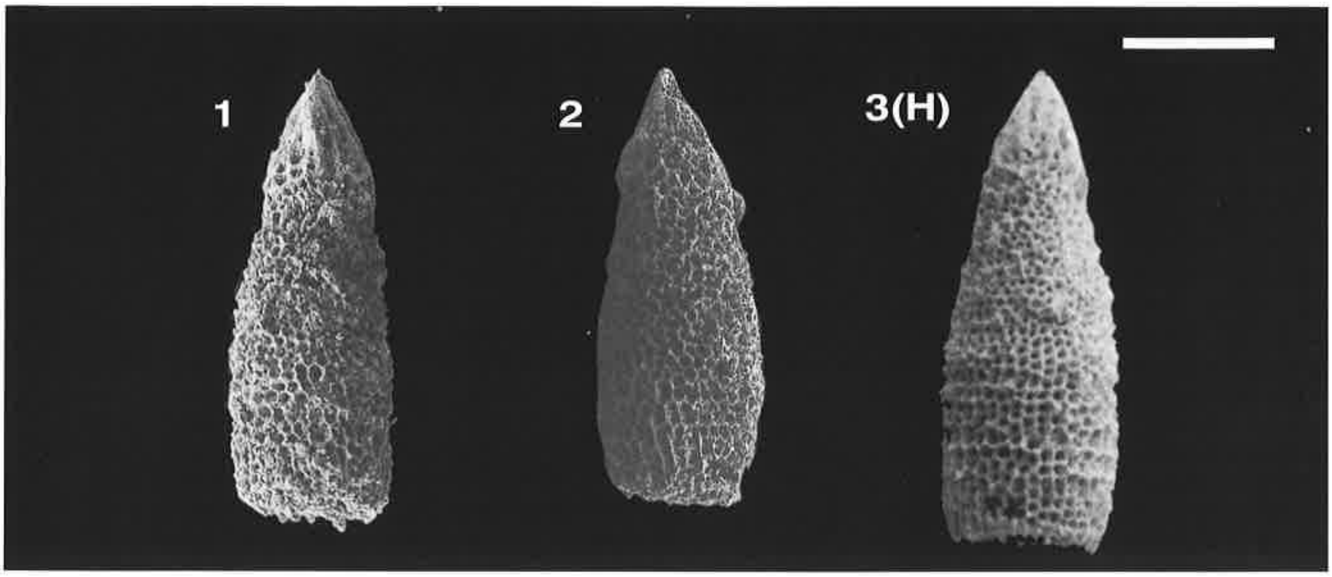


Plate 4028. ***Laxtorum* (?) *hichisoense* ISOZAKI & MATSUDA.** Magnification x200. **Fig. 1.** MA2876, 17-3007. **Fig. 2.** MA2963, 17-3007. **Fig. 3(H).** ISOZAKI & MATSUDA 1985, pl. 2, fig. 2.

LAXTORUM (?) JURASSICUM 3151

Laxtorum (?) *jurassicum* ISOZAKI & MATSUDA

Synonymy.-
Spongocapsula (?) sp. C
YAO et al. 1982, pl. 3, fig. 2.
YAO 1983, text-fig. 3.2.
Spongocapsula sp. C
YAO 1984, pl. 1, fig. 3, not 4-5.
Spongocapsula ? sp. A
KISHIDA & SUGANO 1982, pl. 8, figs. 1-2, ? 3, 4, ? 5-7.
SUNOUCHI et al. 1982, text-fig. 3.2.
SATO et al. 1986, pl. 2, fig. 9.
Laxtorum (?) *jurassicum* ISOZAKI & MATSUDA
ISOZAKI & MATSUDA 1985, p. 435, pl. 1, figs. 1-15.
MATSUOKA & YAO 1986, pl. 1, fig. 6; pl. 3, fig. 3.
HATTORI 1987, pl. 17, fig. 7.
SASHIDA 1988, p. 24, pl. 4, figs. 11-15.
HORI 1990, fig. 9.51.
YAO 1991, pl. 2, fig. 17.
Spongocapsula sp. C
ISHIDA 1985, pl. 1, fig. 6.

Original Definition.- Shell of 8 to 13 segments, possibly more, long, mostly cylindrical, without stricture. Cephalis conical, having a thick wall which is apically even more thickened to form a broad-based, stout, short apical horn. Apex of the horn, eccentric, slightly shifted from the center (rotation axis) of the shell to dorsal side in most specimens. Pores of cephalis, slit-like, longitudinally elongated. Internally, 6 collar pores, divided by median bar, D-bar, V-bar, 2 L-bars and 2 l-bars. A-bar, extending upward, merging into dorsal wall of cephalis just below apical horn. Symmetry plane of outer shell, coinciding with that of internal cephalic structure. Post-cephalic segments, trapezoidal to rectangular in longitudinal section; distal segments almost annular. Each segment slightly widening distally except the distal-most one. Average ratio of height to width for a single post-abdominal segment, approximately 1:4. Wall of segments, triple-layered; inner primary layer with circumferential ridges, outer secondary layer of spongy meshwork and the outermost layer with longitudinal slit-like pores. The inner layer coated by thick spongy outer layers which are very thick proximally and thinning distally. Pores of inner layer, mostly elliptical to irregular, various in size, aligned mostly irregularly or, in spiro-tetragonal latticed pattern, in distal segments. Longitudinal section of the inner wall convex outerward in the middle part of each segment. Secondary spongy layer developed on proximal 5 segments, hiding circumferential ridges, which are invisible externally. The outermost layer, restricted on cephalis and thorax; microgranular in nature around apex of cephalis, submerging rugged surface of primary apical horn (known through observation in transparency) below smooth surface. Internal planiform partitions between segments, imperforate, circular in outline, slightly thickening innerward to form a ring-like inner margin, terminating abruptly to leave a large centrally placed aperture.

Original Remarks.- As shown in the synonymy list, specimens referable to *Laxtorum* (?) *jurassicum* n.sp. have been hitherto classified under the genus *Spongocapsula* PESSAGNO with query by previous workers. *Laxtorum* (?) *jurassicum* n.sp. differs from *Spongocapsula palmerae* PESSAGNO, the type species of the genus, in having markedly larger cephalis (pl. 1, figs. 7, 9) and in lacking stricture at each joint between segments completely.

On the other hand, *Laxtorum* (?) *jurassicum* n.sp. resembles four species belonging to genus *Laxtorum* described by Blome (1984a) from Upper Triassic in North America. Especially in fundamental wall structure, they share common features, such as triple-layered wall structure and irregularity in shape of each pore and also in alignment of pores of the inner wall. On the contrary, robust apical horn of this species considerably differs from finer and slenderer ones of other species of *Laxtorum*. Also extensive development of the outer layer toward distal half of *Laxtorum* (?) *jurassicum* n.sp. gives considerably different appearance from those of the latters. In this paper, this species is provisionally referred to genus *Laxtorum* with query.

Laxtorum (?) *jurassicum* n.sp. is clearly distinguished from *Laxtorum* (?) *hichisoense* n.sp. by having externally visible circumferential ridges and thick cephalic shell with rather smooth surface.

Etymology.- This species is named for its occurrence in Jurassic sequences.

Measurements (in μm).-
Based on 17 specimens. Height, 260-500+ (average: 370). Maximum width, 110-160 (average:140); Diameter of aperture at distal end, 50-70 (average: 60).

Type Locality.- Sample 140, Hisuikyo, Kamiaso area, Gifu Prefecture, central Japan.

UAZones.- 2-3, late Aal. to early-mid Baj.

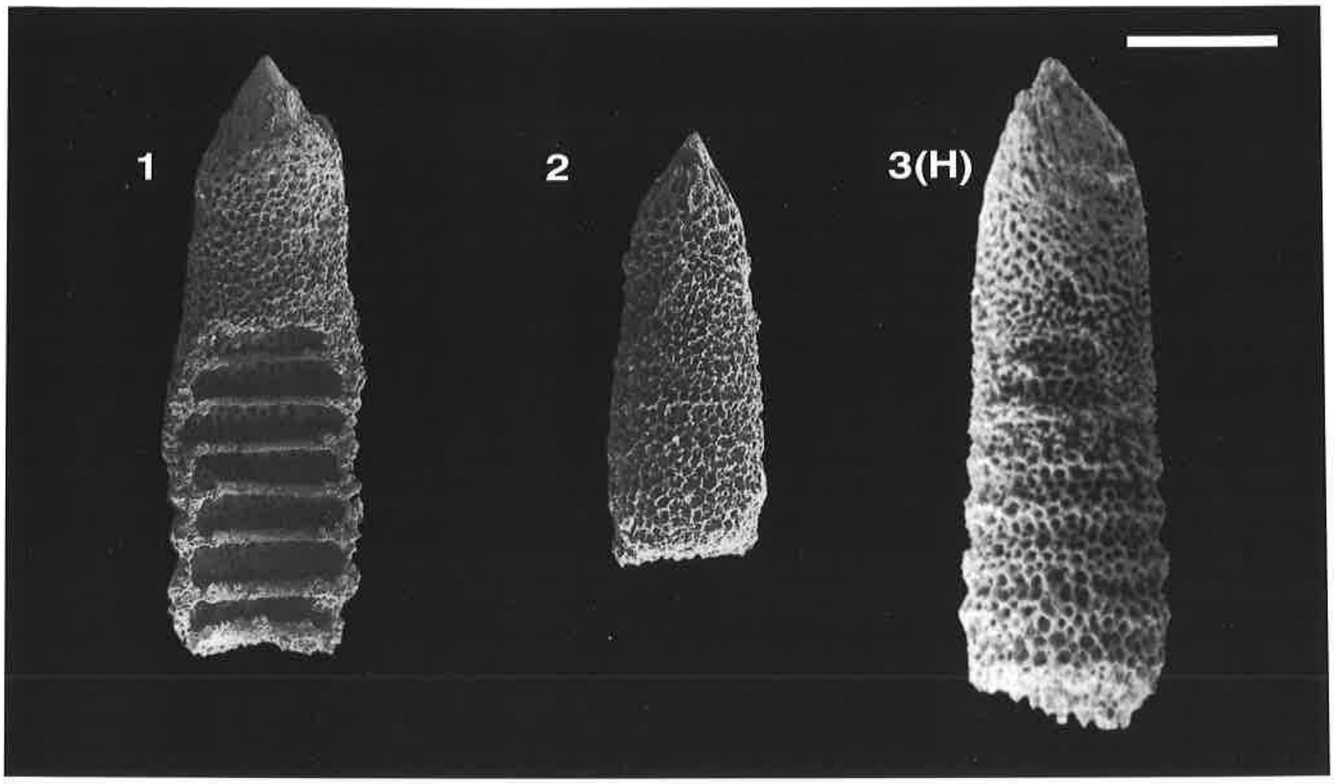


Plate 3151. ***Laxtorum* (?) *jurassicum* ISOZAKI & MATSUDA.** Magnification x200. **Fig. 1.** MA2962, 17-3007. **Fig. 2.** MA2891, 17-3007. **Fig. 3(H).** ISOZAKI & MATSUDA 1985, pl. 1, fig. 1.

leiostraca >> *SETHOCAPSA LEIOSTRACA*		*3062*

lenticulata >> *GODIA LENTICULATA*		*5287*

leporinus >> *BERNOULLIUS RECTISPINUS LEPORINUS*		*4064*

leptoconica >> *PSEUDODICTYOMITRA LEPTOCONICA*		*5973*

LEUGEO 3807

Genus: *Leugeo* YANG & WANG

Synonymy.-
Leugeo YANG & WANG
YANG & WANG, 1990, p. 203.
Levileugeo YANG & WANG
YANG & WAN 1990, p. 203.

Type Species.- *Praeconocaryomma* (?) *hexacubica* BAUMGARTNER 1984.

Original Definition.- Cortical shell spherical to rounded rectangular in outline. Six secondary spines developed and evenly distributed on test surface.

Original Remarks.- To date, the type species is the only known species within the genus.

Etymology.- *Leugeo* (M.) is formed by arbitrary combination of letters (ICZN, 1985, Appendix D, Recomm. 40, p. 201).

Included Taxa.-
3244 *Leugeo hexacubicus* (BAUMGARTNER)

LEUGEO HEXACUBICUS 3244

Leugeo hexacubicus (BAUMGARTNER)

Synonymy.-
Praeconocaryomma (?) *hexacubica* BAUMGARTNER
BAUMGARTNER 1984, p. 780, pl. 7, figs. 11-14.
YAMAMOTO et al. 1985, p. 37, pl. 6, fig. 6.
MARCUCCI et al. 1987, pl. 1, fig. 3.
DANELIAN 1989, p. 183, pl. 7, figs. 12-13.
KITO 1989, p. 98, pl. 3, figs. 11-13, ? figs. 14, 16.
Levileugeo ordinarius YANG & WANG
YANG & WANG, 1990, p. 203, pl. 1, figs. 2, 14; pl. 2, fig. 1.
Leugeonid gen. et sp. indet.
YANG & WANG, 1990, p. 203, pl. 2, fig. 3.

Original Definition.- Cortical shell is a sphere or a rounded cube with eight stout, triradiate primary radial spines extending from the corners of the cube. These spines may be reduced or absent. Surface of cortical shell bears a meshwork of bars forming equilateral triangles which join to form regular hexagons centered around a raised knob with a central pore. Each triangle of bars encloses three pores which results in a perfectly hexagonal pore arrangement of the inner side of cortical shell, visible in fragments or broken up specimens. The central pore of the outer bar hexagons is the depressed central, seventh pore of the internal, concave pore hexagones which are delimited by moderate rounded ridges (see pl. 7, fig. 13 of Baumgartner, 1984). First medullary shell smooth, spherical, with circular pores in pentagonal to hexagonal arrangement, connected to cortical shell by six triradiate radial beams which reach to the center of the square sides of cortical shell. No second medullary shell has been observed.

Original Remarks.- This form is distinguished even in small fragments by its very characteristic wall structure of the cortical shell, which somehow resembles the mammary pore frames described for *Praeconocaryomma media* by PESSAGNO & POISSON 1979. However, this species is doubtfully included with *Praeconocaryomma* as instead of a radial spine there is a pore in the center of each bar hexagone. Besides that, this species may have stout primary radial spines which do not connect inwards to the first medullary shell, which is instead connected by beams centered between the outer spines. Only one, instead of three medullary shells has been observed.

Etymology.- Latin *hexa*, referring to the hexagonal pore frames; *cubica*, referring to the shape of the cortical shell.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Diameter of cortical shell:	195	198	172	225
Diameter of shell:	-	50	45	55
Diameter of bar hexagones:	55	58	52	65
Length of external spines:	75	60	20	76

Type Locality.- Locality no. 30 of locality descriptions (Baumgartner, 1984).

UAZones.- 4-8, late Baj. to mid Call.-early Oxf.

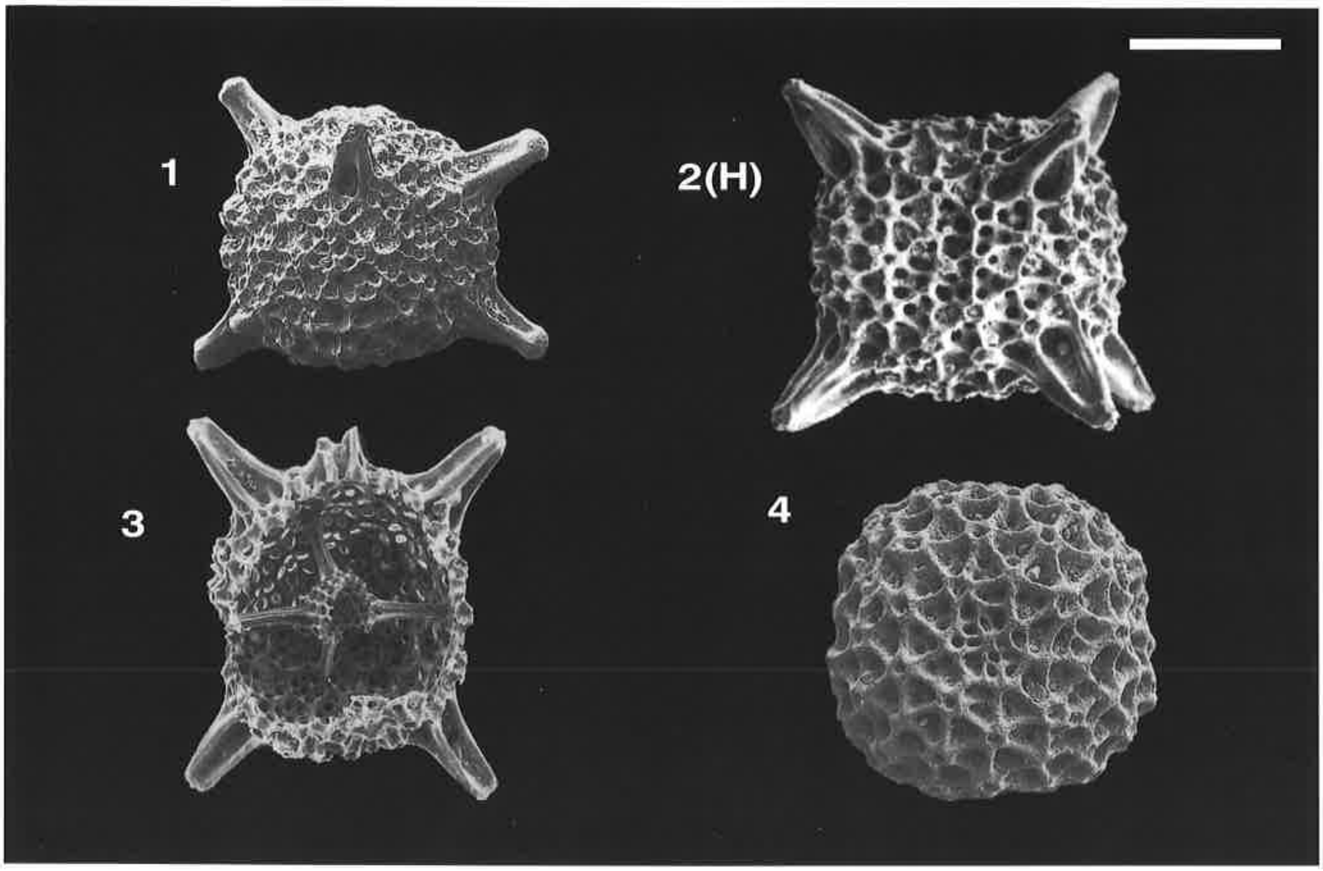


Plate 3244. ***Leugeo hexacubicus*** **(BAUMGARTNER).** Magnification x200. **Fig. 1.** POB81/2456, 534.125.5.40. **Fig. 2(H).** POB81/9154, 76.534A.125.5.111. **Fig. 3.** POB81/9153, 76.534A.125.5.111. **Fig. 4.** POB81/2451, 534A.125.3.60.

levium >> *SAITOUM LEVIUM*	*3024*

levium >> *SAITOUM LEVIUM AFF.*	*3026*

lilyae >> *PSEUDODICTYOMITRA LILYAE*	*5625*

limatum >> *SYRINGOCAPSA LIMATUM*	*5426*

LINARESIA 3811

Genus: *Linaresia* EL KADIRI

Synonymy.-
Linaresia EL KADIRI
EL KADIRI 1992, p. 42.

Type Species.- *Linaresia beniderkoulensis* EL KADIRI 1992.

Original Definition.- "Test conical globose, bearing a cephalic horn, lined by regular, fine and parallel costae. One out of two or three costae is prominent and delimits one or two rows of rectangular or circular pore frames. The distal aperture remains large after a slight constriction of test."

Original Remarks.- "The genus *Linaresia* nov. gen. bears the general characters of the Hsuidae PESSAGNO & WHALEN 1982. It differs from all other genera assigned to this family by its particularly globular test. The genus *Linaresia* nov. gen. is close to other nassellarians, but presents clear differences, as follows:

As the genera *Thanarla* PESSAGNO and *Archaeodictyomitra* PESSAGNO it presents longitudinal continuous costae but diffres from these genera by its globular rather than lanceolate shape, by the presence of a cephalic horn and by generally more than one row of pores between costae.

As the genera *Protunuma* ICHIKAWA & YAO and *Unuma* ICHIKAWA & YAO, its test is globose and bears longitudinal costae and a cephalic horn. However, it differs from the latter genera by much finer and more numerous costae and the lack of a distal appendage."

Etymology.- This genus is dedicated to Asuncion Linares-Rodriguez (University of Granada) in honour of her half-century long work, base of our knowledge of the Jurassic of the Betic Cordillera.

Included Taxa.-
3813 *Linaresia beniderkoulensis* EL KADIRI
3074 *Linaresia chrafatensis* EL KADIRI
2022 *Linaresia rifensis* EL KADIRI

LINARESIA BENIDERKOULENSIS 3813

Linaresia beniderkoulensis EL KADIRI

Synonymy.-
Linaresia beniderkoulensis EL KADIRI
EL KADIRI 1992, p. 44, pl. 1, figs. 5, 9, 10.
PESSAGNO et al. 1993, p. 137, pl. 6, figs. 6, 18, 27; pl. 8, fig. 6.

Original Definition.- "Test conical globose costate, without external segmental constrictions. The number of segments is externally undeterminable. Test is subivided into a reduced proximal conical and distal globose portion representing almost entire size of the test.

The proximal portion is pointed and smooth. Except for its base which is perforate and costulate, it could represent an apical horn (the base of the conical part would correspond to the cephalis).

The distal portion presents numerous continuous costae (about 14 costae visible in lateral view). Some costae are only developed on a part of the length of the test. Generally, the costae are regularly spaced. Three, two, or only one row of circular to square pores are arranged between costae. Pore frames are square because of the perpendicular crossing of external longitudinal and internal transverse costae. These two structures give a reticulate aspect to the outer test surface. Distally, the globose portion narrows slightly and terminates in a rather large aperture".

Etymology.- Oued Béni-Derkoul, type locality of the species.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.
Height of test:	320	330
Width of test:	220	240
Height of horn:	64	40

Type Locality.- Eastern slope of Oued Béni-Derkoul, road side, 30 km East of Chaouene.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

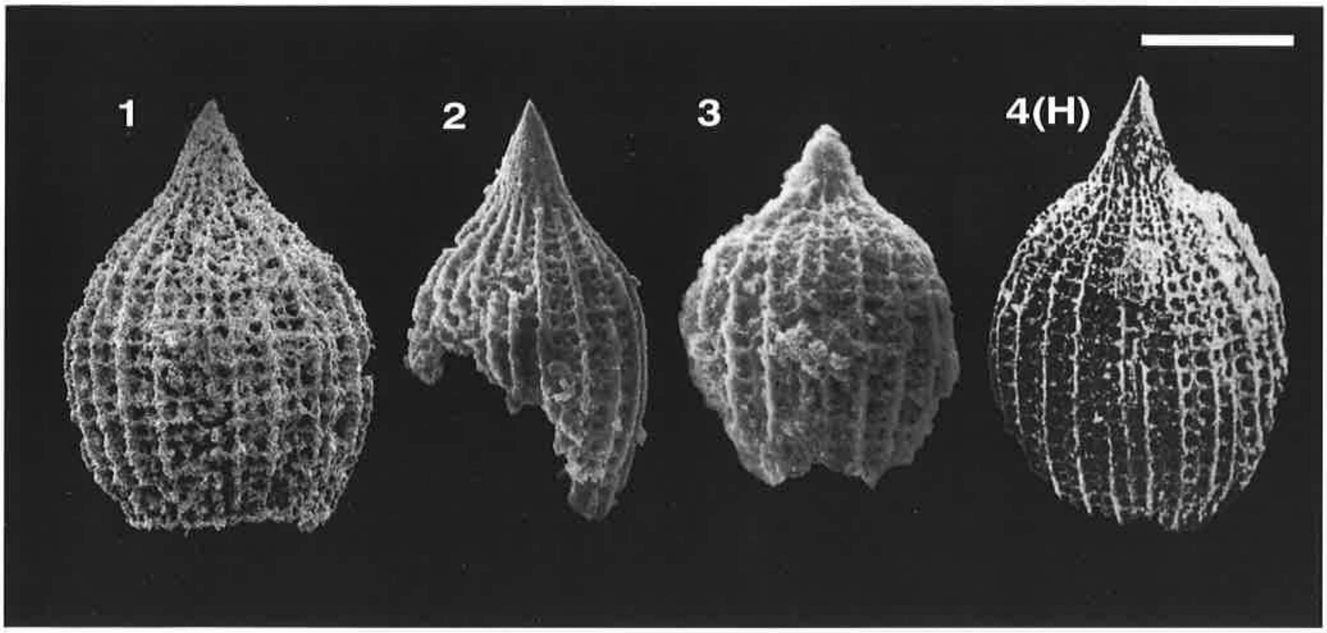


Plate 3813. ***Linaresia beniderkoulensis*** **EL KADIRI.** Magnification x200. **Fig. 1.** AB1015, TM105. 50-b11. **Fig. 2.** GO890139, ZB28. **Fig. 3.** GO 890101, GL 6. **Fig.4(H).** EL KADIRI 1992, pl. 1, fig. 9.

LINARESIA CHRAFATENSIS 3074

Linaresia chrafatensis EL KADIRI

Synonymy.-
Eucyrtid gen et sp. indet.
BAUMGARTNER 1984, p. 763, pl. 3, figs. 13-16.
BAUMGARTNER 1985, fig. 37.n.
GORICAN 1987, p. 182, pl. 2, fig. 9.
Hsuum ? sp. A
EL KADIRI 1984, p. 144, pl. 10, fig. 9; pl. 11, figs. 1, 4, 9, 10.
Canutus sp.
DE WEVER et al. 1985, pl. 1, figs. 9-11.
Hsuum sp. A
TAKEMURA 1986, p. 50, pl. 5, fig. 22.
DANELIAN 1989, p. 161, pl. 5, figs. 14-16.
Linaresia chrafatensis EL KADIRI
EL KADIRI 1992, p. 44, pl. 1, figs. 6-8, 14.

Original Definition.- "Test composed of a slender proximal and a globose distal portion. Proximal conical portion is pointed poreless in the upper half, which corresponds to the cephalic horn. In its lower half it is costate (about 9 costae appear in lateral view), perforate and segmented. Segments are probably respresenting the cephalis, thorax and abdomen. The globose portion results from a gradual to sudden broadening of the test at the base of the conical portion. If the broadening is sudden, the proximal portion reaches its maximal width in its middle part, while a more gradual broadening globose portion is preceeded by a conical proximal portion. The external surface of the test shows 10 to 15 continuous costae in lateral view, which may be irregulary spaced on some specimens. Between costae, three, two or one single longitudinal row of small circular pores are arranged with square or elliptical pore frames"

Original Remarks.- "This species is related to *Linaresia beniderkoulensis* nov. sp. by its general shape. It differs from the latter by its longer cephalic horn and its proximal segments included in the conical rather than the globose portion".

Etymology.- Named after the units of Klippes of Chrafate, containing the type locality and including the most developed radiolarites of the Rif.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.
Height of test:	330	361
Width of test:	168	100
Height of horn:	90	191

Type Locality.- Eastern slope of Oued Béni-Derkoul, road side, 30 km East of Chaouene.

UAZones.- 2-7, late Aal. to late Bath.-early Call.

LINARESIA RIFENSIS 2022

Linaresia rifensis (EL KADIRI)

Synonymy.-
Ogivus rifensis EL KADIRI
EL KADIRI 1992, p. 47, pl. 2, figs. 1, 5, 7.

Original Definition.- "Test with elongated conical proximal and globose distal portion (1/3 of test). Slight intersegmental constrictions allow to recognise the first 3 segments (cephalis, thorax, abdomen). Test bears a massive smooth, pointed cephalic horn. The totality of test is covered by fine longitudinal costae, of which about 30 are visible at the height of the largest width. Costae remain fine and uniform on proximal portion. Some thicken on distal globose portion and delimit square pore frames with 2-3 vertical rows of pores. Test treminates with a slight constriction and a large aperture."

Remarks.- In the original description no comparison is made with *L. chrafatensis*, to which this species is very close. It differs from the former by a proportionally shorter globose portion, a slighter distal constriction, and a larger aperture.

Etymology.- Named after the Rif, the southern portion of the Gibraltar arc, where radiolarites crop out both in the internal an external zones.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.
Height of test:	416	360
Width of test:	280	183
Height of horn:	83	25

Type Locality.- Oued El halka, 5 km SSW of Tétouan, base of red and green radiolarite, middle or base of upper Toarcian (age after El Kadiri, 1992).

UAZones.- 2-3, late Aal. to early-mid Baj.

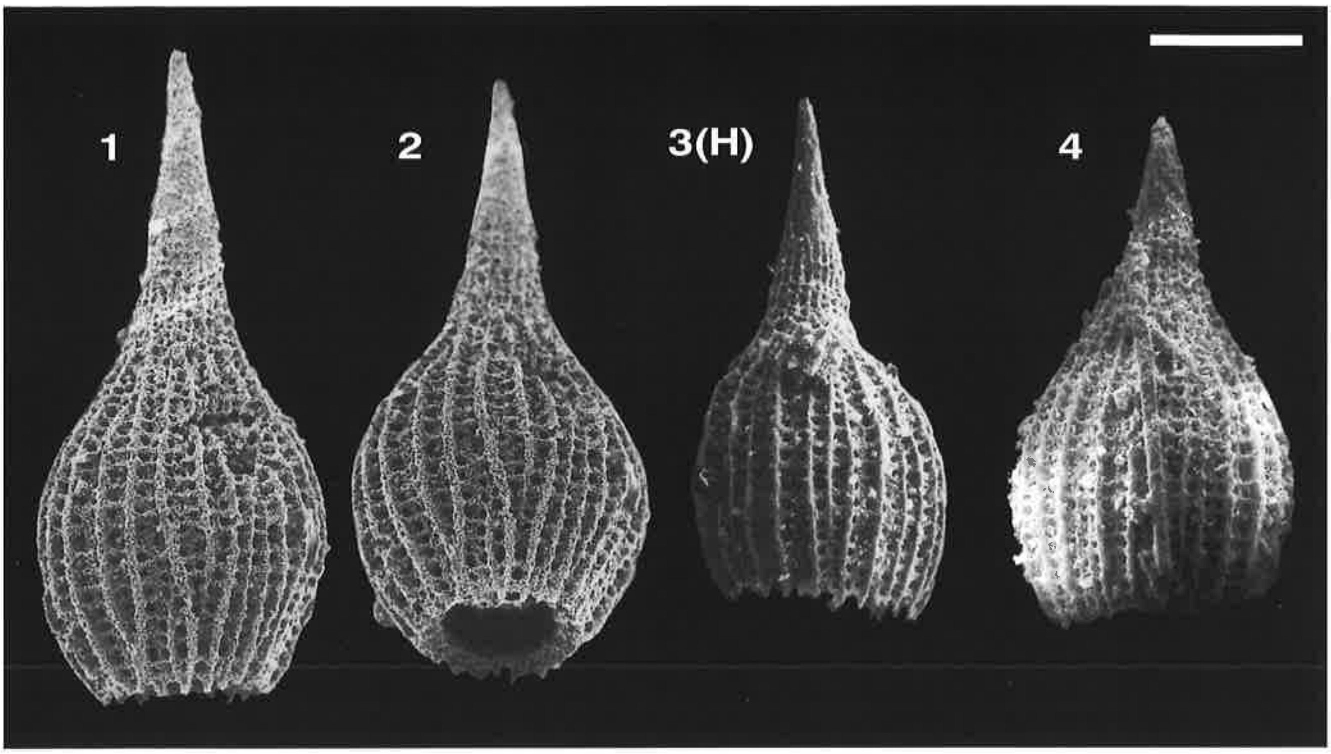


Plate 3074. *Linaresia chrafatensis* EL KADIRI. Magnification x200. **Fig. 1.** POB81/2960, POB1341. **Fig. 2.** POB81/2961, POB1341. **Fig. 3(H).** DW8222-12, A191. **Fig. 4.** DW8226-04, A177.

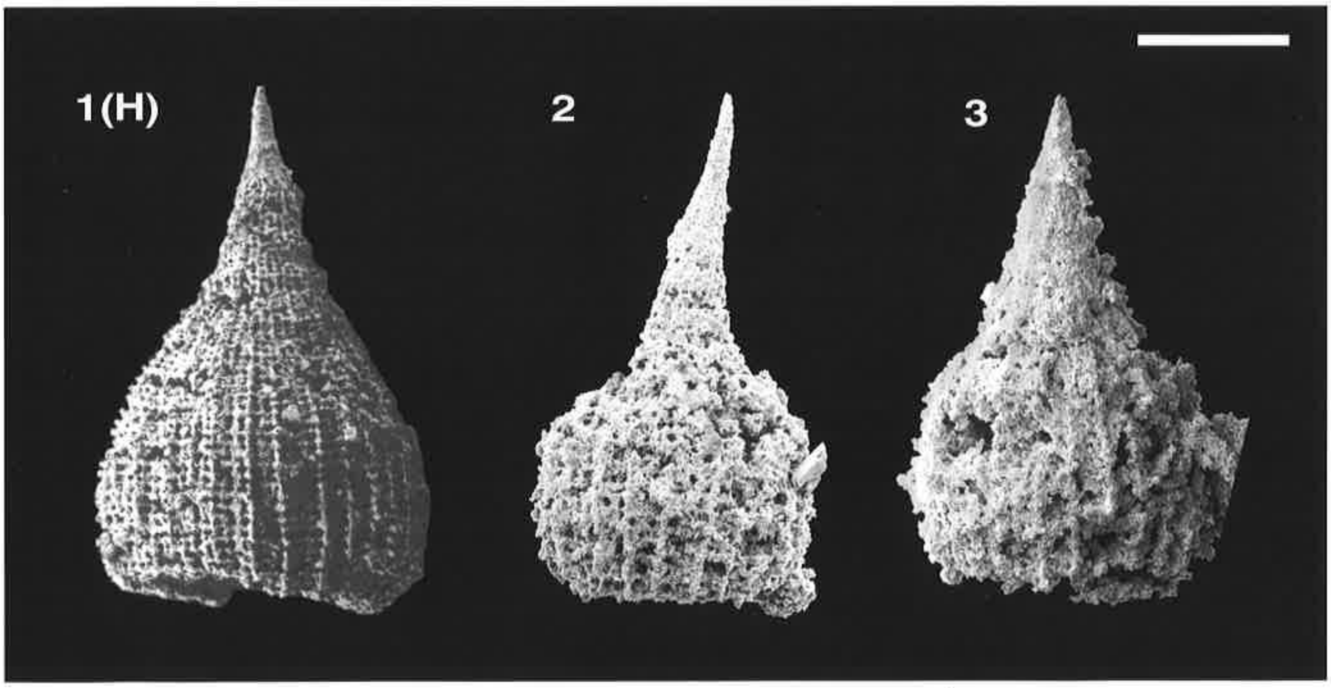


Plate 2022. *Linaresia rifensis* (EL KADIRI). Magnification x150. **Fig. 1(H).** EL KADIRI 1992, pl. 2, fig. 5. **Fig. 2.** AB1026, TM105.50.b16. **Fig. 3.** AB 6516, TM90.32.b34.

lineatum >> *HALESIUM (?) LINEATUM* 5243

lipmanae >> *CRUCELLA LIPMANAE* 5628

LITHATRACTUS 6009

Genus: *Lithatractus* HAECKEL

Synonymy.-
Lithatractus HAECKEL
HAECKEL 1887, p. 319.

Type Species.- *Stylosphaera fragilis* HAECKEL 1887.

Original Definition.- "Druppulida with simple ellipsoidal cortical shell and simple medullary shell, with two large opposite polar spines in the main axis of equal size and similar form."

Original Remarks.- "The genus *Lithatractus*, rich in common and widely distributed species, begins the series of those Druppulida which are characterised by peculiar polar spines at both poles of the main axis. It repeats the formation of *Stylosphaera* and *Ellipsostylus,* and differs from the former in the ellipsoidal form of the cortical shell, from the latter in the possession of a medullary shell. Formerly all these forms were united in the one genus *Stylosphaera* (see above, p. 121)".

Included Taxa.-
5041 *Lithatractus* sp. aff. *L. pusillus* (CAMPBELL & CLARK)

LITHATRACTUS PUSILLUS AFF. 5041

Lithatractus sp. aff. *L. pusillus* (CAMPBELL & CLARK)

Synonymy.-
Stylosphaera (*Stylosphaerella*) *pusilla* CAMPBELL & CLARK
CAMPBELL & CLARK 1944, p. 5, pl. 1, figs. 2, 4-5.
? *Sphaerostylus* (*Sphaerostylantha*) *hastatus* CAMPBELL & CLARK
CAMPBELL & CLARK 1944, p. 5, pl. 1. fig. 1.
? *Stylosphaera pusilla* CAMPBELL & CLARK.
RENZ 1974, p. 798, pl. 9, fig. 20, not pl. 2, figs. 17-18.
? *Ellipsoxiphus pusilla* (CAMPBELL).
FOREMAN 1978, p. 743, pl. 2, figs. 9, 10, 17.
? *Praestylosphaera hastata* (CAMPBELL & CLARK)
EMPSON-MORIN 1981, p. 261, pl. 4, figs. 4, 5a-c.
? *Lithatractus pusillus* (CAMPBELL & CLARK)
TAKETANI 1982a, p. 48, pl. 1, figs. 8a-b; pl. 9, fig. 5.
TAKETANI 1982b, pl. 2, fig. 6.
IWATA & TAJIKA 1989, pl. 3, fig. 3.
Lithatractus sp. aff. *L. pusillus* (CAMPBELL & CLARK)
JUD 1994, p. 82, pl. 12, figs. 9-10.

Definition.- (JUD, 1994) Spherical to slightly ellipsoidal test with two opposite spines. Test with regular, wide hexagonal pore frames with very small spines at vertices. Spines of generally unequal length, conical, unbladed and pointed. Base of spines wide conical, formed by prolonged pore bars.

Remarks.- (JUD, 1994) Specimens occurring in our material differ from *Lithatractus pusillus* (CAMPBELL & CLARK) by having conical, unbladed spines and a cortical shell with very large, hexagonal pore frames. Because of poor preservation possible internal shell(s) could not be observed. Three specimens measured had the following dimensions: total length of test (in μm) 279-360, length of the longer spine 95-117, of the shorter spine 51-100 and a diameter of the sphere 123-143.

UAZones.- 14-22, early-early late Berr. to late Barr.-early Apt.

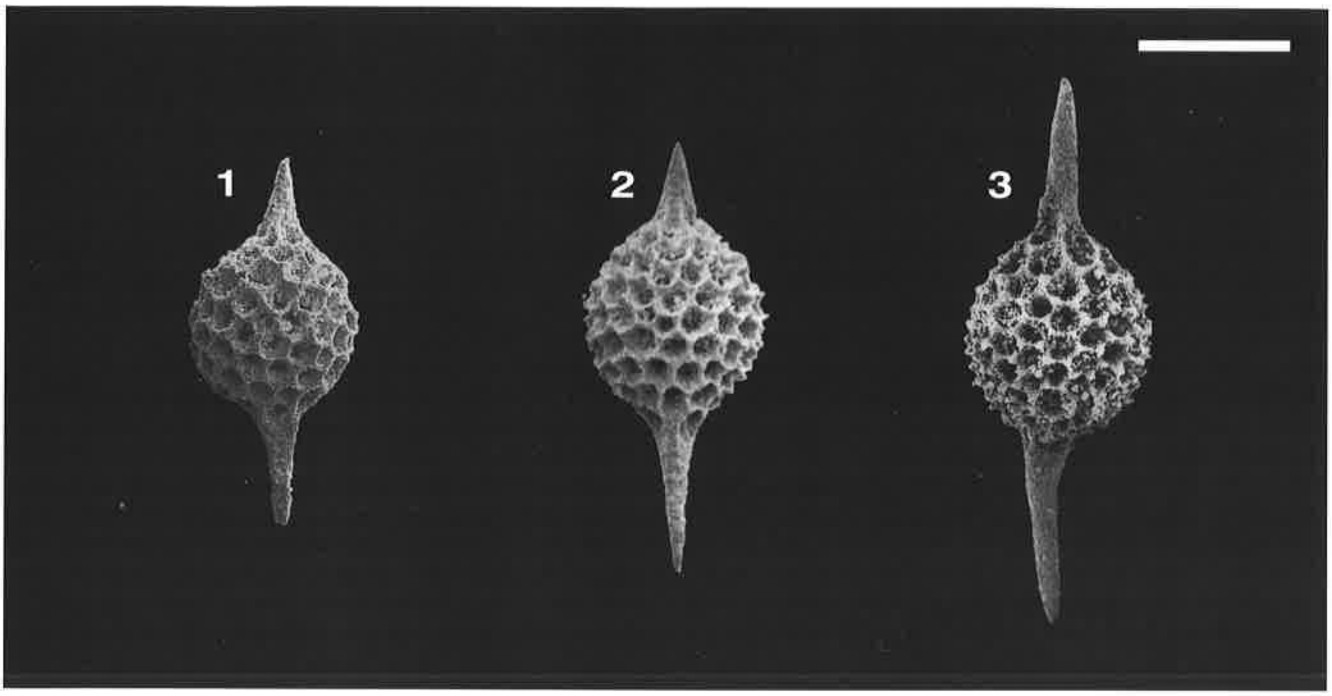


Plate 5041. *Lithatractus* sp. aff. *L. pusillus* (CAMPBELL & CLARK). Magnification x200. **Fig. 1.** RJ173, Pr225.3. **Fig. 2.** RJ24, Pr225.3. **Fig. 3.** RJ142, Br141.55.

lombardensis* >> *EMILUVIA LOMBARDENSIS		***3253***

longa* >> *PARVICINGULA LONGA		***5578***

longipes* >> *ARCHAEOHAGIASTRUM LONGIPES		***3149***

longitubus* >> *SYRINGOCAPSA LONGITUBUS		***5410***

lospensis* >> *NAPORA LOSPENSIS		***3036***

luciae* >> *TRIACTOMA LUCIAE		***5055***

lucifer* >> *OBESACAPSULA LUCIFER		***3283***

luminosum* >> *CYCLASTRUM (?) LUMINOSUM		***5266***

macroxiphus* >> *STYLOSPHAERA (?) MACROXIPHUS		***5044***

magna* >> *PARVIVACCA MAGNA		***3288***

magnum* >> *PARAHSUUM (?) MAGNUM		***3072***

magnus* >> *XITUS MAGNUS		***3259***

MILAX 3805

Genus: *Milax* BLOME

Synonymy.-
Milax BLOME
BLOME 1984b, p. 372.

Type Species.- *Milax alienus* BLOME 1984b.

Original Definition.- Test multicyrtid, conical to subconical, consisting of five to seven chambers. Cephalis and thorax trapezoidal to subtrapezoidal in outline, with or without a cephalic horn. Cephalis imperforate, thorax sparsely perforate, normally buried beneath a layer of accreted microgranular silica. Abdomen and postabdominal chambers (two to four), consisting of a single layer of varied-sized polygonal pore frames with highly angular nodes at the vertices, nodes varying in relief; pore frames becoming larger distally. Final postabdominal chamber inflated, possessing large, pentagonal to hexagonal pore frames with spines of varying length at the pore frames vertices. Abdomen and postabdominal chambers increasing in height and more abruptly in width as added. Chambers poorly constricted.

Original Remarks.- *Milax* differs from *Canesium* BLOME 1984b and *Sethocapsa* HAECKEL 1881 by having a greater number of postabdominal chambers (2-4 vs. 1) and narrower postabdominal chambers which increase less abruptly in width. *Milax* additionally differs from *Canesium* by having a porous thorax and abdomen and a closed final postabdominal chamber with spines at the pore frame vertices.

Etymology.- *Milax* (m.) is a name formed by an arbitrary combination of letters.

Included Taxa .-
5453 *Milax adrianae* JUD

MILAX ADRIANAE 5453

Milax adrianae JUD

Synonymy.-
Podocapsa cf. *guembeli* RÜST
KATO & IWATA 1989, pl. 5, fig. 10.
Milax adrianae JUD
JUD 1994, p. 83, pl. 12, fig. 11.

Original Definition.- Test subconical, consisting of 5 segments. Proximal portion of test slender, conical with a cephalis bearing a short horn. Segments straight to convex in outline with small, irregularly disposed pores and separated from one another by well-marked constrictions. Distal portion consisting of a large, spherical postabdominal segment with 10-15 long, slender, widely spaced bladed spines. Pores of this segment large, with pentagonal to hexagonal pore frames.

Original Remarks.- *Milax adrianae* n.sp. is well distinguished from the other species of the genus *Milax* BLOME and from other species at present included in *Sethocapsa* HAECKEL by the perfectly round terminal segment with long slender spines, and by the long, slender proximal part. Specimens resembling the holotype are frequent in the lower part of the range of the species. At higher levels the terminal segment becomes subspherical and between it and the conical proximal portion a rather deep constriction develops.

Etymology.- This species is dedicated to Adriana Delaloye, librarian at the Institute of Geology and Paleontology at University of Lausanne honouring her friendship and help.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min	max.
Total height of test:	219	221	210	244
Height of proximal part:	95	99	90	110
Width termimal segment:	121	134	112	162

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-20, latest Tith. to late Haut.

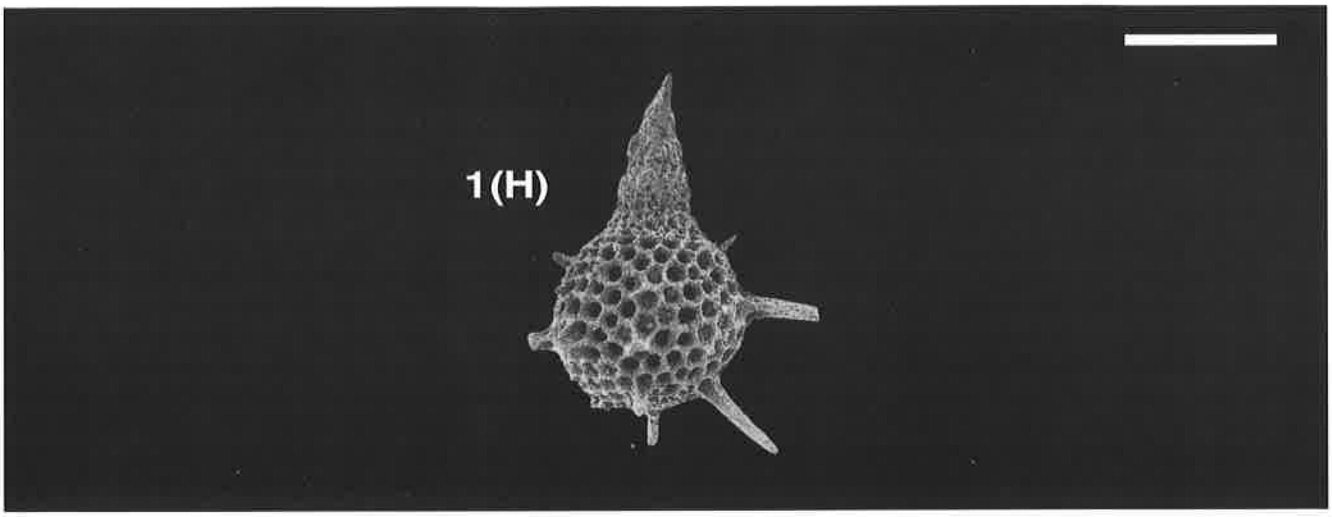


Plate 5453. ***Milax adrianae*** **JUD.** Magnification x200. **Fig. 1(H).** RJ108, Br28.85.

milloti >> *KATROMA MILLOTI*	*5436*

minoensis >> *ARCHAEODICTYOMITRA MINOENSIS*	*3305*

minor >> *ACANTHOCIRCUS SUBOBLONGUS MINOR*	*3085*

minor >> *MIRIFUSUS DIANAE MINOR*	*3286*

mirabilis >> *ARCHAEODICTYOMITRA (?) MIRABILIS*	*3236*

mirabundum >> *HSUUM MIRABUNDUM CF.*	*2006*

MIRIFUSUS 3658

Genus: *Mirifusus* PESSAGNO, emend. BAUMGARTNER

Synonymy.-
Mirifusus PESSAGNO
PESSAGNO 1977a, p. 83.
BAUMGARTNER 1984, p. 769.

Type Species.- *Mirifusus guadalupensis* PESSAGNO 1977a.

Original Definition.- Test spindle-shaped, divided into three parts on the basis of symmetry: (1) a proximal elongate, conical portion which includes the cephalis, thorax, abdomen, and several postabdominal chambers; (2) a highly inflated central portion which includes all but final several postabdominal chambers; and (3) a distal cylindrical portion which includes the last several postabdominal chambers. Cephalis broadly conical, slightly perforate, lacking discrete pore frames and lacking a horn. Thorax slightly perforate, trapezoidal externally, subtrapezoidal internally. Abdomen and all postabdominal chambers perforate and trapezoidal except for final one or two postabdominal chambers, which are cylindrical. Postabdominal chambers increasing little in height; width variable depending on whether position is distal, medial, or proximal. Test wall consisting of two or three layers of polygonal pore frames (pl. 10, figs. 6-8).

Actualized Definition.- (BAUMGARTNER, 1984) General shape of test as given by Pessagno (1977a). Proportions and shape of conical proximal and inflated median portion of test may vary intraspecifically and are often distorted by diagenetic flattening of the large test. Test wall consisting of two layers: Inner layer formed by regular circular to triangular pore frames with two to five transverse rows of pores per segment. Outer layer consisting of regular to irregular diagonal or vertical bars extending over each segment and joining at nodes on circumferential ridges. Outer layer may be variably developed: Early forms may have a poorly developed outer layer on the median portion, whereas later forms tend to have a strongly developed outer layer which may coalesce on the conical proximal portion of test. Late species may show spines extending from nodes and cephalis. The genus is emended to include *Lithocampe chenodes* RENZ and early forms like *M. fragilis* n.sp.

Etymology.- This species was named from the Latin adjective *mirus*, meaning peculiar, extraordinary, astonishing plus the Latin noun *fusus*, meaning spindle.

Included Taxa.-
5716 *Mirifusus appenninicus* JUD
3162 *Mirifusus chenodes* (RENZ)
3161 *Mirifusus dianae* s.l. (KARRER)
3406 *Mirifusus dianae baileyi* PESSAGNO
3274 *Mirifusus dianae dianae* (KARRER)
3286 *Mirifusus dianae minor* BAUMGARTNER
3159 *Mirifusus fragilis* s.l. BAUMGARTNER
2026 *Mirifusus fragilis praeguadalupensis* n.ssp. BAUMGARTNER & BARTOLINI
3160 *Mirifusus guadalupensis* PESSAGNO
5721 *Mirifusus odoghertyi* JUD
5703 *Mirifusus petzholdti* (RÜST)
3158 *Mirifusus proavus* TONIELLI

MIRIFUSUS APENNINICUS 5716

Mirifusus apenninicus JUD

Synonymy.-
Dictyomitra (?) sp.
FOREMAN, 1973b, pl. 9, fig. 6.
Parvicingula boesii (PARONA)
? TUMANDA 1989, p. 38, pl. 4, fig. 2.
Mirifusus apenninicus JUD
JUD 1994, p. 83, pl. 12, figs. 12-15.

Original Definition.- Subglobular broad test consisting of 12-15 segments terminating, if well preserved, with a wide open tube. Apical part short, conical. Cephalis poreless, with a short conical spine. Postcephalic segments increasing rapidly in width to the 8-9th segment, then decreasing, the last segment terminating with a short, wide open tube. Postcephalic segments with nodose circumferential ridges, corresponding to internal partition. Nodes interconnected by longitudinal to oblique bars, forming external layer of triangular, suboval or irregular meshes. Internal layer of 3 rows of alternate pores, which are generally covered completely by the external layer. Tube short, broad, subconical to almost cylindrical, with longitudinally or irregularly developed ridges forming an irregular network with small pores.

Original Remarks.- *Mirifusus apenninicus* n.sp. differs essentially from all the other species of the genus *Mirifusus* PESSAGNO by its subglobular shape, the very short apical portion, by its robust and generally extremely irregular external layer, and by its commonly smaller size.

Etymology.- Named after the Apennines, Italy, where its type locality is situated.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min	max.
Total height of test:	219	221	210	244
Height of proximal part:	95	99	90	110
Width terminal segment:	121	134	112	162

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 14-21, early-early late Berr. to early Barr.

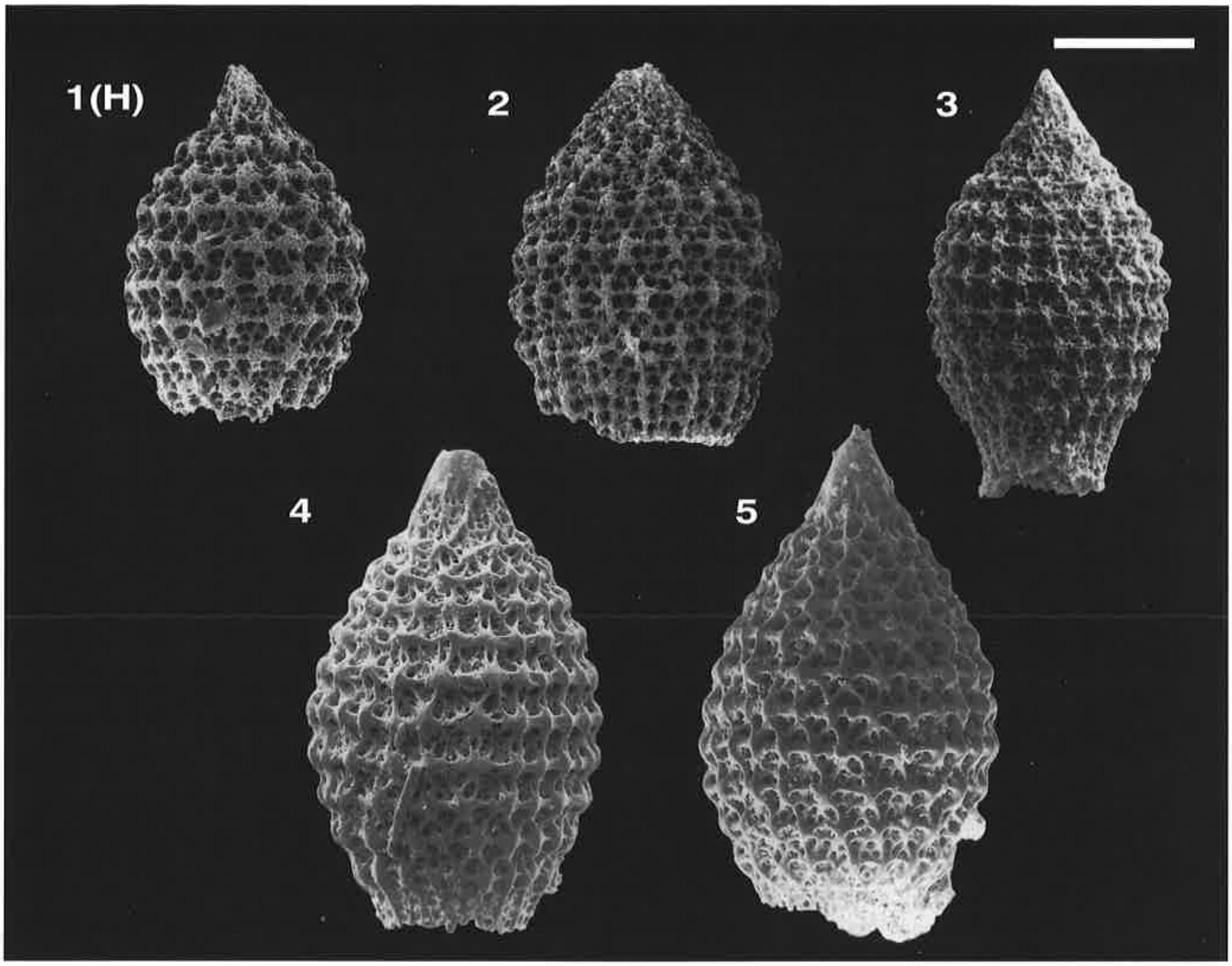


Plate 5716. *Mirifusus apenninicus* JUD. Magnification x200. **Fig. 1(H).** RJ49, Bo449.5. **Fig. 2.** RJ 468, Br28.85. **Fig. 3.** RJ1606, Ru135.50. **Fig. 5.** DU543, Mo46. **Fig. 4.** DU377, Mo46.

MIRIFUSUS CHENODES 3162

Mirifusus chenodes (RENZ)

Synonymy.-
Lithocampe chenodes RENZ
RENZ 1974, p. 793, pl. 7, fig. 30; pl. 12, figs. 14a-d.
RIEDEL & SANFILIPPO 1974, p. 779, pl. 6, figs. 5-7; pl. 13, fig. 1.
SCHAAF 1981, p. 435, pl. 5, fig. 2; pl. 25, figs. 5a-b, 7.
KOCHER 1981, p. 74, pl. 14, fig. 17.
AITA & OKADA 1986, pl. 2, fig. 12.
KATO & IWATA 1989, pl. 1, fig. 3.
Mirifusus chenodes (RENZ)
BAUMGARTNER 1984, p. 770, pl. 5, figs. 9, 15.
SCHAAF 1984, p. 98-99, figs. 3a-b, 4a-b.
? DE WEVER & MICONNET 1985, p. 387, pl. 5, figs. 1-2.
DE WEVER et al. 1986, pl. 9, fig. 8.
PAVSIC & GORICAN 1987, p. 25, pl. 4, fig. 6.
OZVOLDOVA 1988, pl. 6, fig. 6.
TUMANDA 1989, p. 38, pl. 1, fig. 15.
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 3.
BAUMGARTNER 1992, p. 321, pl. 7, figs. 6-7.
MATSUOKA 1992, pl. 1, fig. 6.
TAKETANI & KANIE 1992, figs. 4.1-2.
JUD 1994, p. 84, pl. 12, fig. 16; pl. 13, fig. 1.

Original Definition.- Cephalis spherical with large thick offset apical spine or stout corona-shaped spine; thorax and upper abdominal segments cylindrical numbering six to eight; lower abdominal segments becoming broader and forming a bulbous section which tapers toward the end; total number of segments 14-18; numerous stout spines protrude from this section; pores small, rounded and close set between which very irregular interstitial network of ridges can be seen.

Original Remarks.- This species differs from *L. mediodilatatus* RÜST 1885, as described by Moore 1973, in the characteristics of the apical spine and abdominal spines; the greater number of segments; generally small size and proportions; and in the very characteristic irregular network of ridges.

Remarks.- For biostratigraphic data two different morphotypes have been taken into account: (a) larger forms with a total length, without distal tube, of 338-413 μm and a maximum width of 194-250 μm, and (b) smaller forms with a total length of 290-333 μm and a width of 145-150 μm. The latter are smaller than those measured by Renz (1974). At the moment both forms have been included with *Mirifusus chenodes*. Specimens bearing an apical horn were rarely observed and those with stout corona-shaped spines, as in the type locality, where never found.

Etymology.- The specific name is Greek for goose-like.

Measurements (in μm).-
Based on 3 specimens. Total height 327-372. Maximum width 150-180; Apical spine 33-54. Abdominal spines 45-67.

Type Locality.- DSDP Leg 27, Site 261, eastern Indian Ocean.

UAZones.- 6-22, mid Bath. to late Barr.-early Apt.

MIRIFUSUS DIANAE S.L. 3161

Mirifusus dianae s.l. (KARRER)

Synonymy.-
Lagena dianae KARRER
KARRER 1867, p. 365, pl. 3, figs. 8a-b.
Lithocampe mediodilatata RÜST
RÜST 1885, p. 316, pl. 40 (15), fig. 9.
Mirifusus dianae (KARRER)
DUMITRICA & DE WEVER 1991, p. 553-557, figs. 1, 2a-b.
See also subspecies

Included Taxa.-
3406 *Mirifusus dianae baileyi* PESSAGNO
3274 *Mirifusus dianae dianae* (KARRER)
3286 *Mirifusus dianae minor* BAUMGARTNER

UAZones.- 7-20, late Bath.-early Call. to late Haut.

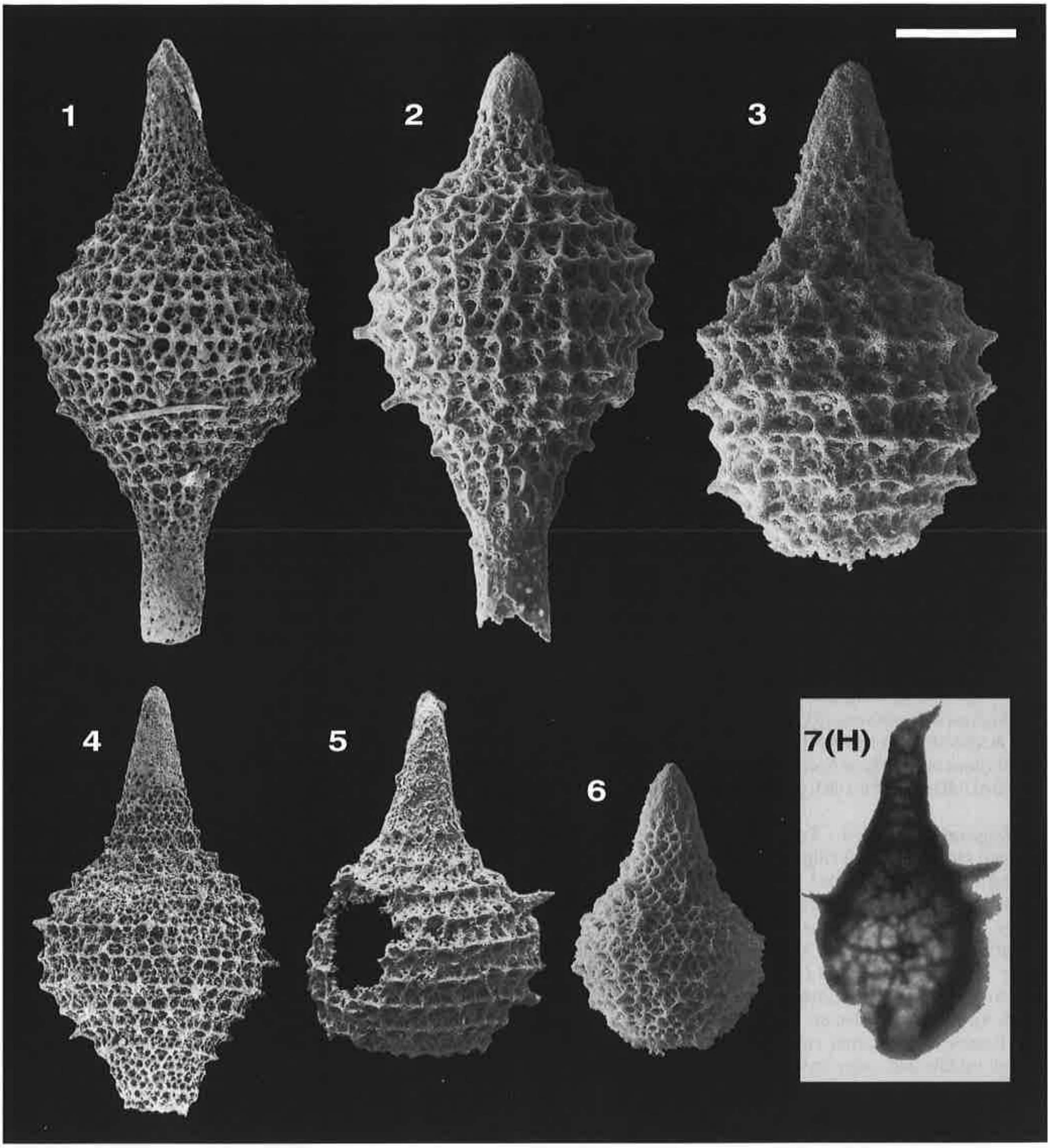


Plate 3162. *Mirifusus chenodes* (RENZ). Magnification x200. **Fig. 1.** RJ536, Bo566.5. **Fig. 2.** DU1291, V40. **Fig. 3.** DU1913, R102. **Fig. 4.** RJ302, Br28.85. **Fig. 5.** POB79/1642, POB79.3. **Fig. 6.** DU3029, PJ10. **Fig. 7(H).** RENZ 1974, pl. 12, fig. 14c.

MIRIFUSUS DIANAE BAILEYI — 3406

Mirifusus dianae baileyi PESSAGNO

***Synonymy*.-**
Lithocampe mediodilatata RÜST
? MOORE 1973, p. 828, pl. 2, figs. 5-6.
RIEDEL & SANFILIPPO 1974, p. 779, pl. 7, fig. 3, not figs. 1-2, 4.
Mirifusus baileyi PESSAGNO
PESSAGNO 1977a, p. 83, pl. 10, figs. 6-8; ? pl. 11, figs. 9-11.
PESSAGNO 1977b, p. 48, pl. 8, figs. 1, 26, ? figs. 8-9.
MIZUTANI 1981, p. 177, pl. 60, fig. 1.
ADACHI 1982, pl. 1, fig. 1.4.
OKAMURA & UTO 1982, pl. 7, fig. 3.
? ISHIDA 1983, pl. 5, figs. 7-8b.
PESSAGNO et al. 1984, p. 26, pl. 2, figs. 1-3, 10, 21-23, ? figs. 13, 17.
MATSUOKA & YAO 1985, pl. 2, fig. 2.
MATSUOKA & YAO 1986, pl. 2, fig. 18.
TUMANDA 1989, p. 38, pl. 1, fig. 14.
Mirifusus mediodilatatus (RÜST)
BAUMGARTNER et al. 1980, p. 56, pl. 5, fig. 11, not figs. 9-10.
YAO et al. 1982, pl. 4, fig. 30.
MURATA et al. 1982, pl. 1, figs. 11, 14.
AOKI & TASHIRO 1982, pl. 4, fig. 8.
YAO 1984, pl. 3, fig. 22.
Mirifusus mediodilatata (RÜST)
NAKASEKO & NISHIMURA 1981, p. 155, pl. 8, fig. 15.
Mirifusus mediodilatus baileyi (PESSAGNO)
BAUMGARTNER 1984, p. 772, pl. 5, figs. 13, 19.

***Original Definition*.-** Test as with genus. Meshwork between circumferential ridges of postabdominal chambers arranged in three distict layers : (1) an inner layer consisting of two rows of small, uniform hexagonal pore frames (plate 11, figures 9-11); (2) a middle layer comprised of two rows of massive triangular pore frames (plate 10, figures 6,8); and (3) an outer layer consisting of two rows of massive triangular pore frames (plate 10, figure 8). Massive nodes occurring at vertices of triangular pore frames where frames connect to circumferential ridges in both middle and outer layers. Tubular extension on final chamber lacking two outermost layers.

***Actualized Definition*.-** (BAUMGARTNER, 1984) Cephalis, thorax and abdomen and sometimes first postabdominal segments externally smooth, poreless or sparsely porous. Remaining postabdominal segments (5-7) of conical proximal portion of test with well developed outer layer of irregular vertical and diagonal bars joining at circumferential ridges in broad nodes; outer layer mostly obscuring inner layer of two rows of pores. Segments of inflated median portion of test with inner layer of two rows of alternating triangular pores per segment. Outer layer becoming regular triangular and congruent with inner layer at top of or in upper part of the inflated median portion of test. Circumferential ridges of outer layer broad, with flat outer surface interrupted by flat nodes at junction of diagonal bars. Distal cylindrical portion delicate, without circumferential ridges (without segments ?), with more or less regular transverse rows of pores.

***Original Remarks*.-** *Mirifusus baileyi* n.sp. bears little resemblance to *M.*(?) *mediodilatata* (RÜST). The latter species seems to possess a one-layered test with two rows of uniform, small hexagonal pore frames between the circumferential ridges bordering postabdominal chambers. Furthermore, the early portion of the test is considerably more elongate than that of *M. baileyi*. *M. baileyi* has been compared to *M. guadalupensis* under the latter species.

***Actualized Remarks*.-** (BAUMGARTNER, 1984) Instead of a three-layered structure as proposed by Pessagno (1977a) for *M. baileyi*, we can only observe a two-layered structure, where the outer layer becomes completely congruent with the inner layer on the median part of the test.

***Etymology*.-** This species is named for Dr. Edgar H. Bailey to honor his numerous contributions to a better understanding of Coast Range geology.

Measurements (in μm).-
Based on 4 specimens. Height cephalis: 20; height thorax 20 to 25; height abdomen: 1 to 35; height PA: 20 to 30. Test length: 500 to 660; test width (max.): 300 to 350.

***Type Locality*.-** Point Sal, Santa Barbara County, California.

***UAZones*.-** 9-11, mid-late Oxf. to late Kimm.-early Tith.

MIRIFUSUS DIANAE DIANAE — 3274

Mirifisus dianae dianae (KARRER)

***Synonymy*.-**
Lagena dianae KARRER
KARRER 1867, p. 365, pl. 3, figs. 8a-b.
Lithocampe mediodilatata RÜST
RÜST 1885, p. 316, pl. 40, fig. 9.
RIEDEL & SANFILIPPO 1974, p. 779, pl. 7, figs. 2, 4, ? fig. 1, not fig. 3.
? FOREMAN 1975, p. 616, pl. 2K, fig. 2; pl. 6, fig. 17.
? OZVOLDOVA 1979, p. 258, pl. 5, fig. 3.
Mirifusus (?) *mediodilatata* (RÜST)
PESSAGNO 1977a, p. 84, pl. 11, figs. 1-2.
Mirifusus mediodilatatus (RÜST)
BAUMGARTNER et al. 1980, p. 56, pl. 5, figs. 9-10, not fig. 11.
NISHIZONO et al. 1982, pl. 3, fig. 10.
PESSAGNO et al. 1984, p. 26, pl. 2, figs. 4, 5, 18, 19.
ISHIDA 1985, pl. 4, fig. 10.
AITA 1987, p. 65, pl. 12, fig. 7.

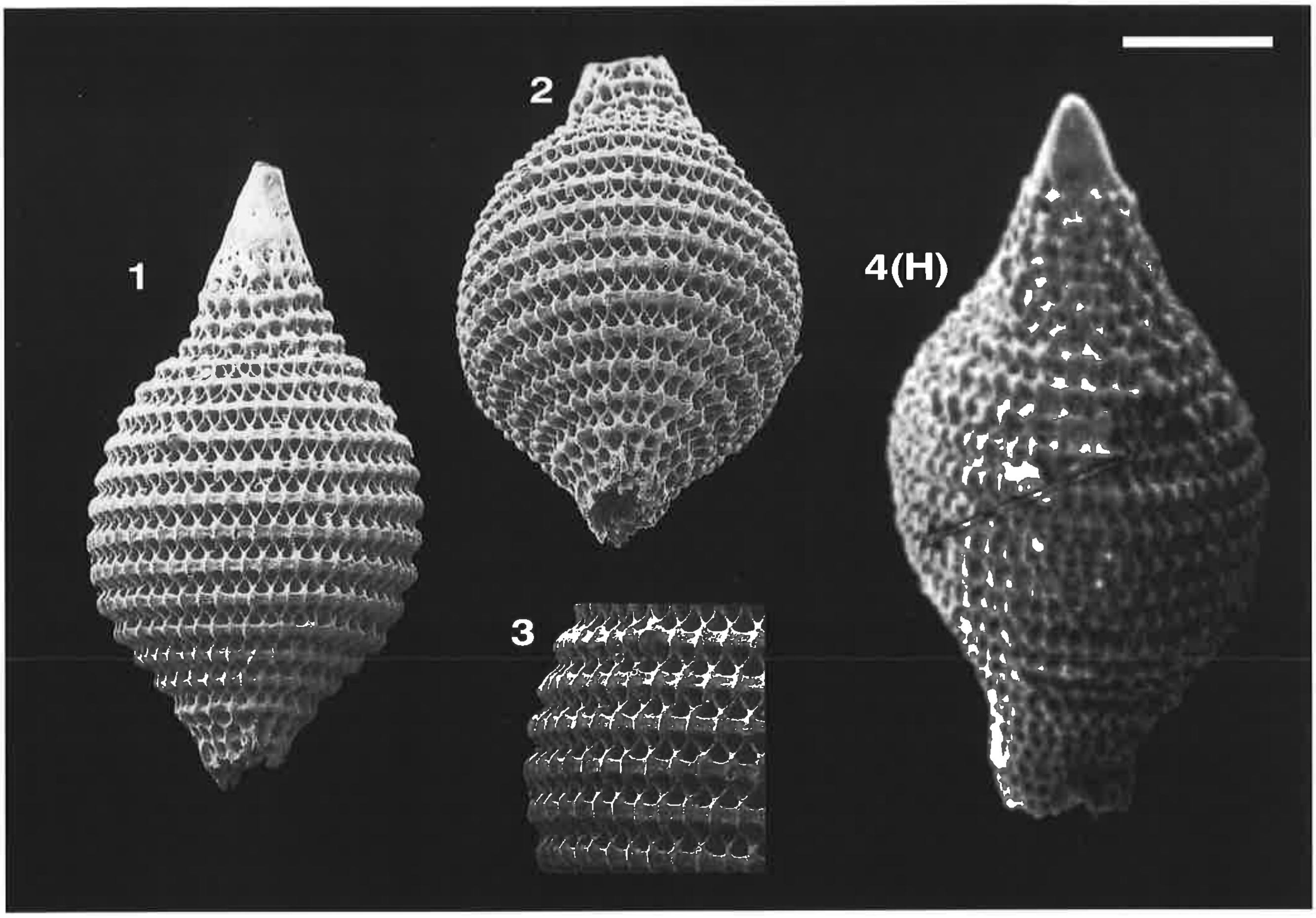


Plate 3406. *Mirifusus dianae baileyi* PESSAGNO. Magnification x150, except Fig. 3 x 275. **Fig. 1.** POB78/8183, POB986.52. **Fig. 2.** POB78/8182, POB986.52. **Fig. 3.** POB78/8184, POB986.52. **Fig. 4(H).** PESSAGNO 1977a, pl. 10, fig. 6.

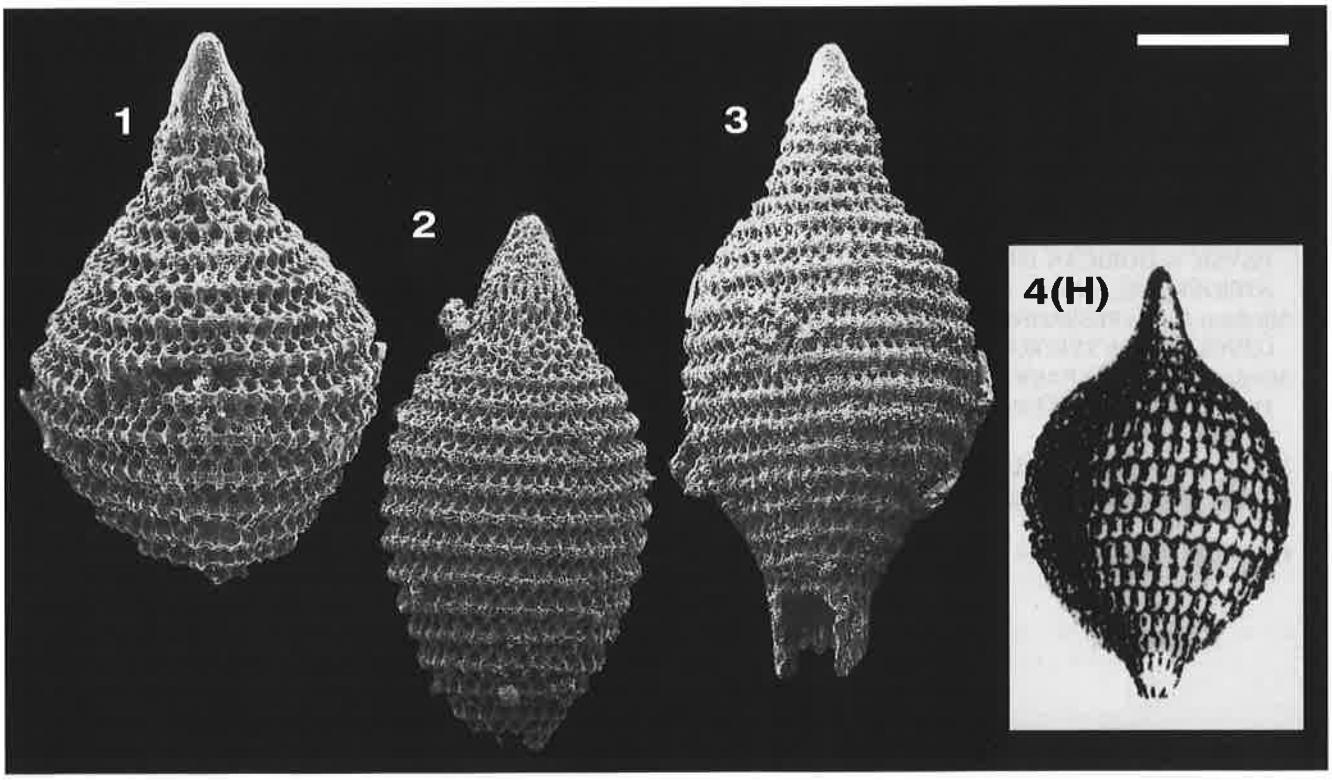


Plate 3274. *Mirifisus dianae dianae* (KARRER). Magnification x150. **Fig. 1.** POB78/3443, POB28.61. **Fig. 2.** POB79/5258, POB1205.3. **Fig. 3.** POB78/6269, POB899.53. **Fig. 4(H).** KARRER 1867, pl. 3, fig. 8a.

YAO 1991, pl. 4, fig. 20.
PESSAGNO et al. 1993, p. 142, pl. 7, fig. 13.
Mirifusus mediodilatus mediodilatatus (RÜST)
BAUMGARTNER 1984, p. 772, pl. 5, figs. 13, 19.
? DE WEVER et al. 1986, pl. 9, fig. 6.
OZVOLDOVA 1990, pl. 5, fig. 1.

Definition.- (RÜST, 1885) "Shell of 16-18 circular segments, which are in the central section so much inflated that the shell possesses a globose shape with two extensions. The form resembles the *Theosyringium*-species. Each segment possesses two rows of pores".

Actualized Remarks.- (BAUMGARTNER, 1984) This subspecies differs from *M. m. baileyi* in having two staggered rows of rounded triangular to circular pores per segment, relatively narrow, slightly nodose circumferential ridges and an outer layer which seems to terminate on upper median inflated portion of the test. There are intermediate forms between the two subspecies.

Measurements (in μm).-
Length 657, width in the central section 415.

Type Locality.- Oxfordian cherty limestones at St Veil near Vienna, Austria.

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

MIRIFUSUS DIANAE MINOR — *3286*

Mirifusus dianae minor BAUMGARTNER

Synonymy.-
Theoperid gen et sp. indet.
FOREMAN 1973b, pl. 12, fig. 2.
Lithocampe mediodilatata RÜST
MOORE 1973, p. 828, pl. 2, figs. 5-6.
RIEDEL & SANFILIPPO 1974, pl. 7, fig. 1.
FOREMAN 1975, p. 616, pl. 2K, fig. 2; pl. 6, fig. 17.
Mirifusus mediodilatatus (RÜST)
FOREMAN 1978, pl. 2, fig. 3.
KANIE et al. 1981, pl. 1, fig. 14.
SCHAAF 1984, p. 122-123, figs. 1-4.
AITA & OKADA 1986, pl. 2, fig. 1.
KITO 1987, pl. 3, fig. 12.
IGO et al. 1987, fig. 2.1.
KATO & IWATA 1989, pl. 1, fig. 1.
TUMANDA 1989, p. 38, pl. 1, fig. 14.
MATSUOKA 1992, pl. 1, fig. 5; pl. 2, fig. 5.
Mirifusus mediodilatatus (RÜST).
SANFILIPPO & RIEDEL 1985, fig. 10.2b only.
Mirifusus mediodilatatus minor BAUMGARTNER
BAUMGARTNER 1984, p. 772, pl. 5, figs. 11, 14.
DE WEVER et al. 1986, pl. 9, fig. 5.
PAVSIC & GORICAN 1987, p. 26, pl. 4, fig. 5.
STEIGER 1992, p. 65, pl. 18, figs. 3-4.
Mirifusus baileyi PESSAGNO
OZVOLDOVA & SYKORA 1984, p. 267, pl. 10, figs. 7, ? 3.
Mirifusus dianae (KARRER)
DUMITRICA & DE WEVER 1991, p. 553-557, figs. 1, 2a-b.
Mirifusus dianae minor BAUMGARTNER
JUD 1994, p. 84, pl. 13, fig. 2.

Original Definition.- Proximal conical portion composed of spherical cephalis, inflated thorax and abdomen and one to at most three postabdominal segments. Entire conical portion externally smooth, sparsely porous, or with irregular, vertically elongated slots formed by the coalescent outer layer. Transverse rows of pores and circumferential ridges delimiting segments appear at the base of the conical portion of test. Inflated median and conical distal portion of test identical as for *M. mediodilatatus baileyi.*

Original Remarks.- *M. m. minor* differs from *M. m. baileyi* as defined in this chapter by including only 4-6 segments in the proximal conical portion instead of 8-10. As a consequence, almost the entire conical portion is externally smooth. *M. m. minor* seems to evolve from *M. m. baileyi* during the Tithonian by a gradual decrease of the number of segments included in the conical portion (retardation). No forms assignable to *M. m. baileyi* have been found in the Neocomian.

Etymology.- *Minor* = younger (Latin), referring to its descendance from *M. m. baileyi.*

Measurements (in μm).-
Based on 7 specimens. Proximal conical portion: height 106-184, average 136, Holotype 138; width 89-156, average 133, Holotype 123. Number of segments: 4?-7?, average 6, Holotype 5?. Inflated median portion: height 319-444, average 385, Holotype 444; width 277-405, average 320, Holotype 356.

Type Locality.- Cava Rusconi, Cittiglio, Prov. Varese, Italy. Locality no. 23 of locality descriptions (Baumgartner, 1984).

UAZones.- 9-20, mid-late Oxf. to late Haut.

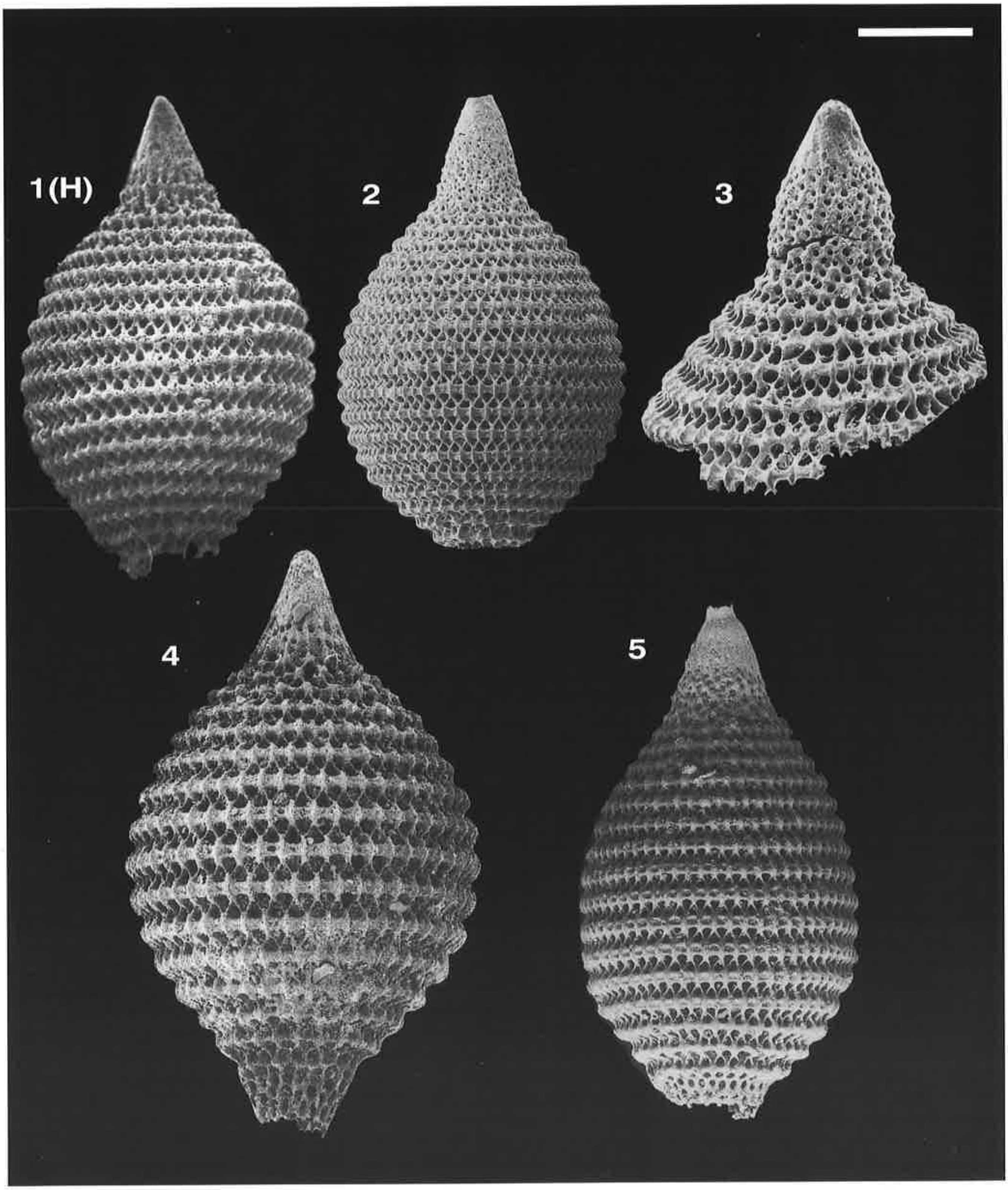


Plate 3286. ***Mirifusus dianae minor*** **BAUMGARTNER.** Magnification x150, except Fig. 3 x250. **Fig. 1(H).** POB79/5038, POB1205.1. **Fig. 2.** DU3573, V40. **Fig. 3.** POB80/2775, V-37. **Fig. 4.** RJ284, Br28.85. **Fig. 5.** DU1341, V40.

MIRIFUSUS FRAGILIS S.L. 3159

Mirifusus fragilis s.l. BAUMGARTNER

Synonymy.-
Mirifusus (?) sp. aff. *M.* (?) *mediodilatata* (RÜST)
? PESSAGNO 1977a, p. 84, pl. 11, fig. 3.
Mirifusus aff. *guadalupensis* PESSAGNO
YAO et al. 1982, pl. 4, fig. 24.
YAO 1983, fig. 3.8.
Mirifusus sp. A
? KIDO et al. 1982, pl. 3, figs 1-2, 4.
? AITA 1982, pl. 2, fig. 13.
Mirifusus fragilis BAUMGARTNER
BAUMGARTNER 1984, p. 770, pl. 5, figs. 12, 16-17, 20-21.
BAUMGARTNER 1985, fig. 43. j-k.
DE WEVER & MICONNET 1985, p. 387, pl. 5, fig. 3.
KISHIDA & HISADA 1986, pl. 2, fig. 1.
PESSAGNO et al. 1993, p. 140, pl. 6. fig. 16; pl. 7. fig. 11.
Mirifusus sp.
DE WEVER et al. 1985, pl. 1, fig. 3.
? TAKEMURA 1986, p. 52, pl. 6, figs. 6-7.

Original Definition.- Test fragile, fusiform as with genus, composed of 20 or more segments. Cephalis hemispherical, poreless or sparsely porous (ditrema and apical pore), often covered with small spinelets. Thorax inflated trapezoidal poreless or with sparse, irregular pores, covered with spinelets. Abdomen and following 7 to 9 postabdominal segments form together a slender conical portion of the test with an inner layer of 3 rows of pores per segment in hexagonal arrangement and weakly developed outer layer of diagonal bars forming triangular frames in which the inner layer is usually exposed, except for the abdomen and the first postabdominal chambers, where the outer layer may form irregular nodes which obscure the regular pore structure of the inner layer. The following about 10 segments form a variably inflated median portion of the test with the same pore structure as the proximal conical part of the test. The outer layer is weakly developed or may be almost absent. Circumferential ridges of outer layer are narrow, of round cross section and bear small vertically elongated nodes at junctions with diagonal bars.

Original Remarks.- Successions of well-preserved samples in the Blake-Bahama Basin (DSDP Site 534), Lombardy (Breggia) as well as the published Japanese material (edited by Nakaseko, 1982) show that this species is the immediate ancestor of *M. guadalupensis* and is partly coexisting with it. *M. fragilis* differs from *M. guadalupensis* by being generally smaller, more fragile and having a weakly developed (late forms) to almost lacking (early forms) outer layer of mostly triangular pore frames which always allow to see the hexagonal pore arrangement of the inner layer, whereas with *M. guadalupensis* it tends to be obscured by the thick, more irregular outer layer. *M. fragilis* has thin, round circumferential ridges, whereas *M. guadalupensis* has broad circumferential ridges with flat outer surface. There are transitional forms.

Etymology.- *Fragilis, fragile* (Latin), referring to the thin fragile test wall.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Prox. conical portion width:	126	134	114	56
Prox. conical portion height:	192	209	192	227
Number of segments :	9-11	9.5	9	11
Median portion width:	249	277	249	312
Median portion height:	279	311	279	334
Width between circum. ridges:	21	27	21	32

Type Locality.- Locality no. 40 of locality descriptions (Baumgartner, 1984).

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

MIRIFUSUS FRAGILIS PRAEGUADALUPENSIS 2026

Mirifusus fragilis praeguadalupensis n.ssp. BAUMGARTNER & BARTOLINI

Type Designation.- AB 2716, TM164.66b8.

Original Definition.- Test as with *M. fragilis* sl. Proximal conical portion of test with well-developed outer layer consisting of diagonal bars forming triangular frames. Inner layer of three rows of pores becomes patially covered by outer layer. Distal inflated portion of test with well developed circumferential ridges of round cross-section. Diagonal bars of outer layer are less dense than on proximal portion, regular and directly superimposed on the inner, hexagonal pore frames, which are always visible. Diagonal bars meet at circumferential ridges and form vertically elongated nodes.

Original Remarks.- *M. fragilis* s.l. includes both (early) forms with and outer layer reduced to a faint nodosity (such as the holotype IN7, 79/4419) and (late) forms with a well develloped outer layer and coarsely nodose circumferential ridges. This subspecies is erected to include only the younger forms that have a well developed outer layer. All transitions are found between naked *M. fragilis fragilis* and typical *M. guadalupensis*, where the outer layer becomes very thick and mostly obscures the inner layer. The development of the outer layer increases with younging age. However, the ranges of *M. fragilis fragilis, M. fragilis praeguadalupensis,* and *M. guadalupensis* are broadly overlapping. *M. fragilis praeguadalupensis* and *M. guadalupensis* do co-occur. In addidion, *M. fragilis praeguadalupensis* differs from *M. fragilis fragilis,* by having a shorter, sturdier proximal conical and a more globose distal portion with proportionally higher and less numerous segments.

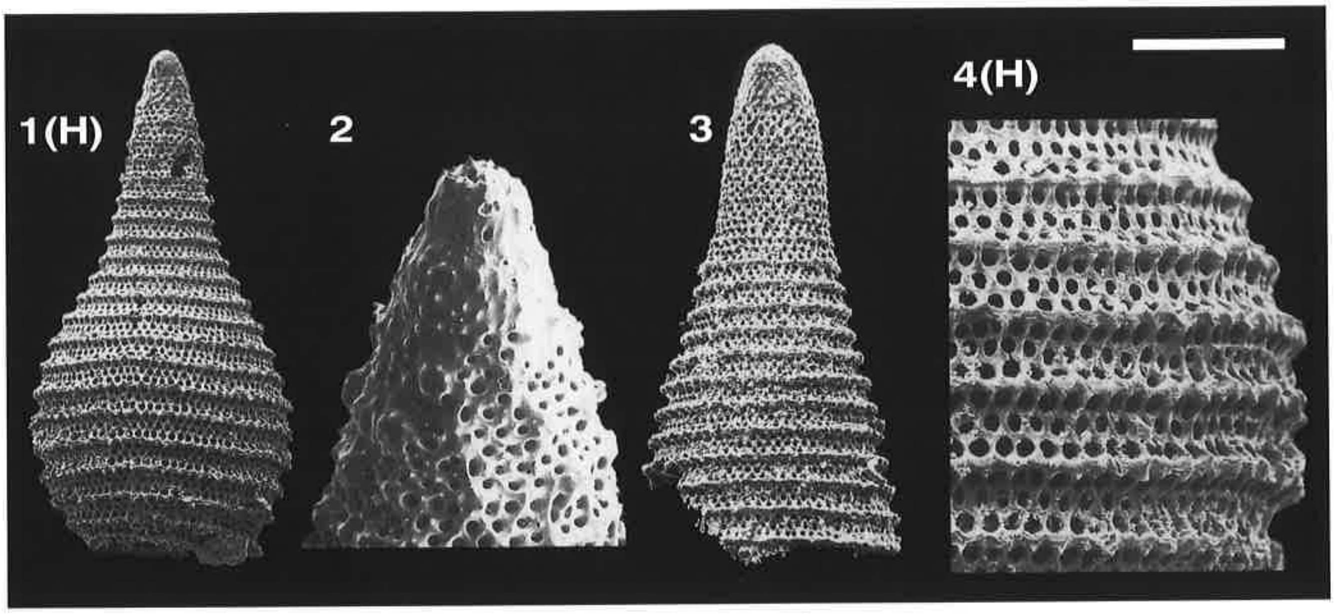


Plate 3159. *Mirifusus fragilis* s.l. BAUMGARTNER. Magnification x100, unless otherwise indicated. **Fig. 1(H).** POB79/4419, IN7. **Fig. 2.** POB81/9158, 76.534A.126.2.125, x400. **Fig. 3.** POB80/3949, IN7, x200. **Fig. 4(H).** POB79/4418, IN7, x400.

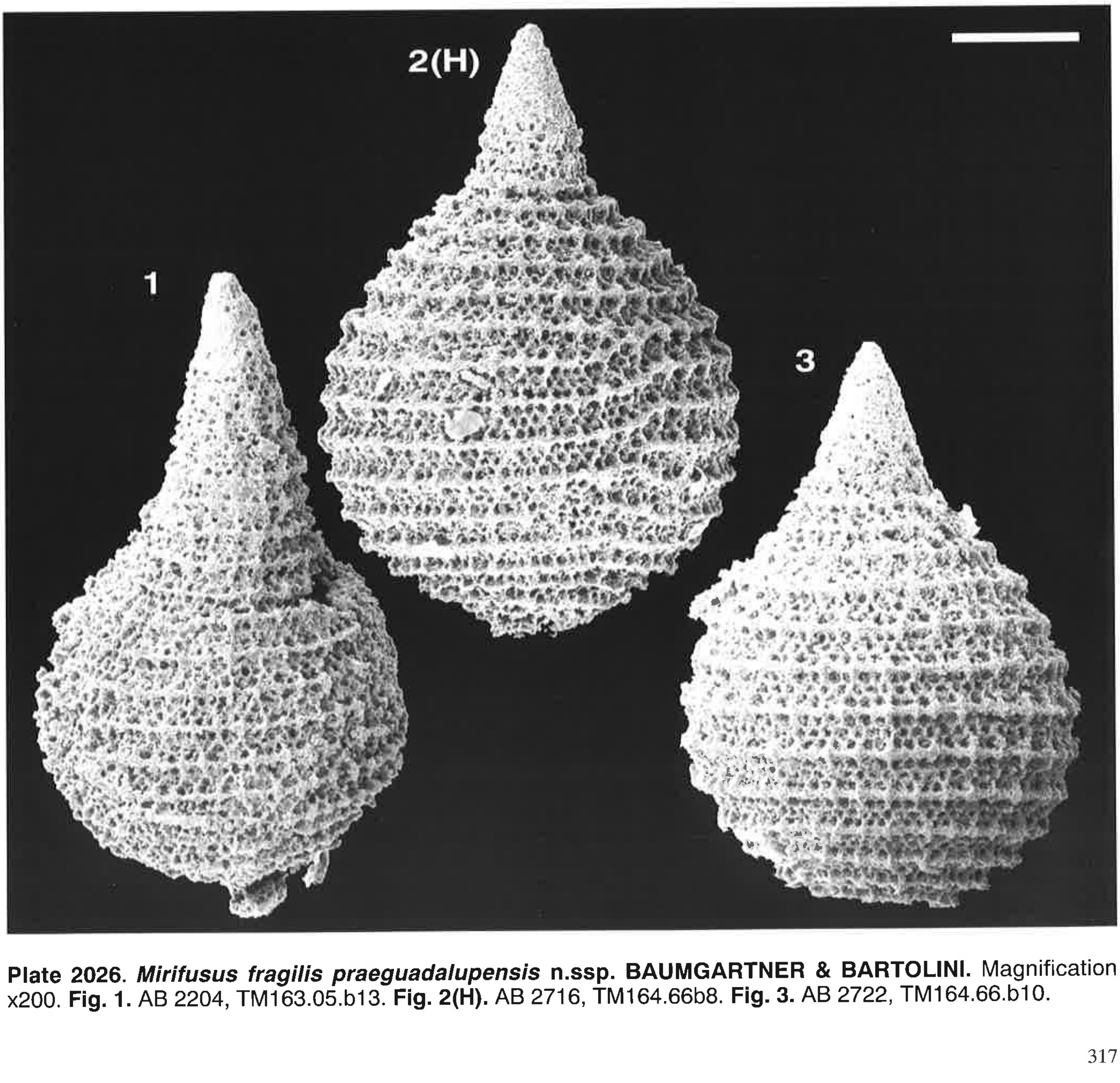


Plate 2026. *Mirifusus fragilis praeguadalupensis* n.ssp. BAUMGARTNER & BARTOLINI. Magnification x200. **Fig. 1.** AB 2204, TM163.05.b13. **Fig. 2(H).** AB 2716, TM164.66b8. **Fig. 3.** AB 2722, TM164.66.b10.

Etymology.- Named for its evolutionary relationship with *M. guadalupensis* PESSAGNO, to which it is the immediate precursor.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
Prox. conical portion width:	50	49	48	55
Prox. conical portion height:	75	85	65	115
Number of segments :	18	16	14	19
Median portion width:	255	280	255	300
Median portion height:	325	318	300	345
Width between circum. ridges:	19	25	20	28

Type Locality.- Terminilletto Section, M. Terminillo, Rieti, Umbria-Marche-Sabina Apennines, Sample TM 164.66 (see Bartolini et al., this volume).

UAZones.- 3-3, early-mid Baj. to early-mid Baj.

MIRIFUSUS GUADALUPENSIS 3160

Mirifusus guadalupensis PESSAGNO

Synonymy.-
Lithocampe mediodilatata RÜST
? OZVOLDOVA 1979, p. 258, pl. 5, fig. 3.
Mirifusus guadalupensis PESSAGNO
PESSAGNO 1977a, p. 83, pl. 10, figs. 9-14.
BAUMGARTNER et al. 1980, p. 55, pl. 5, figs. 12-14.
KOCHER 1981, p. 75, pl. 14, fig. 20.
DE WEVER & CABY 1981, pl. 2, figs. 2 M-N.
ISHIDA 1983, pl. 5, figs. 6a-b.
? ORIGLIA-DEVOS 1983, p. 168, pl. 19, fig. 2.
EL KADIRI 1984, p. 180, pl. 12, fig. 8.
BAUMGARTNER 1984, p. 771, pl. 5, figs. 8, 22.
PESSAGNO et al. 1984, p. 26, pl. 2, figs. 12, 16, 24.
YAO 1984, pl. 2, fig. 29.
BAUMGARTNER 1985, fig. 38.q.
DE WEVER et al. 1986, pl. 9, fig. 7.f
KISHIDA & HISADA 1986, fig. 2.2.
AITA 1987, p. 65.
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, figs. 4-5.
OZVOLDOVA 1988, pl. 2, fig. 3.
DANELIAN 1989, p.162.
CONTI & MARCUCCI 1991, pl. 2, fig. 12.
PESSAGNO et al.1993, p. 140, pl. 6, fig. 9.
Mirifusus sp. A aff. *M. fragilis*
CONTI & MARCUCCI 1991, p. 802, pl. 2, figs. 13-14, 17-18.

Original Definition.- Test as with genus, but with slight stricture between cephalis and thorax. Meshwork of postabdominal chambers consisting of two distinct layers: (1) an inner layer comprised of three rows of small, uniform tetragonal to hexagonal pore frames and (2) an outer layer of two rows of massive triangular pore frames with massive nodes at point of juncture of two vertices with circumferential ridges.

Original Remarks.- *Mirifusus guadalupensis* n.sp. differs from *Mirifusus baleyi* n.sp. by having (1) a two- rather than three-layered test and (2) a slight stricture between its cephalis and thorax. The inner layer of *Mirifusus baileyi* consists of small, uniform hexagonal pore frames, whereas that of *Mirifusus guadalupensis* consists of small, uniform tetragonal to hexagonal pore frames. The tetragonal to hexagonal pore frames of *Mirifusus guadalupensis* are always visible through the outer layer of triangular pore frames. The hexagonal pore frames of the inner layer of *Mirifusus baileyi* are never visible externally and can only be seen on the inside of broken specimens. Because of the similarity of pore frames in the outer layers of both species, it would appear that *Mirifusus guadalupensis* and *Mirifusus baileyi* are closely related. It is likely that *Mirifusus guadalupensis* gave rise to *Mirifusus baileyi.*

Etymology.- This species is named for the town of Guadalupe, Santa Barbara County, California.

Measurements (in μm).-
Based on 4 specimens. Height cephalis: 20; height thorax: 25 to 35; height abdomen: 25; height PA: 20 to 25. Test length: 450 to 670; test width (max.): 300 to 470.

Type Locality.- Point Sal, Santa Barbara County, California.

UAZones.- 5-11, latest Baj.-early Bath. to late Kimm.-early Tith.

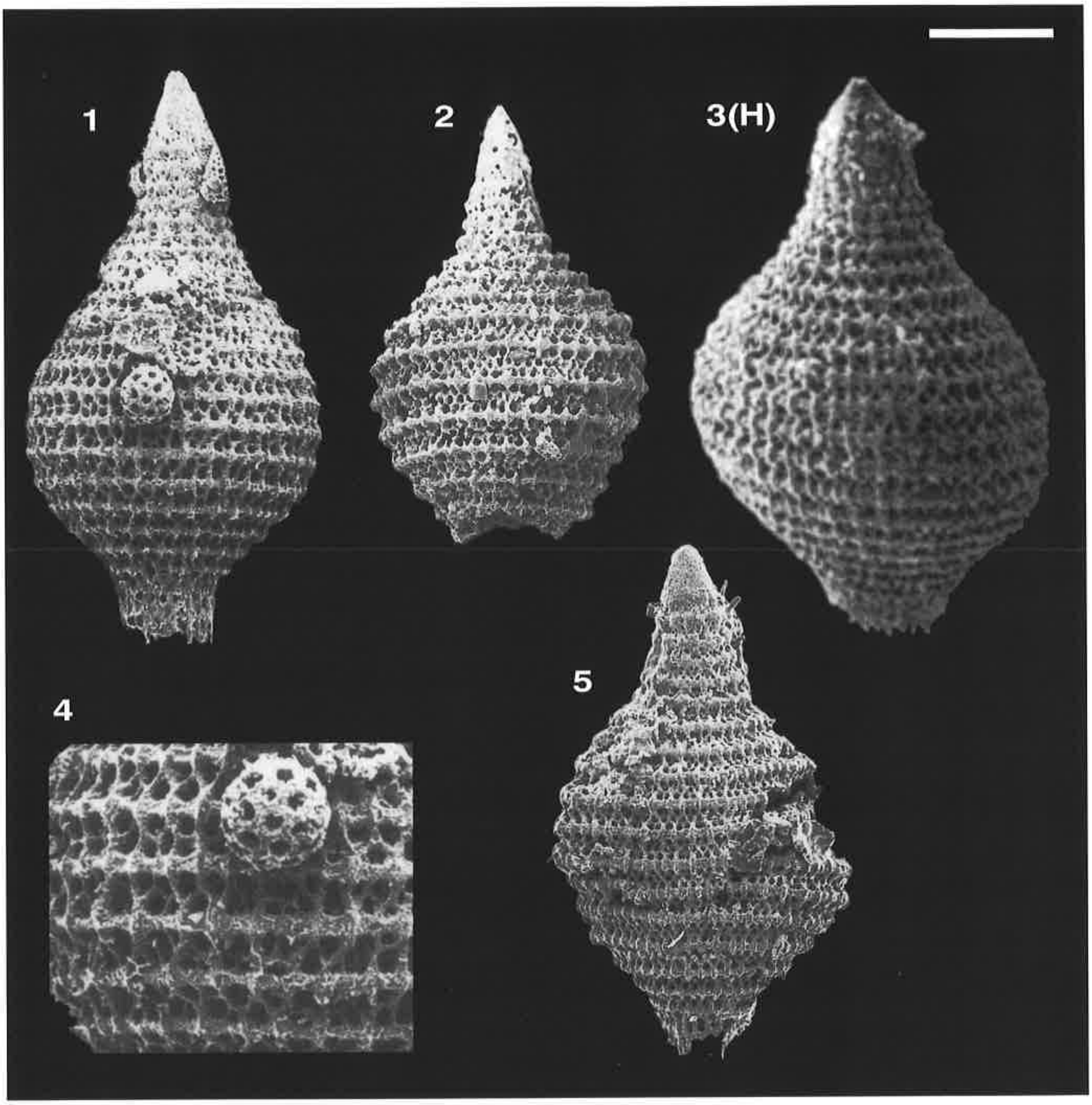


Plate 3160 ***Mirifusus guadalupensis*** **PESSA.** Magnification x150, except Fig. 4 x300. **Fig. 1.** POB79/4714, POB899.53. **Fig. 2.** POB78/6266, POBS4. **Fig. 3(H).** PESSAGNO 1977a, pl. 10, fig. 9. **Fig. 4.** POB78/6267, POB899.53. **Fig. 5.** POB78/3587, POB28.64.

MIRIFUSUS ODOGHERTYI 5721

Mirifusus odoghertyi JUD

Synonymy.-
Mirifusus cf. *fasciata* RÜST
MUZAVOR 1977, p. 121, pl. 6, fig. 1.
Mirifusus odoghertyi JUD
JUD 1994, p. 84, pl. 13, figs. 3-4.

Original Definition.- Fusiform test of more than 15 segments. Proximal part, including probably cephalis and thorax, wide, conical, smooth and poreless. Following 3-5 segments increasing slowly in width, their surface with nodular meshwork, covering an inner layer. Next segments increasing more rapidly in width up to the 12th-14th segments, then fast decreasing. Segmental partition on inflated and terminal parts of test marking internal partition. Test terminating with a long, slender, conical, pointed tube. Test wall of two layers. On proximal part the inner layer has a number of rows of pores difficult to establish and an outer layer with irregular pore-frames. On central, inflated part of test 3 rows of pores are visible to about the maximum diameter of test, then 2 rows of pores per segment remain in the terminal part of test. Circumferential ridges on segmental sutures slightly nodose. Nodes of ridges are at the origin of small, delicate bars arranged diagonally between ridges, forming a triangular to hexagonal meshwork.

Original Remarks.- *Mirifusus odoghertyi* n.sp. is characterized by a wide morphological variety. Some specimens have a rather inflated proximal portion, some have their maximum width in the central portion of the test, whereas others in the distal portion.

Etymology.- This species is dedicated to Luis O'Dogherty, a radiolarist at the Institute of Geology and Paleontology at University of Lausanne, Switzerland, honouring his contributions to the knowledge of Jurassic and Cretaceous radiolarians, his help and his friendship.

Measurements (in μm).-
Based on 14 specimens.

	HT	av.	min.	max.
Length without tube:	473	398	330	552
Maximum width:	236	205	170	257
Length of tube:	63	-	-	-

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Italy.

UAZones.- 13-21, latest Tith. to early Barr.

MIRIFUSUS PETZHOLDTI 5703

Mirifusus petzholdti (RÜST)

Synonymy.-
Stichocapsa petzholdti
RÜST 1885, p. 319 (49), pl. 42, fig. 7.
Stichocapsa (?) *perpasta*
RÜST 1885, p. 319 (49), pl. 42, fig. 10.
Mirifusus petzholdti (RÜST)
JUD 1994, p. 85, pl. 13, fig. 5.

Original Definition.- "Of 18 to 19 members, which are only little increasing up to the middle, but then are enlarging to a wide sphere. Each member with two rows of small pores."

Actualized Definition.- (JUD, 1994) Test fusiform of 20-30 segments with a long conical proximal part and large inflated middle and distal parts. Uppermost proximal portion rounded, without visible segmentation. Surface with irregular pore frames and irregularly arranged ridges. Lower part of proximal portion with visible segmentation and two rows of alternate pores between circumferential ridges. Inflated middle and terminal portion of test consisting of 12-16 segments with 2 rows of alternate pores between circumferential ridges. Terminal part unknown because of poor preservation.

Actualized Remarks.- (JUD, 1994) Two extreme morphotypes have been included in this species: one, herein illustrated, with the proximal part as long as half the length of test, and one with a shorter proximal portion its length reaching only a third of length of test. Between these extreme morphotypes transitional forms have been observed. The specimens included under this species differ from *Stichocapsa petzholdti* as illustrated by Rüst by having a rounded apical part and a less marked passage between the proximal conical and the inflated distal parts. *Mirifusus petzholdti* (RÜST) differs also from *Mirifusus fragilis* BAUMGARTNER by having only 2 rows of pores instead of 3 rows, and from all the other species of *Mirifusus* by its long, narrow proximal portion. Our specimens (measurements based on 4 specimens), having a length of test of 720-761 μm and a width of 357-368 μm, are a little longer and narrower then the specimen illustrated by Rüst.

Measurements (in μm).-
Based on 5 specimens. Length 675, diameter of the sphere 408.

Type Locality.- Jaspers, western switzerland, locality not mentioned

UAZones.- 16-17, early Val. to late Val.

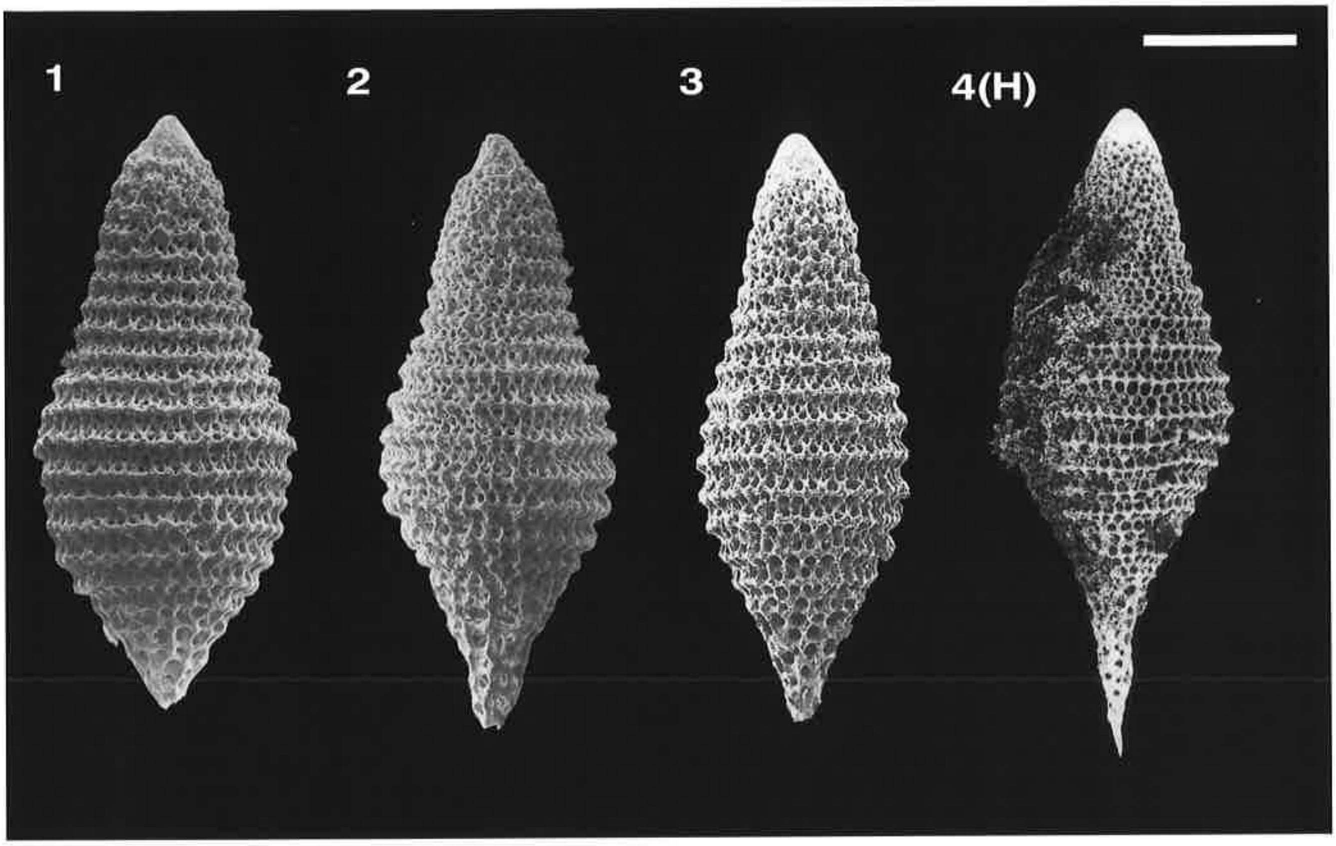


Plate 5721. *Mirifusus odoghertyi* JUD. Magnification x150. **Fig. 1.** DU893, Mo46a'. **Fig. 2.** DU636, Mo46. **Fig. 3.** POB81/0976, MO46a'. **Fig. 4(H).** RJ418, Br28.85.

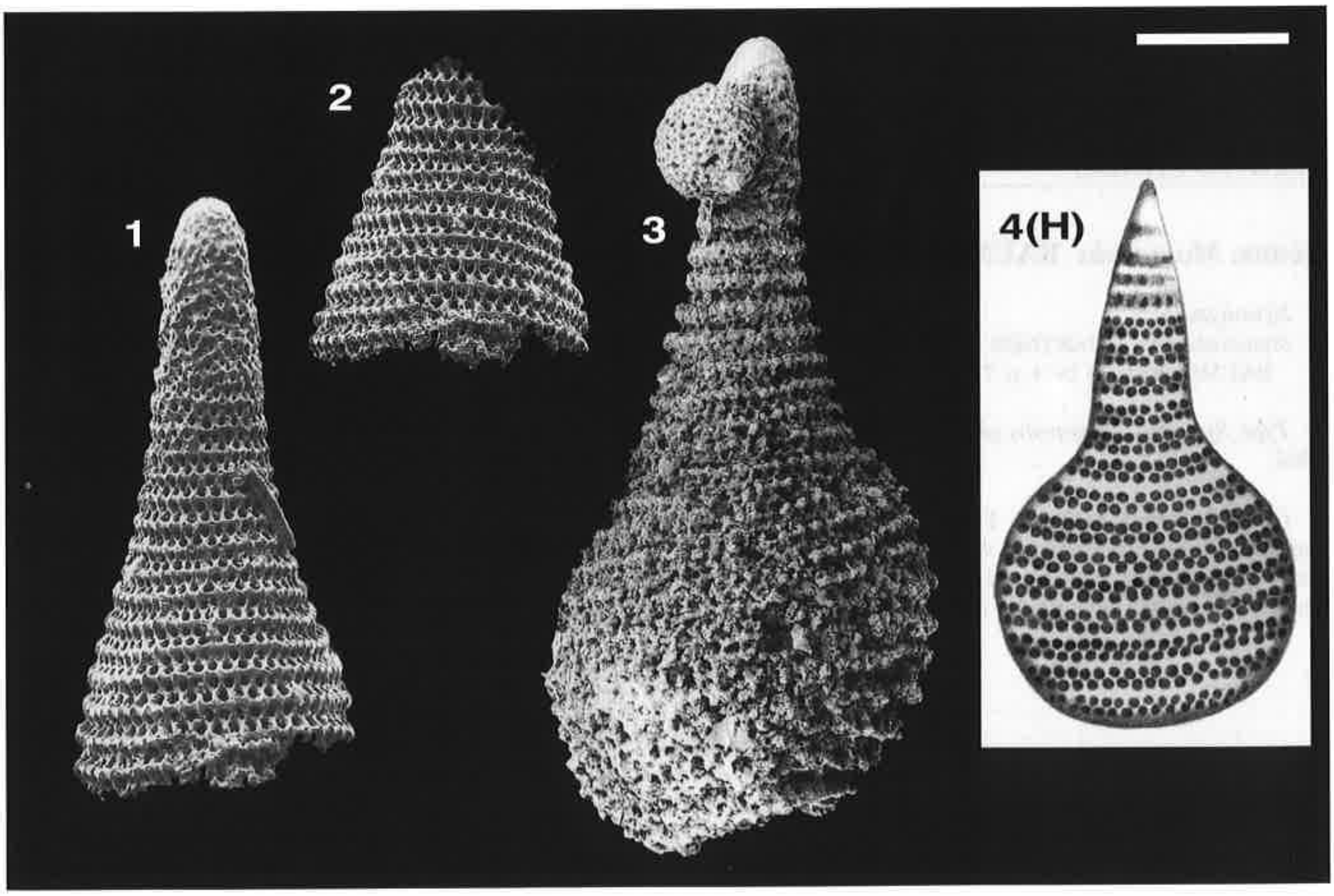


Plate 5703. *Mirifusus petzholdti* (RÜST). Magnification x150. **Fig. 1.** POB80/2683, V-37. **Fig. 2.** POB80/2684, V-37. **Fig. 3.** RJ226, Bo449.5. **Fig. 4(H).** RÜST 1885, pl. 42, fig. 7.

MIRIFUSUS PROAVUS — 3158

Mirifusus proavus TONIELLI

Synonymy.-
Mirifusus proavus TONIELLI
TONIELLI 1991, p. 24, pl. 2, figs. 2-4, 8.

Original Definition.- "Test fusiform as with genus (sensu Baumgartner 1984), higher h/w ratio than the other species and composed of 30 or more segments. Cephalis and thorax with sparse pores and acute cone-shaped as a whole; apical portion of test covered with small, weakly developed nodes, without apical horn; abdomen perforate with small subcircular pores. Inner layer of postabdominal test of 3 rows of pores per segment, outer layer without diagonal bars, except for the last chambers where the outer layer consists of poorly developed bars. The circumferential ridges of outer layer are in the proximal part spaced at 10 μm, while in the distal part are spaced at 20 μm and are more prominent."

Original Remarks.- "This species can be attributed neither to the genus *Ristola* which includes "only species which have a conical proximal portion, a very long cylindrical portion" (Baumgartner, 1984) nor to the genus *Parvicingula,* because it has no apical horn. *M. proavus* differs from all other Middle-Upper Jurassic species of the genus *Mirifusus* by having not a typical amphora shape of test with a wide inflated median portion. *M. proavus* has 3 rows of pores like *M. fragilis*, but it differs from this latter in h/w ratio.

This new species is the oldest known form of *Mirifusus*, and could represent the ancestral form of which the jounger forms with inflated median portion developed during the Middle-Upper Jurassic. The inflated median portion could represent an adaption to floating and/or to increase the space for symbionts (e.g. Zooxanthellae)."

Etymology.- *Proavus*, ancestor (Latin), referring to the early appearance of this species and to its ancestral relation to other species of *Mirifusus*.

Measurements (in μm).-
Based on 30 specimens.

	HT	av.	min.	max.
Width:	159	169	130	220
Height:	800	641	550	800
H/W ratio:	5	4	3	5

Type Locality.- Calcari Diasprigni Formation, Mt, Terminilleto, Central Italy.

UAZones.- 2-4, late Aal. to late Baj.

monoceros >> *BERNOULLIUS (?) MONOCEROS* — 5359

MONOTRABS — 3660

Genus: *Monotrabs* BAUMGARTNER

Synonymy.-
Monotrabs BAUMGARTNER
BAUMGARTNER 1984, p. 773.

Type Species.- *Monotrabs plenoides* BAUMGARTNER 1984.

Original Definition.- Form consisting of one hagiastrid-like (tritrabin?) ray, with two rows of alternating pores in depression between adjacent external longitudinal beams. No central area can be observed. One end tapering to a structure of triangular cross section made of three beams, the other end blunt, bearing spines.

Original Remarks.- Fragments of forms belonging to this genus mimick hagiastrid rays belonging to the Tritrabinae BAUMGARTNER 1980. Because of the absence of a central area and the peculiar tapering of one end, this form can only doubtfully be included with the hagiastrids.

Included Taxa.-
3152 *Monotrabs plenoides* gr. BAUMGARTNER

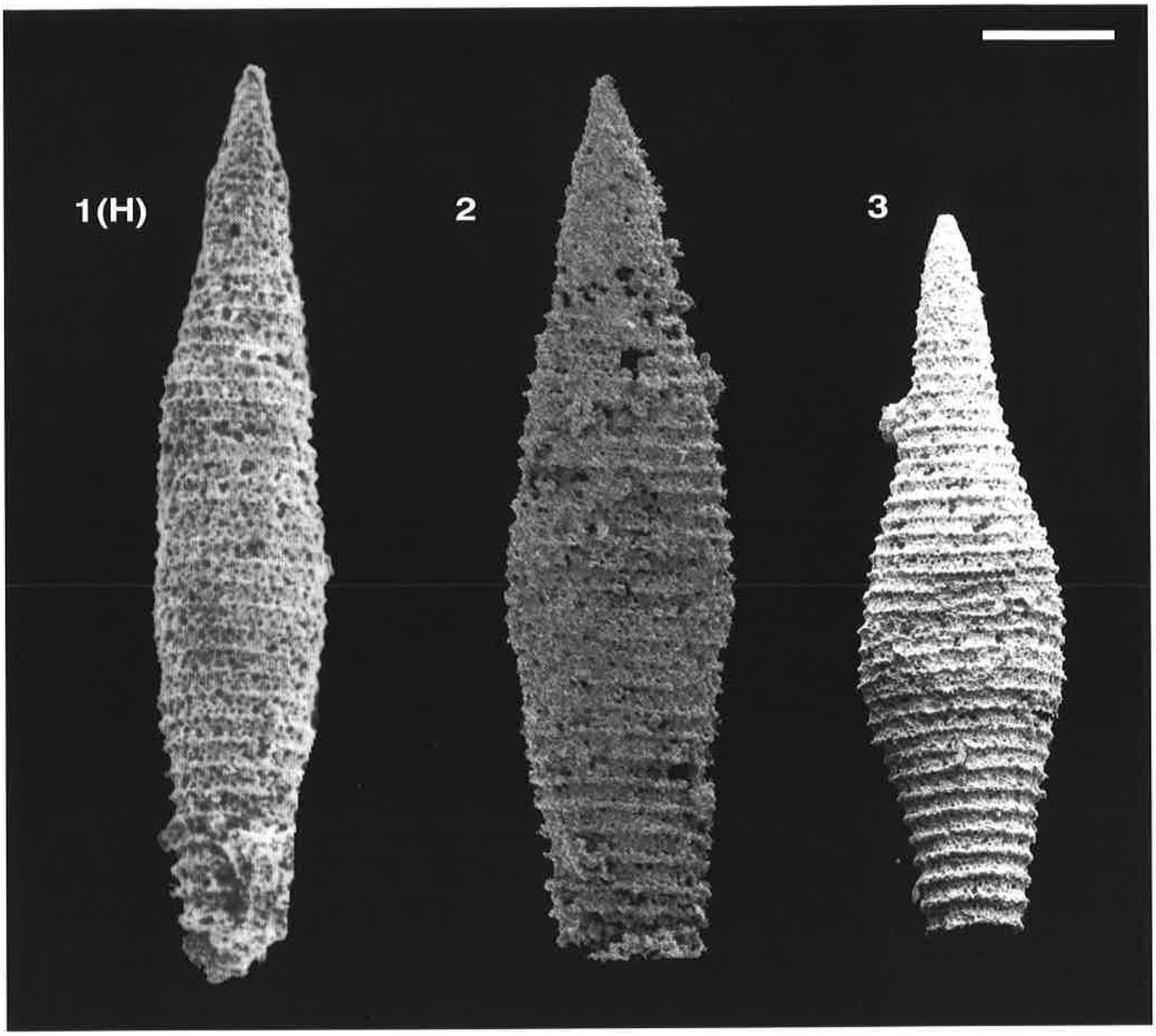


Plate 3158. ***Mirifusus proavus*** **TONIELLI.** Magnification x150. **Fig.1(H).** TONIELLI 1991, pl. 2, fig. 2. **Fig. 2.** AB 660 ,TM 90.32-b1. **Fig. 3.** AB 7122, TM 109.25.c23.

MONOTRABS PLENOIDES GR. *3152*

Monotrabs plenoides gr. BAUMGARTNER

Synonymy.-
Hagiastrid sp. cf. *Tetraditryma pseudoplena* BAUMGARTNER
KOCHER 1981, p. 70, pl. 14, fig. 4.
Monotrabs plenoides BAUMGARTNER
BAUMGARTNER 1984, p. 773, pl. 6, figs. 1-2, 5.
DANELIAN 1989, p.165, pl. 6, fig. 1.

Original Definition.- Hagiastrid-like ray with two stout, triradiate lateral spines at one end, which stand at right angle to the axis of ray as with *Tetraditryma pseudoplena*. Ray structure rather tritrabin: 3-5 longitudinal, slightly nodose external beams visible per half circumference are separated by a depression with two rows of alternating pores. The opposite end tapers into an extension consisting of three beams connected by bars forming longitudinal rows of pores. The external beams may bear long secondary lateral spines.

Original Remarks.- Fragments of this species can be distinguished from fragments of *Tetraditryma pseudoplena* by having a tritrabin, rather than a tetraditrymin ray structure.

Etymology.- *Plenoides* in allusion to the lateral spines of *Tetraditryma pseudoplena.*

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Length of ray:	216	333	216	450
Width of ray:	50	51	44	60
Length of lateral spines:	31	62	31	100
Length of extension:	77	-	-	-

Type Locality.- Blake Bahama Basin (West Atlantic, DSDP Leg 76, site 534).

UAZones.- 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

morinae >> TURANTA MORINAE GR. *3247*

morroensis >> OBESACAPSULA MORROENSIS *3266*

mulleri >> PARONAELLA MULLERI *3139*

multipora >> EMILUVIA PESSAGNOI MULTIPORA *3226*

multispina >> PODOBURSA MULTISPINA *5427*

munitum >> ARCHAEOHAGIASTRUM MUNITUM *3271*

murcheyae >> PALINANDROMEDA MURCHEYAE *3004*

nana >> EMILUVIA NANA *3212*

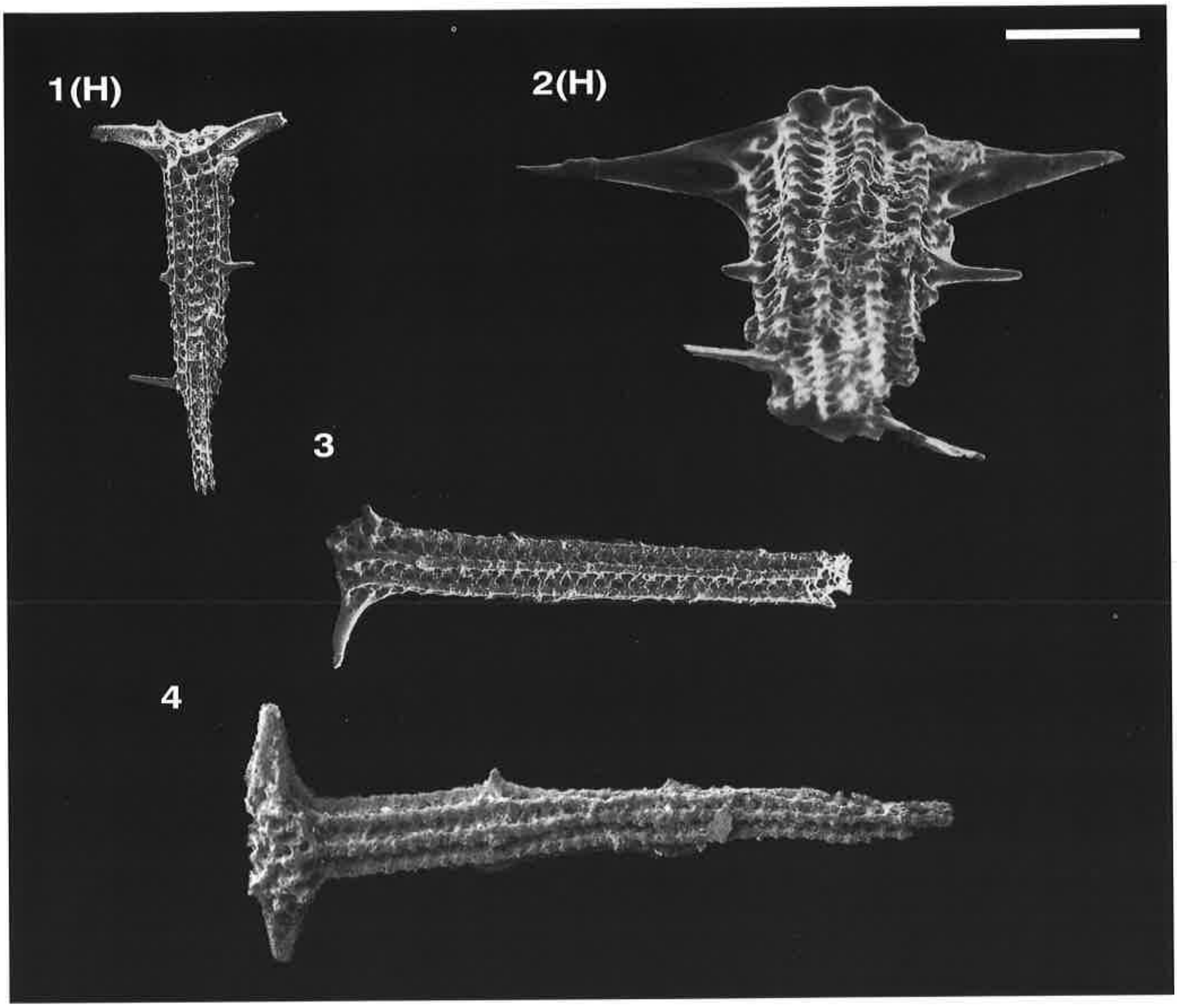


Plate 3152. *Monotrabs plenoides* gr. BAUMGARTNER. Magnification x200, except Fig. 2(H) x600. **Fig. 1(H).** POB81/2686, 534.124.1.52. **Fig. 2(H).** POB81/2687, 534.124.1.52. **Fig. 3.** POB81/2389, 534.121.1.26. **Fig. 4.** TD88009/06, BB5-1.5.

NAPORA 3661

Genus: *Napora* PESSAGNO

Synonymy.-
Napora PESSAGNO
PESSAGNO 1977a, p. 94.
PESSAGNO et al. 1986, p. 34.
TAKEMURA 1986, p. 43.
Ultranapora PESSAGNO
PESSAGNO 1977b, p. 38.

Type Species.- *Napora bukryi* PESSAGNO 1977a.

Original Definition.- Test dicyrtid with a large conical cephalis and a large subglobular thorax. Cephalis with massive horn bearing longitudinal ridges and grooves and often having subsidiary spines. Thorax with coarse, equal size, polygonal (usually hexagonal) pore frames and circular pores and with a large circular aperture (mouth) at base; three slightly curved feet with longitudinally developed ridges and grooves occurring at base of thorax.

Actualized Definition.- (PESSAGNO et al. 1986) As with that of family but restricted to forms that lack a thoracic velum and may or may not have a cephalocone.

Original Remarks.- *Napora* n.gen. differs from *Tripilidium* in possessing a dicyrtid test with a well-developed apical horn.

Actualized Remarks.- (TAKEMURA, 1986) Pessagno 1977a, b considered *Napora* to differ from *Ultranapora* by lacking a cephalocone. Because we have observed a cephalocone on specimens of *Napora bukryi* PESSAGNO, 1977a, the type species of *Napora*, this definition is no longer valid. *Ultranapora* must therefore be considered a junior synonym of *Napora*. Although forms that appear to lack a cephalocone may be present in our Jurassic samples, we tentatively include all such forms under *Napora* until the taxonomic and phylogenetic significance of the cephalocone is assessed. This more conservative approach corresponds to that of Baumgartner et al. (1980).

Pessagno (1977a) described genus *Napora* and made a comparison between *Napora* and *Tripilidium*. However, the shape of *Napora* resembles that of Cenozoic *Lychnocanium* or *Pterocanium*, of which shells are composed of two or three segments. *Napora* always possesses a triradiate apical horn, but *Lychnocanium* and *Pterocanium* bear a rod-like apical horn. *Napora* possesses MB, A, V, D, two L and two l as cephalic skeletal elements and six collar pores at collar plate. Two L and D lengthen downward throughout the thoracic wall and protrude as three feet. Since cephalic skeletal structure of *Lychnocanium* or *Pterocanium* is unknown, the forms which possess cephalo-thorax, triradiate apical horn and three triradiate feet are described under the genus *Napora* in this study.

Pessagno (1977b) described the genus *Ultranapora*, bearing a cephalocone which is a protrusion of the vertical spine. Although some forms of middle Jurassic *Napora* bear a cephalocone on their cephalis the others of the same species (for example, *N. nipponica*) do not. Moreover, the size of the cephalocone varies among the same species. In this paper the genus *Ultranapora* is not used. The cephalic skeletal structure of *Napora* is identical to that of *Jacus* DE WEVER (1982, pl. 55, fig. 10; pl. 56, fig. 4) *Napora* may be related phylogenetically to the early Jurassic *Jacus* .

Etymology.- *Napora* is an anagram for C.F. Parona, one of the early students of Jurassic Radiolaria.

Included Taxa.-
3037 *Napora boneti* PESSAGNO, WHALEN &YEH
3035 *Napora deweveri* BAUMGARTNER
3031 *Napora latissima* TAKEMURA
3036 *Napora lospensis* PESSAGNO
3410 *Napora nipponica* TAKEMURA
3033 *Napora pyramidalis* BAUMGARTNER
3032 *Napora saginata* TAKEMURA
3030 *Napora* sp. A
3034 *Napora* sp. B

NAPORA BONETI 3037

Napora boneti PESSAGNO, WHALEN & YEH

Synonymy.-
Napora boneti PESSAGNO, WHALEN & YEH
PESSAGNO et al. 1986, p. 36, pl. 9, figs. 3-4, 17, 19, 23.

Original Definition.- Cephalis small, hemispherical, with cephalocone and medium-length horn. Proximal one half of horn triradiate in axial section with three deep, narrow longitudinal grooves alternating with three parallel, massive, rounded ridges. Distal half of horn circular in axial section, lacking longitudinal ridges and grooves; about one-half the width of proximal half. Thorax hemispherical with massive, nodose, relatively large pentagonal and hexagonal pore frames. Feet of medium length, triradiate in axial section with 3 rounded longitudinal ridges that alternate with 3 deep longitudinal grooves; ridges and grooves about equal in width.

Original Remarks.- *Napora boneti* n.sp. differs from *N. burckhardti* n.sp., by having shorter feet and a proportionately smaller thorax with larger, more massive, and less numerous nodose pore frames. Furthermore, the thorax of *N. boneti* is hemispherical in shape, whereas that of *N. burckhardti* is subcylindrical. The two species share horns of similar structure and it is likely that *N. boneti* n.sp. is ancestral to *N. burckhardti* n.sp.

Etymology.- This species is named for the late Dr. Federico Bonet (Institute of Petroleum, Mexico, D.F., Mexico), in honor of his many valuable contributions to Mexican micropaleontology and biostratigraphy.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	max.	min.
Length of cephalis:	25	23	25	17
Length of thorax:	75	67	75	50
Width of thorax at top:	50	57	62	37
Width of thorax at base:	87	87	10	62
Length of horn:	80	63	80	32
Width of horn at base:	25	24	37	22
Length of foot:	75	67	75	50

Type Locality.- Route 85 (Mexico D.F.- Nuevo Laredo highway); east of km 267 and west of major turn in road.

UAZones.- 10-11, late Oxf.-early Kimm. to late Kimm.-early Tith.

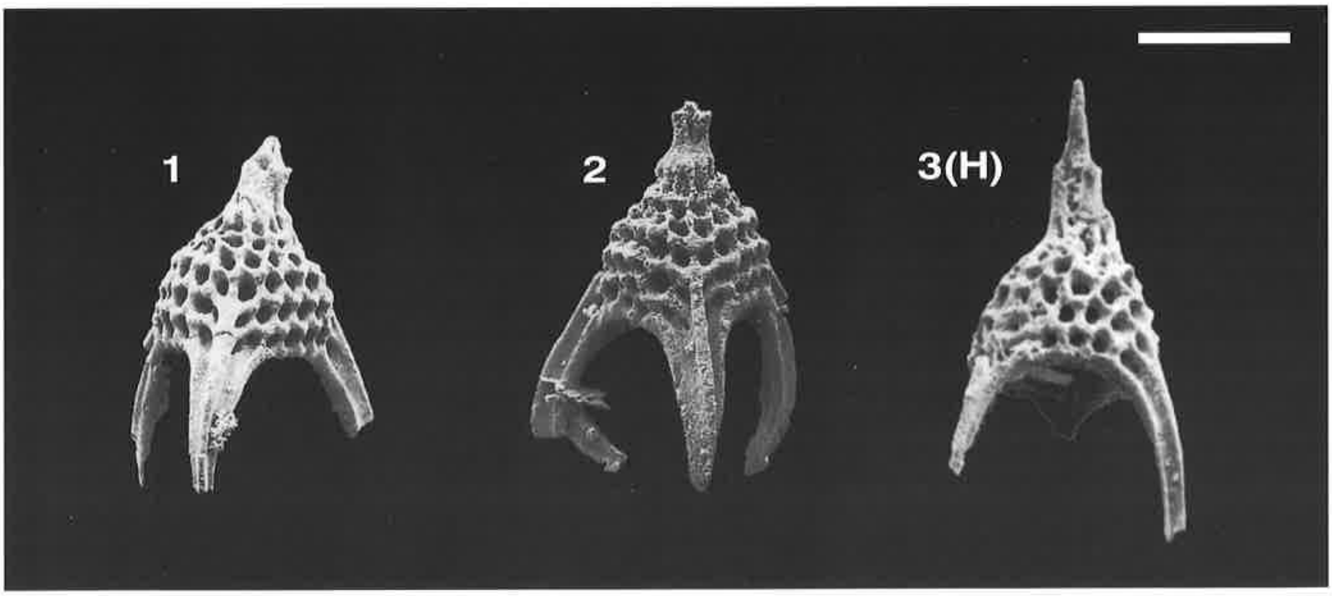


Plate 3037. *Napora boneti* PESSAGNO, WHALEN & YEH. Magnification x200. **Fig. 1.** POB78/8176, POB986.52. **Fig. 2.** POB78/8200, POB986.51. **Fig. 3(H).** PESSAGNO et al. 1986, pl. 9, fig. 3.

NAPORA DEWEVERI 3035

Napora deweveri BAUMGARTNER

Synonymy.-
Napora deweveri BAUMGARTNER
BAUMGARTNER et al. 1980, p. 56, pl. 3, figs. 1-3, 5; pl. 6, fig. 9.
KOCHER 1981, p. 78, pl. 14, fig. 24.
BAUMGARTNER 1984, p. 774, pl. 6, fig. 3.
AITA 1987, p. 65.
DANELIAN 1989, p.167, pl. 6, fig. 3.
Napora deweveri BAUMGARTNER s. l.
PESSAGNO et al. 1986, p. 39, pl. 10, fig. 14.

Original Definition.- Robust form with stout horn and stout, strongly curved feet. Cephalis bearing a horn with a broad tip. Halfway before the tip six protrusions are placed around the horn, separated by three narrow, deep grooves (the prolongation of the apical pores) and three shallow grooves. Six ridges run down from the protrusions to the surface of the thorax completely enclosing the cephalis. A slightly protruding cephalocone (vertical horn) composed of four or more ridges has been observed on most specimens. Thorax dome-shaped nearly circular in transverse section, with equally distributed pores in rough vertical rows. Basal aperture rounded triangular. Feet as long or longer than height of thorax, three-bladed, strongly curved inwards.

Original Remarks.- This species differs from *N. lospensis* PESSAGNO (to which it is closely related - ancestor ?) in having a stouter horn with ridges completely obscuring the outline of the cephalis, and by having stouter, proportionally longer feet. *N. deweveri* differs from *N. bukryi* by its larger size, stouter horn and feet.

Etymology.- Named for Patrick De Wever, in honor to his milestone on Triassic Radiolaria.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
H. cephalis and horn:	116	109	97	122
Width of cephalis:	63	61	53	68
Height of thorax:	118	106	90	118
Width of thorax:	151	149	143	161
Length of feet:	126	129	115	143

Type Locality.- 4 km east of Angelokastron, Province Korinthos, Greece.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

NAPORA LATISSIMA 3031

Napora latissima TAKEMURA

Synonymy.-
Napora latissima TAKEMURA
TAKEMURA 1986, p. 45, pl. 3, figs. 4-6, 9.
cf. *Napora cosmica* PESSAGNO WHALEN & YEH
PESSAGNO et al. 1986, p. 38, pl. 7, figs. 2, 5-7, 19, 21-22; pl. 11, fig. 10.

Original Definition.- Cephalis small, subspherical and poreless, with stout, triradiate and short apical horn, which posesses nodes at the distal portion on the three ridges. Thorax triangularly pyramidal, with transversely arranged pores. Aperture large and subtriangular. Basal rim of thorax straight or slightly convex, and triangular to subtriangular. Three feet long, robust, protruding transversely proximally and convexely curved remarkably.

Original Remarks.- The shape of cephalo-thorax of *Napora latissima* n.sp. resembles to that of *N. triangularis* n.sp. However, the morphology of three feet of *N. latissima* is quite different from that of *N. triangularis*. The robust and transversely projected feet are observed in only *N. latissima* and *N. saginata*. *N. latissima* difers from *N. saginata* in its thoracic shape.

Remarks.- Included are forms with a short wide thorax, distinctive imperforate cephalis and strong curved feet. The external ridge of the feet is well marked on the outer surface of the thorax.

Etymology.- The species name *latissima* means the widest, derived from the morphology of three feet.

Measurements (in μm).-
Based on 8 specimens. Length of shell including horn and feet, 245-280; Height of cephalo-thorax, 65-80; Maximum width of shell including feet, 210-255; Width of thorax, 90-110.

Type Locality.- Sample TKN-05, Komami, Yamato Village, Gifu Prefecture, central Japan.

UAZones.- 4-7, late Baj. to late Bath.-early Call.

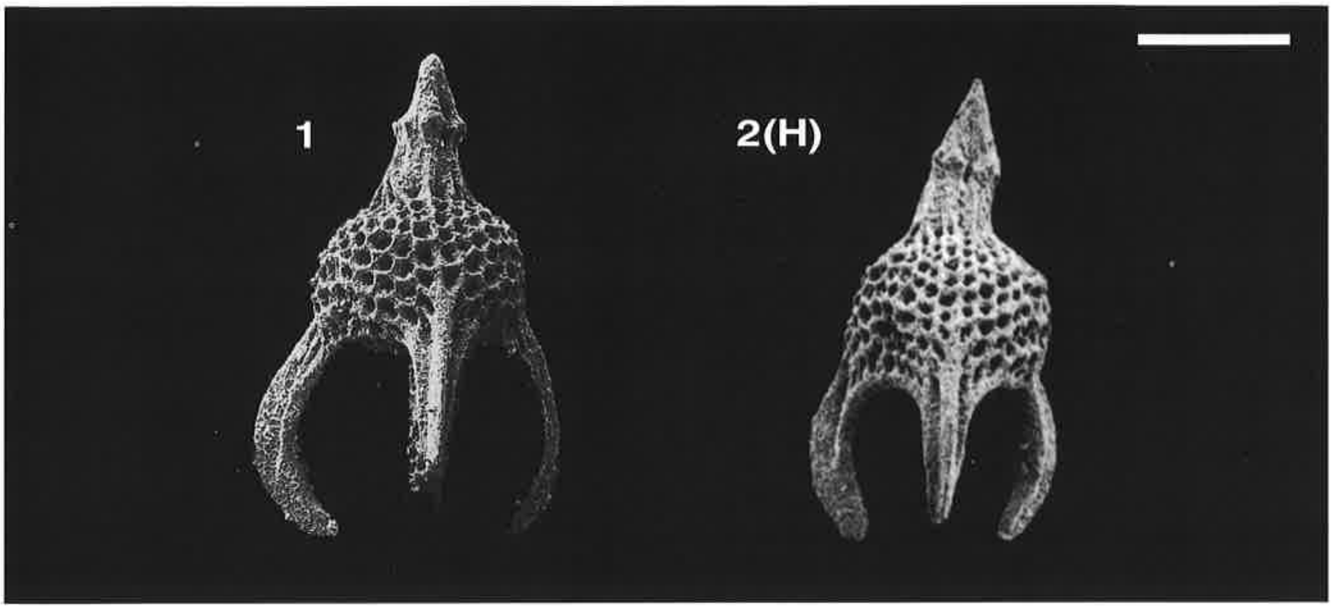


Plate 3035. *Napora deweveri* BAUMGARTNER. Magnification x200. **Fig. 1.** POB78/6462, POB899.53. **Fig. 2(H).** POB78/6452, POB899.

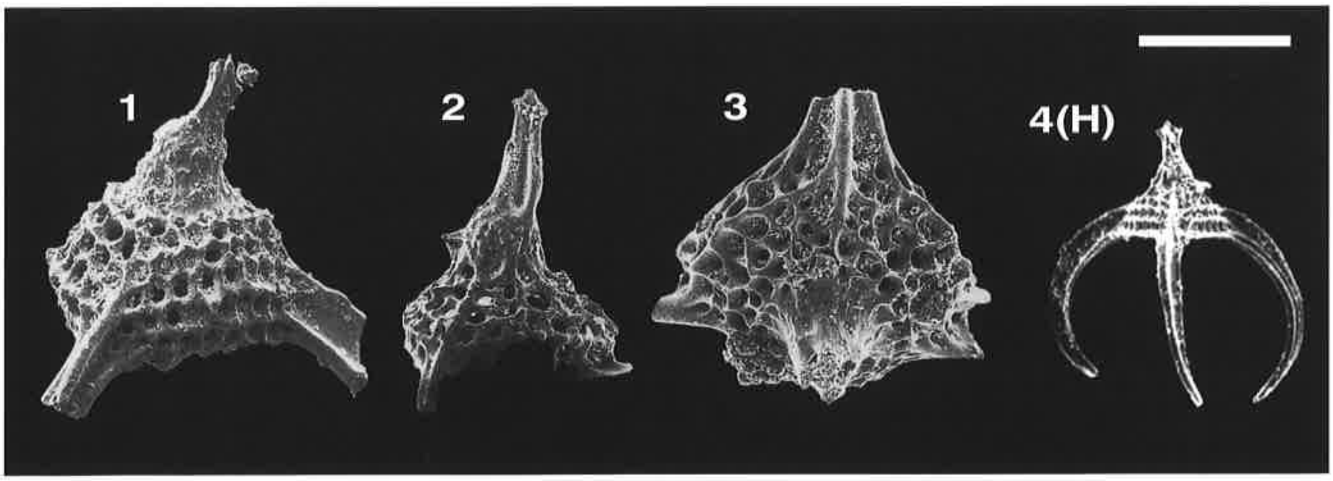


Plate 3031. *Napora latissima* TAKEMURA. Magnification x300, except Fig. 4(H) x150. **Fig. 1.** POB81/2286, 534.122.1.43. **Fig. 2.** POB81/2781, 534.123.1.29. **Fig. 3.** POB81/1387, 534A.125.2.36. **Fig. 4(H).** TAKEMURA 1986, pl. 3, fig. 9.

NAPORA LOSPENSIS 3036

Napora lospensis PESSAGNO

Synonymy.-
Napora lospensis PESSAGNO
PESSAGNO 1977a, p. 96, pl. 12, figs. 9-10.
? BAUMGARTNER et al. 1980, p. 57, pl. 3, fig. 4.
not DE WEVER & CABY 1981, pl. 2, fig. 2K.
BAUMGARTNER 1984, p. 774, pl. 6, fig. 6.
PESSAGNO et al. 1984, p. 24, pl. 2, fig. 9.
DE WEVER et al. 1986, pl. 11, figs. 13, 18, 22.
PESSAGNO et al. 1986, p. 42, pl. 9, figs. 11, 16.
OZVOLDOVA 1988, pl. 8, fig. 6.

Original Definition.- Cepalis inflated, dome-shaped, with short, massive triradiate apical horn with three short subsidiary spines. Cephalis separated from thorax by pronounced stricture. Thorax inflated, globular, with three short, nearly straight triradiate feet.

Original Remarks.- This species differs from *N. dendrocanthos* (SQUINABOL) by virtue of its much shorter, less complicated apical horn.

Etymology.- This species is named for Mt. Lospe in the vicinity of Point Sal, Santa Barbara County, California.

Measurements (in μm).-
Based on 6 specimens. Height cephalis : 20 to 30, height thorax : 40 to 70 , height horn : 20 to 40, length feet : 40 to 65.

Type Locality.- NSF 907, Point Sal, California.

UAZones.- 8-13, mid Call.-early Oxf. to latest Tith.

NAPORA NIPPONICA 3410

Napora nipponica TAKEMURA

Synonymy.-
Napora nipponica TAKEMURA
TAKEMURA 1986, p. 44, pl. 2, figs. 16-21.
CARTER & JAKOBS 1991, p. 343, pl. 3. fig. 1.
PESSAGNO et al. 1993, p. 158, pl. 8, fig. 10.

Original Definition.- Cephalis small and subspherical with straight and triradiate apical horn, and with or without cephalocone. Ridges of apical horn may or may not originate at the base of the cephalis. A node located at the position of about half way along each ridge. Thorax subspherical or hemispherical to trigonally pyramidal, with usually transversely arranged circular pores. Three feet triradiate and curved convexly. Aperture subtriangular to circular with remarkable circular or subtriangular apertural ring around it.

Original Remarks.- Although *Napora nipponica* n.sp. resembles in its shape to *N. bukryi* PESSAGNO, *N. nipponica* differs from *N. bukryi* in possessing a considerably long apical horn and feet, and a transverse arrangement of thoracic pores. *N. nipponica* is also distinguishable from other species of *Napora* by its shape of apical horn and three feet.

Etymology.- The trivial name is derived from Nippon, Japan in Japanese.

Measurements (in μm).-
Based on 15 specimens. Length of the shell including horn and feet, 200-270; Height of cephalo-thorax, 60-85; Maximum width of shell including feet, 115-160; Width of thorax, 75-110.

Type Locality.- Maganese carbonate ore deposit, TKN-105. Gujo-Hachiman area, Mino Terrane, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

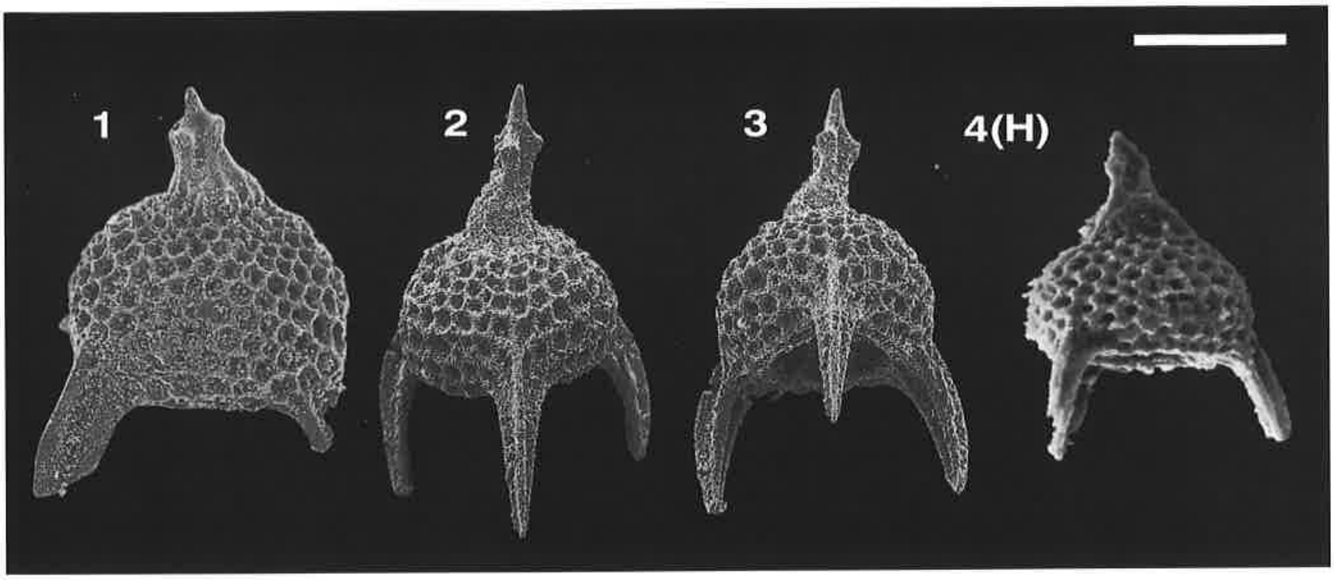


Plate 3036. *Napora lospensis* PESSAGNO. Magnification x200. **Fig. 1.** POB79/0105, POB783. **Fig. 2.** POB79/5237, POB1205.3. **Fig. 3.** POB79/5238, POB1205.3. **Fig. 4(H).** PESSAGNO 1977a, pl. 12, fig. 9.

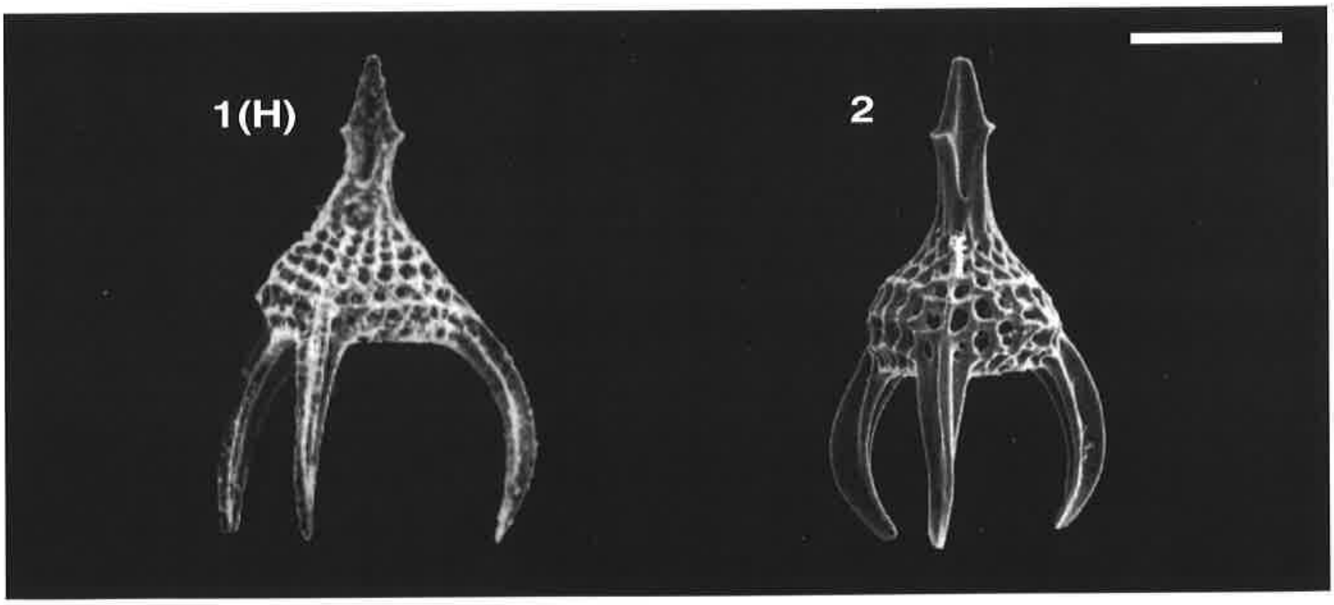


Plate 3410. *Napora nipponica* TAKEMURA. Magnification x150. **Fig. 1(H).** TAKEMURA 1986, pl. 2, fig.16. **Fig. 2.** CARTER & JAKOBS 1991, pl. 3, fig. 1.

NAPORA PYRAMIDALIS 3033

Napora pyramidalis BAUMGARTNER

Synonymy.-
Napora sp. A
BAUMGARTNER et al. 1980, p. 57, pl. 3, figs. 6-7.
KOCHER 1981, p. 78, pl. 15, figs. 1-3.
YEH 1987a, p. 86, pl. 24, fig. 5.
Napora pyramidalis BAUMGARTNER
BAUMGARTNER 1984, p. 775, pl. 6, figs. 11-12.
BAUMGARTNER 1985, fig. 38.o.
YAMAMOTO et al. 1985, p. 36, pl. 5, fig. 7.
TAKEMURA 1986, p. 45, pl. 3, figs. 15-18.
HATTORI 1987, pl. 10, figs. 12-13.
DANELIAN 1989, p.168, pl. 6, fig. 5.
PESSAGNO et al. 1993, p. 158, pl. 8, fig. 18.

Original Definition.- Very small *Napora* with distinctly pyramidal overall shape. Cephalis completely hidden under a sharp apical horn bearing six ridges separated by six deep grooves which originate on top of thorax. Three lateral points may sit on three of the ridges. Thorax pyramidal, with round pores in horizontal rows. The outer ridge of the feet originate on the edges of thorax. Basal aperture triangular, large. Feet triradiate almost in a straight line with edges of thorax, or slightly curved inward, equal or shorter than height of thorax.

Original Remarks.- This species difers from other *Napora* by its small size, its triangular-pyramidal shape, the sharp ridges completely hiding the cephalis and short, almost straight feet.

Etymology.- *Pyramidalis*, like a pyramide (Latin).

Measurements (in μm).-
Based on 22 specimens.

	HT	av.	min.	max.
H. Cephalis and horn:	52	61	41	79
Width of thorax:	29	33	28	43
Height of thorax:	54	66	54	78
Width between feet:	80	88	69	107
Length of feet:	38	67	38	86

Type Locality.- Locality no. 30 of locality descriptions (Baumgartner, 1984).

UAZones.- 2-11, late Aal. to late Kimm.-early Tith.

NAPORA SAGINATA 3032

Napora saginata TAKEMURA

Synonymy.-
Napora saginata TAKEMURA
TAKEMURA 1986, p. 44, pl. 2, figs. 12-15.

Original Definition.- Cephalis small, poreless and subspherical with stout and triradiate apical horn, and without cephalocone. Each of the three rigdes of the apical horn strong and straight, with a node at distal portion of the cephalis. Ridges located just above the side between two feet. Thorax subspherical to hemispherical, divided into two parts. Proximal part, just below cephalis, poreless and subtriangular in transverse profile. Distal part large, with transversely and hexagonally, or irregularly distributed pores. Three feet triradiate and robust, proximally projecting transversely and curved convexly remarkably. Aperture large, subtriangular to subcircular, with narrow apertural ring.

Original Remarks.- *Napora saginata* n.sp. differs from other species belonging to this genus by its characteristic shape of feet, the shape of apical horn, and the size and the shape of thorax.

Etymology.- The species name, *saginata*, derived from *saginatus* in Latin means fattened.

Measurements (in μm).-
Based on 14 specimens. Length of shell including horn and feet, 295-300; Height of cephalo-thorax, 100-125; Maximum width of shell including feet, 210-295; Width of thorax, 130-180.

Type Locality.- Sample TKN-05, Komami, Yamato Village, Gifu Prefecture, central Japan.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

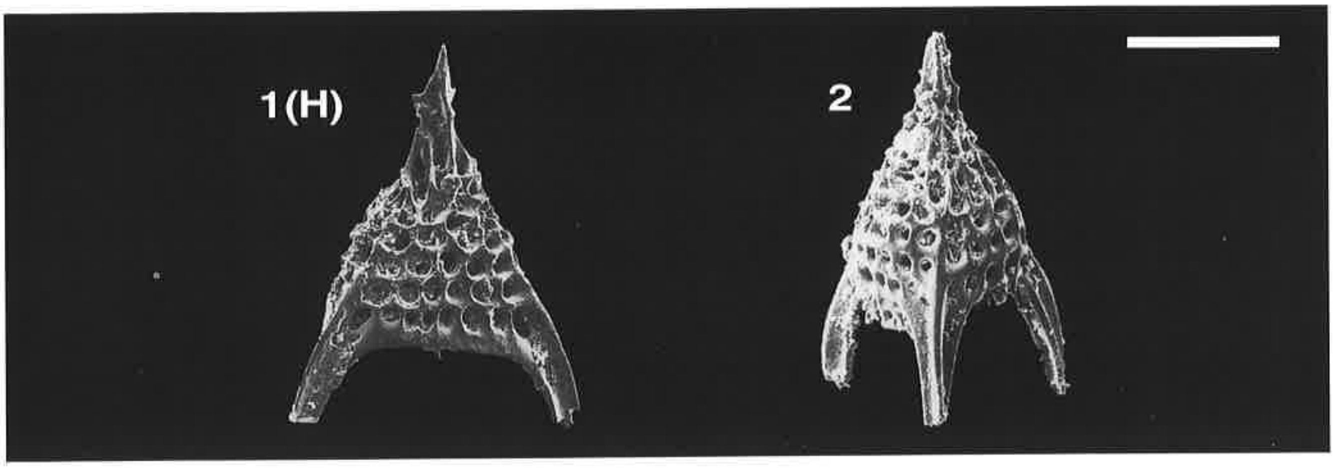


Plate 3033. *Napora pyramidalis* BAUMGARTNER. Magnification x400. **Fig. 1(H).** POB81/2704, 534.124.1.52. **Fig. 2.** POB81/2656, 534.122.1.52.

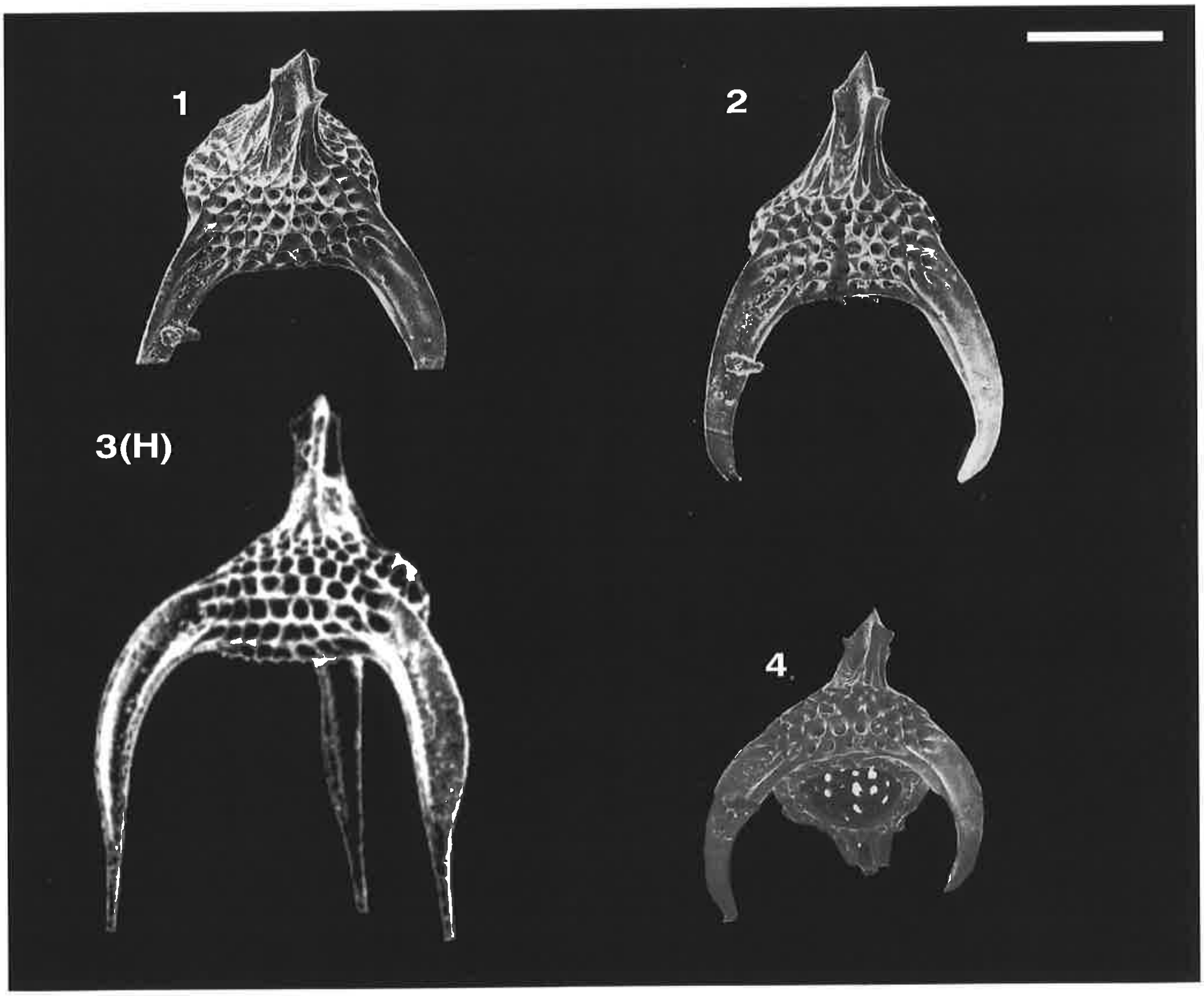


Plate 3032. *Napora saginata* TAKEMURA. Magnification x300. **Fig. 1.** POB81/2418, 534.124.1.52. **Fig. 2.** POB81/2419, 534.124.1.52. **Fig. 3(H).** TAKEMURA 1986, pl. 2, fig. 12. **Fig. 4.** POB81/2420, 534.124.1.52.

NAPORA | *A* 3030

Napora sp. A

***Synonymy*.-**
Napora sp. 1
KITO 1989, p. 171, pl. 18, figs. 14-15.

***Original Definition*.-** Test composed of two segments with a strong and long apical horn and three long feet. Apical horn triradiate in section, having three secondary grooves at the base. Cephalis imperforated. Thorax having almost tetrahedric form with three ridges prolonging distally by three feet. Meshwork of thorax regular. Three feet triradiate, and curved slightly inward, they are parallel each other. Cephalocone is not observed.

Measurements (in μm).-
Based on 4 specimens.

	av.	min.	max.
Length of horn:	150	128	170
Height Cephalis and thorax:	148	102	152
Width of thorax:	148	142	153
Length of feet:	250	234	272

***UAZones*.-** 3-3, early-mid Baj. to early-mid Baj.

NAPORA | *B* 3034

Napora sp. B

***Synonymy*.-**
Napora bukryi PESSAGNO
DE WEVER & CABY 1981, pl. 2, fig. 2K.
BAUMGARTNER 1984, p. 774, pl. 6, fig. 4.

***Remarks* .-** Included are small *Napora* with a clearly visible cephalis with a short triradiate horn with a central and three lateral points. Cephalis offset from thorax by a stricture, thorax rounded, almost hemispherical and thin curved feet.

***UAZones*.-** 7-13, late Bath.-early Call. to latest Tith.

naradaniensis >> *STICHOCAPSA NARADANIENSIS* 3045

natorensie >> *PARAHSUUM (?) NATORENSE* 3073

nipponica >> *NAPORA NIPPONICA* 3410

nodosum >> *EUCYRTIDIELLUM NODOSUM* 3014

normalis >> *DIACANTHOCAPSA NORMALIS* 4012

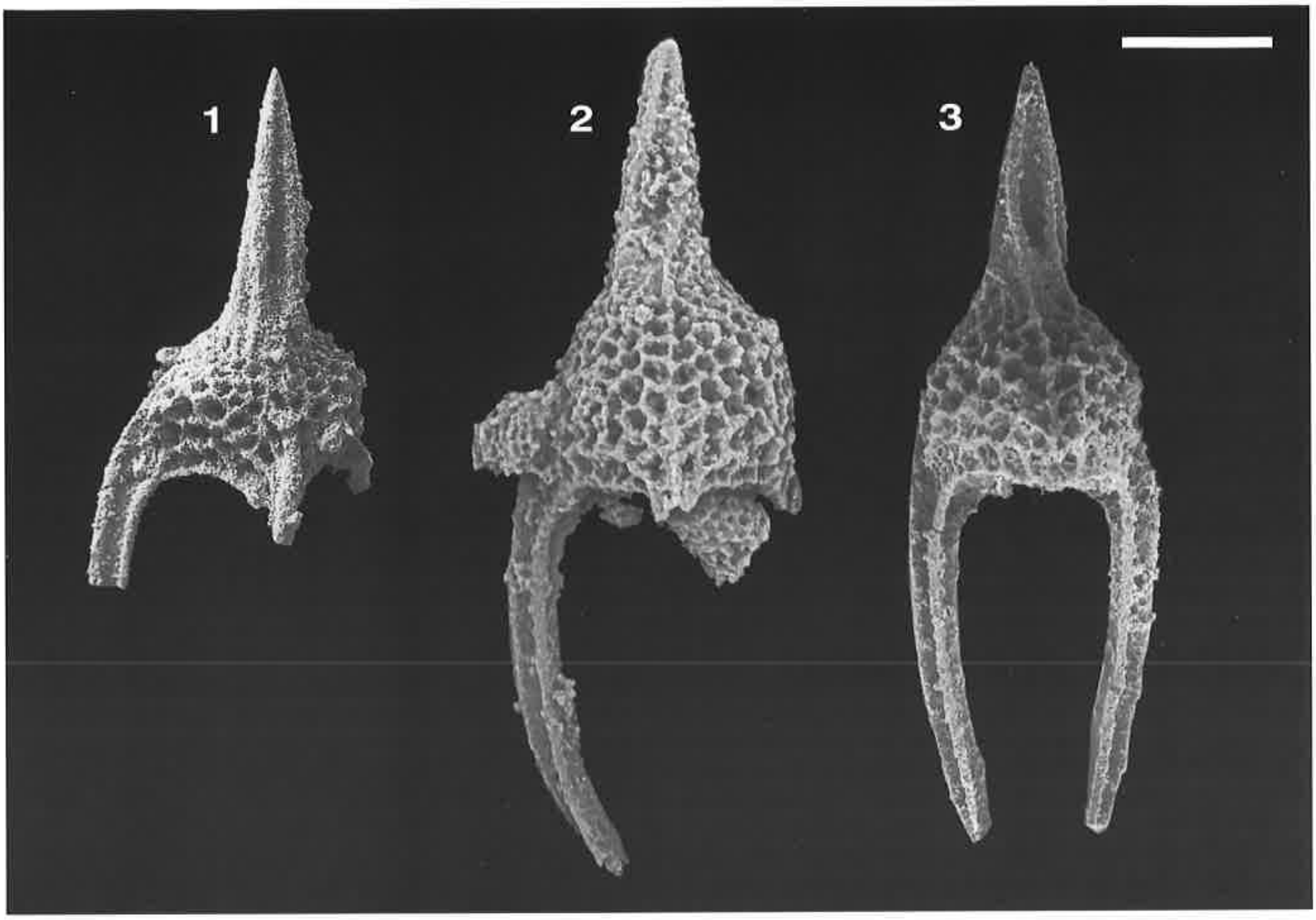


Plate 3030. *Napora* sp. A. Magnification x200. **Fig. 1.** POB81/2857, POB1341. **Fig. 2.** KI8855-1968, S68. **Fig. 3.** KI8823-1142, S66.

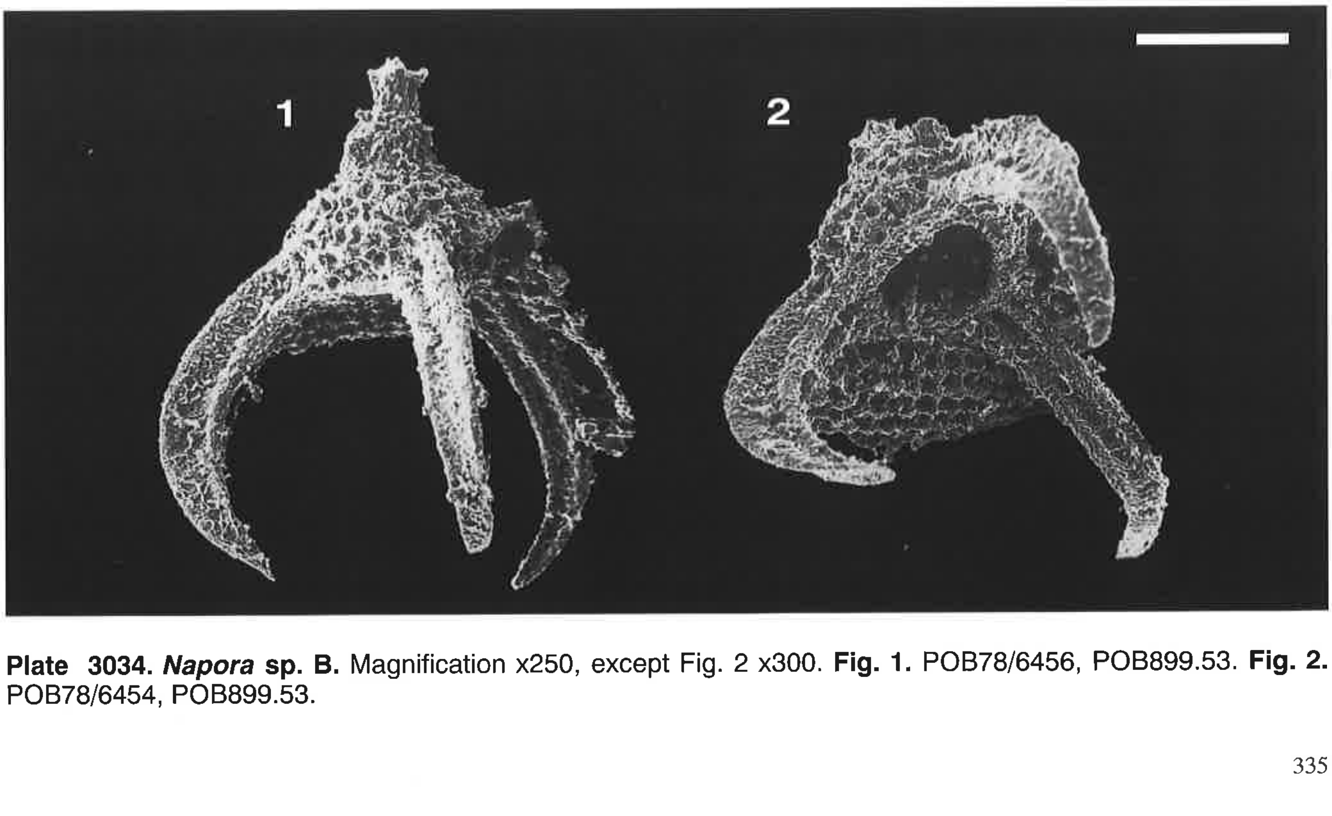


Plate 3034. *Napora* sp. B. Magnification x250, except Fig. 2 x300. **Fig. 1.** POB78/6456, POB899.53. **Fig. 2.** POB78/6454, POB899.53.

NOVIXITUS 6013

Genus: *Novixitus* PESSAGNO

Synonymy.-
Novixitus PESSAGNO
PESSAGNO 1977b, p. 54.

Type Species.- *Novixitus mclaughlini* PESSAGNO 1977b.

Original Definition.- Test as with family but lacking horn. Cephalis imperforate, separated from thorax by single row of pores; thorax sparsley perforate. Final postabdominal chamber with cylindrical to subcylindrical tubular extension lacking tubercles; extension with polygonal pore frames.

Original Remarks.- *Novixitus* n.gen. differs from *Xitus* n.gen. by lacking a horn, by having a single row of pores between the cephalis and thorax, and by having a tubular extension on its final postabdominal chamber.

Remarks.- Species have been distinguished by previous workers on test outline; distribution, size and pattern of pore frames and tubercules; the relative size of the cephalo-thoracic region to the remainder of the test.

Etymology.- *Novus, -a, -um* (Latin, adj.) = new + *Xitus.*

Included Taxa.-
5524 *Novixitus* (?) *daneliani* JUD
5693 *Novixitus* (?) *tuberculatus* WU & LI

NOVIXITUS (?) DANELIANI 5524

Novixitus (?) *daneliani* JUD

Synonymy.-
Novixitus (?) *daneliani* JUD
JUD 1994, p. 85, pl. 13, fig. 6.

Original Definition.- Test conical, consisting of 7 or more segments, with triangular termination. Cephalis, thorax and abdomen smooth, poreless, separated from one another by a single row of small pores. Postabdominal segments separated from one another by a delicate circumferential ridge with a row of pores developed above and below it. These segments are covered by a circumferential row of robust tubercles with few irregularly scattered small pores. Terminal segment wide open, triangular in cross-section, bearing 3 spiny extensions.

Original Remarks.- *Novixitus* (?) *daneliani* n.sp. differs from *Novixitus* (?) *tuberculatus* WU & LI by the presence of the triangular termination bearing 3 spiny extensions. In our material there occur both specimens with a more or less complete triangular terminal segment and specimens with a circular terminal cross section. The circular specimens were assigned by Wu & Li to *Novixitus tuberculatus.* Biostratigraphically the latter species occurrs in older samples than *Novixitus* (?) *daneliani.* The upper portion of *Novixitus* (?) *daneliani* n.sp. differs however from *Novixitus* (?) *tuberculatus* WU & LI in being conical, with straight sides, whereas the latter species has slightly inflated sides.

Etymology.- This species is dedicated to the Greek radiolarist Taniel Danelian, honouring his contributions to the knowledge of Mesozoic radiolarians.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Total height:	213	249	213	271
Maximum width:	110	122	110	129

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

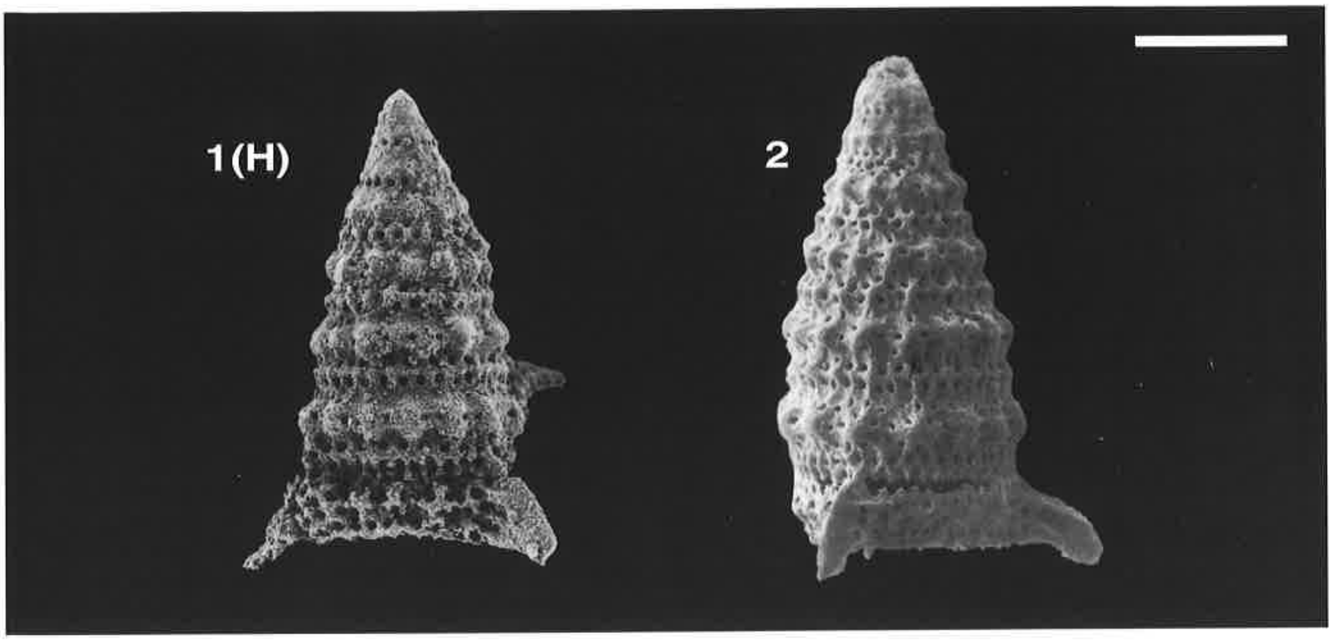


Plate 5524. *Novixitus* (?) *daneliani* JUD. Magnification x250. **Fig. 1(H).** RJ21, Br141.55. **Fig. 2.** DU401, Mo46a'.

NOVIXITUS (?) TUBERCULATUS 5693

Novixitus (?) *tuberculatus* WU & LI

Synonymy.-
Xitus sp. cf. *X. spicularius* (ALIEV)
SCHAAF 1981, p. 441, pl. 4, fig. 12.
Novixitus tuberculatus WU & LI
WU & LI 1982, p. 69, pl. 2, fig. 6.
Gen. et sp. indet.
? OKAMURA & UTO 1982, pl. 7, fig. 2.
Parvicingula sp.
THUROW 1988, p. 403, pl. 6, fig. 10.
Novixitus (?) *tuberculatus* WU
JUD 1994, p. 86, pl. 13, figs. 7-9.

Actualized Definition.- (JUD, 1994) Test conical, with convex sides, consisting of 7 or more segments. Cephalis, thorax and abdomen smooth, poreless, separated from one another by a single row of small pores. Postabdominal segments with circumferential small ridges, marking the internal partition, with a row of pores developed above and below it and circumferential rows of robust tubercles, covered with few, small pores placed on the upper and middle portions of each segment.

Actualized Remarks.- (JUD, 1994) The original diagnosis of this species is in Chinese and its validity should be questioned. *Novixitus* (?) *tuberculatus*, as it was originally illustrated, differs from *Novixitus* (?) *daneliani* n.sp. by lacking the terminal triangular segment and by having a slightly convex outline. Two of our specimens have a total length of test of 237-253 μm and a maximum width of 137-146 μm.

Type Locality.- Olistostrome of the Zongzhuo Formation, Gyangze, southern Xizang, Tibet.

UAZones.- 19-22, early Haut. to late Barr.-early Apt.

nuda >> PSEUDODICTYOMITRA NUDA 5647

nudata >> GUEXELLA NUDATA 3061

obesa >> SPONGOCAPSULA OBESA 5771

OBESACAPSULA 3664

Genus: *Obesacapsula* PESSAGNO

Synonymy.-
Obesacapsula PESSAGNO
PESSAGNO 1977a, p. 87.

Type Species.- *Obesacapsula morroensis* PESSAGNO 1977a.

Original Definition.- Test multicyrtoid, lobulate, with greatly inflated final postabdominal chamber which may form as much as three quarters of the test. Cephalis, abdomen, and all postabdominal chambers except final chamber subtrapezoidal in shape. Final chamber with cylindrical tubular extension, which is about half the diameter of the final chamber.

Original Remarks.- *Obescapsula* n.gen. is compared to *Spongocapsula* under the latter genus.

Remarks.- Species are distinguished by the external characteristics of the wall structure, the overall test shape and by the presence or absence of externally obvious segmental divisions.

Etymology.- This species is named from the Latin adjective *obesus*, meaning fat, plump, plus *capsula*, Latin noun meaning little case.

Included Taxa.-
3955 *Obesacapsula breggiensis* JUD
5568 *Obesacapsula bullata* STEIGER
3203 *Obesacapsula cetia* (FOREMAN)
3283 *Obesacapsula lucifer* (BAUMGARTNER)
3266 *Obesacapsula morroensis* PESSAGNO
5565 *Obesacapsula polyedra* (STEIGER)
6129 *Obesacapsula rusconensis* s.l. BAUMGARTNER
3282 *Obesacapsula rusconensis rusconensis* BAUMGARTNER
5796 *Obesacapsula rusconensis umbriensis* JUD
3202 *Obesacapsula verbana* (PARONA)

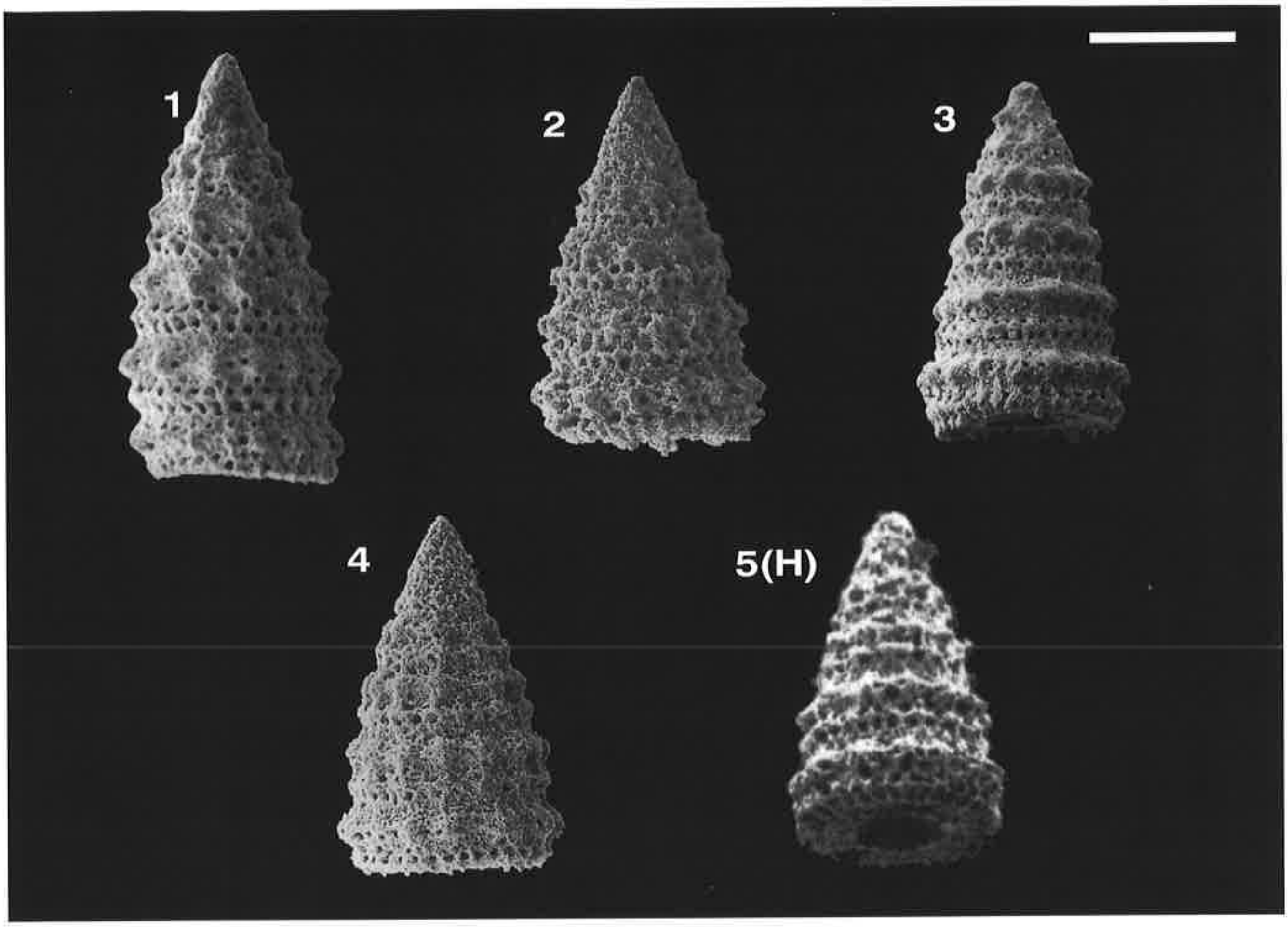


Plate 5693. *Novixitus* (?) *tuberculatus* WU & LI. Magnification x250. **Fig. 1.** RJ129, Pr225.3. **Fig. 2.** RJ100, Pr225.3. **Fig. 3.** RJ158, Bo619.9. **Fig. 4.** RJ105, Pr225.3. **Fig. 5(H).** WU & LI 1982, pl. 2, fig. 6.

OBESACAPSULA BREGGIENSIS 3955

Obesacapsula breggiensis JUD

Synonymy.-
Obesacapsula morroensis PESSAGNO
OZVOLDOVA 1990, p. 267, pl. 4, figs. 4-5.
Obesacapsula breggiensis JUD
JUD 1994, p. 86, pl. 13, fig. 10.

Original Definition.- Fusiform to globose inflated test of at least 5 segments with large distal tube on well preserved specimens. Segmental sutures only partly visible. Apical portion conical, smooth, poreless or with few, tiny pores. The following postabdominal segments are increasing in width and their surface is covered by coarse irregular nodose to spiny pore frames. Last postabdominal segment very large, globose, its height measuring more than half the size of the complete test, with irregular coarse, spiny pore frames. It is terminally flattened and on some specimens bears a long, wide cylindrical tube, as large as half of the width of the globose segment. Surface of this segment rough, covered by dense, irregular pore frames.

Original Remarks.- *Obesacapsula breggiensis* n.sp. differs from *Obesacapsula rusconensis rusconensis* BAUMGARTNER and *Obesacapsula rusconensis umbriensis* n.sp. with which it is closely related, by the weakly pronounced or even absent constrictions and by the more pointed, conical, apical portion which is straight or even slightly concave in outline.

Etymology.- Named after the river Breggia, north-east Chiasso, Switzerland, from where the type material comes.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Height excluding tube:	461	382	311	461
Maximum width test:	273	276	209	321
Maximum width tube:	-	-	178	-

Type Locality.- Breggia Gorge, Ticino, Switzerland.

UAZones.- 13-16, latest Tith. to early Val.

OBESACAPSULA BULLATA 5568

Obesacapsula bullata STEIGER

Synonymy.-
Obesacapsula sp.
AITA & OKADA 1986, p. 112, pl. 2, fig. 14.
TUMANDA 1989, p. 10, pl. 5, fig. 5.
KITO 1989, p. 209, pl. 23, fig. 17.
Obesacapsula bullata STEIGER
STEIGER 1992, p. 68, pl. 19, figs. 3-5.
JUD 1994, p. 87, pl. 14, figs. 1-3.

Original Definition.- "Spongy test of middle to very large size with 4 segments. The proximal conical part consists of the first three segments and is very well separated from the 4th large spherical segment by a very well marked change in outline. Cephalis is smooth and poreless. The following segments possess a spongy surface with numerous irregularly disposed pores. At the lower part of the test is a small central opening. The 4th segment is 2 to 4 times as high as the first three segments together."

Actualized Definition.- (JUD, 1994) Approximately spherical test, consisting of probably 3-5 segments, of which the first 3-4 segments are very small by comparison with the extremely globose last segment. Apical part conical with rounded cephalis, smooth or with only few small pores. Terminal segment very large, spherical, with small, circular aperture in distal position. Large sutural depression with fine meshwork developed at boundary with previous segment. Surface of inflated segment with coarse, irregular, spiny pore frames. Very rarely this segment has a short, wide relict of an additional segment or of a large, wide tube.

Original Remarks.- "*Obesacapsula bullata* n.sp. differs from *Obesacapsula morroensis* PESSAGNO by the visible shoulder at the boundary in between the conical proximal part and the last spherical segment."

Actualized Remarks.- (JUD, 1994) The species shows a wide variety between high forms with long apical part and almost spherical specimens with a very short apical part. The spherical forms are very common mostly in the Berriasian-Lower Hauterivian. As the same type of variability was observed with *O. cetia* (FOREMAN) and *O. polyedra* (STEIGER) all these forms were included under the species *O. bullata*. Another character common with these three species is the presence of a wide depression at the upper part of the last segment, near the boundary with the previous segment. Steiger did not mention and illustrate such a depression, and we wonder if it really exists in his species. In the case that it is absent what we herein consider as *O. bullata* would represent a new species. Our specimens have the following dimensions: height of test 480-583, max. width 452-504, height of apical portion 77-103, width of sutural depression 73-113 μm. They differ therefore clearly in size from the specimens measured by Steiger, this difference being an additional argument in favour of their assignment to another species.

Etymology.- Latin, *Bullata*, bubble.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of test:	490	392	350	490
L/W of abdomen:	365/375	286/307	250/270	365/375

Type Locality.- Kaltenhausen, Salzburg.

UAZones.- 13-19, latest Tith. to early Haut.

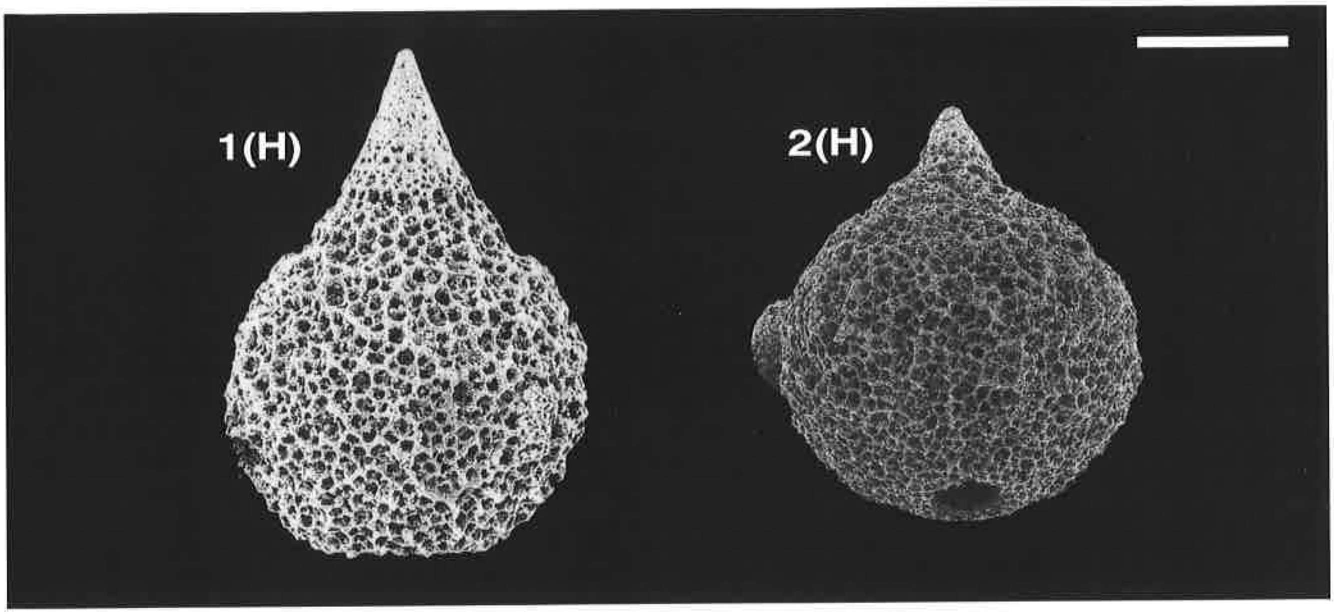


Plate 3955. *Obesacapsula breggiensis* JUD. Magnification x150. **Fig. 1(H).** RJ321, Br1330. **Fig. 2(H).** RJ322, Br1330.

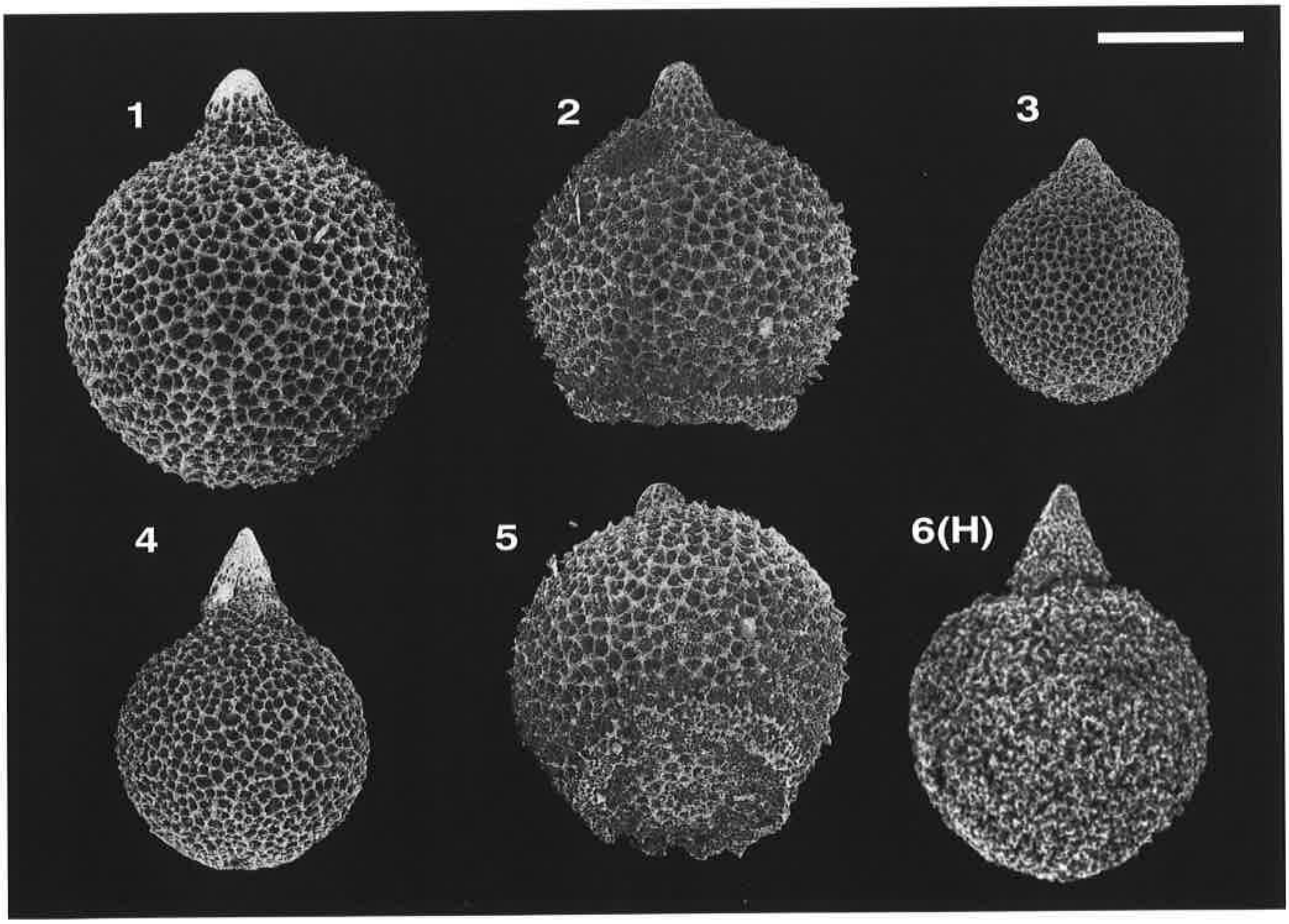


Plate 5568. *Obesacapsula bullata* STEIGER. Magnification x100. **Fig. 1.** RJ37, Br28.85. **Fig. 2.** RJ187, Br28.85. **Fig. 3.** JR328, Br1330. **Fig. 4.** RJ444, Br28.85. **Fig. 5.** RJ188, Br28.85. **Fig. 6(H).** STEIGER 1992, pl. 19, fig. 5.

OBESACAPSULA CETIA 3203

Obesacapsula cetia (FOREMAN)

***Synonymy*.-**
Sethocapsa cetia FOREMAN
FOREMAN 1973b, p. 267, pl. 12, fig. 1; pl. 16, fig. 19.
FOREMAN 1975, p. 617, pl. 6, fig. 14.
MUZAVOR 1977, p. 114, pl. 5, fig. 4.
FOREMAN 1978, p. 749, pl. 2, fig. 1.
BAUMGARTNER et al. 1980, p. 61, pl. 3, fig. 14.
KOCHER 1981, p. 89, pl. 16, figs. 4-5.
BAUMGARTNER 1984, p. 784, pl. 8, fig. 13.
OZVOLDOVA & SYKORA 1984, p. 271, pl. 5, fig. 8.
SCHAAF 1984, p. 154, fig. 4.
SCHAAF 1985, p. 266.
SANFILIPPO & RIEDEL 1985, p. 613, fig. 10.5.
SUYARI & ISHIDA 1985, pl. 2, figs. 4-5
AITA & OKADA 1986, p. 114, pl. 3, fig. 8.
AITA 1987, p. 66, pl. 14, fig. 12.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, fig. 6.
PAVSIC & GORICAN 1987, p. 28, pl. 4, fig. 9.
OZVOLDOVA 1988, pl. 4, figs. 6-7.
STEIGER 1992, p. 62, pl. 17, figs. 5-8.
Obesacapsula cetia (FOREMAN)
BAUMGARTNER 1992, p. 325, pl. 12, fig. 1.
JUD 1994, p. 87, pl. 13, fig. 11.

***Original Definition*.-** The shell is extremely large, of approximately five segments, with a very large, globose terminal segment without aperture. The cephalis is poreless without an apical spine and, in one view, appeared to have internally a branched vertical spine as illustrated in Foreman (1966, text-figures 4-6). The approximately three postcephalic segments before the terminal one form a conical section with a rough surface of small rounded pores, irregular in size and distribution. Sometimes the individual segments are expanded and the dividing strictures can be distinguished. Generally, however, they are obscured by the thick shell wall. The terminal segment has a nodose rough surface with small rounded pores, irregular in size and distribution. It may be almost spherical or flattened apically.

***Original Remarks*.-** This species differs from *Lithobotrys uva* RÜST 1885 in its larger size and more numerous nodes, and from *Stichocapsa conosphaeroides* RÜST 1898 in its considerably larger size and less regular pores. *L. uva* RÜST is reported from the Late Jurassic Aptychus shale of Germany and *Stichocapsa conosphaeroides* from the Late Jurassic Aptychus beds of Northern Italy.

***Remarks*.-** Aita & Okada 1986 have mentioned the presence of a distal apertural tube and the necessity to re-examine the classification of this species. P. Dumitrica found on all his specimens a very small aperture and a depression on the proximal part of the last globose segment. Such a depression seems to exist also on the specimen illustrated by Aita & Okada. By the mentioned depression and the terminal aperture *Obesacapsula cetia* (FOREMAN) should be assigned to a new genus which would also include *Obesacapsula polyedra* STEIGER and *Obesacapsula bullata* STEIGER.

***Etymology*.-** Greek *ketos* m. sea monster + *-ios* related to *cetius, -a, -um* monstrous.

Measurements (in μm).-
Based on 10 specimens. Length, 445-550; maximum width of shell, 330-440

***Type Locality*.-** DSDP Leg 20, Site 196, northwest Pacific basin.

***UAZones*.-** 10-17, late Oxf.-early Kimm. to late Val.

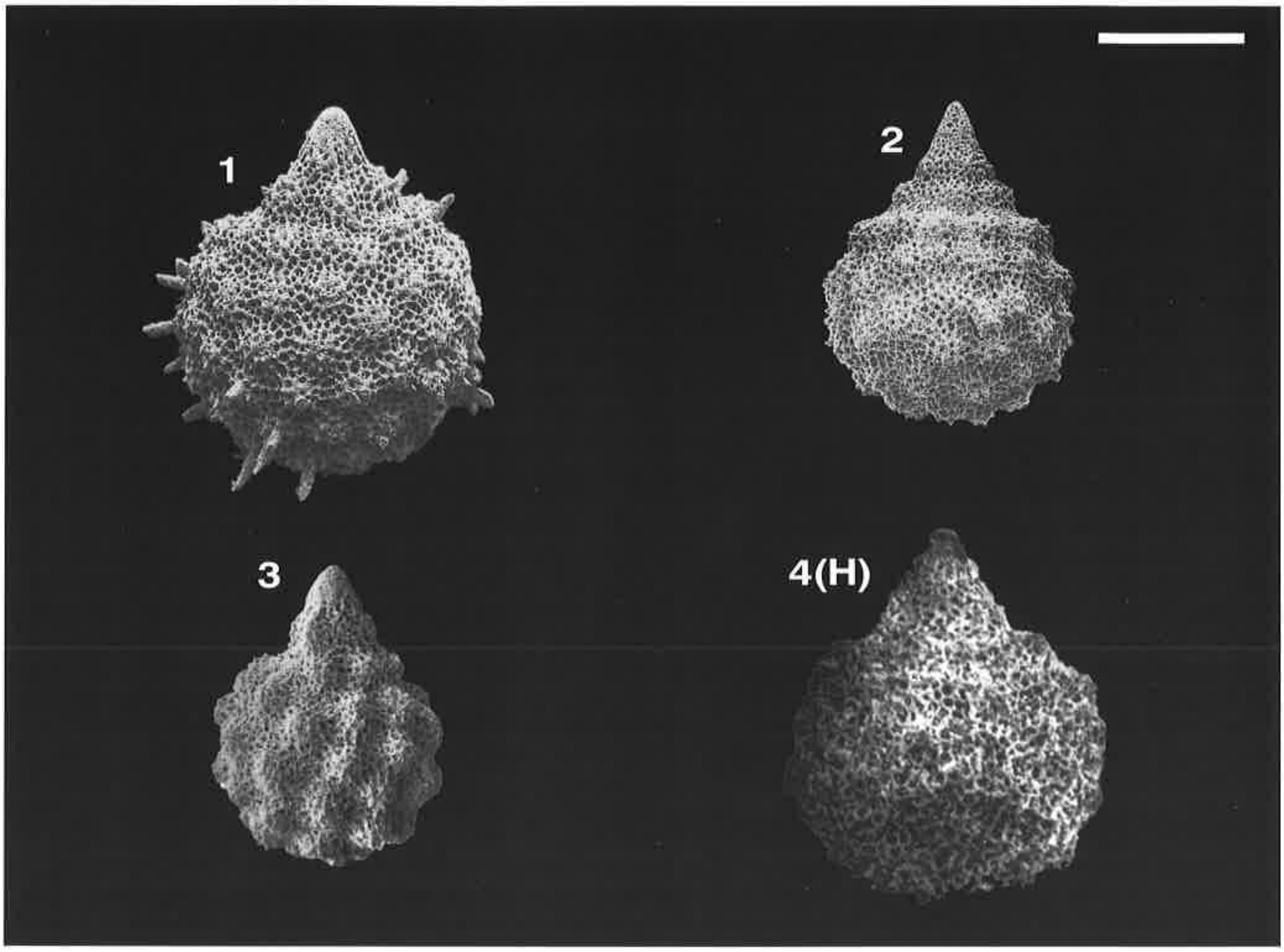


Plate 3203. *Obesacapsula cetia* (FOREMAN). Magnification x100. **Fig. 1.** POB79/5745, POB1205.3. **Fig. 2.** POB80/3019, POB1205. **Fig. 3.** RJ227, V -6.0. **Fig. 4(H).** FOREMAN 1973b, pl. 12, fig. 1.

OBESACAPSULA LUCIFER — 3283

Obesacapsula lucifer (BAUMGARTNER)

Synonymy.-
Syringocapsa lucifer BAUMGARTNER
BAUMGARTNER 1984, p. 786, pl. 9, fig. 5.
STEIGER 1992, p. 59, pl. 16, figs. 2-3.
? *Sethocapsa trachyostraca* FOREMAN
STEIGER 1992, p. 63, pl. 17, fig. 13.
Obesacapsula lucifer (BAUMGARTNER)
JUD 1994, p. 87, pl. 13, figs. 12-13.

Original Definition.- Very large form with spiny spherical postabdominal segment. Cephalis, thorax and abdomen together conical, externally smooth, with small, sparsely distributed pores. Following few (1-3?) postabdominal segments densely porous, forming a conical proximal portion together with the first three segments almost without external segmental strictures. Final postabdominal segment inflated spherical, three times as wide as conical proximal portion and forming more than half of the total height of test; the surface is densely porous, with an irregular system of rounded bars bearing numerous short, sharp spines of rounded cross section. Final segment terminates in a slender, short, imperforate terminal tube.

Original Remarks.- This species differs from *Syringocapsa limatum* FOREMAN 1973b in having a densely porous, spiny final segment and in having only a thin, short, imperforate terminal extension.

Remarks.- Included originally in the genus *Syringocapsa* this species differs from all species of the genus in having apparently a spongy wall. For this reason it seems to be better placed under the genus *Obesacapsula*. The specimen illustrated by STEIGER as *Sethocapsa trachyostraca* FOREMAN represents quite probably a member of this species with the terminal tube broken off. Anyway it does not show the morphologic characters of Foreman's species.

Etymology.- *Lucifer* (Latin) refers to a weapon used by the Middle-Age Swiss.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Height proximal part:	200	173	156	200
Width proximal part:	170	151	128	177
Height final segment:	340	368	334	405
Widthfinal segment:	390	401	362	461
Terminal tube length:	90	104	50	135
Length of spines:	60	69	50	85

Type Locality.- POB 1205.1; see locality description in Baumgartner (1984).

UAZones.- 13-16, latest Tith. to early Val.

OBESACAPSULA MORROENSIS — 3266

Obesacapsula morroensis PESSAGNO

Synonymy.-
Obesacapsula morroensis PESSAGNO
PESSAGNO 1977a, 87, pl. 11, figs. 5-8.
PESSAGNO 1977b, p. 53, pl. 11, fig. 8.
PESSAGNO et al. 1984, p. 29, pl. 4, fig. 5.
SCHAAF 1984, p. 126-127, figs. 1-5b; p. 153, fig. 12.
SUYARI & ISHIDA 1985, pl. 2, fig. 3.
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, figs. 6-7.
OZVOLDOVA 1988, pl. 4, figs. 9, 11.
JUD 1994, p. 88, pl. 13, figs. 14-15.
Obesacapsula rotunda HINDE
? NAKASEKO et al. 1979, pl. 2, figs. 11a-b.

Original Definition.- Proximal portion of test (cephalis-third postabdominal chamber) conical. Well developed strictures between postabdominal chambers. Fourth postabdominal chamber quite large and globular, forming about three quarter of test, and with tubular cylindrical extension when well preserved.

Original Remarks.- *Obesacapsula morroensis* differs from *O.* (?) *rotunda* (HINDE) by having (1) less pronounced strictures between early post-abdominal chambers, (2) fewer postabdominal chambers; and (3) a final postabdominal chamber which is at least three times as large as all previous chambers combined.

Remarks.- In our material this species shows a large variation in height, width and number of segments.

Etymology.- This species is named for Morro Bay in San Luis Obispo County, California.

Measurements (in μm).-
Based on 5 specimens. Height cephalis plus thorax 30-35; height abdomen 20-25; height PA (Post-Abdominal chamber)1: 30-40, PA2: 35-40, PA3: 40-70, PA4: 240-320, width PA4: 220-380.

Type Locality.- NSF 908 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 5-21, latest Baj.-early Bath. to early Barr.

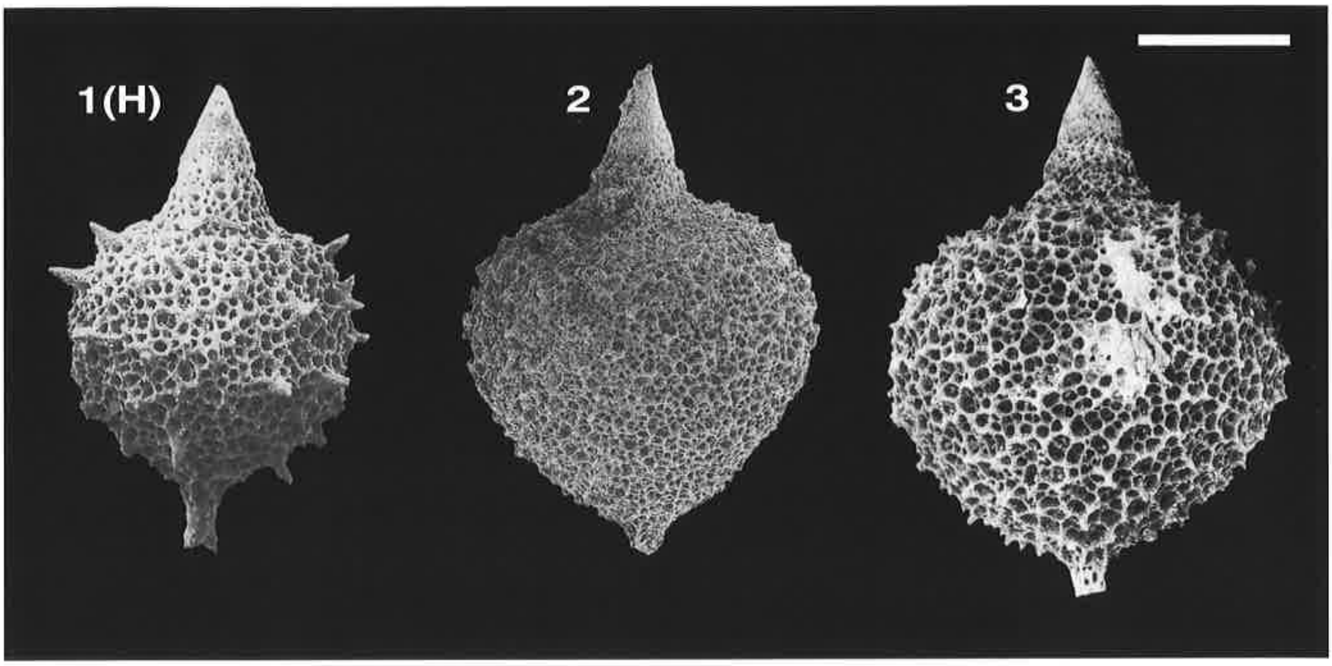


Plate 3283. *Obesacapsula lucifer* (BAUMGARTNER). Magnification x100. **Fig. 1(H).** POB79/5033, POB1205.1. **Fig. 2.** RJ154, Br28.85. **Fig. 3.** RJ51, Br28.85.

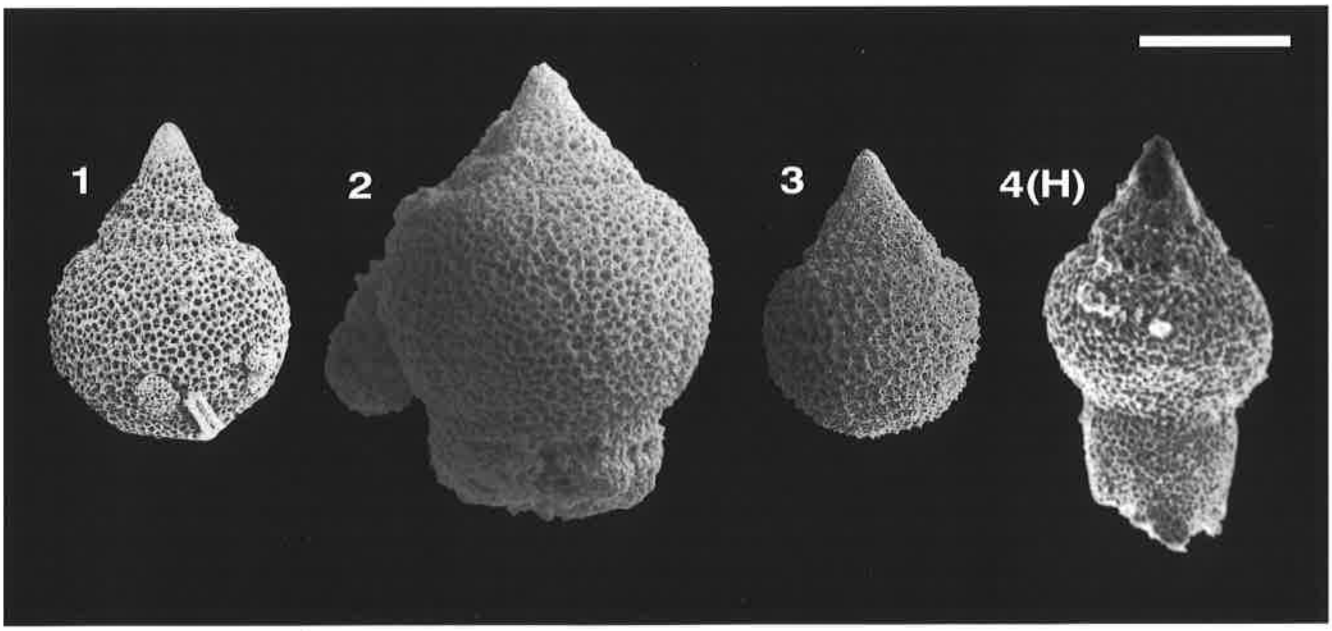


Plate 3266. *Obesacapsula morroensis* PESSAGNO. Magnification x100. **Fig. 1.** RJ419, Br1330. **Fig. 2.** RJ25, Ru146.5. **Fig. 3.** RJ16, Bo311.2. **Fig. 4(H).** PESSAGNO 1977a, pl. 11, fig. 5.

OBESACAPSULA POLYEDRA 5565

Obesacapsula polyedra (STEIGER)

Synonymy.-
Sethocapsa cetia (FOREMAN)
PESSAGNO 1977b, p. 52, pl. 9, fig. 11.
Sethocapsa polyedra STEIGER
STEIGER 1992, p. 63, pl. 17, figs. 9-10.
Obesacapsula polyedra (STEIGER)
JUD 1994, p. 88, pl. 14, figs. 4-8.

Original Definition.- "Large test with 4 segments. Cephalis without pores. Thorax composed of a relatively smooth porate ring. The last segment is approximately twice as high as the previous segments together. It is polyhedric. The surface shows porate mamillae which are interconnected by a delicate meshwork".

Original Remarks.- "*Sethocapsa polyhedra* is younger than *Sethocapsa cetia* FOREMAN. It can be mentioned that *Sethocapsa cetia* is the ancestor of *Sethocapsa polyhedra. Sethocapsa polyhedra* is similar to *Sethocapsa cetia* FOREMAN. *Sethocapsa polyhedra* differs from *Sethocapsa cetia* by having a larger size, four segments and a polyhedric surface of the last segment".

Remarks.- We included in this species several morphotypes possessing on the globose segment more or less pronounced polyhedral depressions. The borders of these depressions are smooth or, on some specimens, slightly tuberculated, the tubercles bearing sometimes long, conical, unbladed strong spines. On the uppermost part of the last globose segment there is a large, circular sutural depression on all the mentioned morphotypes, and in distal position a small aperture. Some specimens were found with a small, wide collar, on the terminal part of the last segment, which may be a relict of an additional segment or of a terminal tube. By the presence of the sutural depression *O. polyedra* (STEIGER) is closely related to *O. bullata* STEIGER and *O. cetia* (FOREMAN).

Etymology.- According to the polyedric form of the test.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of test:	418	463	418	500
Length of abdomen:	317	364	317	400
Width of abdomen:	350	388	350	400

Type Locality.- Gartenau, St. Leonhard, Salzburg.

UAZones.- 13-17, latest Tith. to late Val.

OBESACAPSULA RUSCONENSIS S.L. 6129

Obesacapsula rusconensis s.l. BAUMGARTNER

Synonymy.-
Obesacapsula rusconensis BAUMGARTNER
BAUMGARTNER 1984, p. 776, pl. 6, figs. 7-9.
STEIGER 1992, p. 67, pl. 18, figs. 12-15.
Obesacapsula morroensis PESSAGNO
STEIGER 1992, p. 67, pl. 18, figs. 10-11.
Obesacapsula rusconensis rusconensis BAUMGARTNER
JUD 1994, p. 88, pl. 14, fig. 9.
Obesacapsula rusconensis umbriensis JUD
JUD 1994, p. 88, pl. 14, figs. 10-13; pl. 15, fig. 1.

Included Taxa.-
3282 *Obesacapsula rusconensis rusconensis* BAUMGARTNER
5796 *Obesacapsula rusconensis umbriensis* JUD

AUZone.- 13-19, latest Tith. to early Haut.

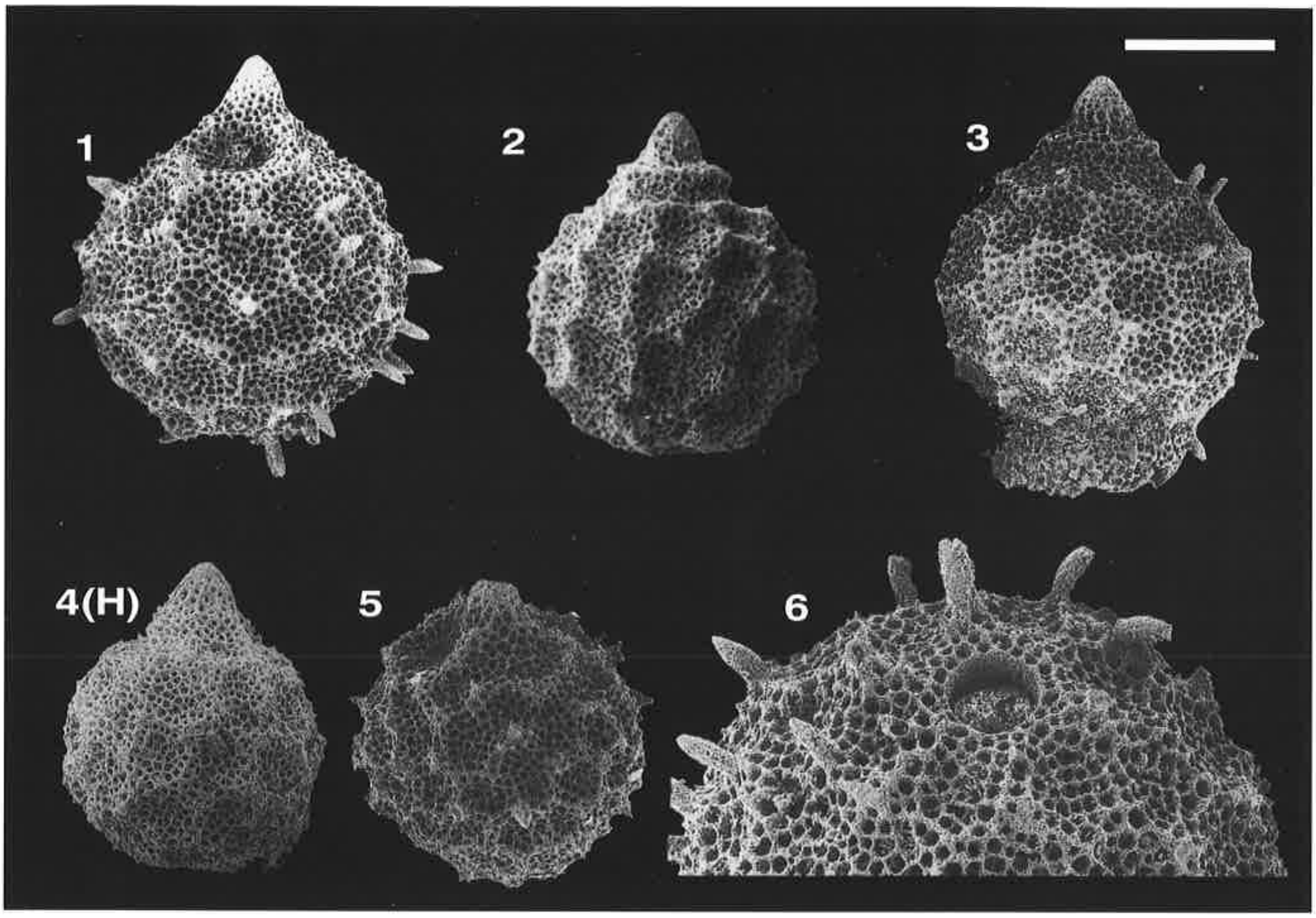


Plate 5565. *Obesacapsula polyedra* (STEIGER). Magnification x100, except Fig. 6 x200. **Fig. 1.** RJ67, Br28.85. **Fig. 2.** RJ14, Pi86.6. **Fig. 3.** RJ446, Br28.85. **Fig. 4(H).** TS27, MS4/2. **Fig. 5.** RJ158, Br28.85. **Fig. 6.** RJ68, Br28.85.

OBESACAPSULA RUSCONENSIS RUSCONENSIS 3282

Obesacapsula rusconensis rusconensis BAUMGARTNER

Synonymy.-
Obesacapsula rusconensis BAUMGARTNER
BAUMGARTNER 1984, p. 776, pl. 6, figs. 7-9.
STEIGER 1992, p. 67, pl. 18, figs. 12-15.
Obesacapsula rusconensis rusconensis BAUMGARTNER
JUD 1994, p. 88, pl. 14, fig. 9.

Original Definition.- Cephalis, thorax and abdomen together smooth, conical, almost without stricture to first postabdominal segment. First, second and third postabdominal segment cylindrical, growing gradually in width and little in height. Fourth postabdominal/final segment inflated annular to spherical, about half the height of entire test, with long tubular extension (where preserved as long as height of entire test) of about the width of third postabdominal segment. Postabdominal segments densely porous, final segments with an ornamentation of rounded irregular, sometimes spiny ridges which enclose areas of a few pores.

Original Remarks.- This species differs from *O. morroensis*, which may be its ancestor, in having a final postabdominal segment, which is less inflated and includes only about half of the test height instead of three quarters. It is further differentiated by the peculiar ornamentation on the final segment.

Etymology.- Referring to the type locality Cava Rusconi in Lombardy (northern Italy).

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Max. width of test:	65	56	50	67
Max. length of test:	68	62	57	68
W 4th segment:	96	84	78	96
L. 4th segment:	36	29	25	36
W. 5th segment:	165	144	121	165
L. 5th segment:	60	48	32	64
W. 6th segment:	234	209	170	234
H. 6th segment:	63	58	43	64
W. last segment:	330	316	305	330
H. last segment:	206	245	206	284
W. tubular extension:	245	218	185	245
W. tubular extension:	275	245	213	284

Type Locality.- Cava Rusconi, Cittiglio, Prov. Varese, Italy. Locality no. 23 of locality descriptions (Baumgartner, 1984).

UAZones.- 13-19, latest Tith. to early Haut.

OBESACAPSULA RUSCONENSIS UMBRIENSIS 5796

Obesacapsula rusconensis umbriensis JUD

Synonymy.-
Obesacapsula morroensis PESSAGNO
STEIGER 1992, p. 67, pl. 18, figs. 10-11.
Obesacapsula rusconensis umbriensis JUD
JUD 1994, p. 88, pl. 14, figs. 10-13; pl. 15, fig. 1.

Original Definition.- Test of 4-5 segments terminating with a broad distal tube. Proximal portion of test conical, compact, slightly inflated or nearly subcylindrical, distal portion consisting of a subglobose large segment. Cephalis wide conical, smooth and poreless. Thorax and abdomen mostly much wider than cephalis, sparsely porous, with slightly rough surface. Postabdominal segments increasing less in width, having coarse irregular pore frames. Last segment greatly inflated, approximately half the height of complete test, with irregular, coarse or spiny pore frames. Well preserved specimens terminating in a tube of the same diameter as distal part of the proximal portion of test; its pore frames finer than on the inflated segment.

Original Remarks.- *Obesacapsula rusconensis umbriensis* n.sp. differs from *O. rusconensis rusconensis* BAUMGARTNER by having less pronounced constrictions on the proximal portion of test, which is conical, compact and slightly inflated, and by generally lacking the very coarse meshwork and spines of the terminal segment. But by the similarity of shape and structure of surface those two subspecies are closely related.

Etymology.- Named after the Umbria-Marche region, Italy, where the type locality is located.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	min.	max.
H. test excl. tube:	393	463	333	327
H. prox. portion:	200	230	174	309
Max. w. of test:	290	299	210	382
W. terminal tube:	197	181	107	238

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

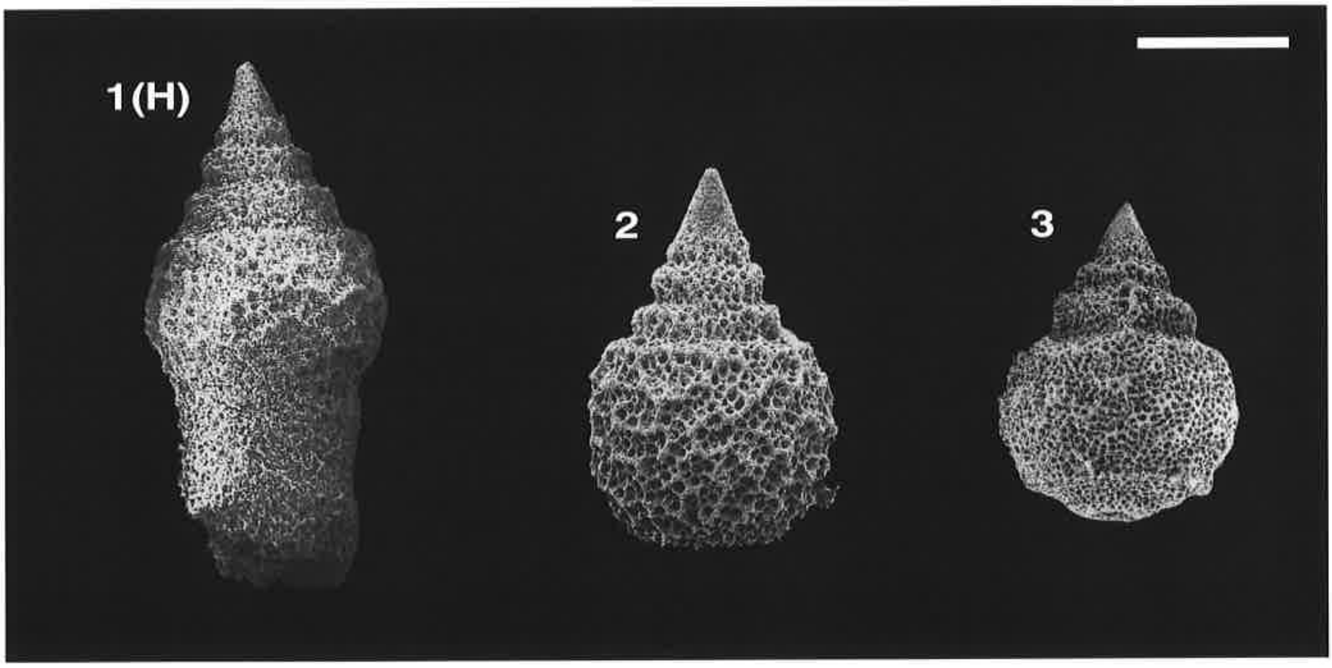


Plate 3282. *Obesacapsula rusconensis rusconensis* BAUMGARTNER. Magnification x100. **Fig. 1(H).** POB80/2996, POB1205. **Fig. 2.** POB79/5039, POB1205.1. **Fig. 3.** RJ344, Br28.85.

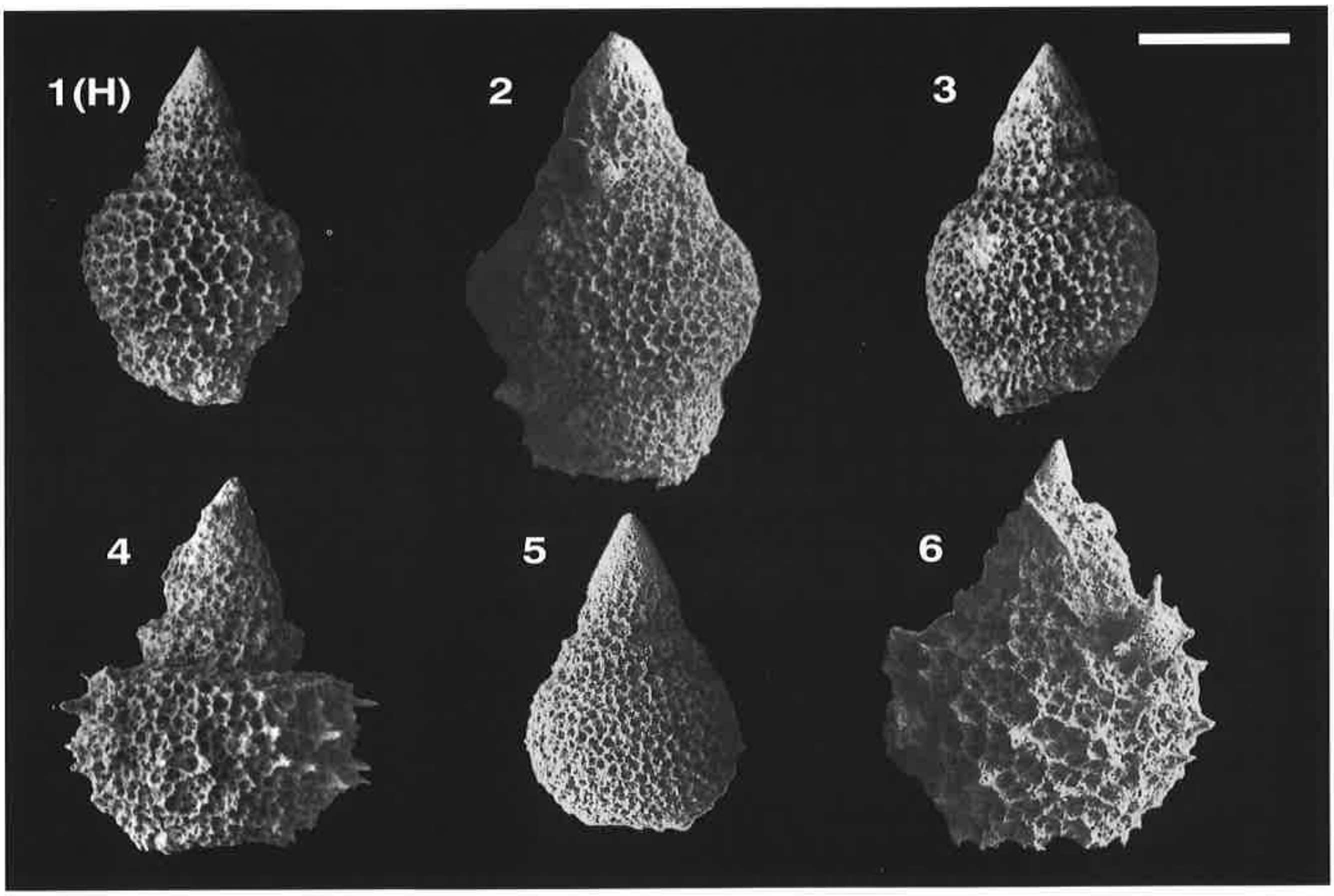


Plate 5796. *Obesacapsula rusconensis umbriensis* JUD. Magnification x100. **Fig. 1(H).** RJ1243, V -6.5. **Fig. 2.** RJ1272, Pi -10.0. **Fig. 3.** RJ1242, V -6.5. **Fig. 4.** RJ1225, Bo311.20. **Fig. 5.** RJ1246, V -6.5. **Fig. 6.** RJ1226, Bo311.20.

OBESACAPSULA VERBANA 3202

Obesacapsula verbana (PARONA)

Synonymy.-

Stichocapsa verbana PARONA
PARONA 1890, p. 171, pl. 6, fig. 14.
RÜST 1898, p. 66, pl. 19, fig. 7.
Lithocampe ingens RÜST
RÜST 1898, p. 62, pl. 17, fig. 13.
Lithocampe magnifica RÜST
RÜST 1898, p. 62, pl. 18, fig. 2.
Stichocapsa rotunda (HINDE)
HINDE 1900, p. 41, pl. 3, fig. 24.
MUZAVOR 1977, p. 122, pl. 5, figs. 11-12.
OZVOLDOVA 1979, p. 257, pl. 5, figs. 5-6.
DE WEVER et al. 1986, pl. 10, fig. 21.
Stichocapsa (?) *rotunda* HINDE
FOREMAN 1973b, p. 265, pl. 11, figs. 1-2; pl. 16, fig. 20.
FOREMAN 1975, p. 616, pl. 2J, fig. 6; pl. 7, fig. 5.
Obesacapsula rotunda (HINDE)
PESSAGNO 1977b, p. 53, pl. 9, figs. 12, 18 only.
NAKASEKO et al. 1979, pl. 2, figs. 11a-b.
NAKASEKO & NISHIMURA 1981, p. 156, pl. 11, fig. 12.
BAUMGARTNER 1984, p. 775, pl. 6, fig. 13.
PESSAGNO et al. 1984, p. 29, pl. 4, figs. 8, 10.
DE WEVER & MICONNET 1985, p. 388.
AITA & OKADA 1986, p. 112, pl. 2, figs. 8-9.
PAVSIC & GORICAN 1987, p. 26, pl. 4, fig. 7.
Syringocapsa rotunda (HINDE)
FOREMAN 1978, p. 749, pl. 2, fig. 2.
BAUMGARTNER et al. 1980, p. 62, pl. 3, fig. 12.
KOCHER 1981, p. 97, pl. 16, fig. 30.
OZVOLDOVA & SYKORA 1984, p. 271, pl. 12, fig. 7; pl. 14, figs. 4, 6.
SCHAAF 1984, p. 152, fig. 15.
Obesacapsula morroensis PESSAGNO
PESSAGNO 1977a, p. 87, pl. 11, figs. 5-8.
PESSAGNO et al. 1984, p. 29, pl. 4, fig. 5.
SCHAAF 1984, p. 126-127, figs. 1-5b; p. 153, fig. 12.
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, figs. 6-7.
OZVOLDOVA 1988, pl. 4, figs. 9, 11.
Obesacapsula verbana (PARONA)
BAUMGARTNER 1992, p. 322, pl. 7, fig. 8.
JUD 1994, p. 89, pl. 15, figs. 2-4.

Original Definition.- "Shell of 5 segments: the smallest one conical, the 2nd inflated, the 3rd subround, the 4th suboval, the 5th, which is distinctly bigger than all others is perfectly oval and as the 2nd and the fourth with the maximal diameter in transverse position. Only on one flanc small pores were observed."

Actualized Definition.- (JUD, 1994) Test conical, consisting of 5-6 segments of which the last one is globose. The first segment wide conical, smooth, apparently with fine irregular pore-frames. All following segments increasing in size, convex in outline, with irregular, rough, pore frames. Each segment is about twice as large as the previous one and covers about one third to one half of the previous segment.

Original Remarks.- "It is one of the biggest forms found in Cittiglio and resembles much *Stichocapsa conglobata* RÜST."

Actualized Remarks.- (JUD, 1994) The species shows a wide variation of the ratio between the height and width of the segments. Most specimens possess 5 segment. Very rarely there is an additional, very large 6th segment. Our specimens have a total length of 485-600 μm and an average width of about 400 μm, being larger than the holotype illustrated by Parona. *Stichocapsa conglobata* RÜST, mentioned by Parona as having affinities with *O. verbana*, has a smaller size of test, which consists of 6-7 segments, its height being of 446 μm and the width of the last segment of 326 μm. On the other way *Obesacapsula verbana* (PARONA) differs clearly from *Stichocapsa conglobata* RÜST by having irregular pore frames instead of regularly arranged round pores.

Measurements (in μm).-
Total height 489, maximal width 306, diameter of pores 6.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 11-20, late Kimm.-early Tith. to late Haut.

oblongula >> *STYLOCAPSA OBLONGULA* 3059

oblongus >> *GONGYLOTHORAX OBLONGUS* 4022

ochiensis >> *PROTUNUMA (?) OCHIENSIS* 3290

oculatus >> *POULPUS OCULATUS AFF.* 3028

odoghertyi >> *MIRIFUSUS ODOGHERTYI* 5721

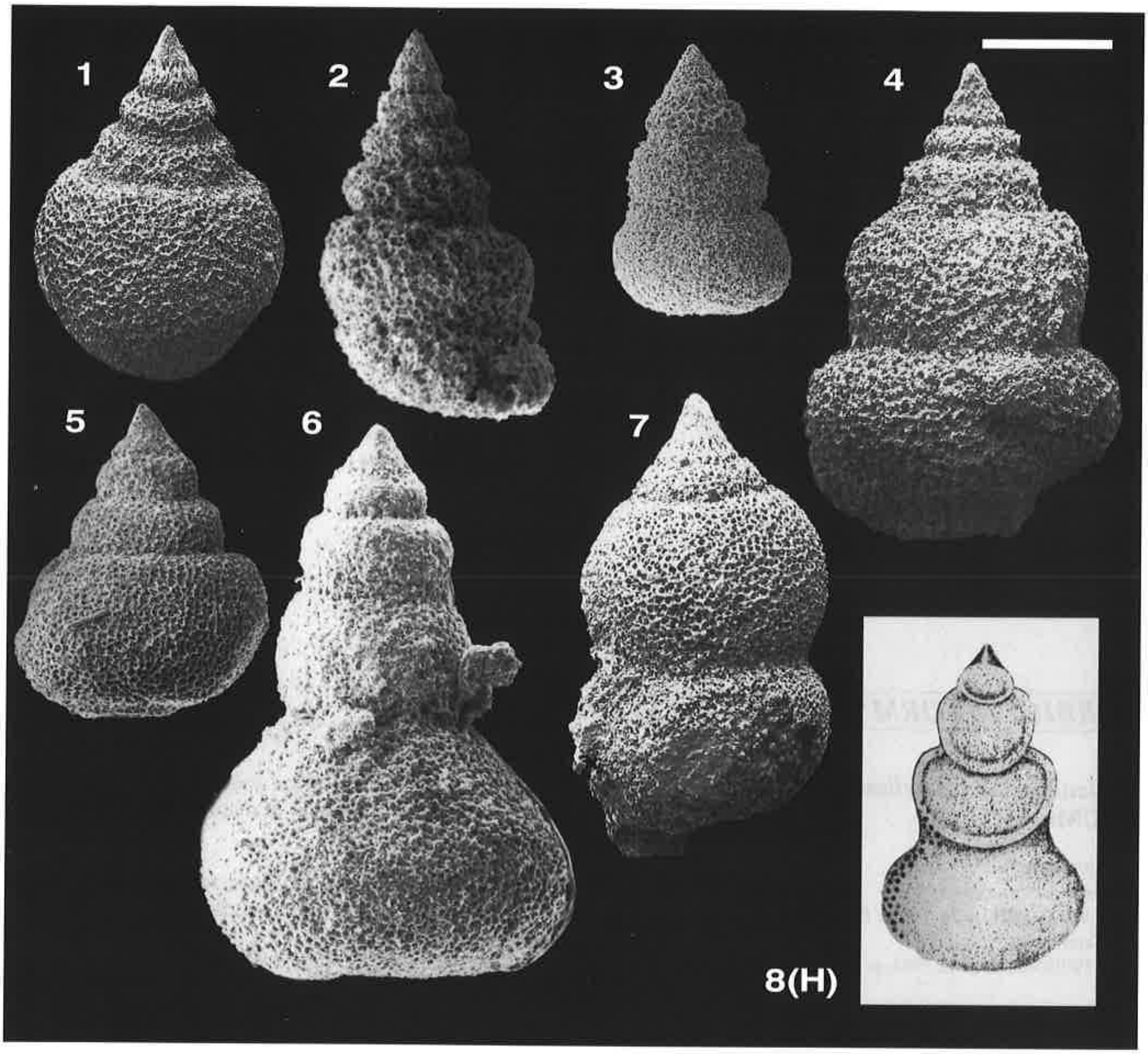


Plate 3202. *Obesacapsula verbana* (PARONA). Magnification x100. **Fig. 1.** POB80/2190, POB1134. **Fig. 2.** RJ23, Pi56.0. **Fig. 3.** RJ46, Ru146.5. **Fig. 4.** POB79/4324, 5A/7/1. **Fig. 5.** RJ51, Ru146.5. **Fig. 6.** GO892624, PK3. **Fig. 7.** POB80/2177, POB1134. **Fig. 8(H).** PARONA 1890, pl. 6, fig. 14.

officerense >> *PARAHSUUM OFFICERENSE* **2011**

okamurai >> *WRANGELLIUM OKAMURAI* **3179**

olorizi >> *PARAHSUUM (?) OLORIZI* **3071**

operculi >> *DIACANTHOCAPSA (?) OPERCULI* **3054**

ORBICULIFORMA 3665

Genus: *Orbiculiforma* PESSAGNO

Synonymy.-
Orbiculiforma PESSAGNO
PESSAGNO 1973, p. 71.

Type Species.- *Orbiculiforma quadrata* PESSAGNO 1973.

Original Definition.- Test circular to square in outline with short peripheral spines. Center of test markedly depressed; central cavity flanked by prominent rim. Central cavity occasionally obscured by fragile secondary meshwork (pl. 17, fig. 5).

Original Remarks.- Species in this genus are distinguished by overall test size and shape, the relative size, shape and depth of the central depression, the characteristics of the peripheral spines and the nature of the meshwork of the test wall. Some forms are questionably assigned to this genus because they lack peripheral spines.

Etymology.- *Orbiculus, i* (m.) = a little circle + *forma, -ae* (Latin, f.) = shape, form.

Included Taxa.-
3204 *Orbiculiforma* (?) *heliotropica* n.sp. BAUMGARTNER
3206 *Orbiculiforma* (?) sp. aff. *O. mclaughlini* PESSAGNO
3205 *Orbiculiforma* (?) *catenaria* OZVOLDOVA
2019 *Orbiculiforma* (?) sp. X

ORBICULIFORMA (?) HELIOTROPICA 3204

Orbiculiforma (?) *heliotropica* n.sp. BAUMGARTNER

Synonymy.-
Orbiculiforma sp. A
WIDZ 1991, p. 247, pl. 2, fig. 12.
Cenodiscus (?) sp.
PESSAGNO et al. 1993, p. 135, pl. 5, fig. 5.

Type Designation.- 78/6113, POB899.51.

Original Definition.- Discoidal spongodiscid with thickened periphery, and central raised knob. Pore frames are small and irregular in central raised area, grow rapidly larger and become hexagonal in the annular depression and become smaller again towards the edge of the disc. The edge is fringed with numerous (about 20) small spinelets. In transmitted light, a spiral structure and a denser spongy central area become apparent.

Original Remarks.- This species differs from other spongodiscids by its regular hexagonal pore pattern of the outer layer.

Etymology.- *Heliotropus*, Latin for sun flower. Named for its resemblance to the seed structure of the sun flower.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Diameter of disc:	194	223	175	325
Diameter ofcentral area:	48	52	45	55

Type Locality.- Sample POB 899, Lower Angelokastron Chert, Didhimi-Trapezona Composite Unit, Basal Sequence, near Angelokastron, Prov. Korinthos, Northern Argolis Peninsula, Greece.

UAZones.- 3-9 , early-mid Baj. to mid-late Oxf.

ORBICULIFORMA (?) MCLAUGHLINI AFF. 3206

Orbiculiforma (?) sp. aff. *O. mclaughlini* PESSAGNO

Synonymy.-
aff. *Orbiculiforma mclaughlini* PESSAGNO
PESSAGNO 1977a, p. 74, pl. 4, figs. 4-7.

Remarks.- This species differs from *Orbiculiforma mclauglilini* PESSAGNO by proportionally narrower central cavity and convex instead of vertical sides.

UAZones.- 8-9, mid Call.-early Oxf. to mid-late Oxf.

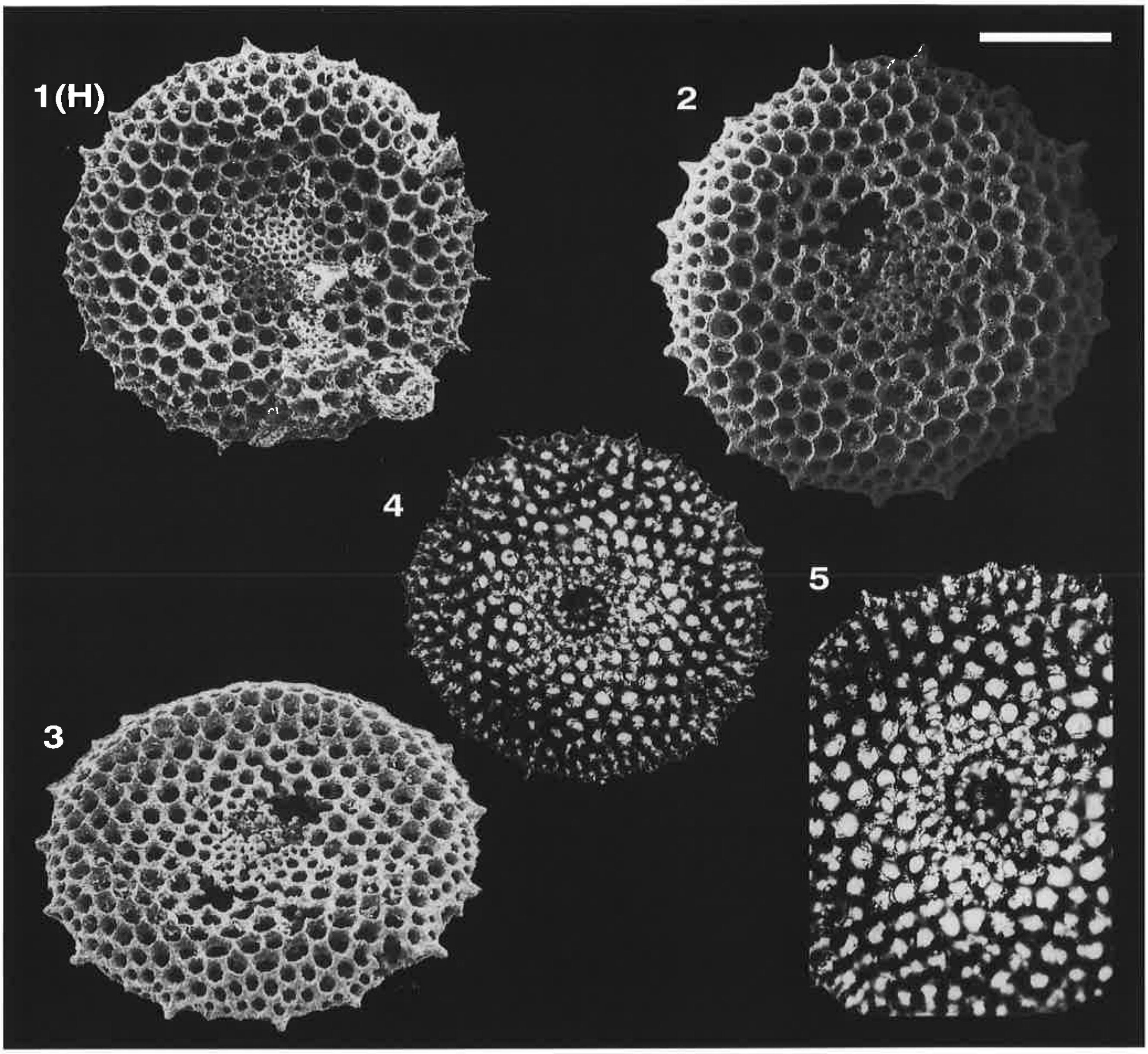


Plate 3204. *Orbiculiforma* (?) *heliotropica* n.sp. BAUMGARTNER. Magnification x200, except Fig. 5 x300. **Fig. 1(H).** POB78/6113, POB899.51. **Fig. 2.** POB79/1649, POB79.5 899. **Fig. 3.** POB79/1681, POB79.5 899. **Fig. 4.** POB899. **Fig. 5.** POB899.

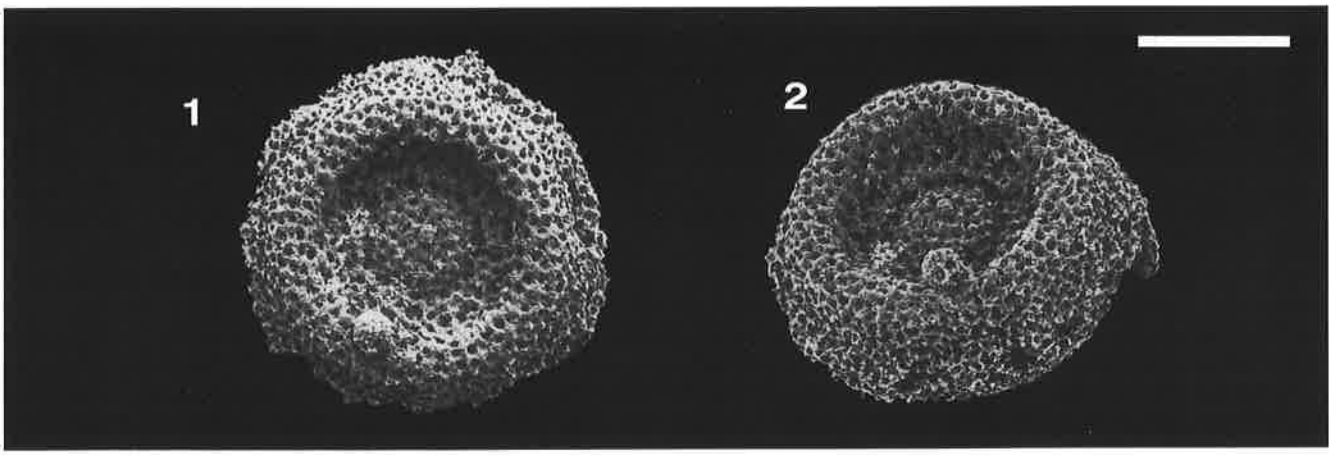


Plate 3206. *Orbiculiforma* (?) sp. aff. *O. mclaughlini* PESSAGNO. Magnification x200. **Fig. 1.** POB78/6117, POB899.51. **Fig. 2.** POB78/6118, POB899.51.

ORBICULIFORMA (?) CATENARIA 3205

Orbiculiforma (?) *catenaria* OZVOLDOVA

Synonymy.-
Orbiculiforma sp.
OZVOLDOVA 1988, pl. 2, figs. 1-2.
OZVOLDOVA 1990, p. 302, pl. 3, fig. 1.
Orbiculiforma sp. D
WIDZ 1991, p. 248, pl. 2, figs. 15-16.
Orbiculiforma (?) *catenaria* OZVOLDOVA
AUBRECHT & OZVOLDOVA 1994, p. 223, pl. 5, figs. 1-2.

Original Definition.- Test is circular in outline. Central cavity form 1/4 of the test diameter. Meshwork of the test consists of large tetragonal to polygonal pore frames of unequal size. The margin of the central cavity is conspicuously raised. It is formed by a chain of large pores to oblong shape. The central cavity is finely porous. Its centre is slightly raised.

Remarks.- Discoidal spongodiscid with a central depression in which a spherical, spongy inner shell is visible. Pores near the central depression large, circular and irregularly placed, becoming small near the periphery of the disc. Central depression with imperforate rim, inner shell with very small irregular pores.

This species is differentiated form other spongodiscids by its rimmed central depression and massive circular pore frames around it.

Etymology.- Latin *catenarius* = chain; according to the chain of pores around the central cavity.

Measurements (in μm).-

	HT	min.	max.
Width of the test:	270	230	310
Width of central cavity:	65	50	80

Type Locality.- Czajakowa Radiolarite Formation, Horné Srnie - Samasky, Pienniny Klippen Belt, Western Carpathians, Slovakia.

UAZones.- 7-9, late Bath.-early Call. to mid-late Oxf.

ORBICULIFORMA (?) \ X 2019

Orbiculiforma (?) sp. X

Remarks.- Test circular in outline with thickened periphery and rised central knob. Peripheral spines have been rarely observed. *Orbiculiforma* (?) sp. X differs from *Orbiculiforma* (?) *heliotropica* by the small and irregular pores on the entire test surface.

UAZones.- 1-6, early-mid Aal. to mid Bath.

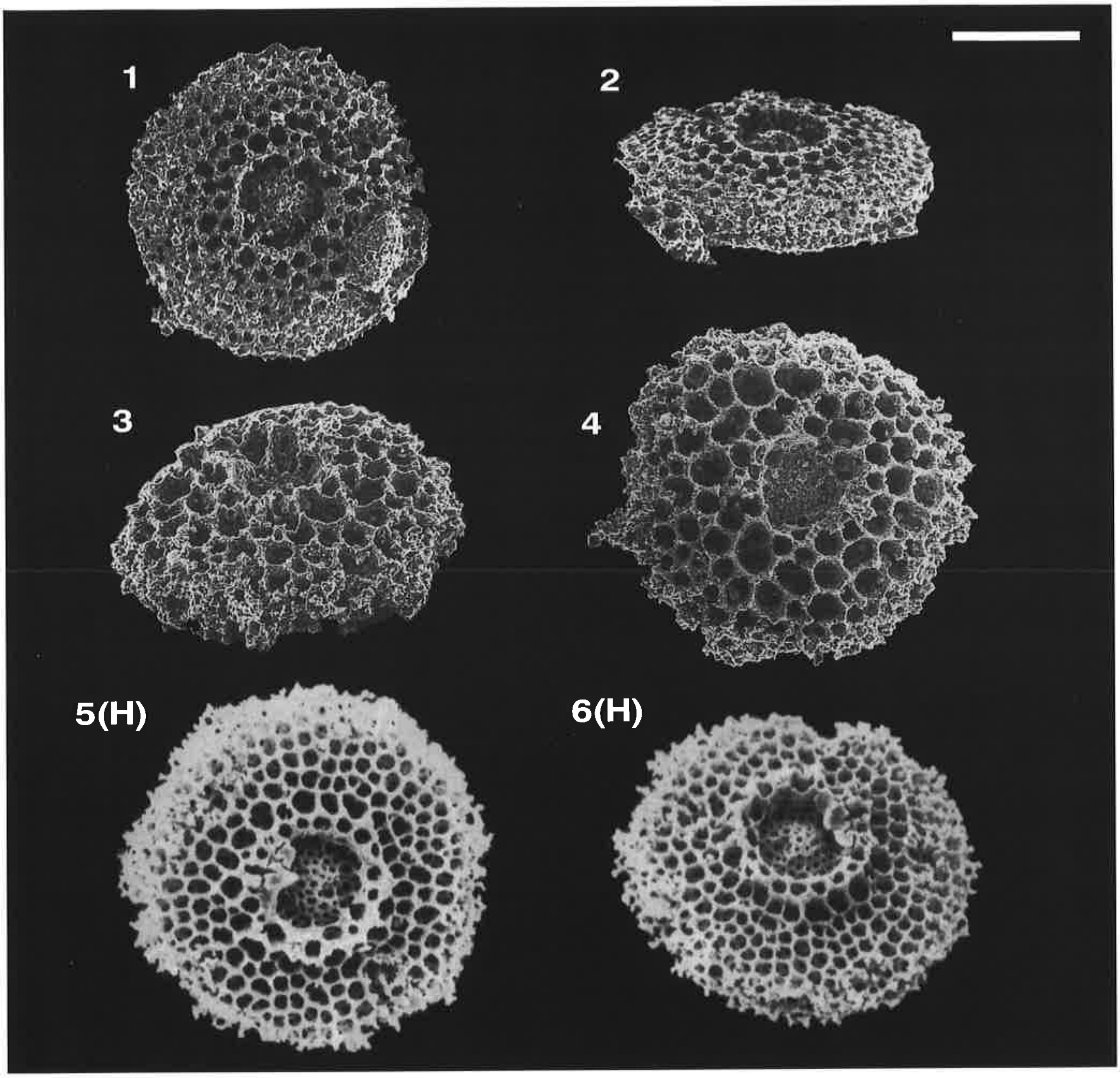


Plate 3205. *Orbiculiforma* (?) catenaria OZVOLDOVA. Magnification x200. **Fig. 1.** POB78/6535, POB899.54. **Fig. 2.** POB78/6536, POB899.54. **Fig. 3.** MC08/89, GR6. **Fig. 4.** MC09/89, GR6. **Fig. 5(H)** AUBRECHT & OZVOLDOVA 1994, pl.5, fig.1. **Fig. 6(H).** AUBRECHT & OZVOLDOVA 1994, pl.5, fig.2.

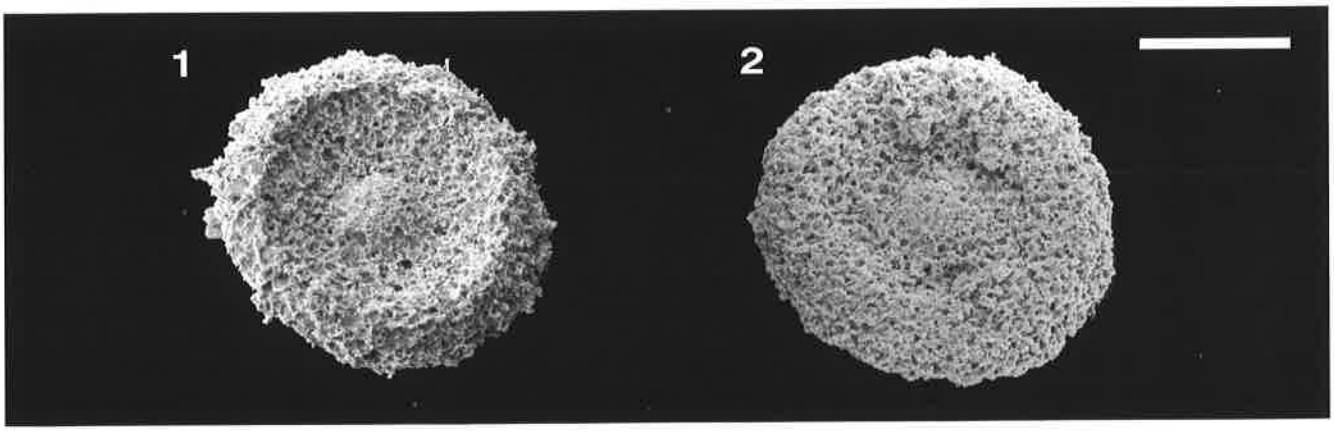


Plate 2019. *Orbiculiforma* (?) sp. X. Magnification x200. **Fig. 1.** AB6862, TM105.50.d28. **Fig. 2.** AB 2395, TM163.05.d71.

orca >> SETHOCAPSA (?) ORCA	*5553*

ordinaria >> EMILUVIA ORDINARIA	*4015*

ordinarium >> PERISPYRIDIUM ORDINARIUM GR.	*3100*

orea >> EMILUVIA OREA OREA	*3224*

orea >> EMILUVIA OREA S.L.	*4069*

orea >> EMILUVIA OREA ULTIMA	*4070*

osteosa >> DITRABS (?) OSTEOSA	*3912*

ovalis >> QUARTICELLA OVALIS	*4078*

ovum >> PHASELIFORMA OVUM	*5362*

ovum >> ZHAMOIDELLUM OVUM	*4079*

pachyderma >> ARCHICAPSA (?) PACHYDERMA	*4007*

pagei >> SAITOUM PAGEI	*3020*

pagei >> SAITOUM PAGEI AFF.	*3027*

PALINANDROMEDA 3606

Genus: *Palinandromeda* PESSAGNO, BLOME & HULL

Synonymy.-
Andromeda BAUMGARTNER
BAUMGARTNER et al. 1980, p. 49.
TAKEMURA 1986, p. 63.
"Andromeda" BAUMGARTNER
YANG & WANG, 1990, p. 212.
Palinandromeda PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 159.

Type Species.- *Andromeda crassa* BAUMGARTNER 1980.

Original Definition.- Broadly conical theoperid with five or more (usually six or seven) segments and large basal aperture. Cephalis dome-shaped, poreless, usually with apical horn. Cephalic spines : dorsal, vertical and primary lateral spines form a junction near the center of the base of the cephalis. The apical spine is close to, or attached to the cephalic wall (see plate 4, figures 6-8 of Baumgartner et al. 1980). Secondary lateral spines seem to be lacking. Thorax small, cylindrical, directly joined to the cephalis. Abdomen and postabdominal segments trapezoidal or bell-shaped; pores markedly increasing in size distally, usually of hexagonal arrangement resulting in linear vertical rows extending over all postabdominal segments. Final postabdominal segment extended trapezoidal or bell-shaped, with a sharp basal edge often fringed with outwards directed spines. Basal surface planiform with a large central aperture surrounded by an annular irregularly porous surface. Aperture surrounded by an annular irregularly porous surface. Aperture may be covered by a delicate meshwork of wide, irregular pores.

Original Remarks.- This genus differs from other theoperid genera by its peculiar broad conical shape, its large basal aperture and its distinct cephalic structure.

Actualized Remarks.- (TAKEMURA, 1986) Baumgartner et al. (1980) presented a SEM photograph of cephalic skeletons of *Andromeda crassa* BAUMGARTNER et al. 1980 (pl. 4, fig. 9). However, the preservation of this specimen does not allow examination of the details of the internal structure. *Andromeda praepodbielensis* from TKN-105 possesses a weak VB on the inner surface of the cephalis, the genus *Andromeda* is assigned to the family Amphipyndacidae.

Etymology.- Named after the wife of the mythical heros *Perseus*, founder of *Mycenae.* The new generic name *Palinandromeda* is proposed because the name *Andromeda* was occupied.

Included Taxa.-
3009 *Palinandromeda crassa* (BAUMGARTNER)
3005 *Palinandromeda depressa* (DE WEVER & MICONNET)
3415 *Palinandromeda* sp. aff. *P. depressa* (DE WEVER & MICONNET)
3004 *Palinandromeda murcheyae* n.sp. BAUMGARTNER
3008 *Palinandromeda podbielensis* (OZVOLDOVA)
3007 *Palinandromeda praecrassa* (BAUMGARTNER)
3006 *Palinandromeda praepodbielensis* (BAUMGARTNER)
3010 *Palinandromeda sognonensis* n.sp. BAUMGARTNER

PALINANDROMEDA CRASSA *3009*

Palinandromeda crassa **(BAUMGARTNER)**

Synonymy.-
Andromeda crassa BAUMGARTNER
BAUMGARTNER et al. 1980, p. 50, pl. 4, figs. 1-9; pl. 6, fig. 12.

Original Definition.- Large inflated form with seven segments. Cephalis bearing a short slender horn. Cephalis, thorax and abdomen together conical, externally smooth without visible strictures; abdomen with a single row of pores. Postabdominal segments inflated trapezoidal, rapidly increasing in width and height. Pores large, rounded. Final postabdominal segment tire-shaped, inflated, about double the height of second last segment. The distal (basal) edge is fringed with eight to twelve slender, outwards directed spines. The basal surface is slightly concave. Rare specimens show a preserved fragile concave meshwork spread over the large aperture.

Original Remarks.- This species differs from *A. violae* by its inflated shape, by a conical imperforate cephalothorax, one more segment and its concave basal surface, etc.

Etymology.- *Crassus, a, um* = Latin, fat, corpulent.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Max. H. test:	83	73	60	83
Width abdomen:	75	64	50	75
H/W 4th seg.:	29/105	26/93	23/70	29/105
H/W 5th seg.:	33/173	32/150	30/134	35/173
H/W 6th seg.:	70/293	62/260	54/250	70/293
H/W 7th seg.:	189/395	178/373	145/349	235/395
W. basal aper.:	-	214	195	230
L. basal spines:	86	74	71	86

Type Locality.- Angelokastron, Korinthos, Greece.

UAZones.- 7-10, late Bath.-early Call. to late Oxf.-early Kimm.

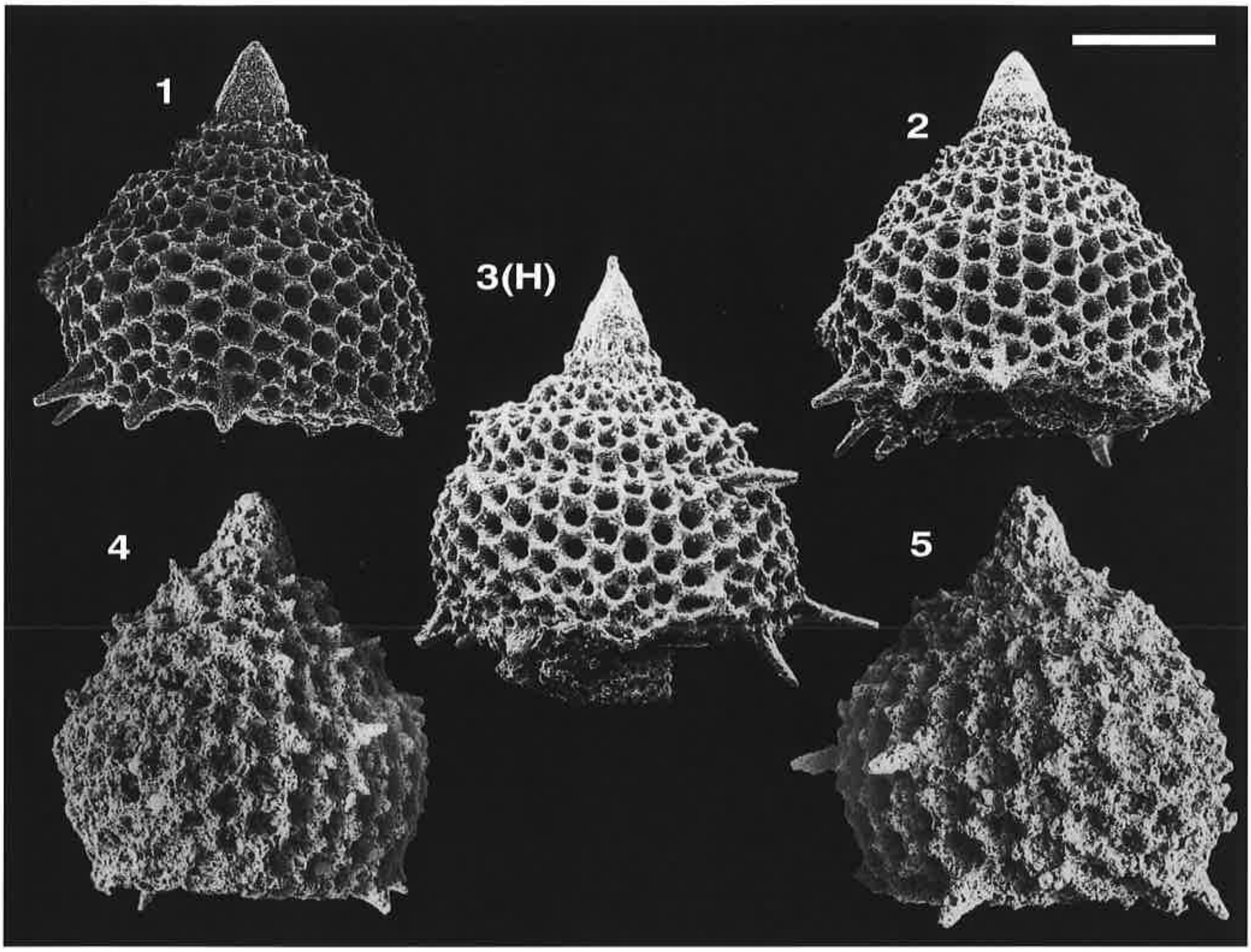


Plate 3009. ***Palinandromeda crassa*** **(BAUMGARTNER).** Magnification x150. **Fig. 1.** POB78/6547, POB899.54. **Fig. 2.** POB78/6514, POB899.54. **Fig. 3(H).** POB78/6521, POB899.54. **Fig. 4.** DU3754, SV19. **Fig. 5.** DU3753, SV19.

PALINANDROMEDA DEPRESSA 3005

Palinandromeda depressa (DE WEVER & MICONNET)

Synonymy.-
Andromeda depressa DE WEVER & MICONNET
DE WEVER & MICONNET 1985, p. 384, pl. 2, figs. 1-2, 4-5.
DANELIAN 1989, p. 138, pl. 2, figs. 9-10.
Andromeda podbielensis (OZVOLDOVA)
SCHAAF et al. 1985, pl. II A, fig. 8.
EL KADIRI 1984, p. 269, pl. 2, figs. 5-6 only.

Original Definition.- "Very flattened form with proximal part conical. Apical horn stout, its outline having no notable difference as compared to that of cephalis. The first three proximal segments (cephalis, thorax, abdomen) form together a generally conical body the outline of which shows constrictions at the level of each intersegmentary boundary. Postabdominal segments are much broader than the preceeding segments whereas their height remains similar giving the skeleton a very flattened appearance. A depression, in apical view, is visible at the junction of the third and fourth segments, resulting in the crushed aspect of this species. Pores are regularly arranged on the shell. Cephalis possesses pores on the distal part only. The other segments present pores of sensibly same size disposed in more or less regular vertical rows on thorax and abdomen. Pores of adjoining vertical rows are quincuncially disposed".

Original Remarks.- "This species differs from all the other species of the genus by its extremely flattened appearance and by a very high width\height ratio".

Etymology.- From the latin *depressa*, depressed, this form seeming flattened in proximo-distal direction as compared to other species of the genus.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.
Height\width of cephalis:	30-60	28-67
Height\width of thorax:	30-110	28-105
Height\width of abdomen:	40-180	42-180
Height\width of largest segment:	60-450	52-425
Height\width of entire sell:	150-450	175-430

Type Locality.- Radiolarite section 750m north of San Fele in the canyon of Bradano torrent.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

PALINANDROMEDA DEPRESSA AFF. 3415

Palinandromeda sp. aff. *P. depressa* (DE WEVER & MICONNET)

Definition.- Broadly conical form of 8-9 segments with concave outlines in lateral view, and flattening-out terminal segment. Cephalis bears a very small horn or is rounded. Cephalis, thorax and abdomen together slenderly conical, covered with fine spines and nodes, postabdominal segments trapezoidal, rapidly growing in width. Each segment makes a distinct shoulder in lateral view. Second last and last segment form together more than half of the test height and never more than three times the width of the previous segment. Last segment flattens out to a basal edge that is fragile and bears, when preserved, small thorns on vertices of pores, that could possibly represent the attachment of a more delicate but not preserved meshwork. Pores roughly organized in vertical rows, getting very large and distinctly oval shaped on last segment. The basal surface seems to be connected by an inner latticed meshwork of bars to the upper surface of the last segment. This meshwork is visible through the large oval pores.

Remarks.- This species compares in overall shape to *Palinandromeda depressa* and *P. murcheyae*. However, it differs from *P. depressa* by possesing much larger pores on the last segment and from *P. murcheyae* by the absence of a sharp, spiny basal edge.

UAZones.- 3-4, early-mid Baj. to late Baj.

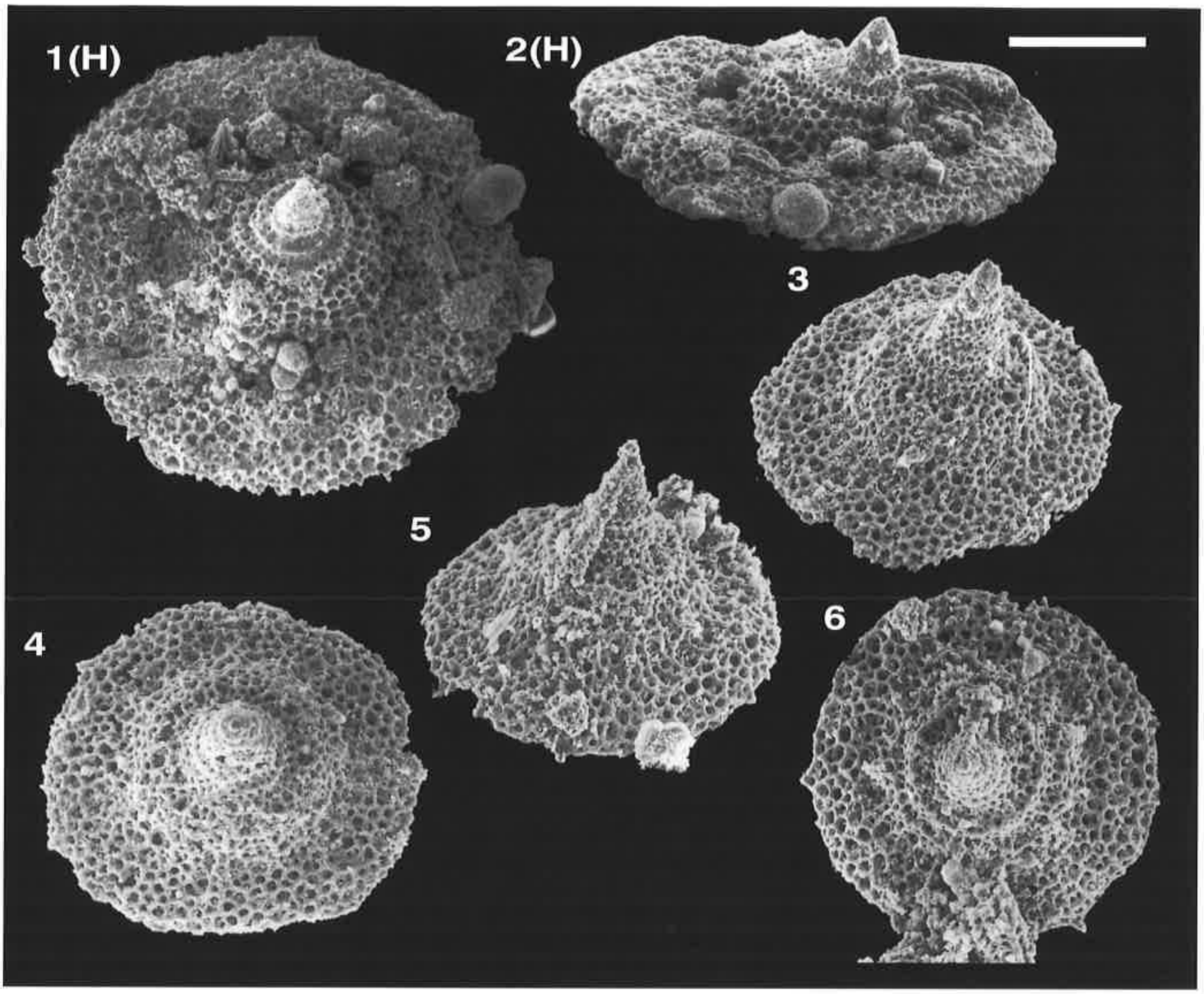


Plate 3005. *Paliandromeda depressa* (DE WEVER & MICONNET). Magnification x150. **Fig. 1(H).** DW8309-16, 15181. **Fig. 2(H).** DW8309-17, 15181. **Fig. 3.** MC1, GR6. **Fig. 4.** MC2, GR6. **Fig. 5.** MC3, GR6. **Fig. 6.** MC4, GR6.

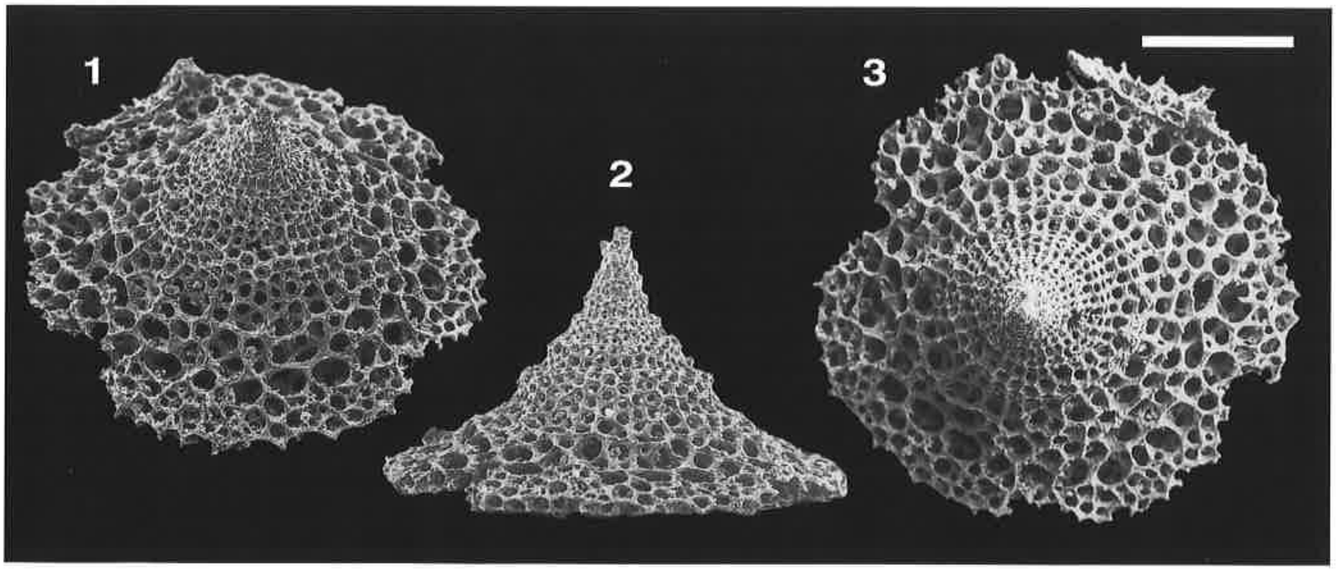


Plate 3415. *Palinandromeda* sp. aff. *P. depressa* (DE WEVER & MICONNET). Magnification x150. **Fig. 1.** POB79/4439, IN7. **Fig. 2.** POB79/4438, IN7. **Fig. 3.** POB79/4442, IN7.

PALINANDROMEDA MURCHEYAE 3004

Palinandromeda murcheyae n.sp. BAUMGARTNER

Type Designation.- 81/2887, POB 1341.

Original Definition.- Broadly conical form of usually 6-7 segments with concave outlines in lateral view and flattening-out terminal segment. Cephalis bears a short blunt horn. Cephalis, thorax and abdomen together conical, smooth, poreless except for the abdomen. Postabdominal segments inflated trapezoidal, growing rapidly in width. Last segment is nearly 3 times as high and 3 times as wide as the second last, broadly bell shaped and flares out distally towards basal edge bearing about 10-15 short spines. Pores roughly organized in vertical rows, rapidly growing in size from abdomen to last segment. Irregular vertical ridges emerge on second last and on last segment, separating rows of pores. Basal surface broad, concave, with a lip around aperture, the width of which is less than a third of the basal width of entire test.

Remarks.- This species has similar proportions as *A. depressa* DE WEVER & MICONNET, it is distinguished from the latter by the presence of spines on the basal edge and by the different pore structure.

Etymology.- Named in honour of Dr. Benita Murchey, U.S. Geological Survey, Menlo Park, California, in honor of her radiolarian work in Western North America.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
H/W whole test:	233/433	235/440	225/430	245/450
W. basal aperture:	150	160	150	165

Type Locality.- Sample POB 1341, collected 4.10 m below sharp base of the basal green radiolarites in the top part of the Sogno Formation. Locality no. 19 of Baumgartner (1984, p. 796, pl. 12).

UAZones.- 3-6 , early-mid Baj. to mid Bath.

PALINANDROMEDA PODBIELENSIS 3008

Palinandromeda podbielensis (OZVOLDOVA)

Synonymy.-
Anthocorys podbielensis OZVOLDOVA
OZVOLDOVA 1979, p. 257, pl. 4, figs. 1-3.
Andromeda violae BAUMGARTNER
BAUMGARTNER et al. 1980, p. 50, pl. 4, figs. 10-14; pl. 6, fig. 11.
SATO et al. 1982, pl. 4, fig. 9.
NISHIZONO et al. 1982, pl. 2, fig. 15.
EL KADIRI 1984, p. 267, pl. 2, figs. 1, 3; pl. 3, fig. 5; pl. 25, fig. 9.
PESSAGNO et al. 1984, p. 30, pl. 4, figs. 16, 18, 19.
SATO et al. 1986, pl. 2, fig. 19.
AITA 1987, p. 64.
Acanthocorys podbiliensis OZVOLDOVA
STEIGER 1981, pl. 14, fig. 9.
Andromeda podbielensis (OZVOLDOVA)
KOCHER 1981, p. 54, pl. 12, figs. 8-9.
ORIGLIA-DEVOS 1983, p. 151, pl. 17, figs. 18-19.
BAUMGARTNER 1984, p. 755, pl. 1, figs. 11-12.
not EL KADIRI 1984, p. 269, pl. 2, figs. 2, 4-6.
DE WEVER & MICONNET 1985, p. 384, pl. 3, figs. 1-2, 6-7, 9.
? DE WEVER et al. 1986, pl. 9, figs. 10-11, 17.
KISHIDA & HISADA 1986, fig. 2.20.
OZVOLDOVA & PETERCAKOVA 1987, pl. 31, figs. 4-5.
OZVOLDOVA 1988, pl. 6, fig. 5.
DANELIAN 1989, p. 138, pl. 2, fig. 11.
Andromeda depressa DE WEVER & MICONNET
DE WEVER et al.1987, pl. A, fig. 5.
Andromeda crassa BAUMGARTNER
KITO 1989, p. 216, pl. 25, fig. 8, not fig. 7.

Original Definition.- Test with meshwork consists of 6 segments. The first one -cephalis- is of a hemispherical shape. The other four ones form a high cone with it. The last segment suddenly expands in width into a bell shape and its height forms almost a half of the whole test height. In the place of connection with the other one, each segment expands in width into a terrace by which the surface of the cone gains undulated morphology. First four segments are finely porous, with pore structure not clear. Pores of the fifth segment are of a rounded hexagonal shape and they are about half as large as those of the previous segments. The last segment is formed by a large porous hexagonal meshwork. On the circumference of the last segment, 9-11 sharp and short thorns ascend, distributed without any conspicuous symmetry. Mouth is open, wide, lined with a porous belt, width of which ranges to 1/4 of test width.

Etymology.- After the type locality - Podbiel, Orava.

Measurements (in μm).-
Based on 5 specimens.

	HT	min.	max.
Height of test:	250	230	300
Width of test:	350	330	350
Length of thorns:	20	10	30

Type Locality.- The Cervena Skala klippe at Podbiel, Orava, Slovakia

UAZones.- 5-9, latest Baj.-early Bath. to mid-late Oxf.

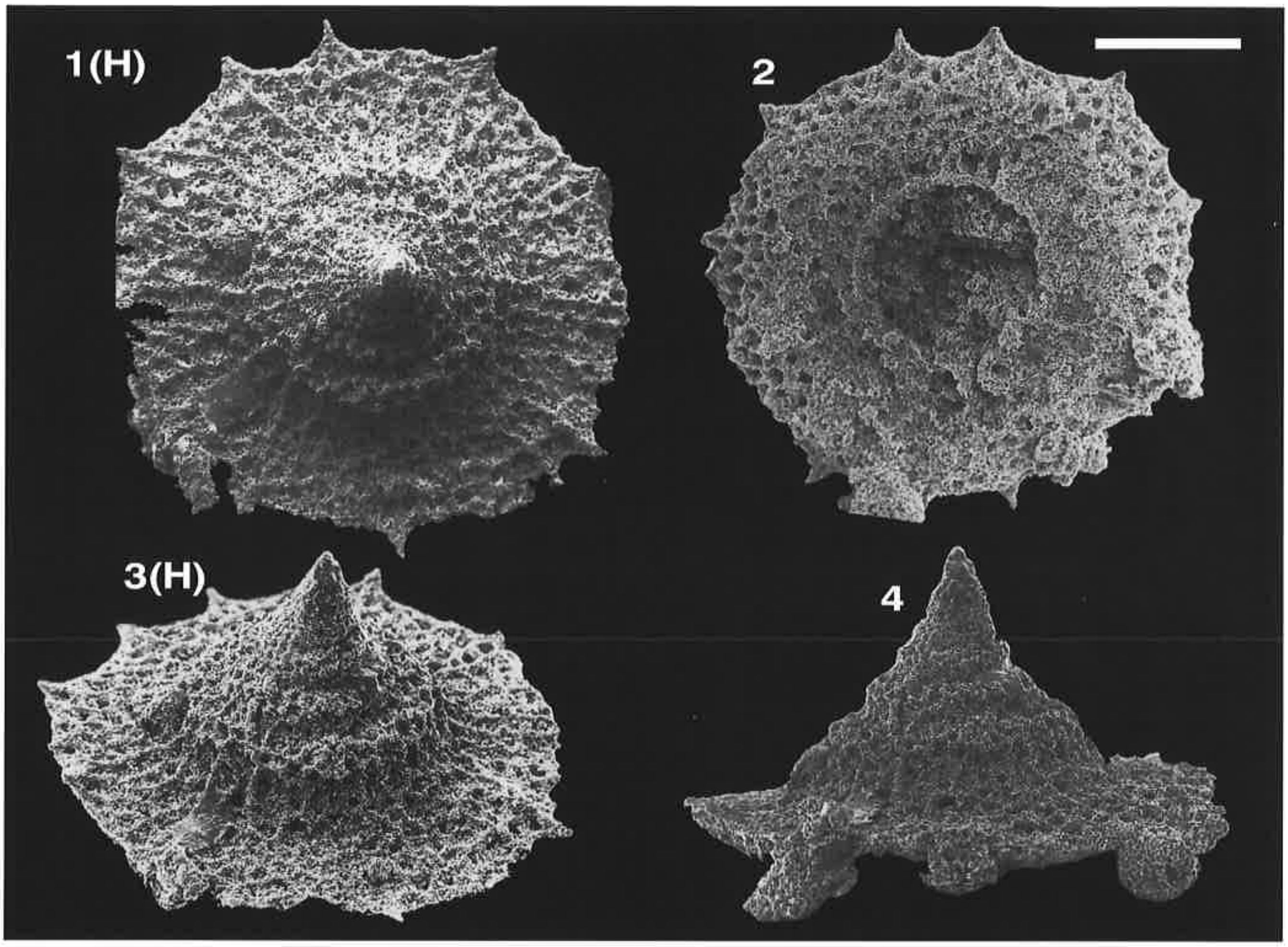


Plate 3004. *Palinandromeda murcheyae* n.sp. BAUMGARTNER. Magnification x150. **Fig. 1(H).** 81/2881, POB1341. **Fig. 2.** POB81/2963, POB1341. **Fig. 3(H).** 81/2887, POB1341. **Fig. 4.** 81/2891, POB1341.

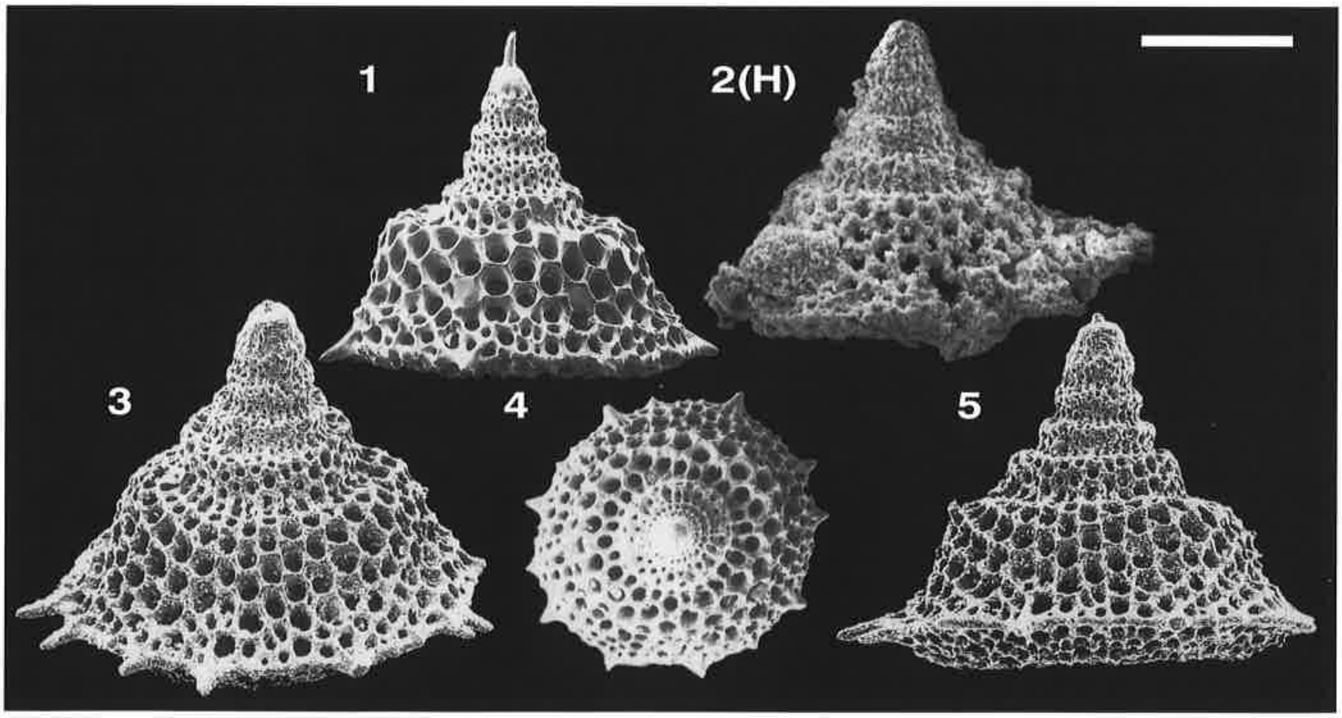


Plate 3008. *Palinandromeda podbielensis* (OZVOLDOVA). Magnification x150, except Fig 4. x100. **Fig. 1.** 81/9142, 76.534A.126.2.125. **Fig. 2H.** OZVOLDOVA 1979, pl. 4, fig. 1. **Fig. 3.** 78/6486, POB28.67. **Fig. 4.** 81/9141, 76.534A.125.5.11. **Fig. 5.** 78/6487, POB28.67.

PALINANDROMEDA PRAECRASSA 3007

Palinandromeda praecrassa (BAUMGARTNER)

Synonymy.-
Andromeda praecrassa BAUMGARTNER
BAUMGARTNER 1984, p. 755, pl. 1, figs. 16-18.

Original Definition.- Inflated conical form of 7 segments. Cephalis with short slender horn. Cephalis and thorax together conical, externally smooth, thorax with a single row of pores distally. Abdomen cylindrical with small pores in irregular vertical rows. Postabdominal segments rapidly growing in width and height, inflated cylindrical, tyre-shaped. Last segment only slightly higher than second last, tyre-shaped, with few, slender outwards directed spines on basal edge. Basal surface concave, with large aperture.

Original Remarks.- This species differs from *A. crassa*, which may be its descendant, in including only thorax and abdomen in the proximal smooth portion of the test. It furthermore differs in having a last segment which is only slightly larger than the second last.

Etymology.- *Prae-* Latin, before, to indicate the probable phyletic relationship to *A. crassa*.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Height of test:	-	72	64	87
W. abdomen:	60	70	56	99
H/W 4th seg.:	32-102	35-122	32-102	38-150
H/W 5th seg.:	34-150	47-196	34-150	57-246
H/W 6th seg.:	52-192	63-263	52-192	78-320
H/W 7th seg.:	86-330	90-330	85-305	100-355
W. aperture:	-	180	-	-

Type Locality.- Locality no. 19 of locality descriptions (Baumgartner, 1984).

UAZones.- 3-9 , early-mid Baj. to mid-late Oxf.

PALINANDROMEDA PRAEPODBIELENSIS 3006

Palinandromeda praepodbielensis (BAUMGARTNER)

Synonymy.-
Andromeda praepodbielensis BAUMGARTNER
BAUMGARTNER 1984, p. 756, pl. 1, figs. 13-15.
BAUMGARTNER 1985, fig. 37j.
GORICAN 1987, p. 181, pl. 2, fig. 7.
TAKEMURA 1986, p. 63, pl. 11, figs. 4-7.
KITO 1989, p. 216, pl. 25, figs. 9-11, 15.
TONIELLI 1991, p. 21, pl. 1, figs. 4, 13.
YAO 1991, pl. 3, fig. 15.
Andromeda praecrassa BAUMGARTNER
KITO 1989, p. 216, pl. 25, figs. 4-6, ? 16.

Original Definition.- Test composed of 7 or 8 segments forming a regular stepped cone. Cephalis, thorax and abdomen very similar to *A. podbielensis* with sparse, irregular pores. Postabdominal segments gradually growing in width and height, with vertical rows of pores. Last segment nearly two times as high as second last, bell-shaped,wedging outwards to basal edge which is fringed with numerous spines or teeth. Basal surface planar or concave.

Original Remarks.- This species differs from *A. podbielensis*, which may be its decendant, by having one or two more segments and by having a planar to concave, rather than convex basal surface. It seems as if the last and second last segment would become the last segment of *A. podbielensis*.

Etymology.- *Prae-* (Latin), before, to indicate the probable phyletic relationship to *A. podbielensis*.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Height of test:	72	70	52	85
Width of abdomen:	66	60	49	69
H/W 4th segment:	36/96	24/87	20/70	36/96
H/W 5th segment:	39/123	31/117	25/94	39/146
H/W 6th segment:	39/168	40/173	31/146	45/209
H/W 7th segment:	48/240	49/246	42/209	60/267
H/W 8th segment:	90/387	88/348	63/313	104/387
Widht of basal aperture:	-	237	198	288

Type Locality.- Locality no. 19 of locality descriptions (Baumgartner, 1984).

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

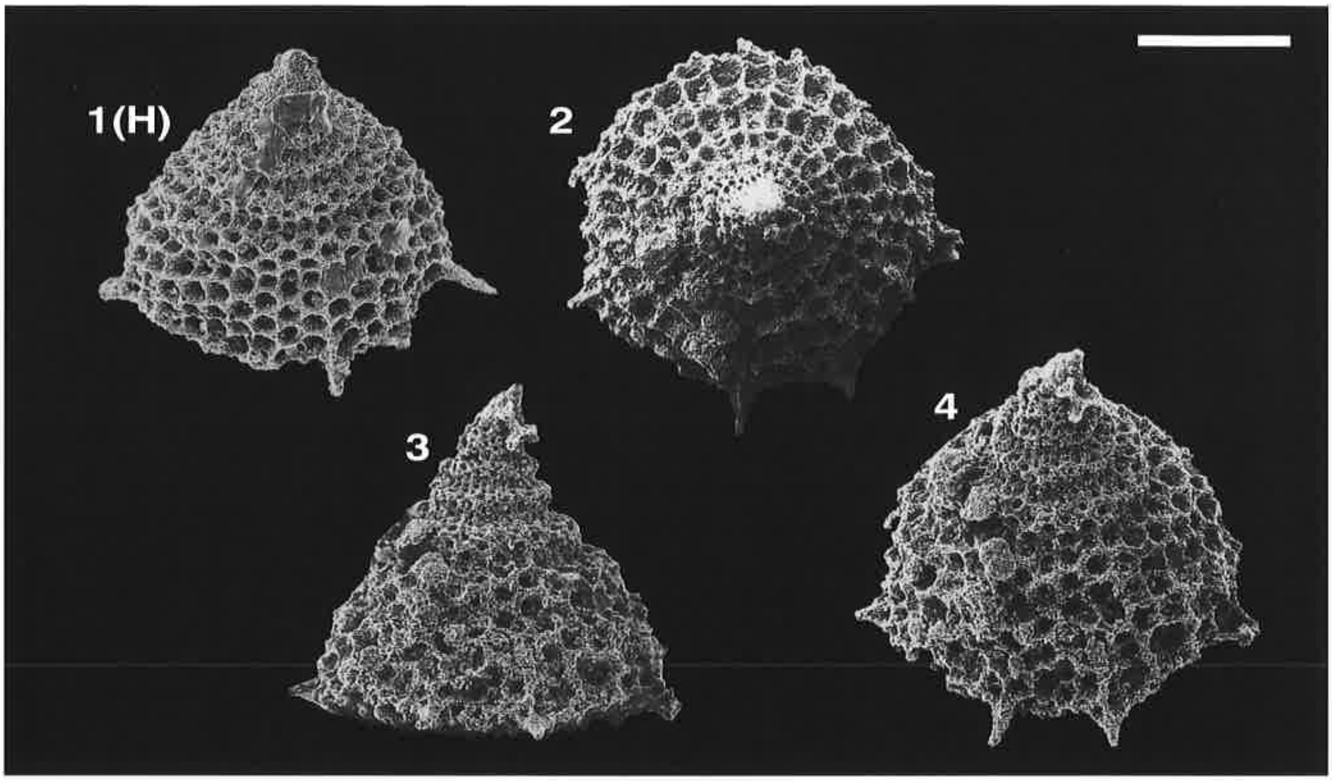


Plate 3007. *Palinandromeda praecrassa* (BAUMGARTNER). Magnification x150. **Fig. 1(H).** POB81/2975, POB1341. **Fig. 2.** POB81/2880, POB1341. **Fig. 3.** POB81/2890, POB1341. **Fig. 4.** POB81/2885, POB1341.

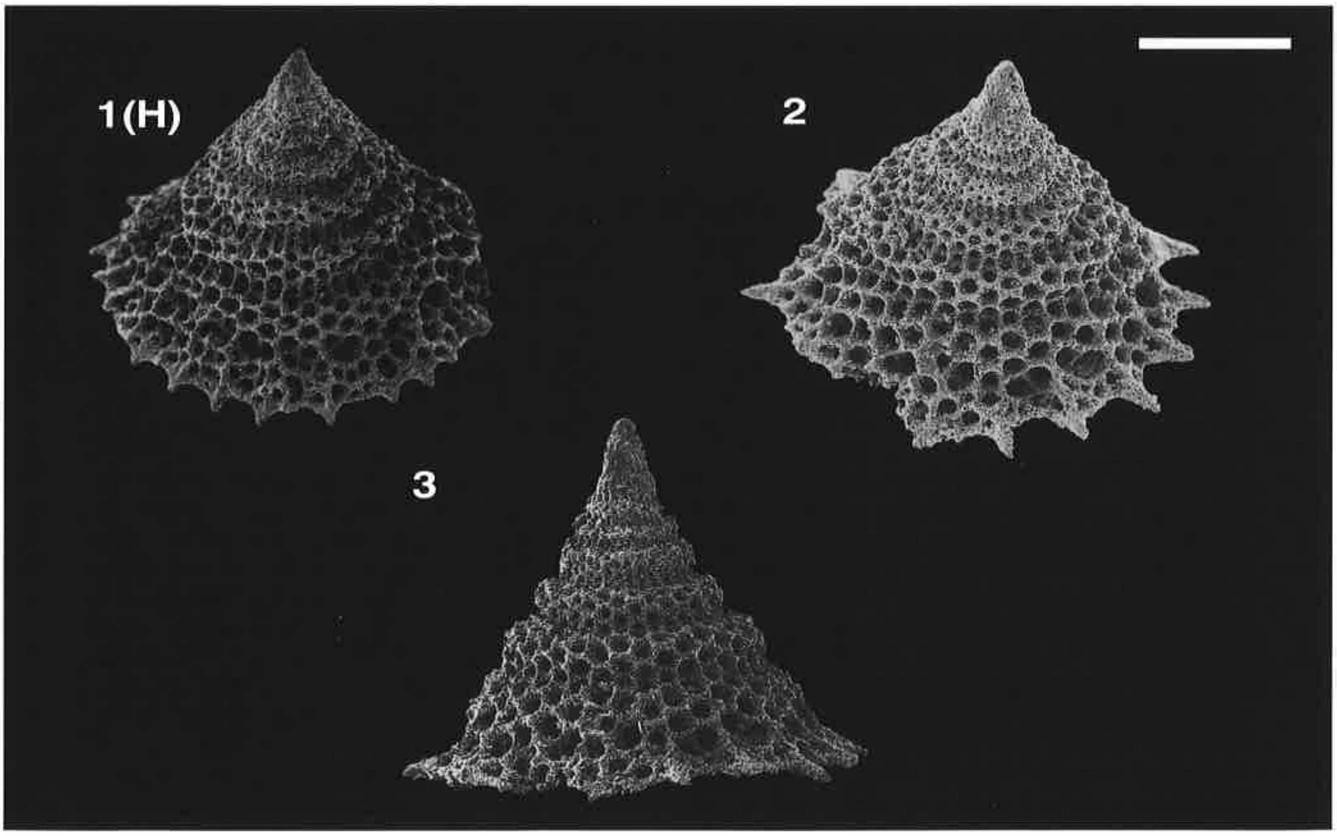


Plate 3006. *Palinandromeda praepodbielensis* (BAUMGARTNER). Magnification x150. **Fig. 1(H).** POB81/2978, POB1341. **Fig. 2.** POB81/2977, POB1341. **Fig. 3.** POB81/2981, POB1341.

PALINANDROMEDA SOGNOENSIS 3010

Palinandromeda sognoensis n.sp. BAUMGARTNER

***Synonymy*.-**
Andromeda (?) sp.
TAKEMURA 1986, p. 63, pl. 11, fig. 8.
Andromeda sp. 1
KITO 1989, p. 217, pl. 25, figs. 1-3.
Andromeda aff. *A. praepodbielensis* BAUMGARTNER
CONTI & MARCUCCI 1991, p. 797, pl. 1, fig. 7.

***Type Designation*.-** 81/2928, POB 1341.

***Original Definition*.-** Small, high conical form with about 10-12 segments, with concave outline in lateral view. Cephalis small, hidden in the base of a stout long horn. Cephalis thorax abdomen, and first postabdominal segments together slenderly conical, externally without visible strictures, smooth, sparsely porous. Last 5-7 segments inflated trapezoidal to tyre-shaped, with strictures marking the segmental divisions, gradually growing in width and height. Pores regularly increase in size distally and are organized in loose vertical rows which become lost on the last segments of some specimens. The final postabdominal segment as high as the second last, trapezoidal or tyre-shaped. Basal edge fringed with about 8-10 outward directed spines. Basal surface convex or planar with large aperture.

***Original Remarks*.-** This species differs from other *Palinandromeda* by its long slenderly conical proximal test and its small size. It differs from *Parahsuum* (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER by the lack of vertical costae-like ridges.

***Etymology*.-** Named after the type locality, near the top of the Sogno Formation, above Torre di Busi, Prov. Como, Lombardy, Northern Italy (locality No. 19, p. 796, Baumgartner, 1984).

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Height of test:	445	440	415	460
Width of abdomen:	46	50	42	54
H/W 4th segment:	22/50	21/48	19/45	23/55
H/W 5th segment:	24/94	24/95	23/90	25/98
H/W 6th segment:	25/144	25/142	24/141	26/145
H/W 7th segment:	26/188	24/185	23/180	26/190
H/W 8th segment:	33/245	33/245	30/240	35/250
Widht of basal aperture:	136	135	130	140

***Type Locality*.-** Sample POB 1341, collected 4.10 m below sharp base of the basal green radiolarites in the top part of the Sogno Formation. Locality No. 19 of Baumgartner (1984, p. 796, pl. 12).

***UAZones*.-** 1-3, early-mid Aal. to early-mid Baj.

palmerae >> *SPONGOCAPSULA PALMERAE* 3199

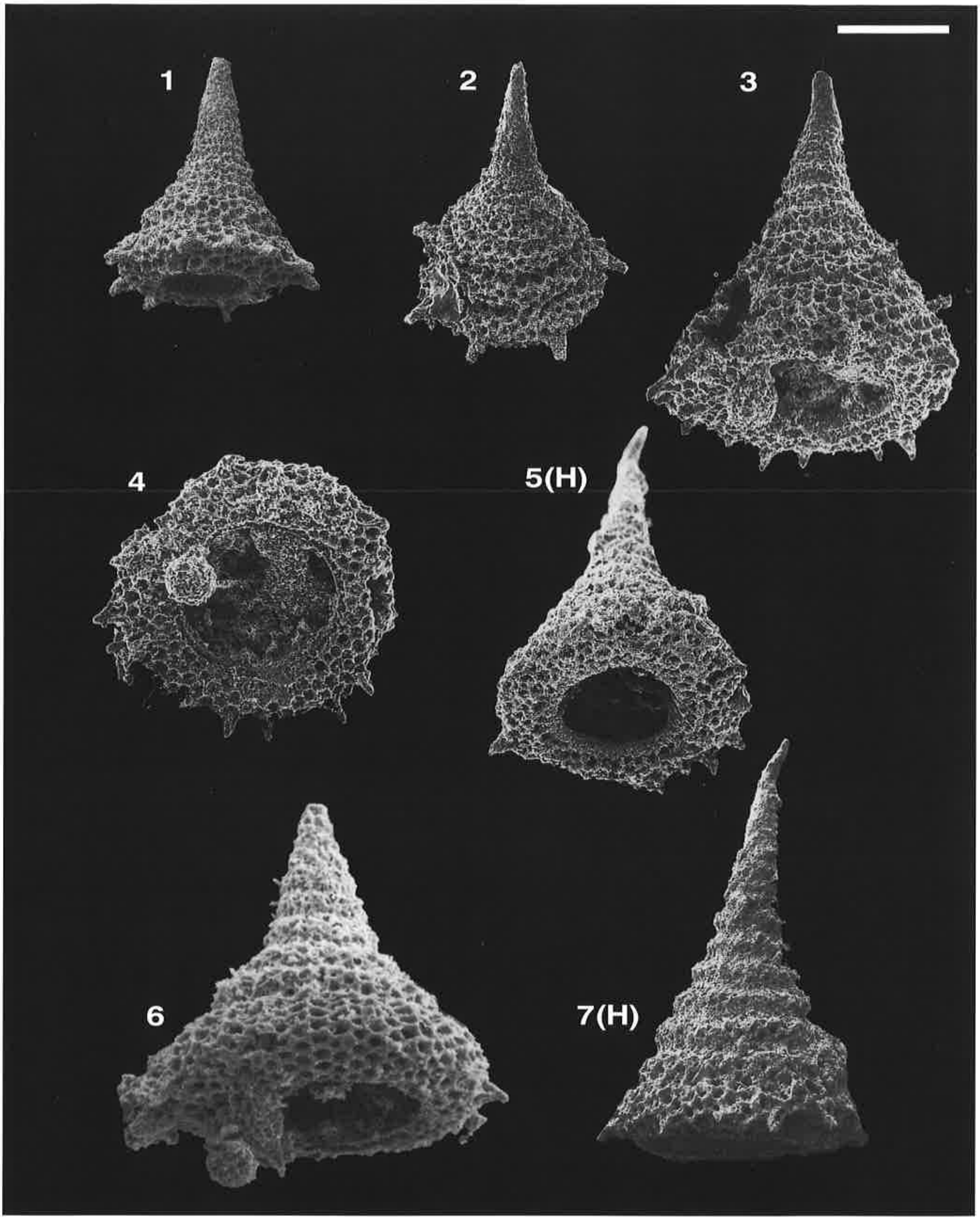


Plate 3010. *Palinandromeda sognoensis* n.sp. BAUMGARTNER. Magnification x150, except fig. 3 x200. **Fig. 1.** POB81/2951, POB1341. **Fig. 2.** POB81/2884, POB1341. **Fig. 3.** MC6/89, GR6 5-5. **Fig. 4.** MC7/89, GR6. **Fig. 5(H).** POB81/2969, POB1341. **Fig. 6.** MC7/88, GR6. **Fig. 7(H).** POB81/2968, POB1341.

PANTANELLIUM 3667

Genus: *Pantanellium* PESSAGNO

Synonymy.-
Pantanellium PESSAGNO
PESSAGNO 1977a, p. 78.

Type Species.- *Pantanellium riedeli* PESSAGNO 1977a.

Original Definition.- Test devided into ellipsoidal to subspherical cortical shell and spherical first medullary shell, both with massive polygonal pore frames having nodes at vertices. Cortical shell with bipolar primary spines possessing well-developed alternating, longitudinally arranged ridges and grooves. One spine often somewhat shorter than other. Primary spines interconnected and occurring along same axis as primary beams which connect cortical shell to first medullary shell; diameter of two primary beams about half that of primary spines. Secondary radial beams also connecting cortical shell; extending from nodal points of pore frame vertices of both cortical and first medullary shells.

Original Remarks.- *Pantanellium* n.gen. differs from *Protoxiphotractus* PESSAGNO in having bipolar spines with longitudinally arranged, alternating grooves and ridges. Many workers, for example Foreman (1973b, p. 258) have included species assignable to this genus under *Sphaerostylus* HAECKEL. Unfortunately, the single illustration and the description of the type species of *Sphaerostylus* (i.e., *S. zitteli* RÜST) are exceedingly poor and of virtually no use to any worker hoping to make a definitive identification. The resurrection of the name *Sphaerostylus* can serve no purpose. It is suggested, therefore, that the name *Sphaerostylus* be considered a nomen dubium.

Etymology.- This genus takes its name from Dante Pantanelli, one of the early students of Mesozoic Radiolaria.

Included Taxa.-
3280 *Pantanellium berriasianum* BAUMGARTNER
5065 *Pantanellium* sp. aff. *P. cantuchapai* PESSAGNO & MACLEOD
3078 *Pantanellium riedeli* PESSAGNO
5607 *Pantanellium squinaboli* (TAN)
3042 *Pantanellium* sp. L

PANTANELLIUM BERRIASIANUM 3280

Pantanellium berriasianum BAUMGARTNER

Synonymy.-
Pantanellium (?) *berriasianum* BAUMGARTNER
BAUMGARTNER 1984, p. 776, pl. 6, figs. 14-15.
JUD 1994, p. 89, pl. 15, figs. 5-6.

Original Definition.- Ellipsoidal to spherical cortical shell with massive bipolar spines and one to several triradiate secondary spines placed on some nodal points of the pentagonal to hexagonal pore frames. The secondary spines are short, tapering into a sharp point, and seem to be randomly placed both in equatorial and peripolar position. Their number varies from one (usually in peripolar position) to six or eight. The remaining triple-junctions of the pore frames are slightly raised and bear moderate nodes.

Original Remarks.- This species differs from all other species included with *Pantanellium* PESSAGNO 1977a and *Pachyoncus* PESSAGNO & BLOME 1980, in having short, sharp secondary spines placed randomly on some nodal points of the pore frames. The species is doubtfully included with *Pantanellium* as its definition (Pessagno, 1977a) does not include such secondary spines. It is not included with *Pachyoncus* because the secondary spines of this genus are different and occur at most nodal points.

Remarks.- The form illustrated in pl. 3280, fig. 3, close to *P. berriasianum* was recovered from the Middle Jurassic (Bajocian) radiolarites of the Mino Terrane (Japan). This datum was not included for the calculation of Unitary Associations because of its isolated occurrence far removed from the Early Cretaceous range of *P. berriasianum*.

Etymology.- Referring to the first occurrence of this species in the Berriasian.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Polar diameter:	132	104	78	132
Equatorial diam.:	135	102	78	135
Polar spines:	78/117	65/89	51/64	78/117

Type Locality.- Cava Rusconi, Cittiglio, Prov. Varese, Italy. Locality no. 23 of locality descriptions (Baumgartner, 1984).

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

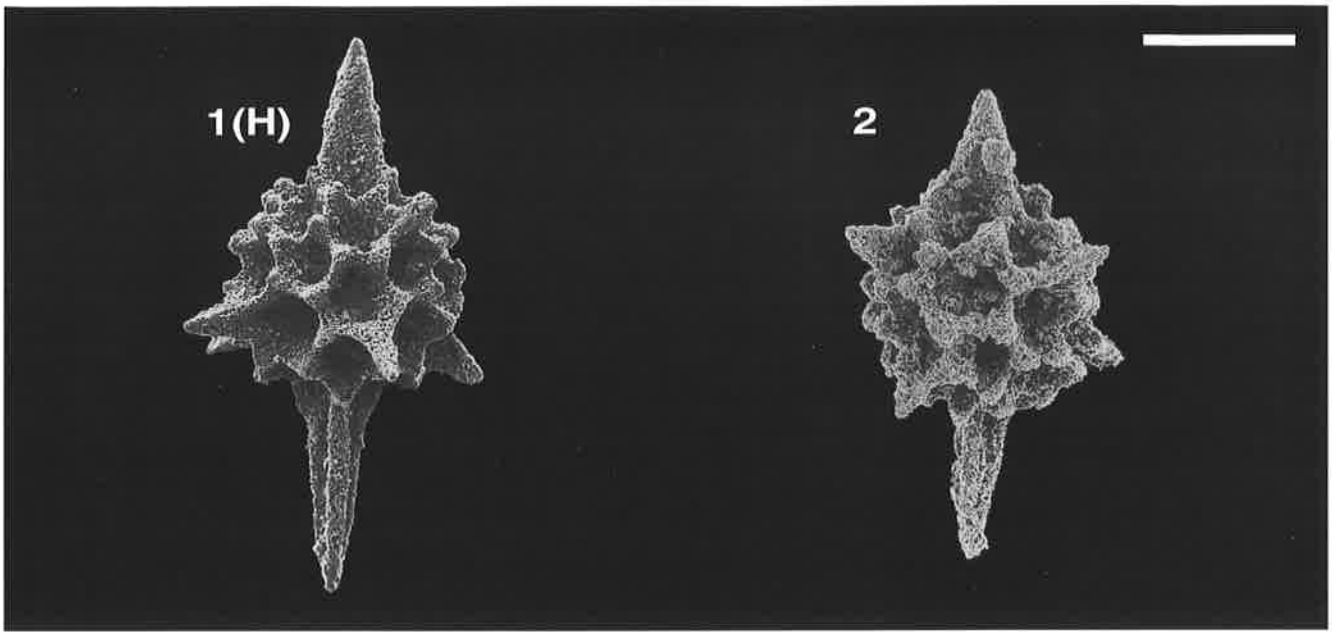


Plate 3280. ***Pantanellium berriasianum*** **BAUMGARTNER.** Magnification x250. **Fig. 1(H).** POB79/5265, POB1205.3. **Fig. 2.** RJ401, Br1330.

PANTANELLIUM CANTUCHAPAI AFF. 5065

Pantanellium sp. aff. *P. cantuchapai* PESSAGNO & MAC LEOD

Synonymy.-
? *Pantanellium cantuchapai* PESSAGNO & MAC LEOD
PESSAGNO et al. 1987, p. 20, pl. 1, figs. 8, 9, 13-15, 22; pl. 7, fig. 2
? *Sphaerostylus lanceola* (PARONA)
MUZAVOR 1977, p. 50, pl. 1, fig. 7, not fig. 6
Pantanellium sp. aff. *P. cantuchapai* PESSAGNO & MAC LEOD
JUD 1994, p. 89, pl. 15, figs. 7-9.

Remarks.- Our specimens differ from *Pantanellium cantuchapai* PESSAGNO & MAC LEOD by having more robust main spines with stout ends, and a narrower, less equatorially expanded cortical shell.

Etymology.- This species is named for Dr. A. Cantu Chapa (Instituto Mexicano del Petroleo, Mexico, D. F.) in honor of his contributions to the Jurassic stratigraphy of Mexico.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
Heigth of shell:	95	104	95	125
L. first polar spines:	112	125	100	162
L. second polar spine:	85	84	68	102
Width of shell:	25	126	100	145
W. base shorter spine:	22	28	22	37
W. base longer spine:	20	24	20	30

UAZones.- 13-21, latest Tith. to early Barr.

PANTANELLIUM RIEDELI 3078

Pantanellium riedeli PESSAGNO

Synonymy.-
Pantanellium riedeli PESSAGNO
PESSAGNO 1977a, p. 78, pl. 6, figs. 5-11.
PESSAGNO 1977b, p. 33, pl. 3, fig. 12.
AITA 1982, pl. 3, fig. 19.
BAUMGARTNER 1985, figs. 38a-c.
Sphaerostylus lanceola (PARONA) gr.
KOCHER 1981, p. 92, pl. 16, fig. 16.
Sphaerostylus sp. A.
? MATSUOKA & YAO 1985, pl. 2, fig. 14.
Pachyoncus sp. A
KISHIDA & HISADA 1986, fig. 2. 25.

Original Definition.- Cortical shell spherical to subspherical with massive, triradiate bipolar spines having three narrow ridges alternating with three wide grooves; one spine somewhat shorter than other. Meshwork of cortical shell comprised of massive hexagonal and pentagonal pore frames with nodes at vertices. Five pore frames present in area between spines along a line aligned with grooves of spines. First medullary shell with pentagonal pore frames.

Original Remarks.- *Pantanellium riedeli* n.sp. differs from *Pantanellium fischeri* (PESSAGNO) by having (1) a spherical to subspherical test and (2) bipolar spines with wider grooves. It is obvious that these two species are closely related.

Foreman (1973b, p. 258) and Riedel & Sanfilippo (1974, p. 780) included this form under *Sphaerostylus lanceola* (PARONA). Parona's (1890, pl. 1, fig. 19) illustration of the type specimen of *Stylosphaera laceola* is too generalized to allow this name to be applied to any known taxon. Further, the use of this name in the paleontological literature will serve no purpose other than to perpetuate continual confusion. In the present report *Stylosphaera lanceola* is regarded as a nomen dubium. For similar reasons, *Stylosphaera squinaboli* TAN 1927, *Stylatractus ovatus* HINDE 1900, and *Meyenella hensoni* DAVIS 1950 are also regarded as nomina dubia. It is further suggested that the names *Xiphostylus felsinae* Neviani 1900, *Xiphosphaera manzonii* NEVIANI 1900, *Stylatractus tener* HINDE 1900, and *Stylatractus paronae* HINDE 1900 be declared nomina oblita because (1) the illustrations of the type specimens of these species are too poor to be useful and (2) because these names have not been used as synonyms for over 50 years (ICZN, Art.23b).

Remarks.- The name *P. riedeli* is used to separate smaller Late Jurassic forms with more numerous pores from *P. squinaboli* (TAN). We suggest that the name *P. lanceola* should be regarded as obsolete.

Etymology.- This species is named for Mr. William R. Riedel in honor of his contributions to the study of Radiolaria.

Measurements (in μm).-
Based on 10 specimens.

	min.	max.
Length of shell:	70	90
Width of shell:	70	90
Length of upper spine:	50	89
Length of lower spine:	70	110

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

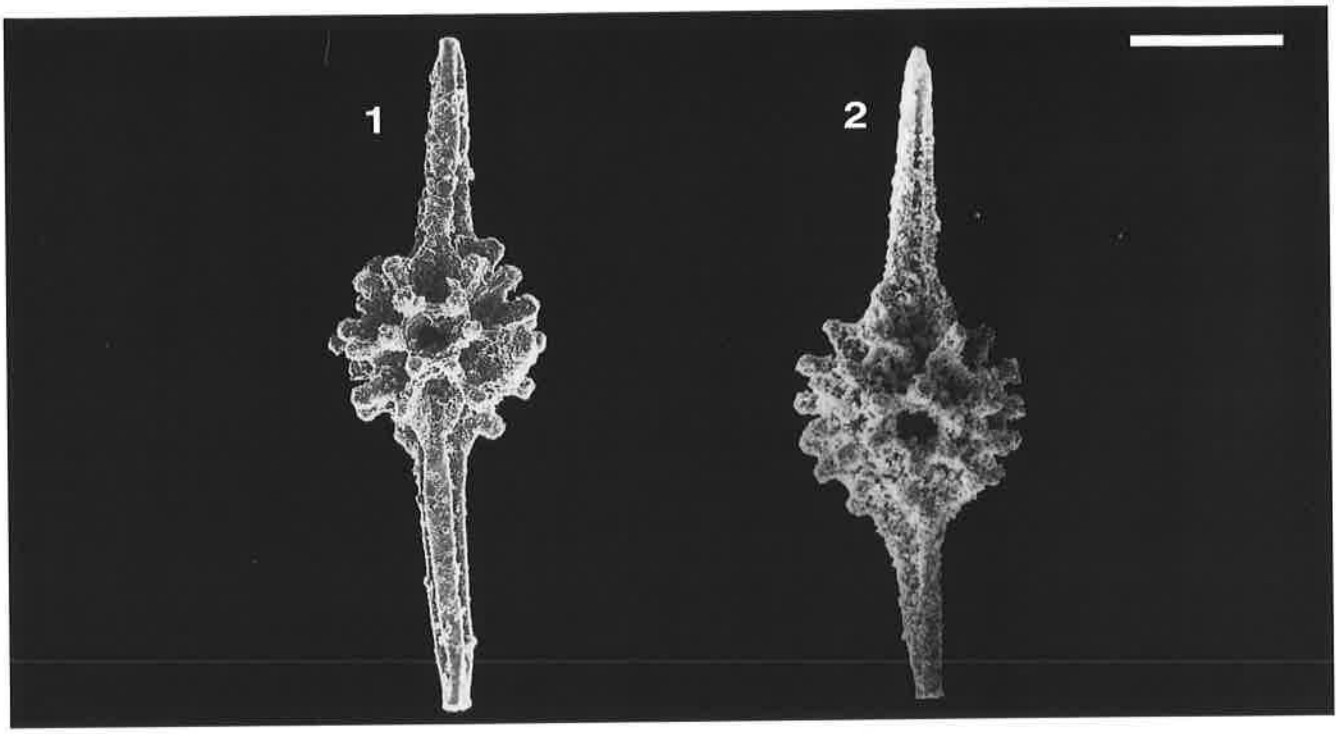


Plate 5065. *Pantanellium* sp. aff. *P. cantuchapai* PESSAGNO & MACLEOD. Magnification x250. **Fig. 1.** POB81/0952, MO46a'. **Fig. 2.** RJ84, Ru146.5.

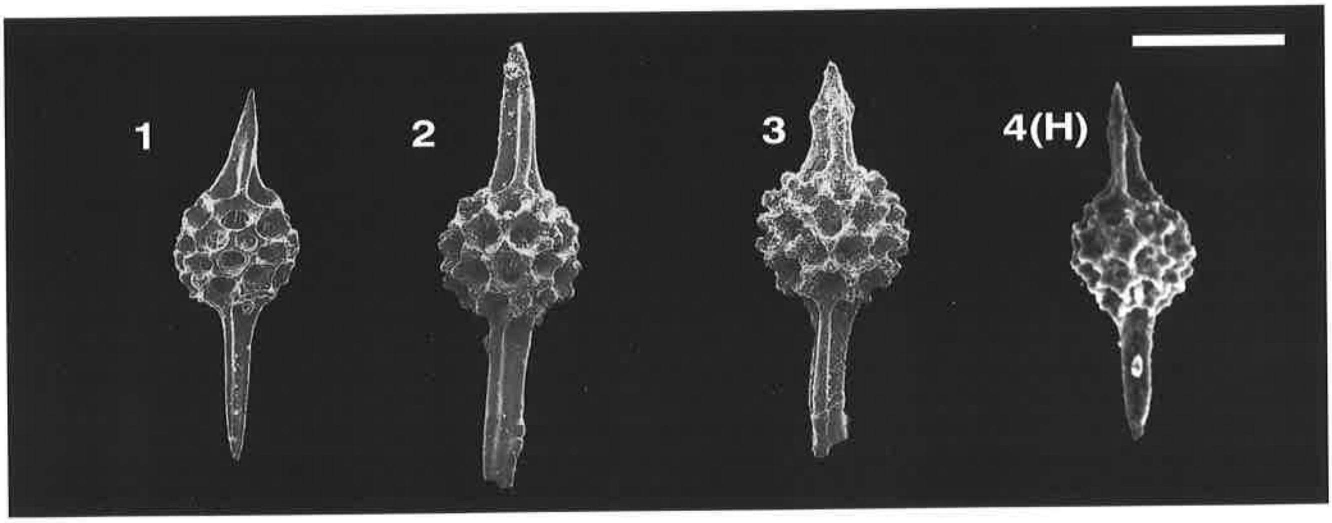


Plate 3078. *Pantanellium riedeli* PESSAGNO. Magnification x250. **Fig. 1.** POB81/2675, 534.124.1.52. **Fig. 2.** POB81/2249, 534.122.1.43. **Fig. 3.** POB81/2248, 534.122.1.43. **Fig. 4(H).** PESSAGNO 1977a, pl. 6, fig. 5.

PANTANELLIUM SQUINABOLI 5607

Pantanellium squinaboli (TAN)

Synonymy.-
Staurosphaera squinaboli TAN
TAN 1927, p. 35, pl. 6, figs. 9a-d.
Sphaerostylus lanceola (PARONA)
FOREMAN 1973b, p. 258, pl. 1, figs. 7-11.
KANIE et al. 1981, pl. 1, fig. 6.
BOUYSSE et al. 1983, fig. 4.1.
YAO 1984, pl. 4, fig. 19.
KIMINAMI et al. 1985, pl. 2, fig. 4.
AITA & OKADA 1986, p. 120, pl. 1, figs. 2-3.
CONTI 1986, pl. 1, fig. 9.
KATO & IWATA 1989, pl. 1, fig. 10.
IWATA & TAJIKA 1989, pl. 4, fig. 7.
TUMANDA 1989, p. 35, pl. 1, fig. 1.
IWATA 1990, pl. 1, fig. 5; pl. 2, fig. 7.
Pantanellium corriganensis PESSAGNO
PESSAGNO 1977b, p. 33, pl. 3, figs. 5-6.
DE WEVER et al. 1986, pl. 6, fig. 1.
Pantanellium squinaboli (TAN)
NAKASEKO & NISHIMURA 1981, p. 156, pl. 1, figs. 1, 10.
MIZUTANI et al. 1982, p. 64, pl. 5, fig. 7.
OZVOLDOVA & SYKORA 1984, p. 267, pl. 6, fig. 1.
JUD 1994, p. 90, pl. 15, figs. 10-12.
Pantanellium lanceola (PARONA) gr.
DE WEVER & THIEBAULT 1981, p. 589, pl. 2, fig. 9.
SCHAAF 1984, p. 114-115, figs. 1-6; p. 153, figs. 13-14.
DE WEVER et al. 1986, pl. 6, fig. 2.
PAVSIC & GORICAN 1987, p. 26, pl. 4, figs. 1-2.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, fig. 1.
OZVOLDOVA 1988, pl. 3, fig. 5; not pl. 1, fig. 4.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 7-12.
Pantanellium portovenerensis CIARAPICA & ZANINETTI
CIARAPICA & ZANINETTI 1982, p. 169, pl. 1, figs. 1-8.
Pantanellium sp.
KITO 1987, pl. 1, fig. 4.
Pantanellium squinaboli squinaboli (TAN)
BAUMGARTNER 1992, p. 322, pl. 8, figs. 2- 3.

Original Definition.- "Irregular spherical test with thick wall and a few large pores. The test is equipped with two opposite placed three-bladed spines. These spines are not always of equal length and not always precisely axially placed. The pores are hexagonal and pentagonal. These two types of pores are then disposed in that way on the test that around a hexagonal pore are always alternately placed a hexagonal and a pentagonal pore. Thus there are 3 pentagonal and 3 hexagonal pores alternately placed around 1 hexagonal pore. The highest part of the pore bars have a knoddy thickening. The inner shell is thin and measures on fig. 9d 1/4 to 1/5 of the diameter of the external shell. This shell cannot be observed usually because the shell being filled up with mud. Fig. d shows a cross section of *Stylosphaera Squinaboli.* (Formes with the inner shell lacking should be assigned to *Xiphosphaera*); fig. b shows the arrangement of the pores around a pentagonal pore. fig. c the arrangement around a hexagonal pore."

Original Remarks.- "*Stylatractus squinaboli* is very much similar to Jurassic *Xiphosphaera manzonii* NEVIANI (pl. IX. fig. 5) which is however smaller regarding in addition the cross section of it. Therefore they can only with difficulties be compared to our forms. *Stylatractus ovatus* HINDE (pl. IV, figs. 31, 32, 33, 36) seems to me being a *Lithatractus*, thus with two concentric and not with three."

Remarks.- In this species several morphotypes were herein included, all of them characterized by a small number of very large hexagonal or pentagonal pores but distinguished from one another by the ratio in length and width of test and spines, and by the size and the number of pores or smooth or nodose aspect of the surface of the cortical shell.

Measurements (in μm).-
Total length, 270; width 120, length of spines 75, thickness of outer shell 30, diameter of pores of the inner shell 40.

Type Locality.- Rotti Island, Moluccas Archipelago, East Indian Ocean.

UAZones.- 11-22, late Kimm.-early Tith. to late Barr.-early Apt.

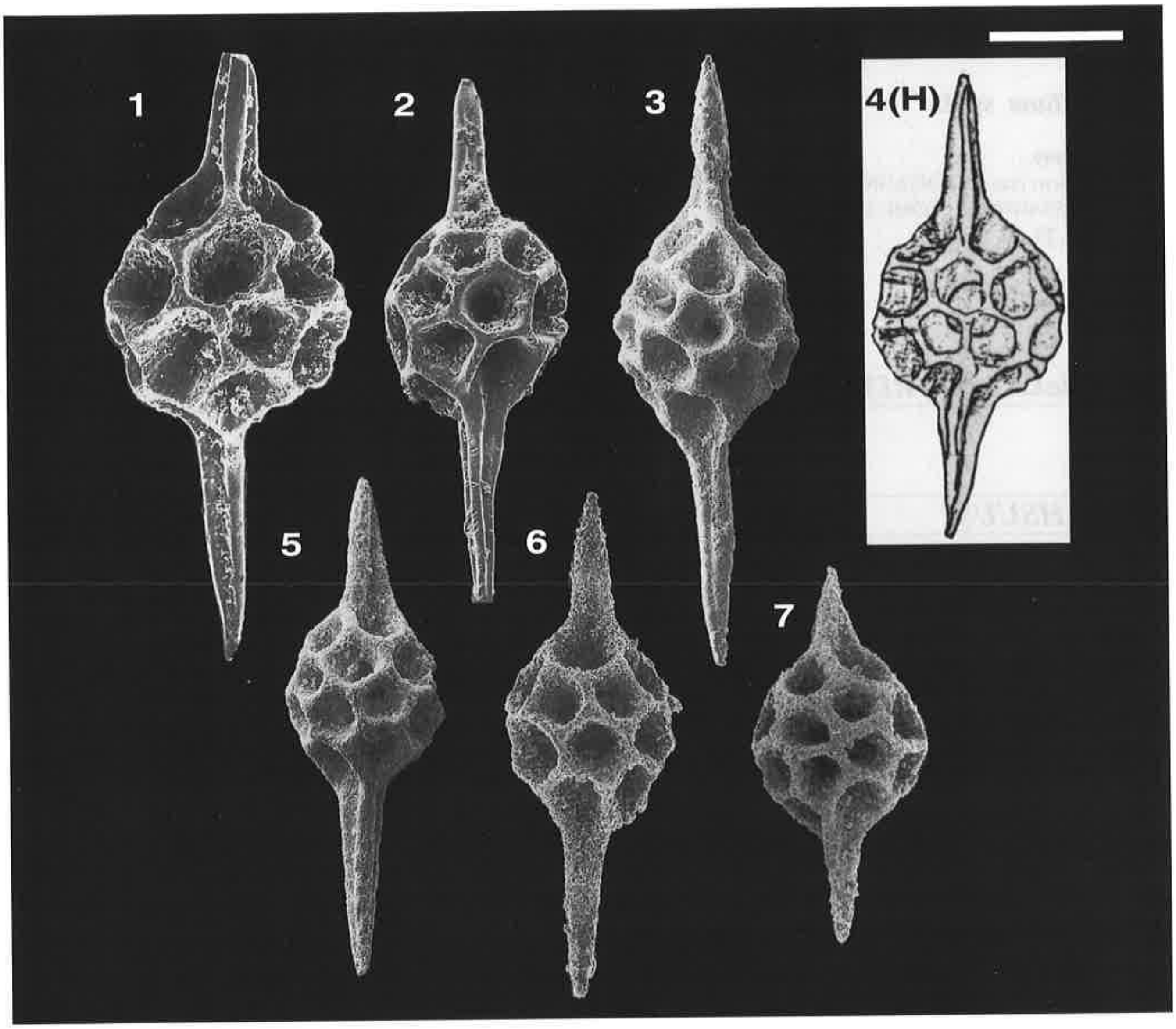


Plate 5607. ***Pantanellium squinaboli*** **(TAN).** Magnification x250. **Fig. 1.** POB80/2810, V-34. **Fig. 2.** POB80/2811, V-34. **Fig. 3.** DU2148, Mo22. **Fig. 4(H).** TAN 1927, pl. 6, fig. 9a **Fig. 5.** DU2289, MO22. **Fig. 6.** RJ42, Br1330. **Fig. 7.** RJ239, Br449.50.

PANTANELLIUM \ L 3042

Pantanellium sp. L

Synonymy.-
Pachyoncus crassus PESSAGNO & BLOME
cf. PESSAGNO & BLOME 1980, p. 236, pl. 11, figs. 8, 21, 26.
Pachyoncus sp.
YAMAMOTO et al. 1985, p. 36, pl. 5, figs. 8a-b.

Remarks.- All two-spined Pantaneliids with lobate pore-frames included.

UAZones.- 2-4, late Aal. to late Baj.

parablakei >> TRIACTOMA PARABLAKEI 3413

PARAHSUUM 3668

Genus: *Parahsuum* YAO

Synonymy.-
Parahsuum YAO
YAO 1982, p. 61.
TAKEMURA 1986, p. 47.
Lupherium PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 135.

Type Species - *Parahsuum simplum* YAO 1982.

Original Definition.- Shell multisegmented, conical to spindle-shaped lacking well-developed strictures. Cephalis conical to dome-shaped, poreless with or without apical horn. Thorax trapezoidal in outline with sparse irregularly displaced pores. Abdomen and post-abdominal segments with continuous edged costae. Single row of square pore frames with circular, primary pores between costae.

Original Remarks.- *Parahsuum* differs from *Hsuum* PESSAGNO (1977a, p. 81) in having single row of pores between costae, from *Archaeodictyomitra* PESSAGNO (1977b, p. 44) in having edged costae.

Remarks.- (TAKEMURA, 1986) Yao (1982) and Pessagno & Whalen (1982) did not mention the cephalic skeletal structure of *Parahsuum* (or *Lupherium*). All the species of *Parahsuum* from TKN-105 possess MB, A, V, D, two L and two l as cephalic skeletal elements and a thick and poreless cephalic wall, like the cephalis of *Napora* (text-fig. 3). Pores on the shell of *Parahsuum* are irregularly distributed in the proximal two or three segments and they are regularly distributed in distal segments where pores are arranged in both longitudinal and latitudinal lines. Costae which are situated between each longitudinal line of pores originate in the abdomen or the fourth segment.

Etymology.- This genus is named according to the similarity of the external shape with *Hsuum* PESSAGNO.

Included Taxa.-
2010 *Parahsuum cruciferum* TAKEMURA
4031 *Parahsuum* (?) *grande* HORI & YAO
3011 *Parahsuum* (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER
2012 *Parahsuum izeense* (PESSAGNO & WHALEN)
3072 *Parahsuum* (?) *magnum* TAKEMURA
3073 *Parahsuum* (?) *natorense* (EL KADIRI)
2011 *Parahsuum officerense* (PESSAGNO & WHALEN)
3071 *Parahsuum* (?) *olorizi* (EL KADIRI)
2023 *Parahsuum stanleyense* (PESSAGNO)
2015 *Parahsuum* sp. M
3240 *Parahsuum* sp. S

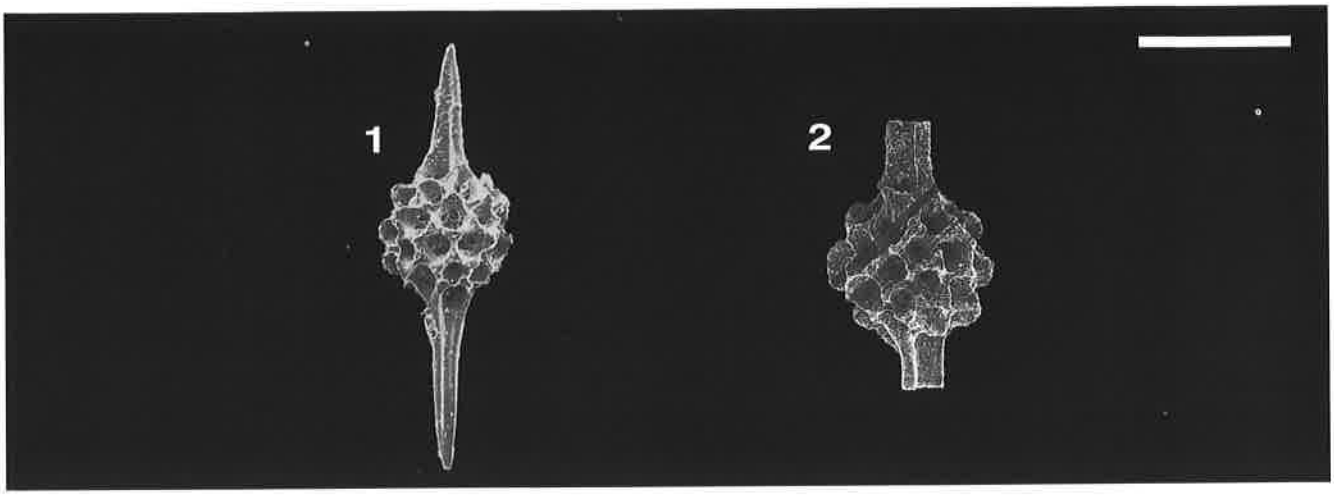


Plate 3042. ***Pantanellium*** **sp. L.** Magnification x250. **Fig. 1.** POB81/3011, IN7. **Fig. 2.** POB80/3934, POB 926.

PARAHSUUM CRUCIFERUM 2010

Parahsuum cruciferum TAKEMURA

Synonymy.-
Parahsuum cruciferum TAKEMURA
TAKEMURA 1986, p. 49, pl. 5 figs. 9-11.

Original Definition.- Shell conical to cylindrical, with usually eight to ten segments, and with strictures at the joints of each segment except collar one. Cephalis relatively large and hemispherical, with well-developed tetraradiate apical horn and rough surface which depends on the existence of nodes and relict pores. Post-cephalic segments cylindrical to barrel-shaped. Thorax and abdomen with irregularly distributed relict pores and polygonal pore frames bearing small nodes at vertices. The fourth segment with irregular surface or with costae. About 28 to 32 costae covering all the distal segments with small nodes at vertices of square pore frames. Pores of post-abdominal segments arranged in four or five transverse rows for each segment, and remaining open at the distal part of shell.

Original Remarks.- *Parahsuum cruciferum* n.sp. is distinguished from the other species of *Parahsuum* by its characteristic tetraradiate apical horn and the presence of strictures at joints. This type of the apical horn is also observed in *Hsuum primum* n.sp. However, *P. cruciferum* differs from the latter in the lack of *Hsuum* type costae.

Etymology.- The name, *cruciferum*, means bearing cross.

Measurements (in μm).-
Based on 5 specimens. Length of shell, 295-335; Maximum width of shell, 100-120.

Type Locality.- Sample TKN-105, Gujo-Hachiman area in the Mino terrane, central Japan.

UAZones.- 1-1, early-mid Aal.

PARAHSUUM (?) GRANDE 4031

Parahsuum (?) *grande* HORI & YAO

Synonymy.-
Archaeodictyomitra sp. A
? YAO et al. 1980, pl. 3, figs. 7, ? figs. 8-9.
Parahsuum sp. D
YAO et al. 1982, pl. 2, fig. 19.
MATSUOKA 1983b, fig. 4.5.
MATSUOKA & YAO 1986, pl. 1, fig. 7.
Archaeodictyomitra sp. A
KIDO 1982, pl. 4, fig. 7.
Hsuum bipartitum GRILL & KOZUR
? GRILL & KOZUR 1986, pl. 5, fig. 6, only.
Parahsuum (?) *grande*
HORI & YAO 1988, 54, pl. 2, figs. 7a-e, 8-12.
HORI 1990, fig. 9.45.
YAO 1991, pl. 2, fig. 13.

Original Definition.- Shell of more than 11, mostly about 13 segments, elongate conical, with weak strictures in distal part. Cephalis mostly poreless, conical, with or without apical horn. Surface of cephalis smooth, occasionally with shallow longitudinal grooves. Post-thoracic segments with about 34 continuous longitudinal costae. Each of post-thoracic segments with a longitudinal row of pores between costae and 3 to 4 transverse rows of pores. Pores arranged in the form of lattice and pore frames tetragonal. Shell possessing 3 to 4 circumferential ridges in distal part. The circumferential ridge is formed by aligned numerous short discontinuous, weak-developed costae.

Original Remarks.- The generic assignment of this species is doubtful because of the presence of discontinuous costae on distal portion. This feature is rather character of *Transhsuum* than *Parahsuum*, but the discontinuous costae are developed weakly and scarcely. Therefore this species is included in *Parahsuum*.

Parahsuum sp. D YAO et al. (1982, pl. 2, fig. 19) was the provisional name of this species. As *Parahsuum* sp. D of YAO et al. (1982) was not sufficiently described, there has been some confusion to identify *P.* sp. D. *Parahsuum* (?) *grande* sp. nov. morphologically resembles *P. transiens* sp. nov. The shell of *P.* (?) *grande* mostly consists of twelve to thirteen segments, while shell of *P. transiens* consists of eigth to nine segments. In addition, it can be distinguished from *P. transiens* by having remarkable circumferential ridges in distal portion of shell; the circumferential ridges are formed by aligned weak-developed discontinuous costae. It is likely that *P. transiens* gave rise to *P.* (?) *grande.*

P. (?) *grande* is similar to *Hsuum* sp. G of SATO et al. (1986, p. 21, 23, fig.6) and *Transhsuum medium* TAKEMURA (1986, pl. 5, fig. 25) by having short discontinuous costae in distal portion of shell. However, the former differs from the latter in lacking discontinuous costae developed on more than 4 distal segments.

Remarks.- This species is very similar to *Hsuum hisuikyoense* ISOZAKI & MATSUDA, but differs from the latter by the discontinuous costae developing around less than final 2 or 3 segments, by the thinner wall around the cephalis and by its larger test.

Etymology.- This name is derived from the Latin adjective *grandis*, meaning great and large.

Type Locality.- Sample IYII5, Iwayakannon section, Inuyama, Gifu Prefecture, central Japan.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

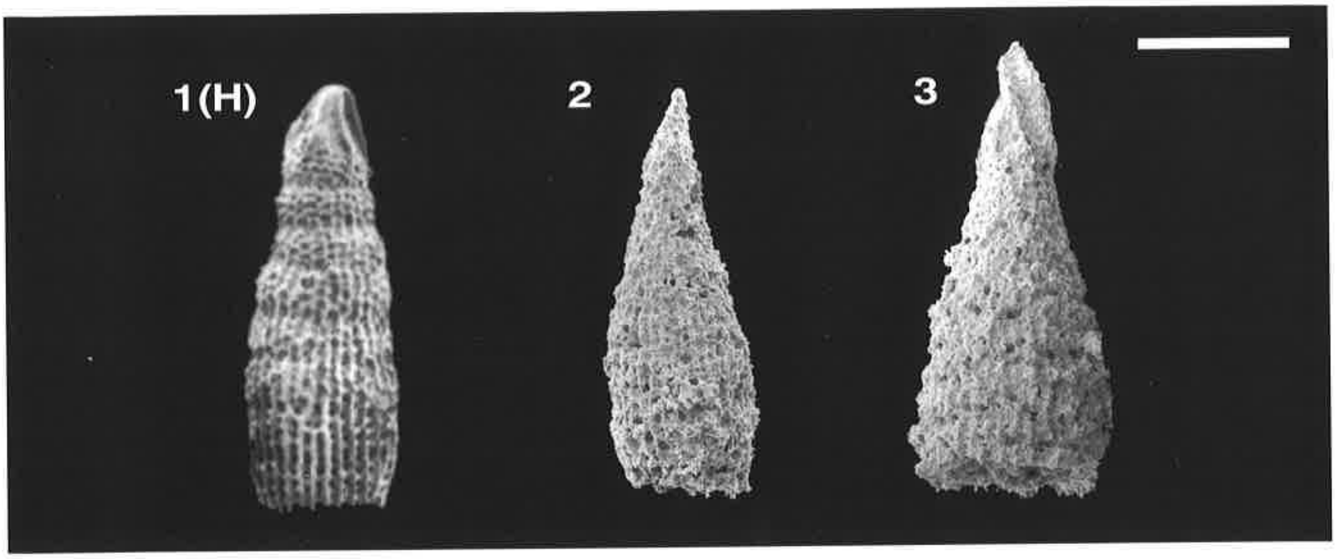


Plate 2010. ***Parahsuum cruciferum*** **TAKEMURA.** Magnification x200. **Fig. 1(H).** TAKEMURA 1986, pl. 5, fig. 9. **Fig. 2.** AB 2015, TM25.15.a35. **Fig. 3.** AB 2030, TM25.15.a56.

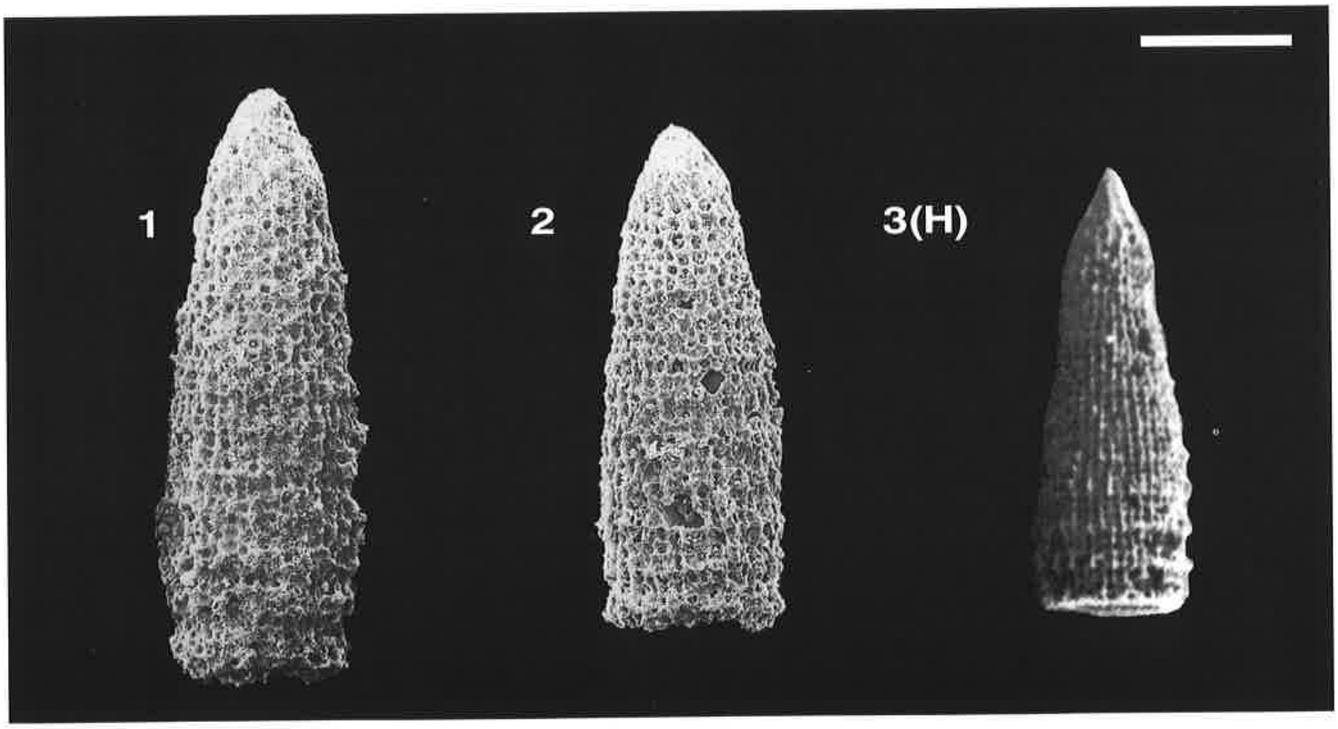


Plate 4031. ***Parahsuum (?) grande*** **HORI & YAO.** Magnification x200. **Fig. 1.** GO921926, GL123. **Fig. 2.** GO921920, GL123. **Fig. 3(H).** HORI & YAO 1988, pl. 2, fig. 7a.

PARAHSUUM (?) HICONOCOSTA 3011

Parahsuum (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER

Synonymy.-
Andromeda (?) sp.
DE WEVER et al. 1985, pl. 1, figs. 12-13, 16.
GORICAN 1987, p. 181, pl. 2, fig. 8.

Type Definition.- 81/2841, POB 1341.

Original Definition.- High conical form with 10-12 segments, with concave, wedge-shaped outline in lateral view. Cephalis small, hidden in the base of a stout long horn. Cephalis thorax and abdomen together slenderly conical, externally almost without visible strictures, smooth or slightly nodose, poreless. Hsuid pore structures are present on all postabdominal segments and on the abdomen of some specimens. Segments are well marked by a protruding nodose circumferential ridge, the stricture above this ridge is the external expression of the segmental division. Pores appear somewhat irregularly between nodes on the first abdominal segments, they regularly increase in size distally and are organized in vertical rows, separated by ridges forming rectangular pore frames. Each 2-5 rows of pores the vertical ridges are elevated like costae. The final postabdominal segment nearly two times as high as the second last, trapezoidal or tyre-shaped. Basal edge nodose, without spines. Basal surface very narrow, planar to concave with large aperture.

Remarks.- This species differs from *Andromeda* spp. by the presence of rectangular (hsuid ?) pore-frames and vertical costae-like ridges. Since the cephalic structure is unknown. It is doubtfully included with the genus *Parahsuum.*

Etymology.- Mnemonic abbreviation for high conical costate.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of horn:	20	18	15	25
H. test with horn:	400	390	370	425
Heigth last seg.:	33	41	33	46
Width last seg.:	166	185	160	250
Width aperture:	160	165	156	168

Type Locality.- Sample POB 1341, collected 4.10 m below sharp base of the basal green radiolarites, in the top part of the Sogno Formation. Locality No. 19 of Baumgartner (1984, p. 796, pl. 12).

UAZones.- 2-4, late Aal. to late Baj.

PARAHSUUM IZEENSE 2012

Parahsuum izeense (PESSAGNO & WHALEN)

Synonymy.-
Canutus izeensis PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 129, pl. 6, figs. 8, 10, 15.

Original Definition.- Test short, inflated, spindle-shaped, usually with six post-abdominal chambers. Cephalis hemispherical, knoblike; remaining chambers trapezoidal in cross section; cephalis and thorax usually imperforate. Abdomen and all but last two or three post-abdominal chambers increasing rapidly in width and gradually in length as added; last two or three post-abdominal chambers decreasing somewhat in width. Inner latticed layer of post-abdominal chambers consisting of moderately sized square to rectangular pore frames with nodes at vertices; 15 rows of pore frames visible laterally; three pore frames per row occurring between two longitudinal ridges and joints of chamber. Outer (second) latticed layer consisting of fragile, irregular, polygonal pore frames. Outer latticed layer best developed on earlier post-abdominal chambers.

Original Remarks.- *Canutus izeensis* n.sp. differs from *C. tipperi* n.sp. by having a less inflated test, a hemispherical, knoblike cephalis, and considerably smaller pore frames in the inner layer.

Etymology.- This species is named for the village of Izee near its type locality.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Maximum lenght:	350	303	250	350
Maximum width:	200	175	150	200

Type Locality.- Nicely Formation of east-central Oregon.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

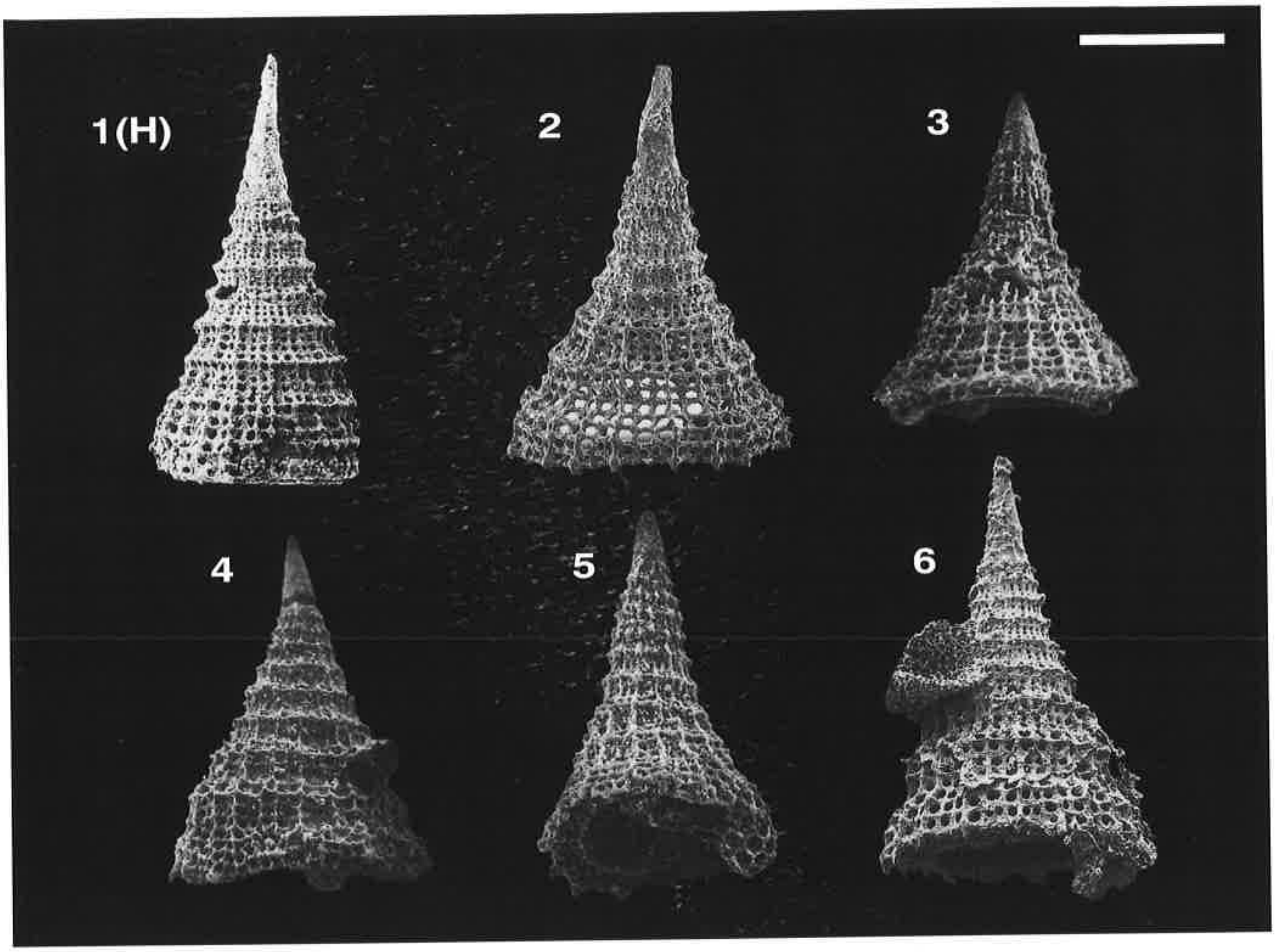


Plate 3011. ***Parahsuum* (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER.** Magnification x150. **Fig. 1(H).** POB81/2841, POB1341. **Fig. 2.** POB79/4428, IN7. **Fig. 3.** DW8222-28, A191. **Fig. 4.** DW8225-22, A215. **Fig. 5.** DW8124-09, A105. **Fig. 6.** POB79/4430, IN7.

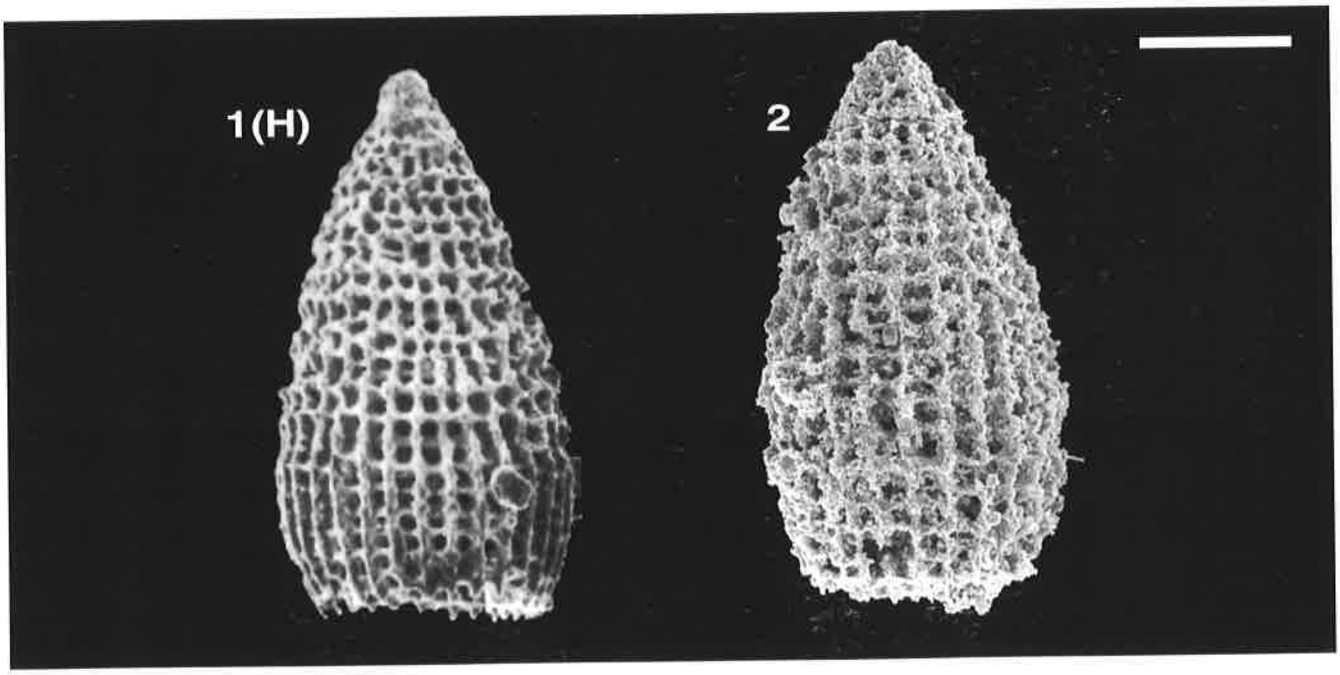


Plate 2012. ***Parahsuum izeense* (PESSAGNO & WHALEN).** Magnification x200. **Fig. 1(H).** PESSAGNO & WHALEN 1982, pl. 6, fig. 8. **Fig. 2.** AB 7063, TM105.50.f43.

PARAHSUUM (?) MAGNUM 3072

Parahsuum (?) *magnum* TAKEMURA

Synonymy.-
Parvicingula sp. G
KISHIDA & SUGANO 1982, pl. 10, fig. 1.
Parahsuum (?) *magnum* TAKEMURA
TAKEMURA 1986, p. 49, pl. 5, figs. 12-15.
KITO 1989, p. 175, pl. 20, fig. 6.
YAO 1991, pl. 3, fig. 17.
EL KADIRI 1992, p. 47, pl. 2, figs. 2, 6, 8, 9, 13.

Original Definition.- Shell large, with conical proximal half and cylindrical distal half, and with well developed, rectangular or round-pointed and tetraradiate apical horn, which covers the surface of the cephalo-thorax. Cephalo-thorax hemispherical, with irregularly distributed pores. Abdomen and post-abdominal segments cylindrical, with squarely distributed pores and with three transverse rows of pores. In the cylindrical distal part, circumferential ridges between segments distinct, rather than costae.

Original Remarks.- Although this species possesses a rectangular arrangemennt of pore on post-thoracic segments, it is questionably assigned to the genus *Parahsuum*, because the costae of this species are inconspicuous by far. The shape of *P.* (?) *magnum* resembles that of *Mirifusus* PESSAGNO (1977a), but the pore arrangement is quite different.

Etymology.- The species name, *magnum*, derived from *magnus* (Latin), means large.

Measurements (in μm).-
Based on 8 specimens. Length of shell, 325-405; maximum width of shell, 155-265.

Type Locality.- Sample TKN-05, Komami, Yamoto Village, Gifu Prefecture, central Japan.

UAZones.- 2-5, late Aal. to latest Baj.-early Bath.

PARAHSUUM (?) NATORENSE 3073

Parahsuum (?) *natorense* (EL KADIRI)

Synonymy.-
Parahsuum (?) sp. 5
KITO 1989, p. 178, pl. 19, figs. 21-22.
Canutus (?) *natorensis* EL KADIRI
EL KADIRI 1992, p. 41, pl. 1, figs. 11-13.

Original Definition.- "Conical test with a proximal elongated and a distal globose portion that represents 3/4 of test. Proximal portion shows slight intersegmental constrictions, allowing to recognize cephalis, thorax and abdomen. This portion bears a smooth, straight, pointed cephalic horn of circular cross section. The globose portion shows no constrictions. However, broken specimens reveal three to four internal intersegmental divisions. This portion is finely costate with about 15-20 costae visible in lateral view. These longitudinal costae together with the transverse costae (ribs) form quare pore frames with small nodes at intersections. Distal aperture large after a slight constriction of test."

Definition.- Spindle-shaped multicyrtid nassellarian. Proximal portion slender conical, including cephalis, thorax, abdomen and several postabdominal segments. Segmentation externally not or very poorly visible. Cephalis hidden in base of horn, internal structure unknown. Closely spaced vertical rows of pores originate on the proximal conical portion and are continuous to the base of test. Each row of pores is separated by a smooth or nodose ridge (costa?). Similar, but less raised horizontal ridges intersect with the vertical ones forming nodes. A regular square pore pattern results on the inflated part of test. Distal part constricted, fragile, with more irregular horizontal ridges, leaving a ragged opening suggesting the presence of a fragile terminal tube (?).

Original Remarks.- "*Canutus* (?) *natorensis* nov. sp. is related to *Canutus tipperi* PESSAGNO & WHALEN 1982, by its globose test. It differs from the latter by its more massive and longer horn, and by its three proximal segments that are not included in the globose portion. This species differs from other species of this genus by its more massive horn and by finer pore frames. It is placed in this genus on a preliminary basis, until the description of a new genus."

Etymology.- Named after the unit Hafat Nator, that contains the type locality.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.
Length of shell:	360	205
Maximum width:	400	230

Type Locality.- Oued El Halka, 5 km SSW of Tetouan. Base of red/green radiolarites.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

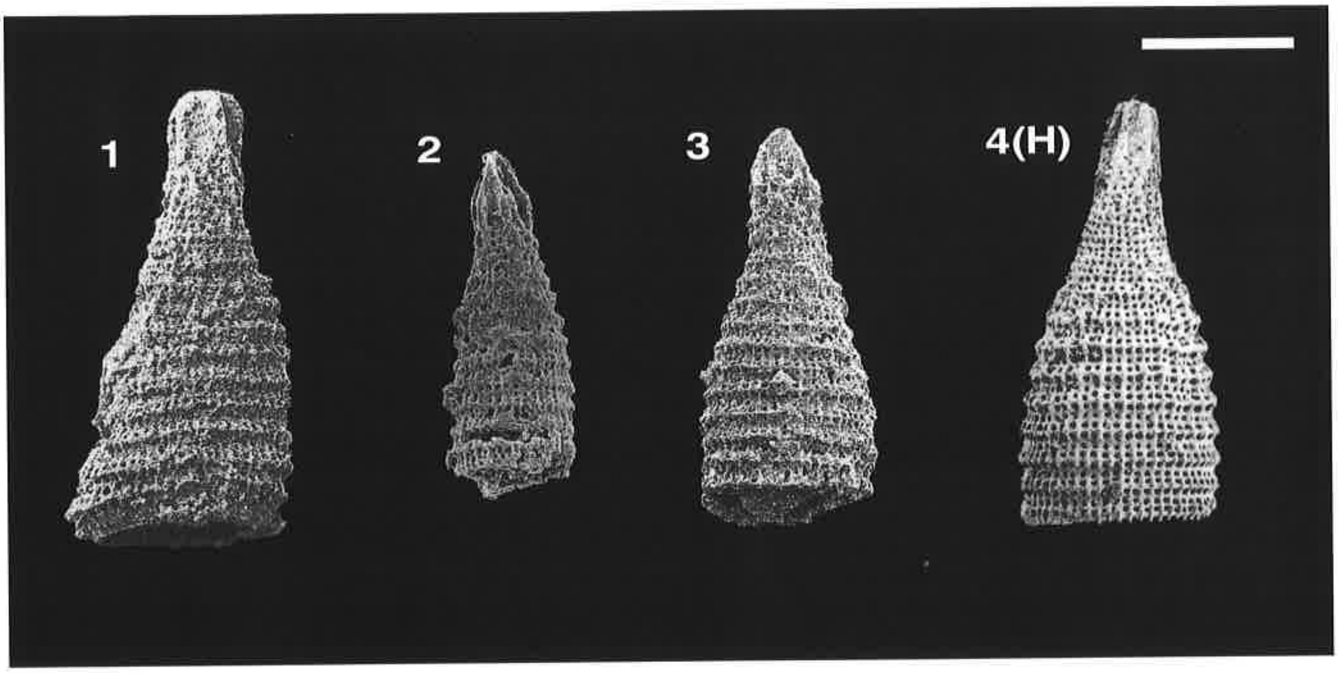


Plate 3072. ***Parahsuum* (?) *magnum* TAKEMURA.** Magnification x150. **Fig. 1.** POB81/2865, POB1341. **Fig. 2.** GO922009, GL 123. **Fig. 3.** GO922008, GL 123. **Fig. 4(H).** TAKEMURA 1986, pl. 5, fig. 12.

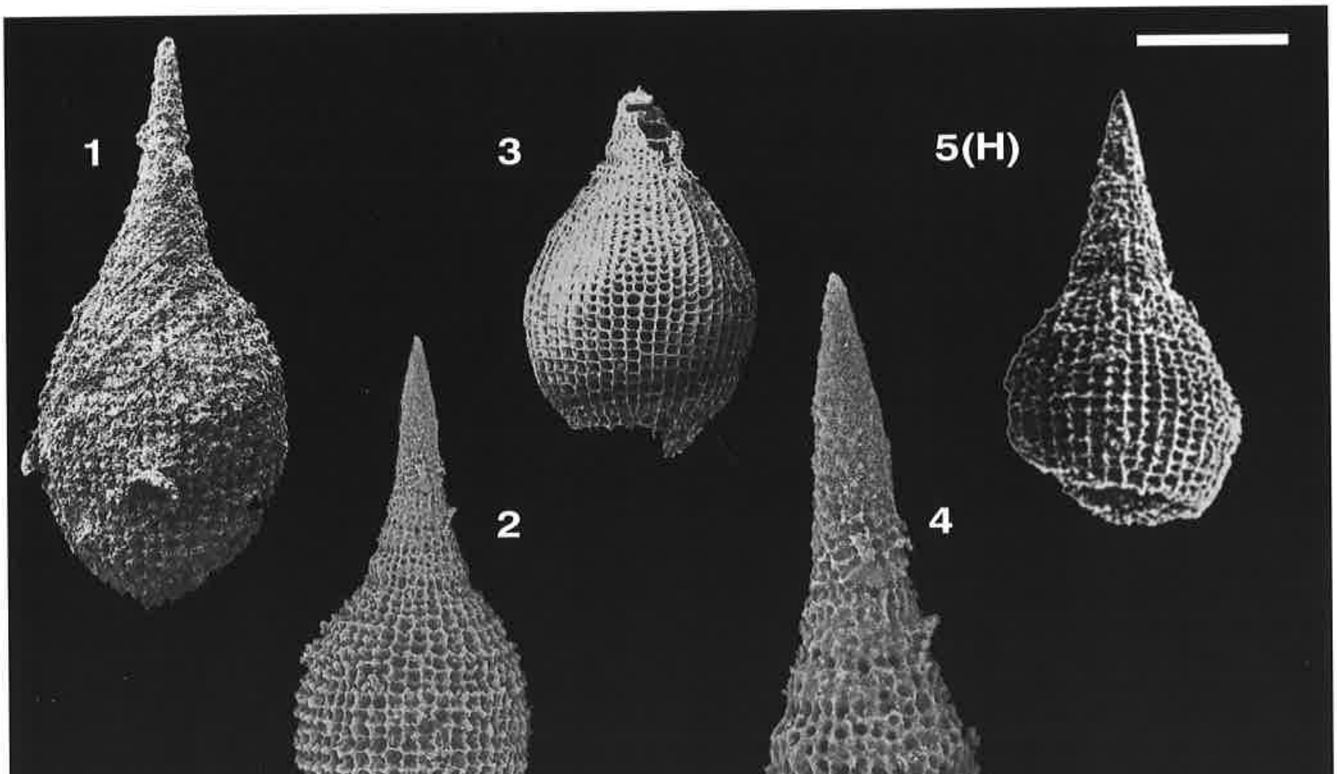


Plate 3073. ***Parahsuum* (?) *natorense* (EL KADIRI).** Magnification x150, except Fig. 4 x300. **Fig. 1.** POB81/2844, POB1341. **Fig. 2.** KI8840-1664, S70. **Fig. 3.** POB81/2985, IN7. **Fig. 4.** KI8840-1664, S70. **Fig. 5(H).** EL KADIRI 1992, pl. 1, fig. 11.

PARAHSUUM OFFICERENSE — 2011

Parahsuum officerense (PESSAGNO & WHALEN)

Synonymy.-
Lupherium officerense PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 135, pl. 6, figs. 5, 13, 18; pl. 12, fig. 5.

Original Definition.- Test elongate, quite pointed apically with short, delicate, cylindrical horn on small, hemispherical cephalis and eight to 11 post-abdominal chambers. Thorax and subsequent chambers trapezoidal in outline. All but final one or two post-abdominal chambers increasing rapidly in width, gradually in length as added; final one or two post-abdominal chambers decreasing in width. Costae fine, closely spaced proximally, becoming somewhat more widely spaced distally. Pores circular to elliptical in shape.

Original Remarks.- *Lupherium officerense* n.sp. is compared to *Lupherium snowshoense* n.sp. under the latter species.

Etymology.- This species is named for Officer Creek, near its type localities.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
Maximum lenght:	175	205	175	205
Maximum width:	85	99	70	99

Type Locality.- Holotype from OR 516. Lower part of midddle member of Snowshoe Formation of east-central Oregon.

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

PARAHSUUM (?) OLORIZI — 3071

Parahsuum (?) *olorizi* (EL KADIRI)

Synonymy.-
Parvicingula sp. H
KISHIDA & SUGANO 1982, p. 271, pl. 10, fig. 2.
Canutus (?) sp.
DE WEVER et al. 1985, pl. 1, fig. 15.
Hsuum olorizi EL KADIRI
EL KADIRI 1992, p. 42, pl. 1, figs. 1-4.

Original Definition.- "Conical elongated test bearing a smooth apical horn of circular cross section and with a flattened, hat shaped end. The three or four first segments at the base of this horn bear regularly distributed nodes. For all other segments, these nodosities are extended as fine discontiuous and not aligned ridges, except for the last two segments (that do not carry ridges). The outline of test shows distinct constrictions (17-20). The external wall is finely perforate and shows, besides the discontinuous ridges fine continuous longitudinal and transversal costae, which from together square pore frames and give the test wall a finely reticulate appearance"

Definition.- Slender conical multicyrtid with more than 20 segments. Cephalis small, hidden inside a stout horn which is T-shaped in lateral view and circular in axial view. Thorax, abdomen and first postabdominal segment covered by thick raised nodes between which some small pores are visible. Vertical rows of pores start to appear on the first postabdominal segments, where nodes become sparser and smaller. The remaining distal part of the test is characterized by a hsuid pore structure: Segmental divisions are externally marked by circumferential ridges formed by nodes developed on the vertical costae, and three horizontal rows per segment. Pore frames are rectangular, with 2-3 vertical rows of pores between the discontinuous costae. The distal part of test (beyond the 20th segment) is fragile and rarely preserved.

Original Remarks.- "*H. olorizi* nov.sp. differs from all other species described under *Hsuum* PESSAGNO and *Parvicingula* PESSAGNO, by the presence of clearly visible transverse costae, by its hat shaped horn, and by the presence of nodes on the first, post-cephalic segments."

Remarks.- This species is characterized by its T-shaped horn and knobby proximal test. Its test structure resembles that of *Parahsuum*. This species is therefore tentatively included with *Parahsuum*.

Etymology.- Named in honor of Federico Oloriz-Saez, for his work on the biostratigraphy (Ammonites, calpionellids) of the Upper Jurassic of the Betic Cordillera.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.
Maximum lenght:	520	497
Maximum width:	155	154

Type Locality.- Oued El Halka, 5 km SSW of Tetouan (Morocco). Base of red/green radiolarites.

UAZones.- 2-4, late Aal. to late Baj.

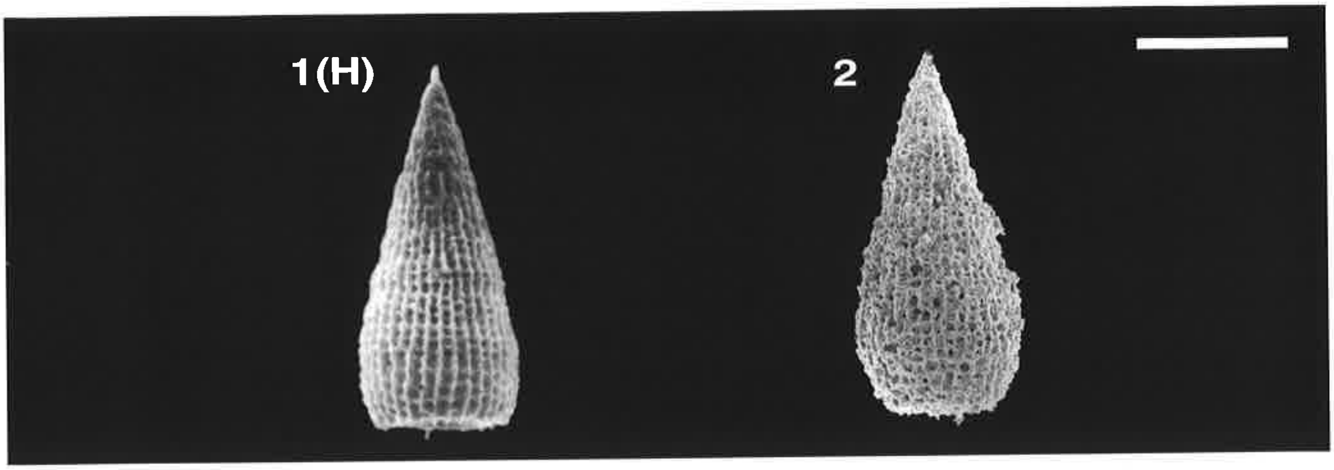


Plate 2011. ***Parahsuum officerense*** **(PESSAGNO & WHALEN).** Magnification x250. **Fig. 1(H).** PESSAGNO & WHALEN 1982, pl. 6, fig. 5. **Fig. 2.** AB 1937, TM109.23.p94.

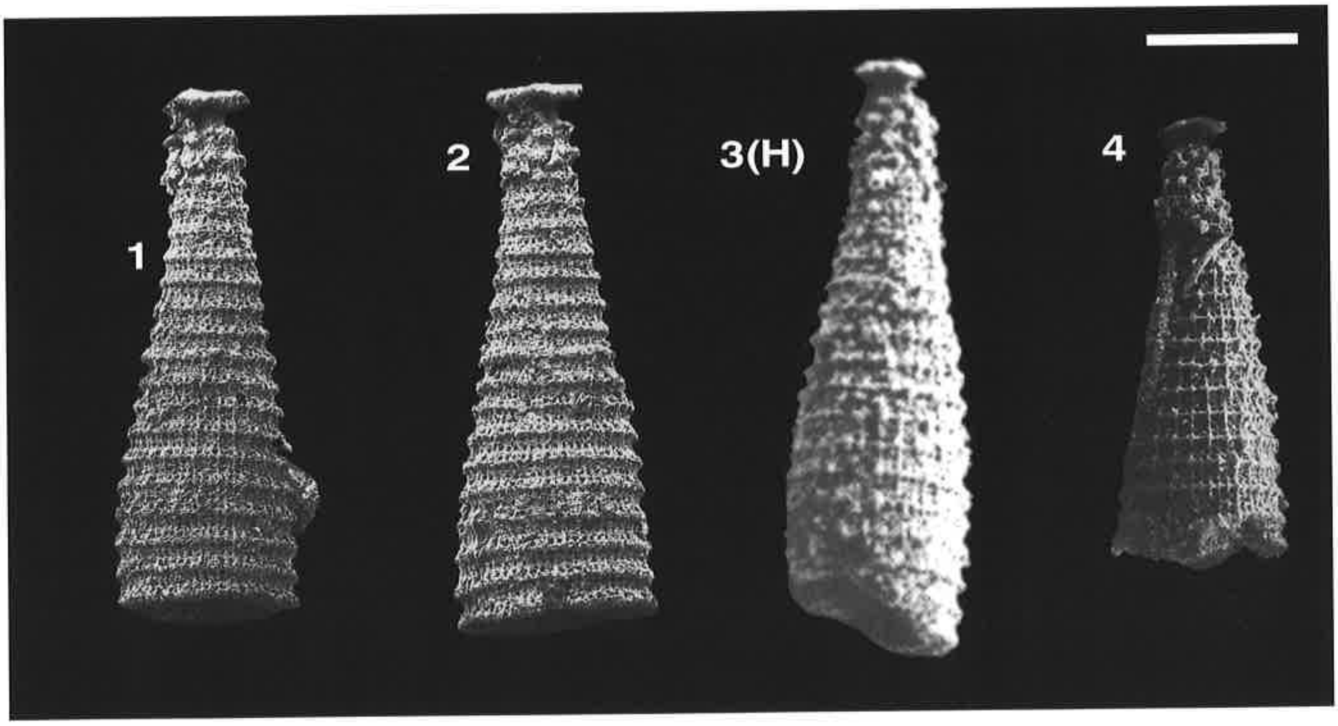


Plate 3071. ***Parahsuum*** **(?)** ***olorizi*** **(EL KADIRI).** Magnification x150. **Fig. 1.** POB81/2867, POB1341. **Fig. 2.** POB81/2962, POB1341. **Fig. 3(H).** EL KADIRI 1992, pl. 1, fig. 1. **Fig. 4.** DW8222-15, A-191.

PARAHSUUM STANLEYENSE 2023

Parahsuum stanleyense (PESSAGNO)

Synonymy.-
Hsuum (?) *stanleyensis* PESSAGNO
PESSAGNO 1977a, p. 82, pl. 8, figs. 5-8.

Original Definition.- Cephalis and thorax imperforate; cephalis with short cylindrical horn. Abdomen and postabdominal chambers with linearly arranged, large square to rectangular pore frames with nodes at corners; pores circular to elliptical; predominantly circular.

Original Remarks.- This species is questionably placed in *Hsuum* because it lacks true costae. Furthermore, it has far larger and more uniformly sized pore frames than do other species of *Hsuum*.

Etymology.- This species is named for Stanley Mountain near its type locality.

Measurements (in μm).-
Based on 6 specimens. Height cephalis plus thorax: 15 to 25; height abdomen: 15 to 25; height PA 1 to PA 3: 20 to 30; height PA 4 to PA 15: 25 to 30. (PA = postabdominal chamber, PA 1 = 1st Postabdominal chamber).

Type Locality.- NSF 973. Stanley Mountain area; San Luis Obispo County, California Coast Ranges.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

Parahsuum | M 2015

Parahsuum sp. M

Synonymy.-
Parahsuum sp. aff. *P. magnum* (TAKEMURA)
HORI 1990, fig. 9.37

Remarks.- This taxon is similar to *P. magnum*. *Parahsuum* sp. M differs from *P. magnum* by its smaller size and a sharpened apical horn of circular cross section.

UAZones.- 1-1, early-mid Aal.

PARAHSUUM | S 3240

Parahsuum sp. S

Synonymy.-
Parahsuum sp. S
MATSUOKA 1986c, pl. 2, fig. 13; pl. 3, fig. 14.
? *Droltus hecataensis* PESSAGNO & WHALEN
DE WEVER et al. 1986, pl. 11, figs. 6, 8.

Definition.- Shell conical, with 5 to 8 segments. Cephalis spherical internally, bearing a pronounced apical horn.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

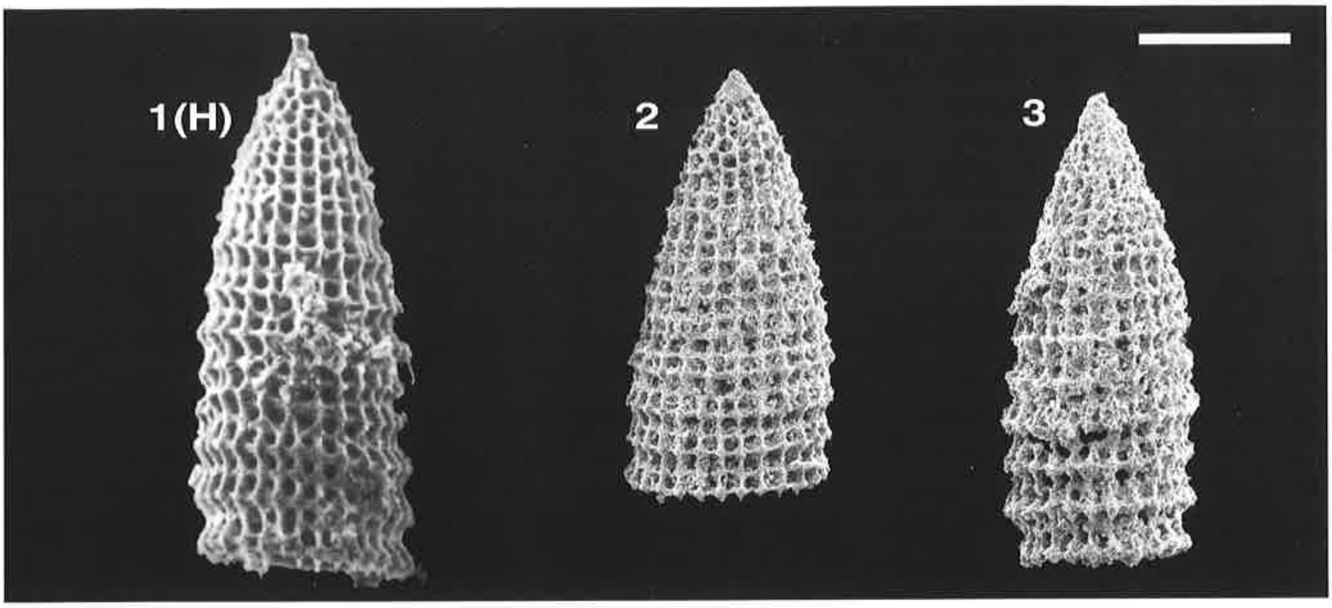


Plate 2023. *Parahsuum stanleyense* (PESSAGNO). Magnification x200. **Fig. 1(H).**PESSAGNO 1977a, pl. 8, fig. 5. **Fig. 2.** AB 4504, TM168.15.i36. **Fig. 3.** AB4622, TM174.86.b40.

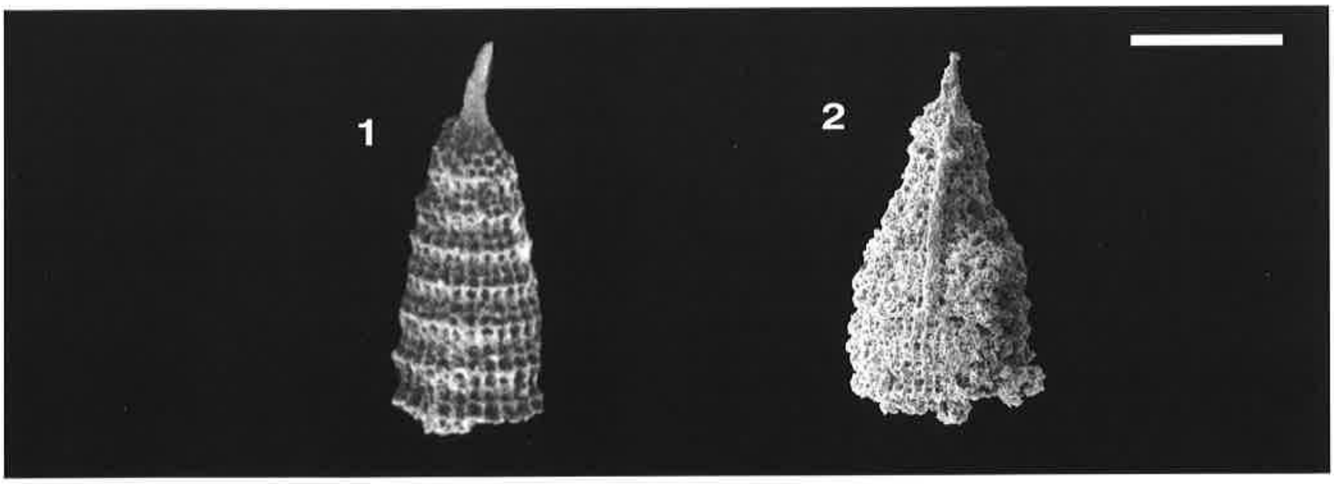


Plate 2015. Parahsuum sp. M. Magnification x200. **Fig. 1.** HORI 1990, Fig. 9.37. **Fig. 2.** AB6406, TM40.15.a50.

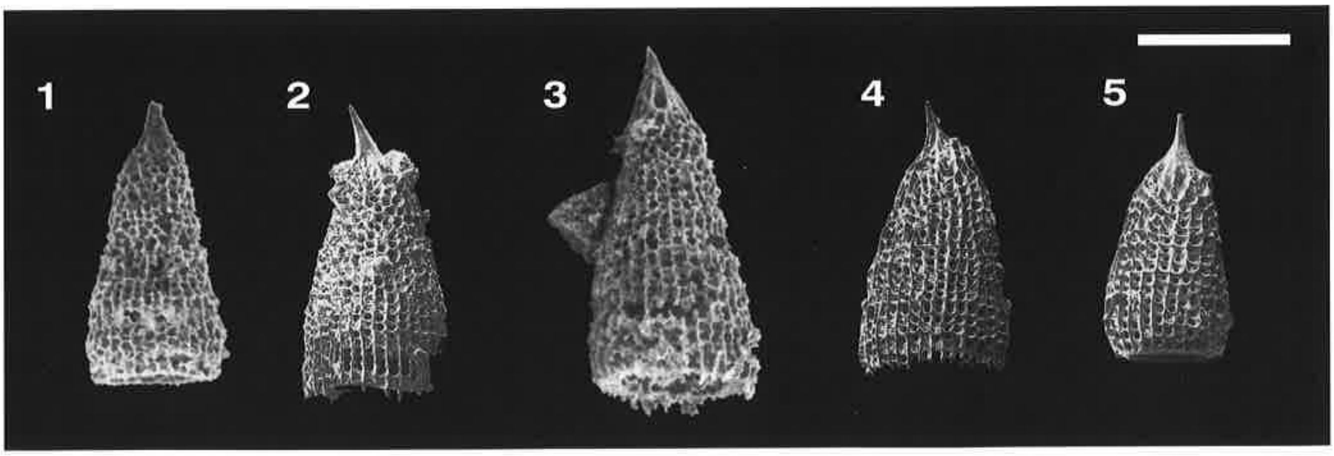


Plate 3240. *Parahsuum* sp. S. Magnification x200. **Fig. 1.** DW8138-21, S111. **Fig. 2.** POB81/2666, 534.124.1.52. **Fig. 3.** DW8138-24, S111. **Fig. 4.** POB81/2662, 534.124.1.52. **Fig. 5.** POB81/2664, 534.124.1.52.

PARAPODOCAPSA 6014

Genus: *Parapodocapsa* STEIGER

Synonymy.-
Parapodocapsa STEIGER
STEIGER 1992, p. 62.

Type Species- *Parapodocapsa furcata* STEIGER 1992.

Original Definition.- "Test consists of three segments which increase in size distally. The abdomen is spherical and has three longitudinal, tube-like, porous appendices. Thorax and cephalis are located centrally on the abdomen and are separated from each other by distinct strictures. Two of the appendices are curved to one another. The third appendix is straight. The angle between the appendices is approximately 120 degrees."

Original Remarks.- "*Parapodocapsa* differs from *Podocapsa* RÜST emend. FOREMAN by the lack of a terminal tube. In contrast to *Podocapsa* the arrangement of the appendices shows that two of them are curved to one another, and the third is straight."

Included Taxa.-
5396 *Parapodocapsa furcata* STEIGER

PARAPODOCAPSA FURCATA 5396

Parapodocapsa furcata STEIGER

Synonymy.-
Parapodocapsa furcata STEIGER
STEIGER 1992, p. 62, pl. 17, figs. 2-4.
JUD 1994, p. 90, pl. 15, fig. 13.

Original Definition.- "The test consists of three segments distally increasing in size. Cephalis and thorax each composed of a pore ring. The spherical abdomen and three appendices are completely covered with pores. The size of the pores is approximately equal on all segments of the test. The pores are rounded, embedded in hexagonal pore frames. The abdominal appendices are longitudinal tubes. Their surface is covered by pore rows which show a slight torsion. Two of the appendices are curved forming a bilateral symmetry in longitudinal section. At the place where these appendices insert the abdomen they are distinctly widened. Their distal ends are stout, lacking a specific pore pattern. The distal part of the abdomen is spherical."

Original Remarks.- "The observed specimens are equal in shape. A certain similarity exists to *Podocapsa haeckeli* RÜST 1885. Probably *Parapodocapsa furcata* is close to ? *Podocapsa haeckeli* described by Rüst (1885). The dimensions of both species coincide. Further similarities are the number of appendices, their stout distal ends and the curved pore rows. The description of Rüst (1885) is based on a completely different definition of the test. His figure (pl. 36, fig. 7) shows a drawing with no resemblance to *Parapodocapsa furcata*. Cephalis and thorax are missing and the morphology of the two larger appendices ("basal appendices") is not curved but straight. The illustration possibly is a view of the distal part of the test, where the pore pattern of the abdomen grades into that of the appendices. Cephalis and thorax are located on the other side of the test.

Rüst firstly described *Podocapsa* as a monocyrtid (1885) and later as a dicyrtid (1898). Foreman (1973b) emended the genus by increasing the caracteristic number of segments to three and defining the distal part of the abdomen by the existence of a terminal tube. The observed form cannot be assigned to one of the described genus definitions of *Podocapsa*. They also are not comparable to the species *Podocapsa haeckeli* RÜST 1885".

Etymology.- According to the fork-like shape of the test.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Length of test:	160	105	30	160
Length curved prolongations:	220	215	140	250
Length straight prolongation:	150	210	150	25
Width test between prolong:	425	434	360	500
Width prolong. proximal:	65	64	50	75
Width prolong. distal:	40	42	35	50
Diameter of pores:	10	10	10	12

Type Locality.- Gartenau, sample Ga39, quarry near St Leonhard, Salzburg.

UAZones.- 13-16, latest Tith. to early Val.

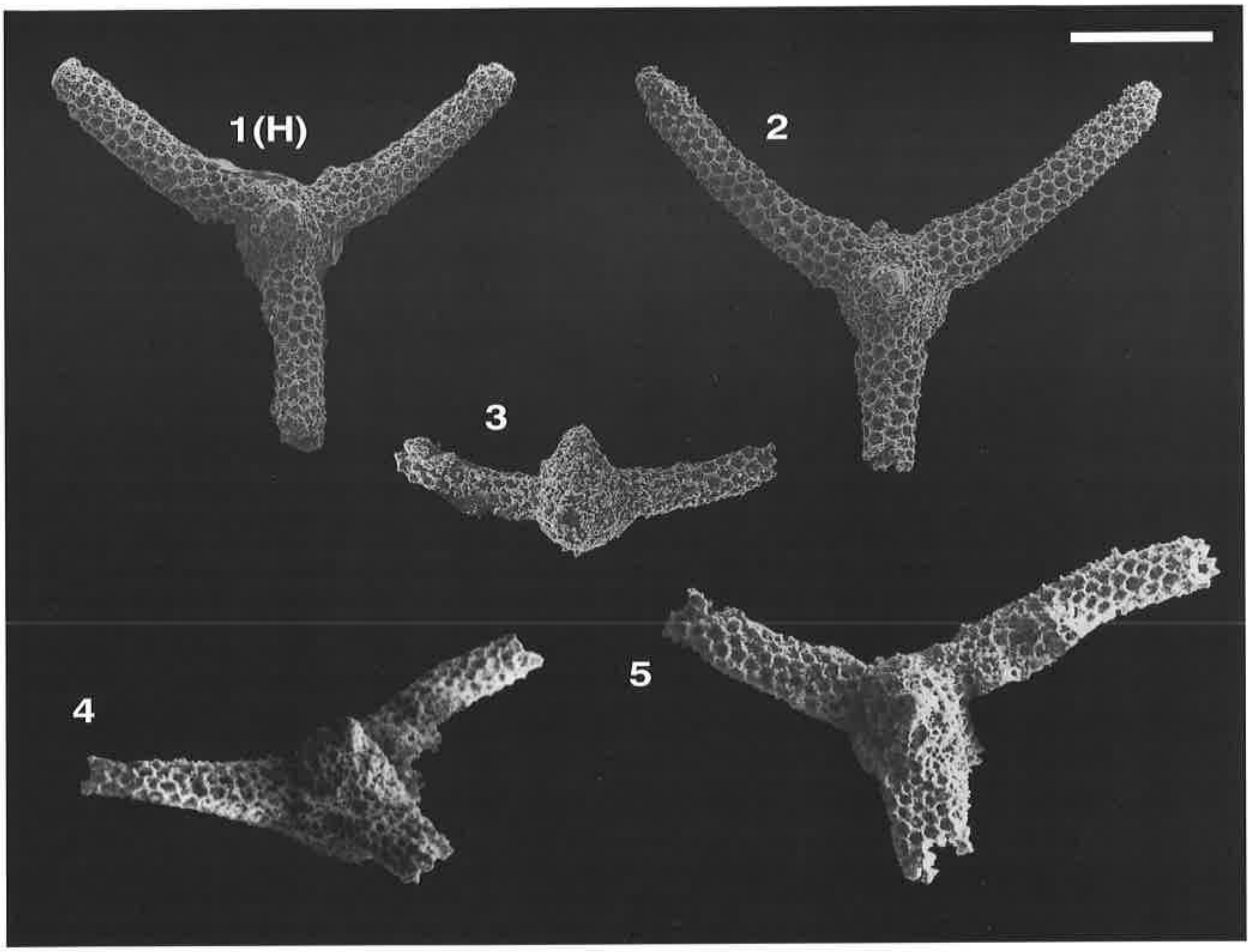


Plate 5396. *Parapodocapsa furcata* STEIGER. Magnification x150. **Fig. 1(H).** TS31, Ga39/2. **Fig. 2.** TS31, Ga39/4. **Fig. 3.** TS18, Ga50/1. **Fig. 4.** RJ866, Pi40.20. **Fig. 5.** RJ865, Pi40.20.

PARASATURNALIS 3821

Genus: *Parasaturnalis* KOZUR & MOSTLER

Synonymy.-
Parasaturnalis KOZUR & MOSTLER 1972
KOZUR & MOSTLER 1972, p. 43.
DE WEVER 1984, p. 18.

Type Species.- *Spongosaturnalis ? diplocyclis* YAO 1972.

Original Definition.- "The double to triple ring encloses a single row of pores and has two polar, or four to five radial rods that connect to a spongy central shell. Moderately long spines occur on the outer rim of the secondary ring."

Original Remarks.- "Related with *Helicosaturnalis* the inner ring is closely attached to the spongy shell. With *Pseudosaturnalis* the secondary ring shows numerous pores."

Etymology.- Composed of the prefix *Para-* and *saturnalis*.

Included Taxa.-
2013 *Parasaturnalis diplocyclis* (YAO)

PARASATURNALIS DIPLOCYCLIS 2013

Parasaturnalis diplocyclis (YAO)

Synonymy.-
Spongosaturnalis ? diplocyclis YAO
YAO 1972, p. 33, pl. 7, figs. 1-2, 6-10.

Original Definition.- Spongosaturnalid with double ring, and with second spines on second ring. Shell not preserved, but fragmentary thorns on sturdy spines probably indicate that shell may be spongy. Polar spines a little long or short, somewhat thin, with no ridge. Ring double, first (inner) ring and second (outer) ring, joined by bars (called as first spines), bilaterally symmetrical, circular to subcircular, with smooth surface, and no ridge. First ring curves smoothly, with no auxiliary spine on inner margin. Second ring slightly waves with short wave-length, but in some specimens curves smoothly. Thirteen or more first spines (bars) on first ring, constant in size and shape, joining with second ring. Thirteen or more second spines on second ring, situated respectively at middle point of part joined with first spines, short, thornlike or low protrusive, with rounded or somewhat sharp ends. Spaces enclosed by both rings and first spines, elliptical or subrectangular. One space at end of each polar spine generally larger than others, and in some specimens divided in two parts by transversal bar.

Original Remarks.- Although only eight specimens, which are represented by fragmentary ring, were found, this species is established because of the morphological feature lacking auxiliary spines. ? *S. catadelos* having a more complicated ring, is described by Foreman (1968, p. 11-12, pl. 1, figs. 1a-f; Latest Cretaceous, Moreno formation, California). The ring of ? *S. catadelos* is broad and flat, and perforated by numerous pores arranging in some measure of regularity. It probably indicates that the complicated ring is a combination of the fundamental rings (first ring, second ring etc.) and spines (first spines, second spines etc.). There is considerable variation in the number of spines among specimens.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
D. of 1 ring; (polar spines):	203	180	150	203
D. of 1 ring; (transversely):	260	250	190	315
D. of 2 ring; (polar spines):	313	285	230	330
D. of 2 ring; (transversely):	325	302	270	350
Diameter of shell:	126	113	100	126
Length of polar spine:	23	21	13	30
Length of first spine:	18-25	15-25	10	35
Length of sec. spine:	23	11	3	25
Breath of 1 ring:	15	9	3	15
Breath of 2 ring:	8	7	3	13

Type Locality.- Inuyama area, Gifu Prefecture, Japan.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

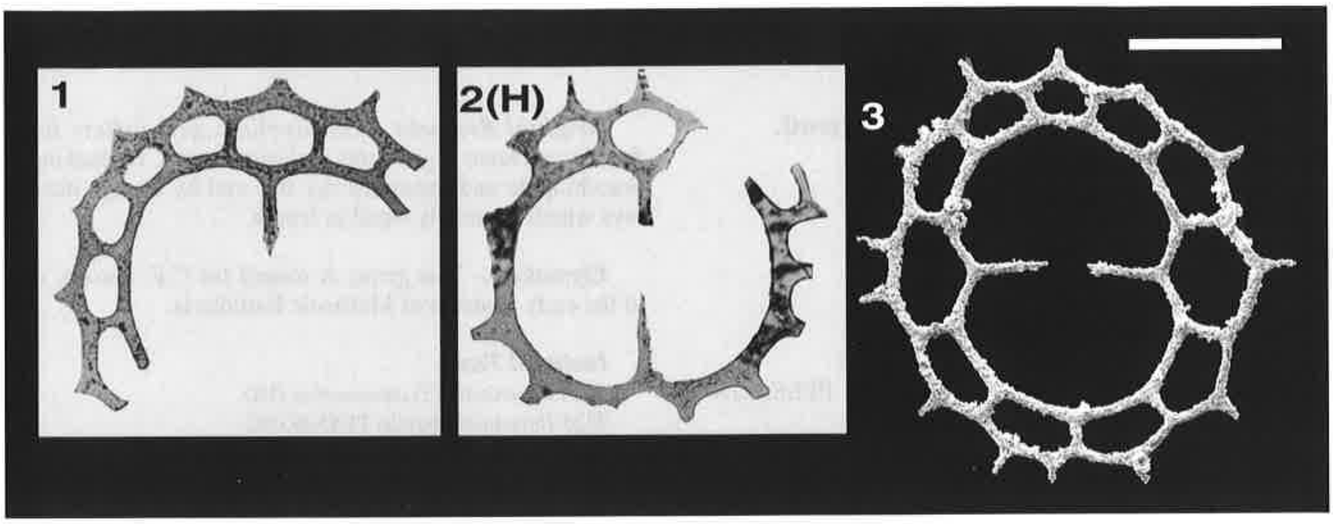


Plate 2013. *Parasaturnalis diplocyclis* (YAO). Magnification x200. **Fig. 1.** YAO 1972, pl. 7, fig. 1. **Fig. 2(H).** YAO 1972, pl. 7, fig. 2. **Fig. 3.** AB 2.7158, CB20.45.00.

PARONAELLA 3671

Genus: *Paronaella* PESSAGNO, emend. BAUMGARTNER

Synonymy.-
Paronaella PESSAGNO
PESSAGNO 1971a, p. 46.
Paronaella PESSAGNO
emend. BAUMGARTNER 1980, p. 300.

Type Species.- *Paronaella solanoensis* PESSAGNO 1971a.

Original Definition.- Test lack rays with bracchiopyle. Rays always of nearly equal length, expanded or thickened ray tips lacking. Meshwork linear to sublinear, comprised of irregular polygonal pore frames. Pore frames comprised of bars connected to weakly developed nodes.

Actualized Definition.- (BAUMGARTNER, 1980) Three-rayed patulibracchiins lacking a bracchiopyle. In contrast to Pessagno's definition, forms with bulbous or expanded ray tips are included.

Original Remarks.- *Paronaella* n.gen. differs from *Patulibracchium* n.gen. and *Halesium* n.gen. by lacking a bracchiopyle and expanded ray tips and by always having rays which are nearly equal in length.

Etymology.- This genus is named for C.F. Parona, one of the early students of Mesozoic Radiolaria.

Included Taxa.-
5314 *Paronaella* (?) *annemariae* JUD
3135 *Paronaella bandyi* PESSAGNO
3137 *Paronaella broennimanni* PESSAGNO
3310 *Paronaella* sp. aff. *P. corpulenta* DE WEVER
3140 *Paronaella kotura* BAUMGARTNER
3139 *Paronaella mulleri* PESSAGNO
3138 *Paronaella pristidentata* BAUMGARTNER
3133 *Paronaella pygmaea* BAUMGARTNER
2005 *Paronaella skowkonaensis* CARTER
5186 *Paronaella trifoliacea* OZVOLDOVA
5183 *Paronaella* (?) *tubulata* STEIGER

PARONAELLA (?) ANNEMARIAE 5314

Paronaella (?) *annemariae* JUD

Synonymy.-
gen. et sp. indet.
SCHAAF 1981, pl. 10, figs. 1a-b.
THUROW 1988, pl. 10, fig. 16.
Paronaella (?) *annemariae* JUD
JUD 1994, p. 90, pl. 15, fig. 14.

Original Definition.- Triangular, flat test with one side convex and markedly longer than the others, which are concave, shorter and equal in length. Test, except the corners, consisting of spongy meshwork. On both faces in central position there is a circle of 8 or more strong tubercles enclosing inside its perimeter one or more tubercles. Corners of the triangle with rays formed of several longitudinal beams, of which 5 are visible on one face of test. Beams connected by transverse bars forming longitudinal rows of pores. Tips of rays with one central spine and two or more shorter lateral spines, representing the termination of the longitudinal beams. The periphery of the test sometimes bearing short spines.

Original Remarks.- *Paronaella annemariae*, seems to be closely related to *Paronaella* (?) *tubulata* STEIGER by the presence of nodes on the central part of shell, by the structure of the rays and the wide obtuse angle comprised between two of them. Complete specimens were very rarely found, most of them having the rays broken off.

Etymology.- This species is dedicated to Mrs. Anne-Marie Magnenat, secretary at the Institute of Geology and Paleontology at University of Lausanne, Switzerland thanking for her help and her friendship.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Length of longer rays:	200	181	140	180
Length of short ray:	140	140	120	152
Diameter circle nodes:	70	71	65	85

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 14-21, early-early late Berr. to early Barr.

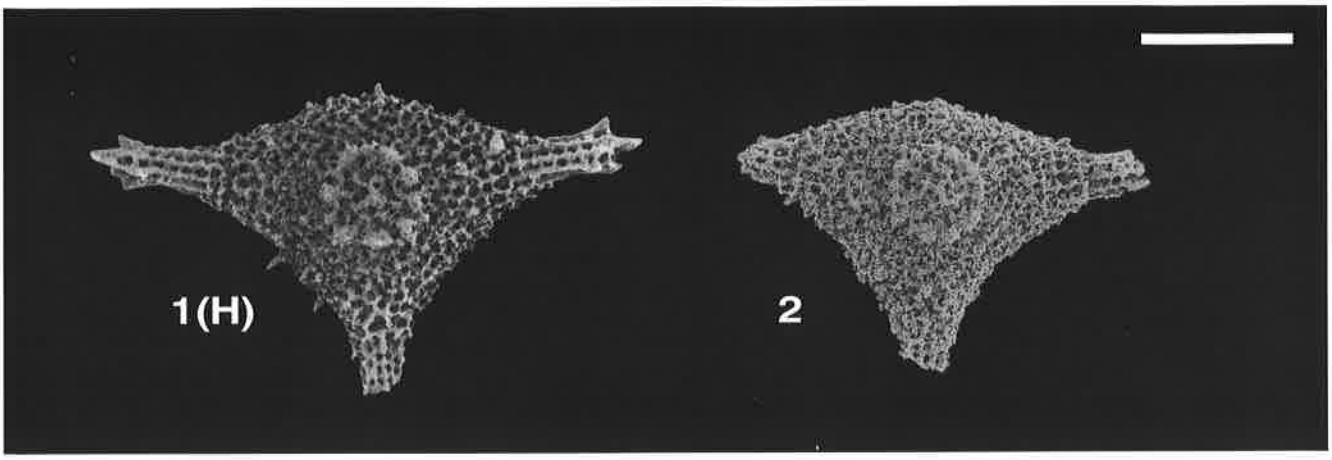


Plate 5314. *Paronaella* (?) *annemariae* JUD. Magnification x200. **Fig. 1(H).** RJ456, Bo566.5. **Fig. 2.** RJ442, Bo566.5.

PARONAELLA BANDYI 3135

Paronaella bandyi PESSAGNO

Synonymy.-
Paronaella bandyi PESSAGNO
PESSAGNO 1977a, p. 69, pl. 1, figs. 1-3.
BAUMGARTNER 1980, p. 300, pl. 9, fig. 4.
BAUMGARTNER 1984, p. 777, pl. 6, fig. 16.
EL KADIRI 1984, p. 204, pl. 15, figs. 1, ? 4.
DANELIAN 1989, p. 172, pl. 6, fig. 10.

Original Definition.- Rays with linearly arranged tetragonal to pentagonal pore frames. Each ray terminating in distinctive bifurcating spine.

Original Remarks.- This species is distinguished from all other *Paronaella* by virtue of the bifurcating spines on its ray tips.

Remarks.- Some forms included here may also have 3 spines on ray tips.

Etymology.- *Paronaella bandyi* n.sp. is named for the late Prof. Orville L. Bandy (University of Southern California) in honor of his many contributions to micropaleontology.

Measurements (in μm).-
Based on 10 specimens. Length of rays: 130 to 200, width of rays: 50 to 70, length of spines: 50 to 65.

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

PARONAELLA BROENNIMANNI 3137

Paronaella broennimanni PESSAGNO

Synonymy.-
Paronaella bronnimanni PESSAGNO
PESSAGNO 1977a, p. 69, pl. 1, figs. 4-5.
? ORIGLIA-DEVOS 1983, p. 97, pl. 12, fig. 14.
EL KADIRI 1984, p. 205, pl. 15, figs. 6, 8.
Paronaella broennimanni PESSAGNO
BAUMGARTNER 1980, p. 300, pl. 9, fig. 6.
KOCHER 1981, p. 80, pl. 15, fig. 5.
BAUMGARTNER 1984, p. 777, pl. 6, fig. 17.
DANELIAN 1989, p. 172, pl. 6, fig. 11.
Paronaella sp.
OZVOLDOVA 1990, p. 302, pl. 4, fig. 8.
Paronaella pristidentata BAUMGARTNER
? WIDZ 1991, p. 250, pl. 2, fig. 23.
Paronaella sp. C
WIDZ 1991, p. 250, pl. 3, fig. 2, not fig. 3.

Original Definition.- Test with medium-sized tetragonal (usually square) pore frames with circular to elliptical pores; pore frames arranged in linear fashion. Rays with blunted tips; two having three short spines and one having four.

Original Remarks.- *Paronaella bronnimanni* n.sp. differs from the type species, *P. solanoensis* PESSAGNO, by having (1) finer meshwork with tetragonal (usually square) pore frames, (2) blunted ray tips, and (3) three short spines on two ray tips and four short spines on one ray tip.

Actualized Remarks.- (BAUMGARTNER, 1980) The spelling *bronnimanni* is incorrect (ICZN Art. 32ci) and has to be emended to *broennimanni* since the species is named for P. Brönnimann.

Despite its linear arrangement of external beams and pores, this species has an inner structure like all patulibracchiids.

Etymology.- This species is named for Dr. Paul Brönnimann (Université de Genève) in honor of his numerous contributions to the study of fossil microplankton.

Measurements (in μm).-
Based on 9 specimens. Lenght of rays : 160 to 300, width of rays : 80 to 130.

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 4-10, late Baj. to late Oxf.-early Kimm.

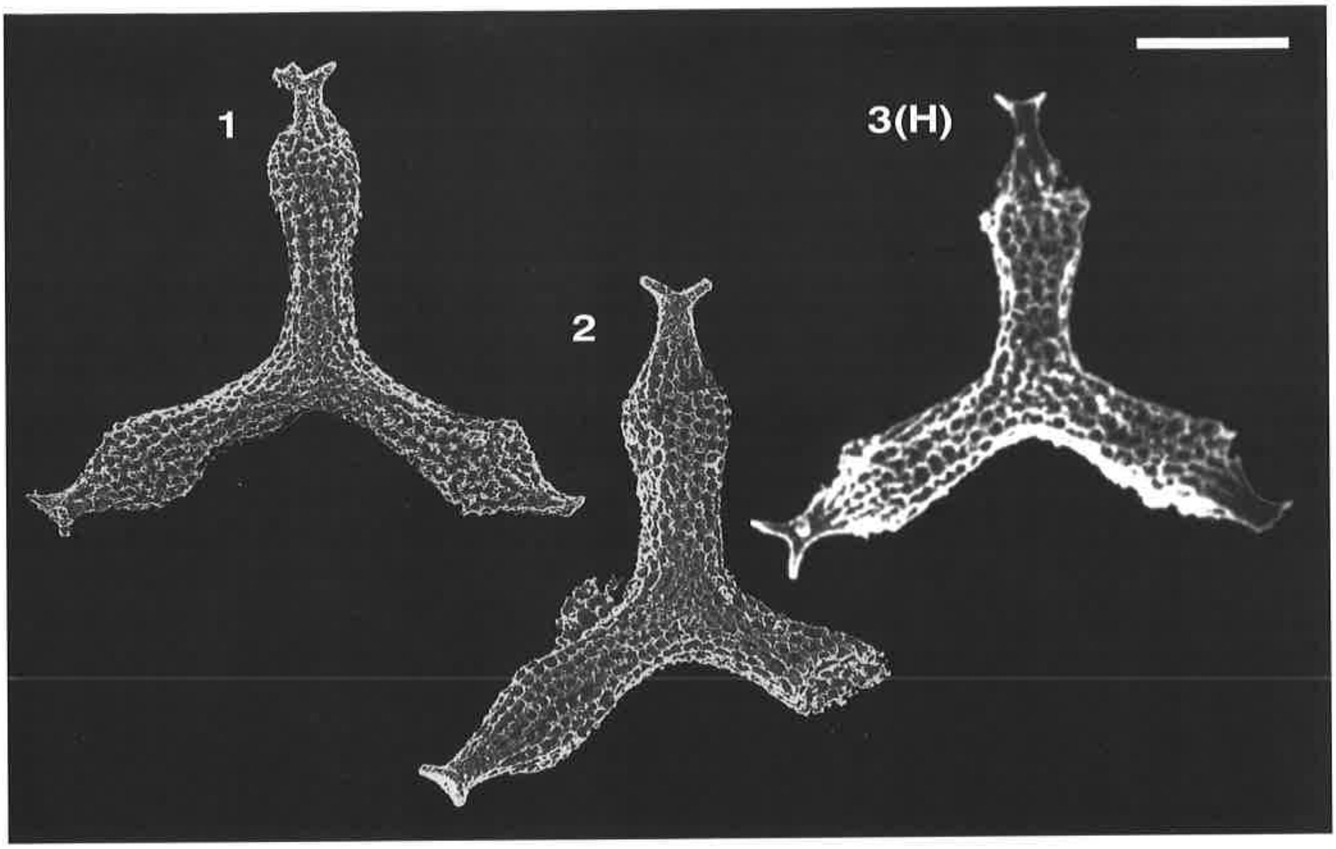


Plate 3135. *Paronaella bandyi* PESSAGNO. Magnification x200. POB78/6217a. **Fig. 1.** POB899.52. **Fig. 2.** POB78/6218, POB899.52. **Fig. 3(H).** PESSAGNO 1977a, pl. 1, fig. 1.

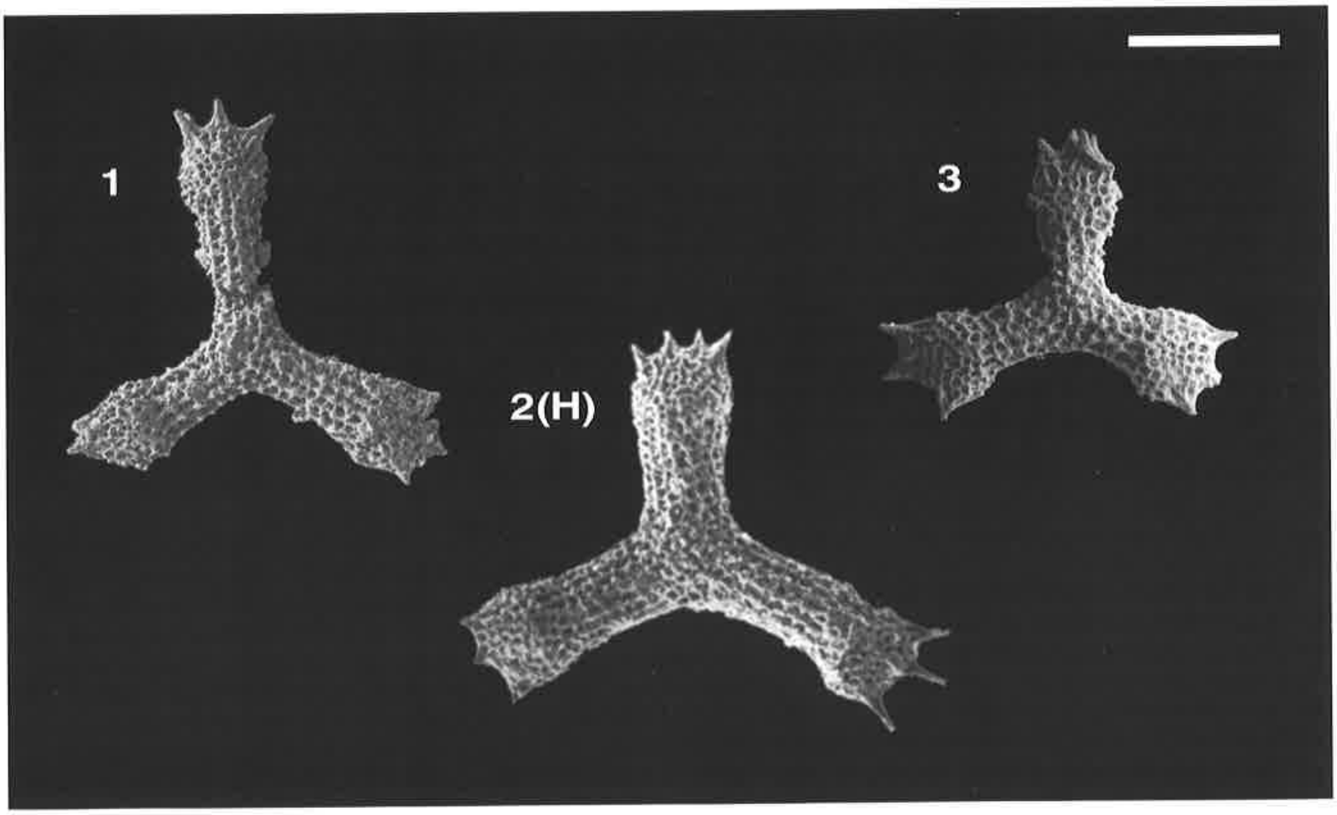


Plate 3137. *Paronaella broennimanni* PESSAGNO. Magnification x100. **Fig. 1.** POB78/3773, POB28.66. **Fig. 2(H).** PESSAGNO 1977a, pl. 1, fig. 4. **Fig. 3.** GO900218, BM102.

PARONAELLA CORPULENTA AFF. 3310

***Paronaella* sp. aff. *P. corpulenta* DE WEVER**

Synonymy.-
Paronaella corpulenta DE WEVER
aff. DE WEVER 1981b, p. 33, pl. 2, figs. 7-9.
KITO 1989, p. 142, pl. 14, figs. 11, 13.
Paronaella sp. 2
KITO 1989, p. 143, pl. 14, figs. 14-15.

Actualized Definition.- Massive shell with three broad arms terminated in a short, robust, three-bladed spine. Arms almost as broad as long and made up of a rougher spongy fabric enveloped by a more delicate one which is usually preserved in a fragmentary state. It is this external spongy layer that gives the shell this corpulent aspect since, in fact, the arms are club-shaped. Due to the thick spongy fabric the primary spines with which the arms terminate appear as sunk in a cushion. Some forms bear also secondary spines between or on arms. The latter spines are always thinner than the primary spines, and sometimes longer.

Remarks.- *Paronaella corpulenta* differs from *Paronaella obesa* (PESSAGNO) by the absence of bracchiopyle, a more massive appearance, thinner and less frequent secondary spines at extremity of arms and presence of a patagium. The very thick aspect and very rounded ouline make it easy to distinguish this species from others. *P. corpulenta* differs frop *Paronaella tripla* by the presence of secondary spines and a different skeletal network.

Measurements (in μm).-
Length of arms: 167-200, average: 177, holotype: 185. Length of primary spines is difficult to know as they emerge from a cushion (mean visible length: 50).

UAZones.- 1-2, early-mid Aal. to late Aal.

PARONAELLA KOTURA 3140

***Paronaella kotura* BAUMGARTNER**

Synonymy.-
Paronaella kotura BAUMGARTNER
BAUMGARTNER 1980, p. 302, pl. 9, figs. 15-19; pl. 12, fig. 8.
KOCHER 1981, p. 80, pl. 15, fig. 7.
BAUMGARTNER 1984, p. 777, pl. 6, fig. 20.
DE WEVER et al. 1986, pl. 9, fig. 2.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, figs. 7, 9.
OZVOLDOVA 1988, pl. 6, fig. 4.
ORIGLIA-DEVOS 1983, p. 99, pl. 14, fig. 6.
? EL KADIRI 1984, p. 207, pl. 15, figs. 2, 5; pl. 16, figs. 5-6; pl. 26, fig. 8.
DANELIAN 1989, p. 173.
CONTI & MARCUCCI 1991, pl. 3, fig. 5.
WIDZ 1991, p. 248, pl. 2, fig. 17.

Original Definition.- Stout form with cylindrical rays and club-shaped expanded ray tips without spines. Central area planiform with a circular area of dense meshwork with small pores and scarcely any nodes. Rays with relatively fine, irregular meshwork, with circular or lengthened pores which may show a faint linear arrangement. Nodes weakly developed. Ray tips with uniform fine spongy meshwork. The distal end of a ray tip is usually a flat vertical surface but some specimens show a fragile, spongy protrusion.

Original Remarks.- This species may come close to *Patulibracchium arbucklensis* PESSAGNO 1971 (p. 27, pl. 16, fig. 1). It differs from the latter species in lacking a bracchiopyle (the spongy protrusion cannot be interpreted as that) in having a generally finer meshwork on the rays. *Paronaella kotura* differs from other *Paronaella* sp. by the spineless ray tips and by the described central area.

Etymology.- Greek, *koturos, os, on,* with blunt tail, pointless.

Measurements (in μm).-
Based on 12 specimens.

	HT	av.	min.	max.
Length of rays AX:	245	325	240	410
Length of rays BX:	300	-	-	-
Length of rays CX:	290	-	-	-
Width of rays:	80	77	50	101
Width of ray tips:	120	120	92	137
L. spongy protrusion:	45	-	-	-

Type Locality.- Locality A, see text-fig 1 and locality descriptions (Baumgartner, 1980).

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

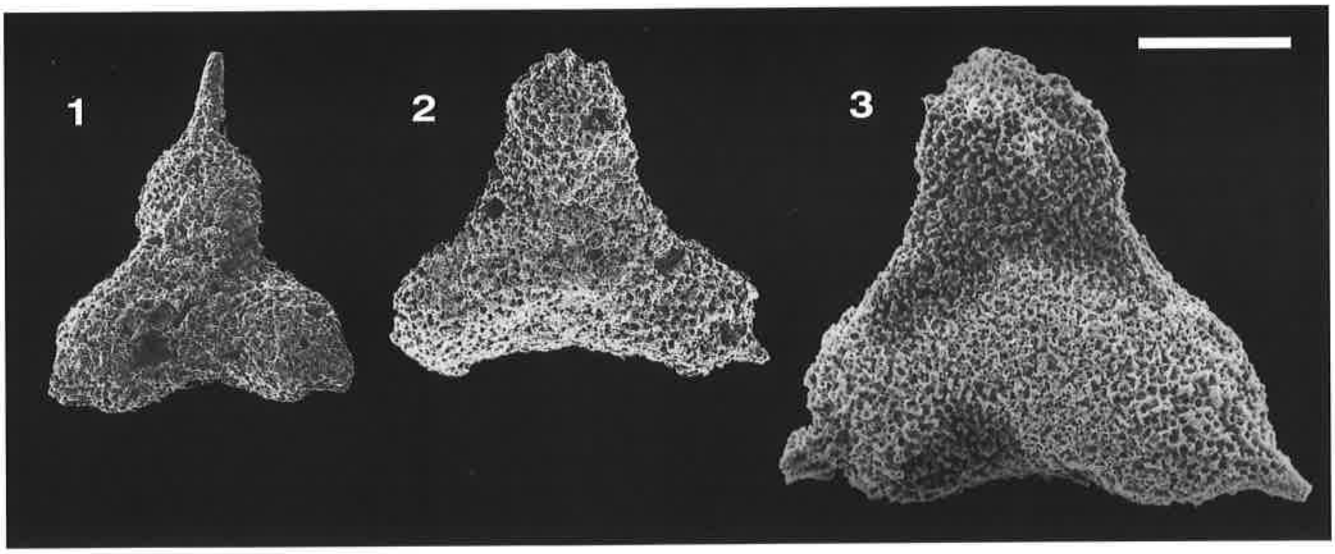


Plate 3310. *Paronaella* sp. aff. *P. corpulenta* DE WEVER. Magnification x150, except Fig. 3 x300. **Fig. 1.** GO893601, GL123. **Fig. 2.** GO893534, GL123. **Fig. 3.** KI8733-4A, S66.

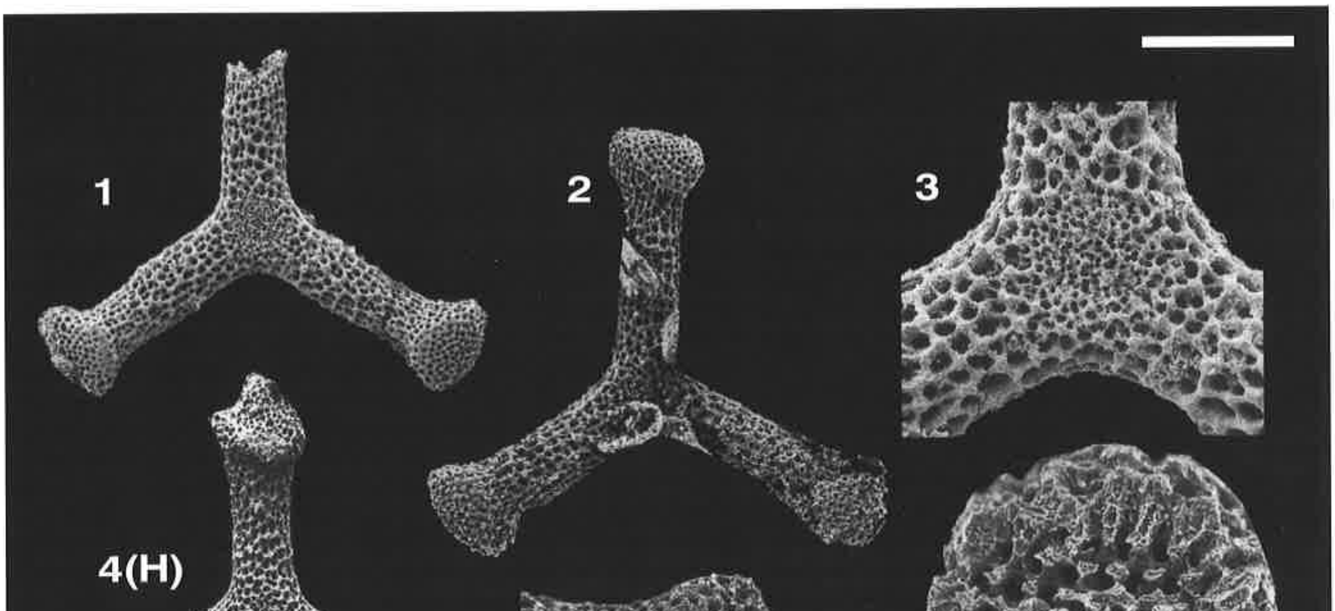


Plate 3140. *Paronaella kotura* BAUMGARTNER. Magnification x100, unless otherwise indicated. **Fig. 1.** POB78/6733, POB899.55. **Fig. 2.** POB78/6217, POB899.52. **Fig. 3.** POB78/6732, POB899.55, x250. **Fig. 4(H).** POB78/6566, POB899. **Fig. 5(H).** POB78/6567, POB899.55, x250. **Fig. 6.** POB78/6731, POB899.55, x500.

PARONAELLA MULLERI 3139

Paronaella mulleri PESSAGNO

Synonymy.-
Paronaella mulleri PESSAGNO
PESSAGNO 1977a, p. 71, pl. 2, figs. 2-3.
BAUMGARTNER 1980, p. 304, pl. 9, fig. 8.
KOCHER 1981, p. 80, pl. 15, fig. 8.
ORIGLIA-DEVOS 1983, p. 100, pl. 14, fig. 2.
EL KADIRI 1984, p. 209, pl. 16, figs. 2, 8.
BAUMGARTNER 1984, p. 778, pl. 6, fig. 21.
? NAGAI 1985, pl. 4, figs. 2-2a.
DE WEVER et al. 1986, pl. 8, fig. 18.
DE WEVER & CORDEY 1986, pl. 1, fig. 20.
OZVOLDOVA 1988, pl. 4, fig. 10.
DANELIAN 1989, p. 173, pl. 6, figs. 12-15.
WIDZ 1991, p. 250, pl. 2, figs. 26-27.
Paronaella sp. cf. *P. mulleri* PESSAGNO
BAUMGARTNER 1980, p. 304, pl. 9, fig. 5; pl. 12, figs. 4-7.
Paronaella denudata (RÜST)
OZVOLDOVA 1990, pl. 1, fig. 7.

Original Definition: Rays relatively slender with tetragonal to hexagonal irregular pore frames; rays terminating in massive, centrally placed spines with linear ridges converging from base of spine toward tip. Central area high in relief with rays sloping from central area to ray tips.

Original Remarks.- *Paronaella mulleri* n.sp. seems most closely related to *P. denudata* (RÜST). Both species share tests with rays sloping away from their central areas. *Paronaella mulleri*, however, has slender rays, whereas *P. denudata* has wide rays with broader ray tips.

Etymology.- This species is named for the late Prof. Siemon W. Muller in honor of his distinguished teaching career at Stanford University, and his many contributions to the study of the Mesozoic stratigraphy of western North America.

Measurements (in μm).-
Based on 8 specimens. Length of rays 150 to 280, width of rays 90 to 110, length of spines 40 to 90.

Type Locality.- NSF 907 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 6-10, mid Bath. to late Oxf.-early Kimm.

PARONAELLA PRISTIDENTATA 3138

Paronaella pristidentata BAUMGARTNER

Synonymy.-
Paronaella pristidentata BAUMGARTNER
BAUMGARTNER 1980, p. 304, pl. 9, fig. 7; pl. 12, fig. 3.
DE WEVER et al. 1986, pl. 9, fig. 4.
OZVOLDOVA 1988, pl. 1, fig. 8.
Paronaella cf. *pristidentata* BAUMGARTNER
OZVOLDOVA & SYKORA 1984, p. 267, pl. 7, figs. 6-7.

Original Definition.- Test with short broad rays of equal or unequal length with rounded, sometimes bulbous tips fringed with bladelike spines. Central area and rays with irregular coarse meshwork sometimes with a weak linearity of pores. Sharp prominent nodes may be developed which give the test a spinose aspect. Five to six flat, two-sided spines fringe the ray tip in equatorial plane, the central spine usually being the longest. Base of spines sometimes with pores.

Original Remarks.- This species differs from all other *Paronaella* spp. by the presence of bladelike spines and the spinose surface.

Etymology.- Latin : *pristis*, sawfish; *dentatus*, with teeth.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Length of ray AX:	165	162	107	200
Length of ray BX:	168	-	-	-
Length of ray CX:	150	-	-	-
Width of rays:	72	73	47	90
Width of rays tips:	97	90	72	136
Lenght of longest spines:	64	49	43	68

Type Locality.- Locality D, see text-figure 1 and locality descriptions (Baumgartner, 1980).

UAZones.- 10-11, late Oxf.-early Kimm. to late Kimm.-early Tith.

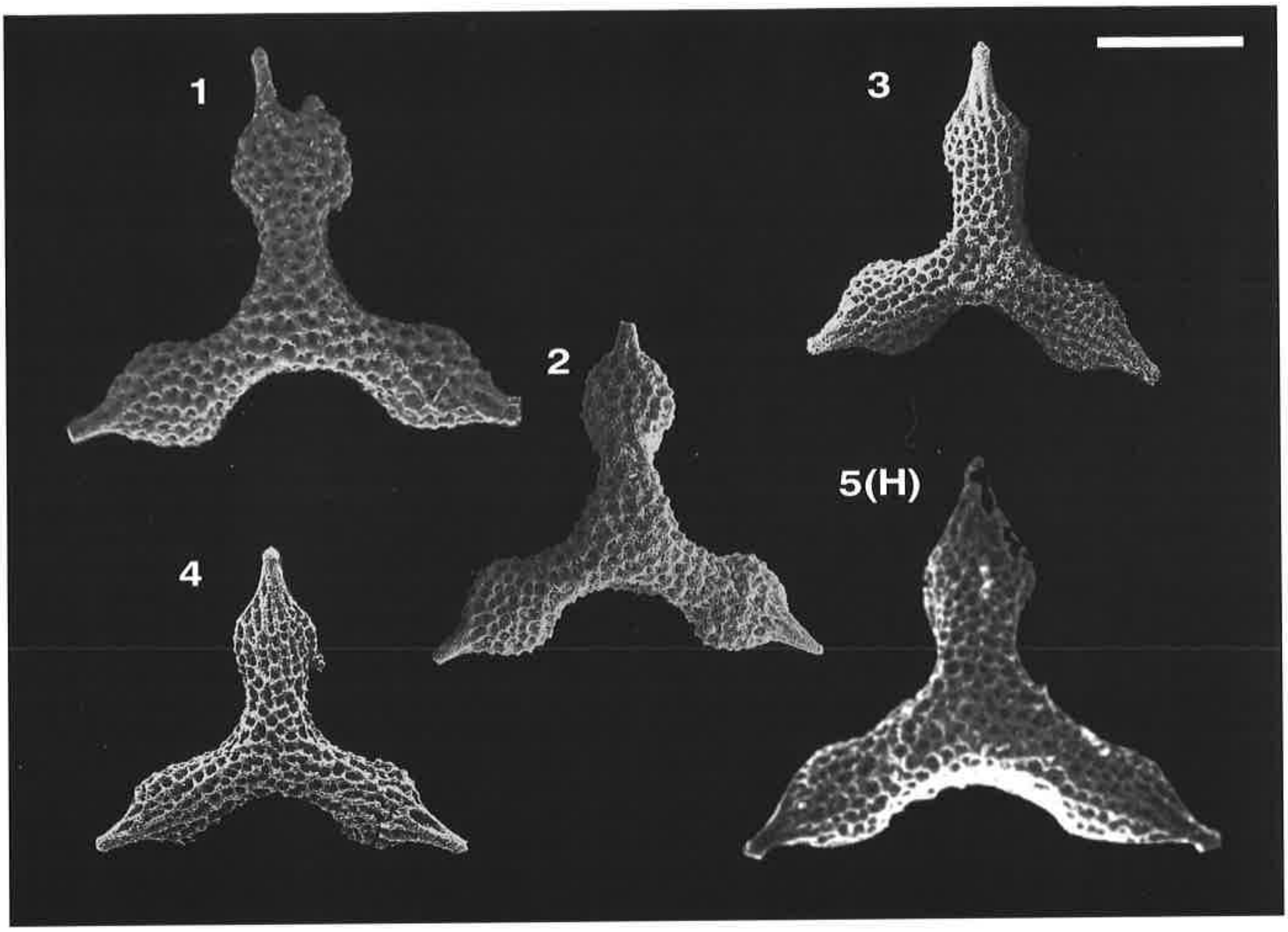


Plate 3139. ***Paronaella mulleri*** **PESSAGNO.** Magnification x150. **Fig. 1.** POB77/0565, POB28.52. **Fig. 2.** DU1842, R102. **Fig. 3.** POB78/6229, POB899.52. **Fig. 4.** POB78/6226, POB899.52. **Fig. 5(H).** PESSAGNO 1977a, pl. 2, fig. 2.

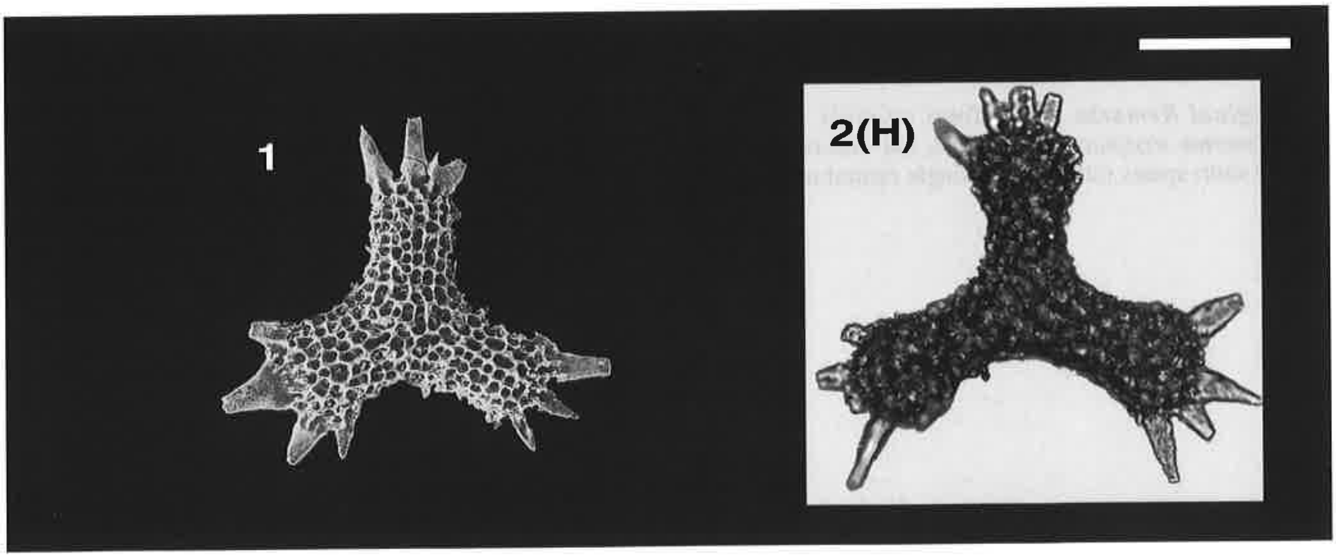


Plate 3138. ***Paronaella pristidentata*** **BAUMGARTNER.** Magnification x150. **Fig. 1.** POB78/8149, POB986.52. **Fig. 2(H).** POBTS8/6, POB986.

PARONAELLA PYGMAEA 3133

Paronaella pygmaea BAUMGARTNER

Synonymy.-
Paronaella pygmaea BAUMGARTNER
BAUMGARTNER 1980, p. 306, pl. 9, figs. 2, 9.
AITA 1987, p. 64, pl. 1, fig. 7; pl. 8, fig. 12.
? OZVOLDOVA 1990, pl. 3, fig. 6.
WIDZ 1991, p. 250, pl. 2, fig. 23.

Original Definition.- Small test with 3 equal rays tapering to a short central spine. Meshwork on rays sublinear, with small circular pores and small nodes. Spines with 3 grooves. Central area may be slightly raised over rays.

Original Remarks.- This species differs from *P. venadoensis* PESSAGNO in its similar size and the lack of lateral spines. It differs from *P. mulleri* PESSAGNO in its smaller size and less raised central area.

Etymology.- Greek : *pygmaeos, a, um*, dwarfish.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Length of ray AX:	85	105	85	132
Length of ray BX:	88	-	-	-
Length of ray CX:	85	-	-	-
Width of ray:	53	61	47	75
Length of longest:	-	-	-	-
Central spine:	40	46	29	64

Type Locality.- Locality B of Baumgartner (1980); Argolis Peninsula (Peloponnesus, Greece).

UAZones.- 7-9, late Bath.-early Call. to mid-late Oxf.

PARONAELLA SKOWKONAENSIS 2005

Paronaella skowkonaensis CARTER

Synonymy.-
Paronaella skowkonaensis CARTER
CARTER et al. 1988, p. 40, pl. 11, figs. 4-5.

Original Definition.- Three-rayed patulibracchiid having long, slender rays with clavate to wedge-shaped tips. Meshwork fine and irregular. Ray tips have numerous short fine spines.

Test large with three long slender rays expanding at tips. Rays subequal in length at approximately 120°. Tips rounded to wedge-shaped. External pore frames small, sublinearly arranged; tetragonal to pentagonal with weak nodes at vertices. Numerous short, fine spines extend from ray tips of well preserved specimens. Internal meshwork layered and spongy.

Original Remarks.- This form strongly resembles *Rhopalastrum trixiphus* RÜST 1898, but differs in having several short spines rather than a single central one on each ray tip. It has been assigned to *Paronaella* because of its layered spongy meshwork.

Etymology.- Named for Skowkona Mountain, southeast of the type locality.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Length of ray AX:	196	197	230	150
Length of ray BX:	188	-	-	-
Length of ray CX:	182	-	-	-
Width of ray:	50	81	70	50
Width of tip:	149	146	205	80

Type Locality.- GSC locality C-080584. Fannin, Whiteaves and Phantom Creek formations, Maude and Graham islands, Queen Charlotte Islands

UAZones.- 1-2, early-mid Aal. to late Aal.

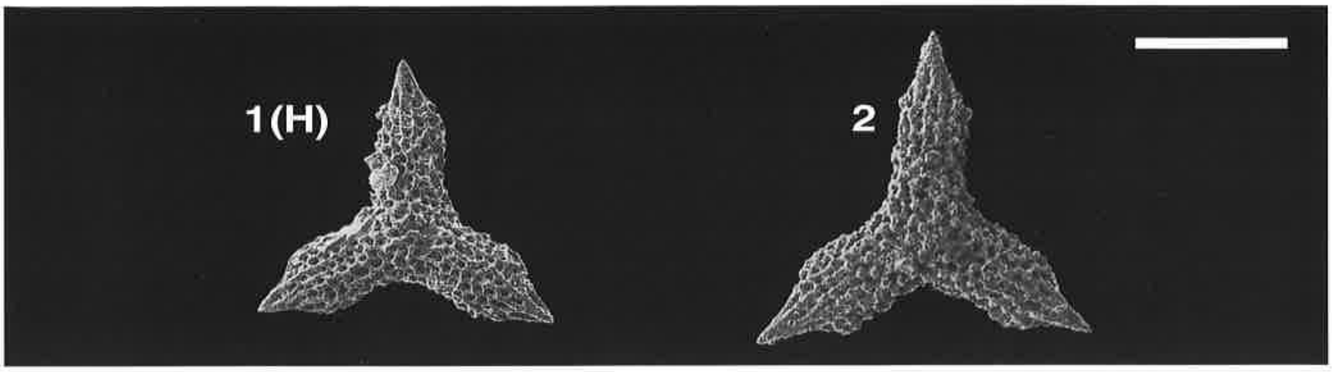


Plate 3133. ***Paronaella pygmaea*** **BAUMGARTNER.** Magnification x200. **Fig. 1(H).** POB78/3772, POB28.66. **Fig. 2.** POB78/3557, POB28.63.

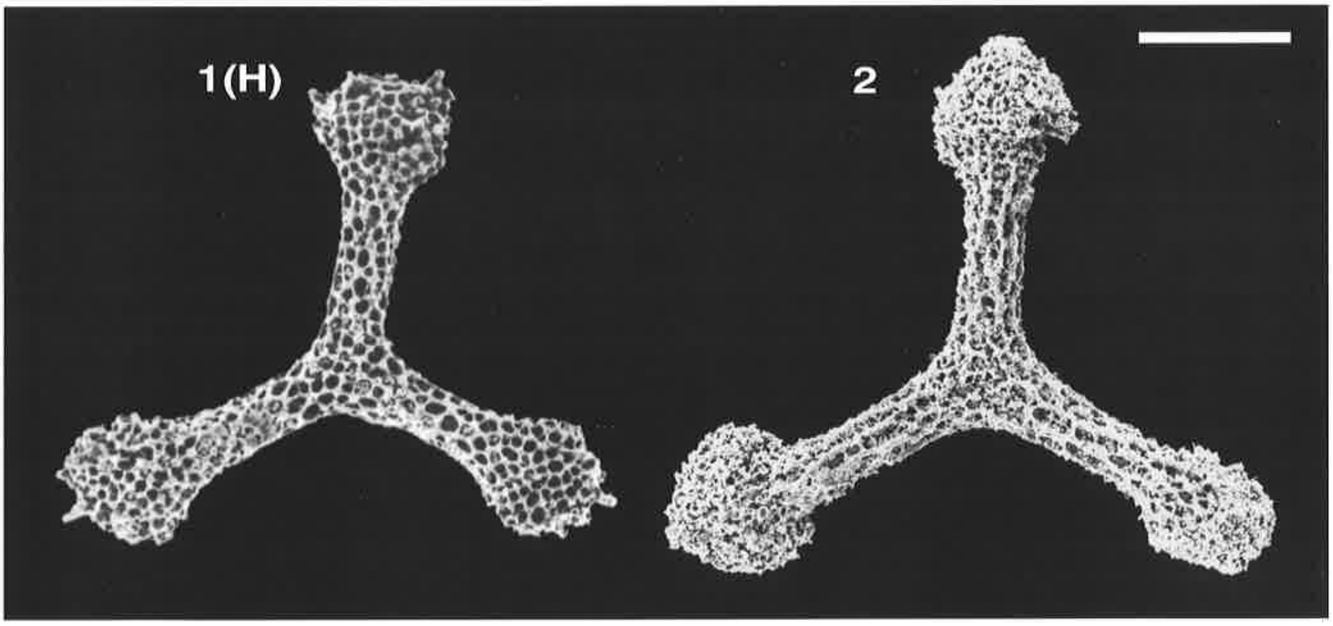


Plate 2005. ***Paronaella skowkonaensis*** **CARTER.** Magnification x150. **Fig. 1(H).** CARTER et al. 1988, pl. 11, figs. 4. **Fig. 2.** AB 1065, TM105.50.c22.

PARONAELLA TRIFOLIACEA 5186

Paronaella trifoliacea OZVOLDOVA

Synonymy.-
Paronaella trifoliacea OZVOLDOVA
OZVOLDOVA & PETERCAKOVA 1992, p. 316, pl. 5, figs. 1-5.
JUD 1994, p. 91, figs. 15-17.

Original Definition.- The test is formed by three rays with slightly rised central area. The rays are short in the proximal part broad, at the ending they become gradually narrower. The cross section of the rays is elliptical. On the lateral side of the rays and on their top there are short thin spines. The meshwork of the rays is irregular, with coarser pores, and with indication of sublinear arrangement in the distal part. Central area is large, in the periphery with raised coarse porous margin, perpendicular to the rays. The inner part of the central area has a fine meshwork. In the center there is a coarse porous protuberance of trefoil-shape.

Actualized Definition.- (JUD, 1994) Test flat, three-rayed, sometimes with sub-triangular outline. Rays of equal length, disposed at equal angles and tapering towards ray tips. Central area with pronounced ridges forming a small triradiate "mercedes-firm" structure rotated 60 degrees relative to main rays. A strong, transverse ridge is developed on the proximal part of each ray closing the angle between the ridges of the central structure. Rays with several more or less disturbed longitudinal beams connected by small bars, forming irregularly disposed pore-frames. Cross section of rays elliptical. Ray tips with an axial prolongation bearing one or several strong spines. Numerous smaller pointed spines are radiating also from periphery of test, almost all of them disposed in the equatorial plane.

Actualized Remarks.- (JUD, 1994) We include in this species all morphotypes bearing peripheral spines and having strong ridges in the central area of the test which more or less form a structure resembling the "mercedes-firm" sign. Our specimens have the following measurements: (in μm) length of rays av. 187, min. 149, max. 254. Excluded is at present a morphotype with a very prominent central structure formed by strong circular ridge around the "Mercedes"-sign. These specimens are generally lacking peripheral spines.

Etymology.- Latin *trifoliaceus*, trefoil-like-shape; course meshwork of trefoil shape in the central area.

Type Locality.- Luckovska Formation, Manin Unit, Mt Butkov, western Carpathians.

UAZones.- 14-22, early-early late Berr. to late Barr.-early Apt.

PARONAELLA (?) TUBULATA 5183

Paronaella (?) *tubulata* STEIGER

Synonymy.-
Paronaella (?) *tubulata* STEIGER
STEIGER 1992, p. 45, pl. 10, fig. 10.
JUD 1994, p. 91, pl. 15, figs. 18-19.

Original Definition.- "Three-armed patulibracchiid with irregular pattern of rounded pores in the central area and on the arms. Two of the angles between the arms have 90 to 120 degrees, the third angle has more than 120 degrees. The connections of the pore frames bear nodes and short spines. In the central area the nodes are located perpendicularly to the surface of the cortical shell, on the arms they diverge increasingly towards the arm ends. In the distal part of the arms a slight linear arrangement of pore rows can be recognized. Each arm end has a central pore tube located distally with short spines at its base. The pore tube is hexagonal: between 6 pronounced longitudinal ribs 6 simple rows of rectangular pores occur. Poretubes are partly turned clockwise".

Original Remarks.- "The species is questionably related to *Paronaella* because of the poretubes which can be bracchiopyles. The genus *Paronaella* PESSAGNO however is defined having no bracchiopyles and is seperated from the genus *Patulibracchium* on the family-level by a bracchiopyle. Consequently test with three bracchiopyles should be assigned to a new family. But this is not yet possible because of the unknown character of the pore tubes and the rare material. *Paronaella* (?) *tubulata* differs from the other species of *Paronaella* by having hexagonal poretubes, which rise centrally at the distal ends of the arms. The form is close to *Paronaella spinosa* (PARONA) and *P. pristidentata* BAUMGARTNER on the base of according characters like oblique secondary spines and a noddy surface of the test".

Remarks.- We have included in *Paronaella* (?) *tubulata* only forms with the characteristic nodose, tuberculate structure in the central part similar to the holotype.

Etymology.- According to the tube-like arm prolongations.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Lenght of arms:	100	96	72	114
Width of arms:	85	72	54	86
Width pore tube:	80	61	24	100

Type Locality.- Trattberg, Salzburg.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

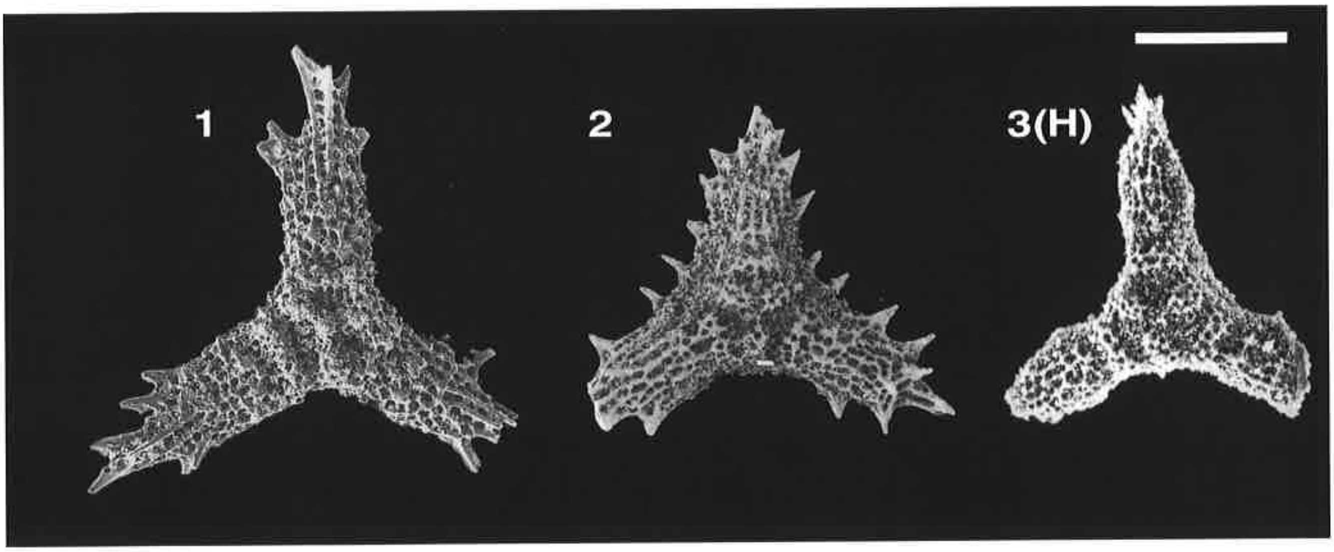


Plate 5186. *Paronaella trifoliacea* OZVOLDOVA. Magnification x150. **Fig. 1.** POB79/3700, MO1 52. **Fig. 2.** 345, Bo566.5 **Fig. 3(H).** OZVOLDOVA & PETERCAKOVA 1992, pl. 5, fig. 1.

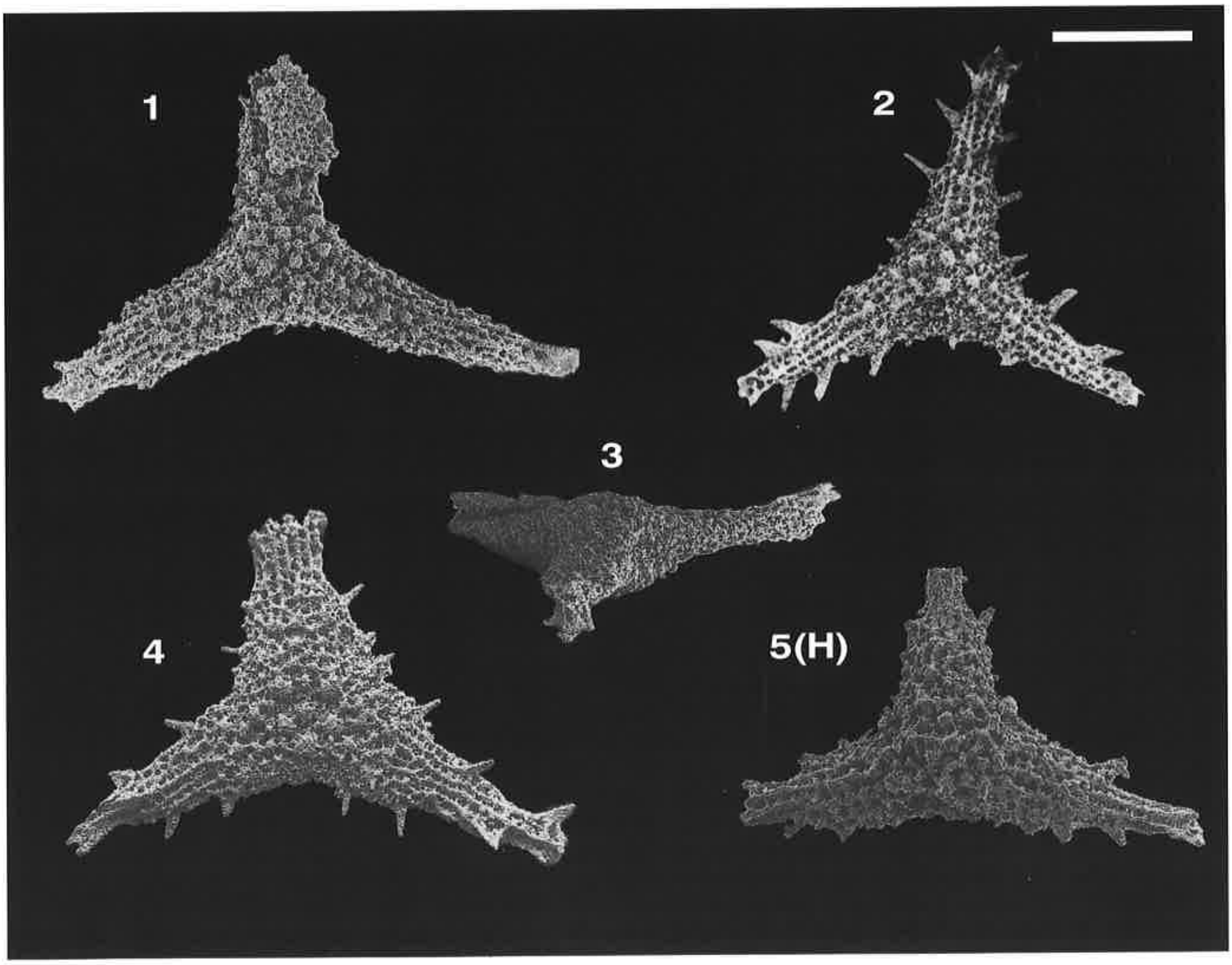


Plate 5183. *Paronaella* (?) *tubulata* STEIGER. Magnification x150. **Fig. 1.** RJ157, Br1330. **Fig. 3.** RJ156, Br1330. **Fig. 2.** RJ76, Br28.85. **Fig. 4.** POB79/5030, POB1205.1. **Fig. 5(H).** TS8, TE4/2.

PARVICINGULA 3672

Genus: *Parvicingula* PESSAGNO

Synonymy.-
Parvicingula PESSAGNO
PESSAGNO 1977a, p. 84.
BAUMGARTNER 1984, p. 778.

Type Species.- *Parvicingula santabarbarensis* PESSAGNO 1977a.

Original Definition.- Cephalis conical with well-developed horn; thorax and abdomen trapezoidal. Postabdominal chambers trapezoidal to cylindrical. Overall test shape elongate, cylindrical with often more than 30 post-abdominal chambers. Postabdominal chambers usually increasing rapidly in width but always slightly in height as added; the exception being the final postabdominal chambers of mature, unbroken specimens which tend to decrease in width and flare inwardly toward the long axis of growth. Final postabdominal chamber with long tubular neck and small terminal aperture (mouth).

Actualized Definition.- (BAUMGARTNER, 1984) Included with this genus are also forms without or with weakly developed horn, which otherwise fit to Pessagno's (1977a) definition. *Ristola* PESSAGNO & WHALEN 1982, which has been erected to include these forms, is herein emended to include only the very long cylindrical parvicingulid species (see remarks under that genus).

Original Remarks.- *Parvicingula* n.gen. differs from *Dictyomitra* ZITTEL (see Pessagno, 1976) by lacking costae; by having chambers that slowly expand in height; by possessing circumferential ridges at chamber joints; and so forth. It should be noted that species belonging to this genus have some of the sturdiest test of all Mesozoic Radiolaria. As a result, they are commonly preserved even when other forms have been crushed due to sedimentary compaction.

Remarks.- No distinction would be made between forms with a horn and those without a horn.

Etymology.- This genus is named from the Latin adjective *parva*, meaning small, plus the Latin noun *cingula*, meaning belt or girdle.

Included Taxa.-
3185 *Parvicingula boesii* (PARONA)
5724 *Parvicingula* (?) sp. aff. *P. cincta* (HINDE) sensu TAN
3255 *Parvicingula cosmoconica* (FOREMAN)
3197 *Parvicingula dhimenaensis* s.l. BAUMGARTNER
4072 *Parvicingula dhimenaensis dhimenaensis* BAUMGARTNER
4071 *Parvicingula dhimenaensis* ssp. A
3188 *Parvicingula* sp. aff. *P. elegans* PESSAGNO & WHALEN
5578 *Parvicingula longa* JUD
3245 *Parvicingula mashitaensis* MIZUTANI
3184 *Parvicingula schoolhousensis* gr. PESSAGNO & WHALEN
3717 *Parvicingula sphaerica* STEIGER
3187 *Parvicingula* (?) *spinata* (VINASSA)
5712 *Parvicingula usotanensis* TUMANDA
3239 *Parvicingula* (?) sp. A

PARVICINGULA BOESII GR. 3185

Parvicingula boesii gr. (PARONA)

Synonymy.-
Dictyomitra boesii PARONA
PARONA 1890, p. 170, pl. 6, fig. 9.
Parvicingula boesii (PARONA)
OKAMURA 1980, pl. 20, figs. 3, 9.
AOKI 1982, pl. 2, fig. 8.
ISHIDA 1985, pl. 5, figs. 1-2.
KIMINAMI et al. 1985, pl. 2, fig. 9.
SUYARI 1986b, pl. 3, fig. 1.
PAVSIC & GORICAN 1987, p. 27, pl. 4, fig. 11.
not OZVOLDOVA & PETERCAKOVA 1987, pl. 34, fig. 4.
OZVOLDOVA 1988, pl. 4, fig. 2; not pl. 7, fig. 7.
THUROW 1988, p. 403, pl. 6, fig. 9.
TUMANDA 1989, p. 38, pl. 4, figs. 1- 2.
YASUDA 1989, pl. 1, fig. 20.
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 12.
STEIGER 1992, p. 86, pl. 23, figs. 2-5, 7, not figs. 1, 6.
Ristola boesii s.l.
PESSAGNO et al. 1984, p. 28, pl. 3, fig. 9.
Ristola boesii (PARONA)
AITA & OKADA 1986, pl. 2, figs. 2-3.
KITO 1987, pl. 3, fig. 9.
IGO et al. 1987, text-fig. 2.2.
KATO & IWATA 1989, pl. 1, fig. 4; pl. 4, fig. 6.
IWATA et al. 1990, pl. 1, fig. 2; ? pl. 2, fig. 2.
Parvicingula boesii (PARONA)
VELLEDITS et al. 1986, pl. 4, fig. 1.
Parvicingula boesii gr. (PARONA)
JUD 1994, p. 91, pl. 16, figs. 1-2.

Original Definition.- "Suboval shell of 7 segments with a circumferential ridge after each one. Segments with 3 rows of small pores".

Remarks.- For biostratigraphic data we included in *Parvicingula boesii* gr. (PARONA) several morphotypes as follows: spindle-shaped forms with or without closed terminal segment, with or without wide terminal tube, and possessing prominent, sligthly elevated or smooth circumferential ridges.

Measurements (in μm).-
Total length 214, max. width 110, height of segments 30.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 9-22, mid-late Oxf. to late Barr.-early Apt.

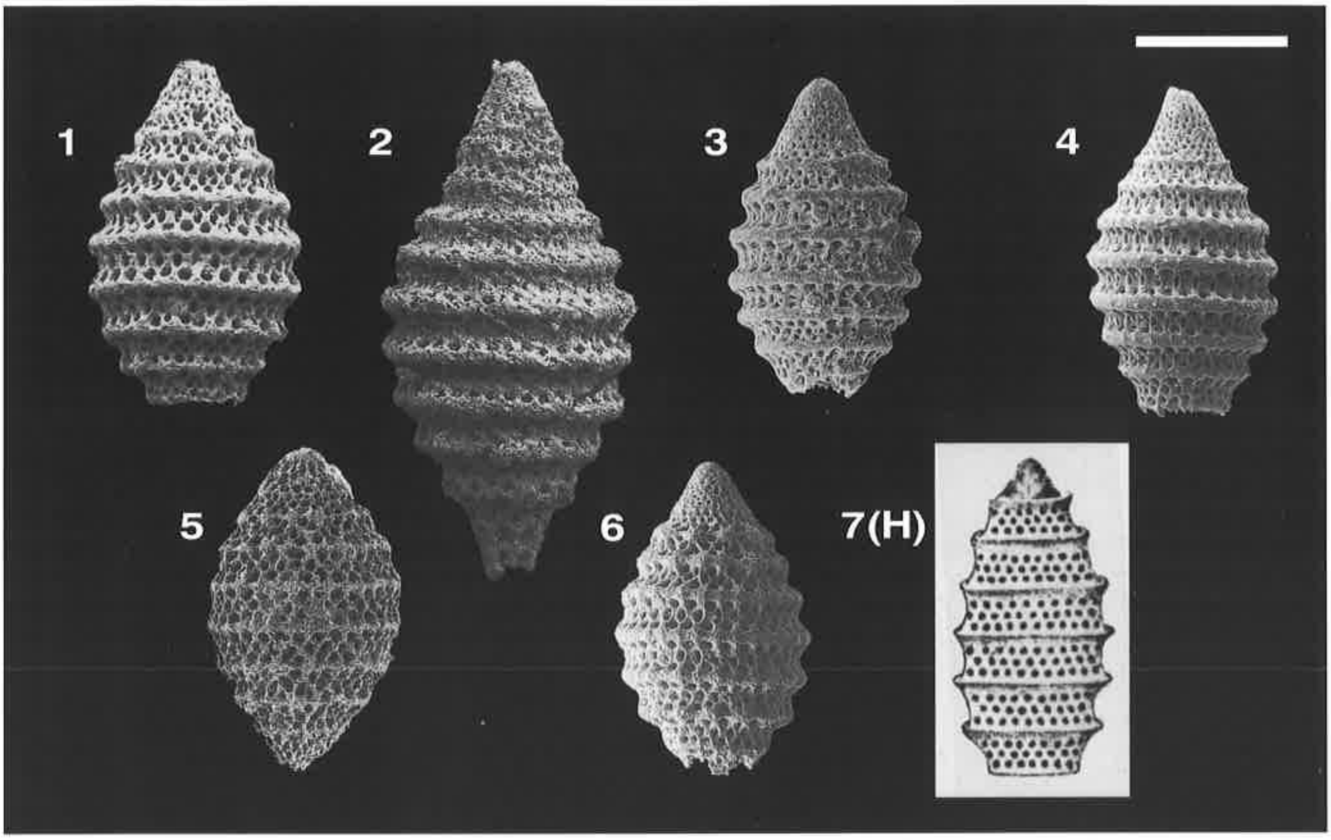


Plate 3185. *Parvicingula boesii* gr. (PARONA). Magnification x200. **Fig. 1.** POB79/0176, MO22. **Fig. 2.** POB79/5017, POB1205.1. **Fig. 3.** DU3529, Mo46. **Fig. 4.** DU3485, Mo46. **Fig. 5.** RJ309, Br28.85. **Fig. 6.** DU2163, Mo22. **Fig. 7(H).** PARONA 1890, pl. 6, fig. 9.

PARVICINGULA (?) CINCTA AFF. 5724

Parvicingula (?) sp. aff. *P. cincta* (HINDE) sensu TAN

Synonymy.-
Eucyrtidium cincta (HINDE)
emend. TAN 1927, p. 60, pl. 12, fig. 96c, not figs. 96a-b

Definition.- (TAN, 1927) "Spindle-shaped shell of 10-12 segments of about the same height. Shell-wall thin and smooth with septal thickenings. Cephalis conical, bearing an apical horn, on fig. a and c merged with the thorax to a cephalo-thorax. Each segment with 3 rows of pores, the pores of the middle row are oval, there is a clear difference between the different pores of a and b. The shell-wall is thickened at the segmental divisions. The thickenings are absent on the apical section. This form is, comparing its intersection, similar to *Lithocampe subcretacea* NEVIANI.".

UAZones.- 17-18, late Val. to latest Val.-earliest Haut.

PARVICINGULA COSMOCONICA 3255

Parvicingula cosmoconica (FOREMAN)

Synonymy.-
Dictyomitra cosmoconica FOREMAN
FOREMAN 1973b, p. 263, pl. 9, fig. 11; pl. 16, fig. 3.
FOREMAN 1975, p. 614, pl. 2H, fig. 3; pl. 7, fig. 1.
Parvicingula cosmoconica (FOREMAN)
BAUMGARTNER et al. 1980, p. 58, pl. 5, fig. 16; pl. 6, fig. 7.
BAUMGARTNER 1984, p. 778, pl. 7, fig. 1.
OZVOLDOVA & SYKORA 1984, p. 268, pl. 9, fig. 5.
SCHAAF 1984, p. 153, fig. 6.
AITA & OKADA 1986, pl. 2, fig. 4.
cf. DE WEVER & CORDEY 1986, pl. 1, fig. 3.
not KITO 1987, pl. 3, fig. 5.
PAVSIC & GORICAN 1987, p. 27, pl. 4, fig. 10.
MATSUOKA 1992, pl. 2, fig. 8.
STEIGER 1992, p. 86, pl. 24, figs. 4-6.
TAKETANI & KANIE 1992, fig. 4.10.
JUD 1994, p. 91, pl. 16, fig. 3.
Foremanina cosmoconica (FOREMAN)
VELLEDITS et al. pl. 4, fig. 2.

Original Definition.- The shell is conical proximally, tending to be cylindrical distally, and consists of 10 to 13 uniform segments which increase only very gradually in length distally. The cephalis and thorax have no, or only a very few pores. Rarely, the cephalis bears a narrow, short, blunt horn. After the first two segmental divisions, which are externally smooth, the segmental divisions are distinguished by a raised ridge formed by the thickening of the intervening pore bars at this point. Pores are rounded, arranged quincuncially in two to three transverse rows. The pores also show a distinct diagonal alignment. Pores on adjacent segments are not opposed and, thus, the diagonally aligned rows tend to be continuous between adjacent segments. The intervening pore bars between these diagonal rows may be slightly raised and, indeed, they form vertical to diagonal ridges or nodes of varying prominence on the transverse segmental dividing ridges as they cross from one segment to another. The terminal margin on all of the specimens observed is ragged and apparently broken.

Original Remarks.- This species is distinguished from *Dictyomitra alievi* as described under that species.

Remarks.- (JUD, 1994) No specimen was observed bearing an apical horn. Our specimens differ from the holotype, which is subconical, by having broad, prominent circumferential ridges and the first 4-5 segments increasing distinctly faster in width than the following segments. The specimens with a slender conical shape and less prominent ridges, which occur also in our material, were excluded from the present study.

Etymology.- Greek *kosmos* (n.) adornment, *konos* (n.) cone, -ikos, -e, -on related to = *cosmoconicus, -a, -um* like an ornate cone.

Measurements (in μm).-
Based on 10 specimens. Length of longest specimen of 13 segments, 450; of first 10 segments, 310-380; greatest width 160-217.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

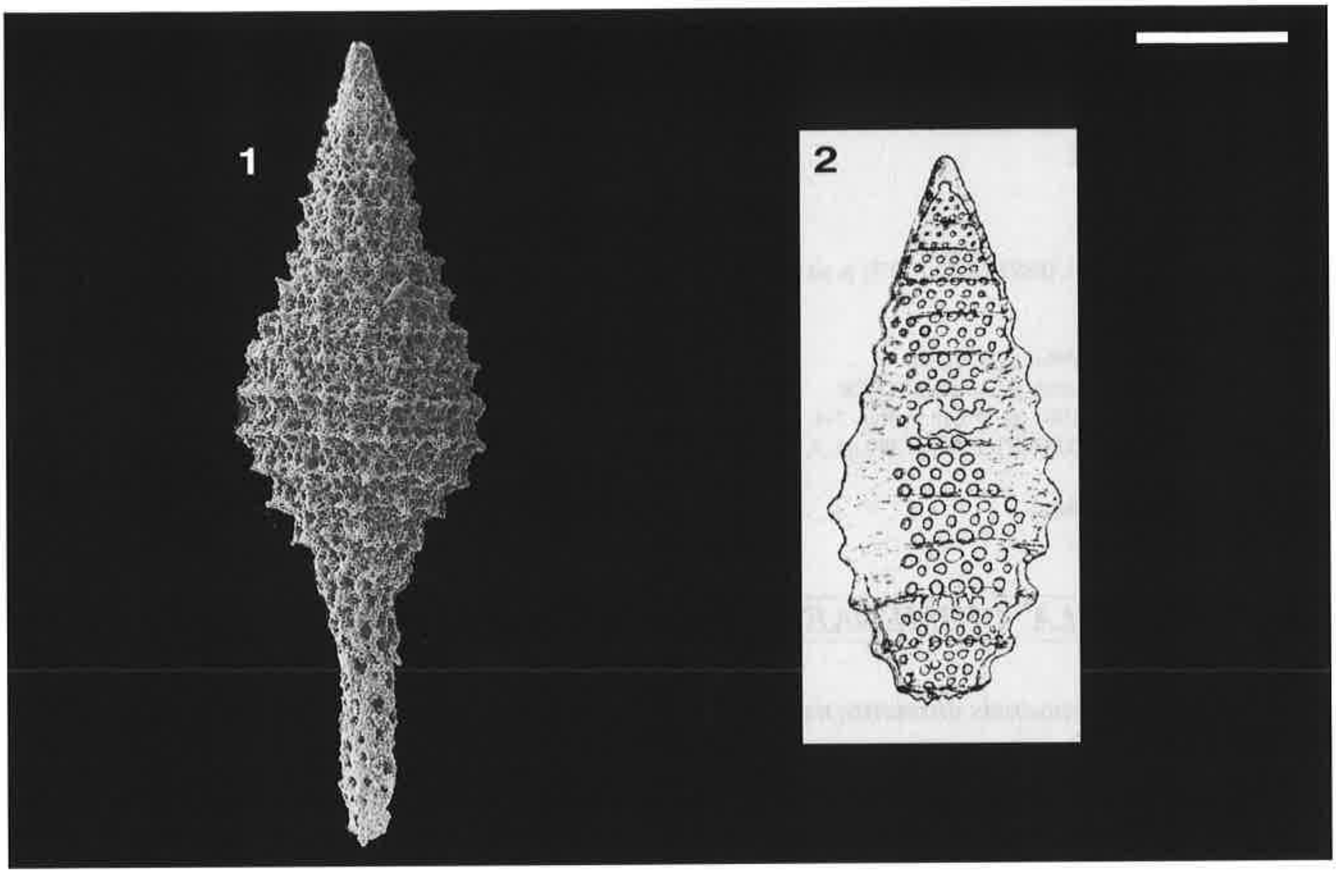


Plate 5724. *Parvicingula* (?) sp. aff. *P. cincta* (HINDE) sensu TAN. Magnification x200. **Fig. 1.** RJ176, Bo449.5. **Fig. 2.** TAN 1927, pl.12, fig. 96c.

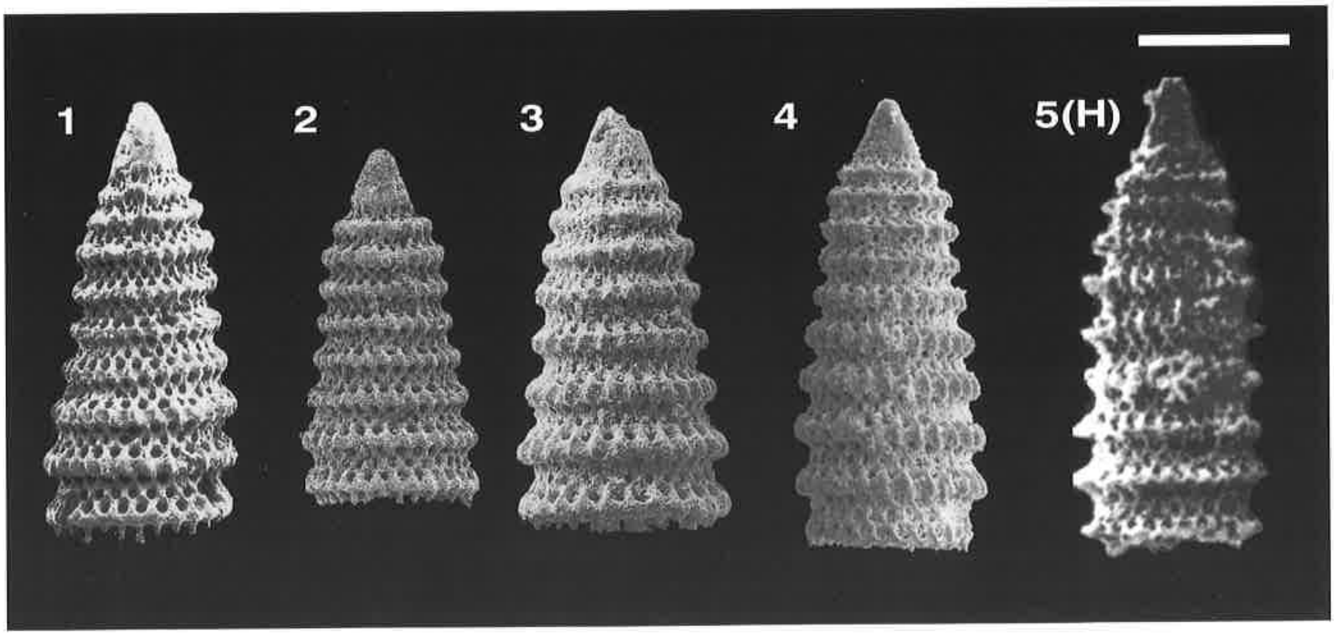


Plate 3255. *Parvicingula cosmoconica* (FOREMAN). Magnification x150. **Fig. 1.** POB81/9111, 76.534A.81.2.64. **Fig. 2.** RJ91, Br1330. **Fig. 3.** DU3291, Mo26. **Fig. 4.** RJ14, Br34.05. **Fig. 5(H).** FOREMAN 1973b, pl. 9, fig. 11.

PARVICINGULA DHIMENAENSIS S.L. 3197

Parvicingula dhimenaensis s.l. BAUMGARTNER

Synonymy.-
Amphipyndax sp.
BAUMGARTNER & BERNOULLI 1976, p. 611, figs. 12 e, i, m.
Amphipyndax ? sp.
NISHIZONO et al. 1982, pl. 3, fig. 16.
Parvicingula dhimenaensis BAUMGARTNER
BAUMGARTNER 1984, p. 778, pl. 7, figs. 2-4.
DE WEVER & MICONNET 1985, p. 389, pl. 4, figs. 4, 6-8.
CONTI 1986, pl. 1, fig. 1.
GORICAN 1987, p. 185, pl. 3, figs. 13-14.
WAKITA 1988, pl. 4, fig. 10, pl. 5, fig. 7.
MATSUOKA 1990, pl. 1, fig. 7.
Parvicingula dhimenaensis BAUMGARTNER gr.
KISHIDA & HISADA 1986, fig. 2.4; fig. 8.2.
See also subspecies.

Included Taxa.-
4072 *Parvicingula dhimenaensis dhimenaensis* BAUMGARTNER
4071 *Parvicingula dhimenaensis* ssp. A

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

PARVICINGULA DHIMENAENSIS DHIMENAENSIS 4072

Parvicingula dhimenaensis dhimenaensis BAUMGARTNER

Synonymy.-
Parvicingula boesii (PARONA)
DE WEVER & CABY 1981, pl. 2, fig. C.
KOCHER 1981, p. 81, pl. 15, fig. 11.
Parvicingula sp. C
AITA 1982, pl. 1, figs. 13-14.
Parvicingula dhimenaensis BAUMGARTNER
BAUMGARTNER 1984, p. 778, pl. 7, figs. 2-3, not fig. 4.
YAMAMOTO et al. 1985, p. 36, pl. 6, fig. 1.
MATSUOKA 1986a, pl. 2, fig. 12.
AITA 1987, p. 66, pl. 2, figs. 3a-b, 5a-b; pl. 9, figs. 12-13.
Parvicingula spinosa AITA
AITA 1985, figs. 6.12-13.

Original Definition.- Slender conical to spindle-shaped parvicingulid. Cephalis hemispherical without or with a weakly developed horn, externally smooth, with a few small pores at base (ditrema). Thorax and abdomen trapezoidal, with irregular pores in roughly horizontal rows. All postabdominal segments with three rows of pores per segment in a uniform hexagonal arrangement. Circumferential ridges at segmental divisions bear nodes or small spines which are regularly spaced between every second adjacent pore. Diagonal bars may connect between nodes of circumferential ridges and form triangular frames which always enclose three pores. Last segment bears a tubular extension with closely spaced pores but without nodes or bars.

Remarks.- Younger form with shorter cephalo-thorax.

Etymology.- Named after a locality in the Argolis Peninsula, where this species abundantly occurs.

Measurements (in μm).-
Based on 7 specimens. Total height of test 230-300, average 255, holotype 270. Max. width of test 105-135, average 117, holotype 113. Width of last segment 80-109, average 91, holotype 80.

Type Locality.- Kandhia, Argolis Peninsula, Peloponnesus, Greece.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

PARVICINGULA DHIMENAENSIS | A 4071

Parvicingula dhimenaensis ssp. A

Synonymy.-
Parvicingula dhimenaensis BAUMGARTNER
BAUMGARTNER 1984, p. 778, pl. 7, fig. 4 only.
Eoxitus baloghi KOZUR
KOZUR 1985, p. 216, fig. 2c.
Eoxitus elongatus KOZUR
KOZUR 1985, p. 217, fig. 1h.
Eoxitus nodosus KOZUR
KOZUR 1985, p. 218, figs. 2a, b, d.

Remarks.- This subspecies differs from *Parvicingula dhimenaensis dhimenaensis* by a proximal portion which is composed of cephalis, thorax abdomen and possibly the first postabdominal segment, which is slenderly conical and externally smooth, without nodes or segmental divisions. This portion is distinctly longer than with *P. dhimenaensis dhimenaensis*. The remainder of the test differs from *P. dhimenaensis dhimenaensis* by having more pronounced spines rather than nodes on circumferential ridges. Most specimens are distally constricted giving the whole test a spindle-shaped outline. If spines are well developed (early Middle Jurassic forms), they are directed upwards in the proximal, outwards in the median, and downwards in the distal portion of the test.

UAZones.- 3-8, early-mid Baj. to mid Call.-early Oxf.

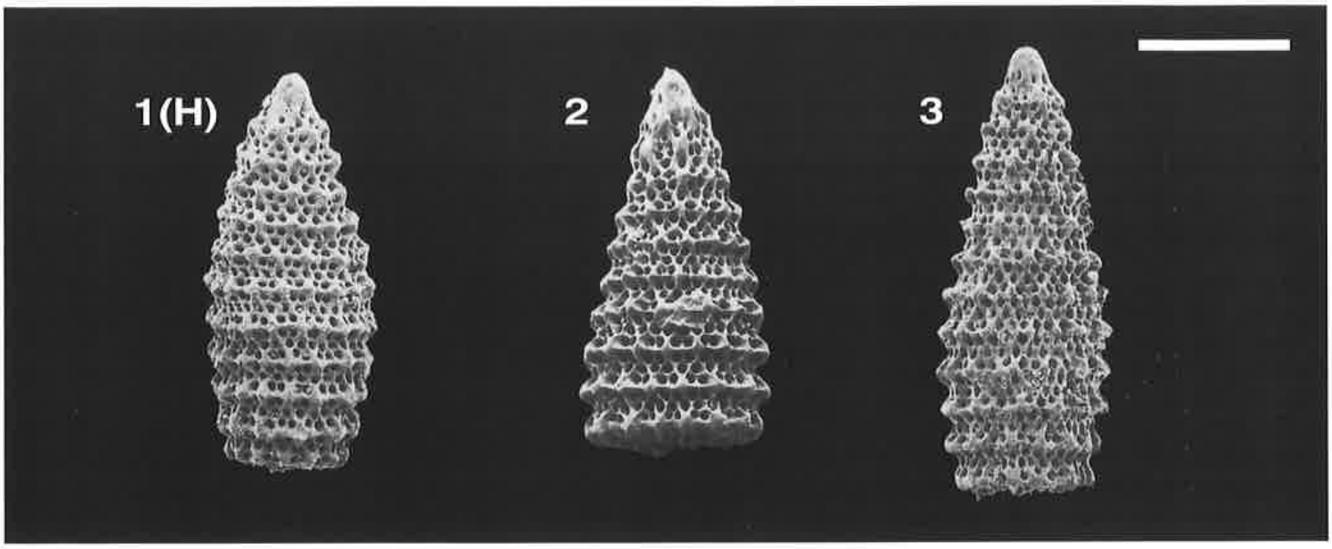


Plate 4072. ***Parvicingula dhimenaensis dhimenaensis*** **BAUMGARTNER.** Magnification x200. **Fig. 1(H).** POB79/0079, POB284.5. **Fig. 2.** POB78/8168. **Fig. 3.** POB78/8082.

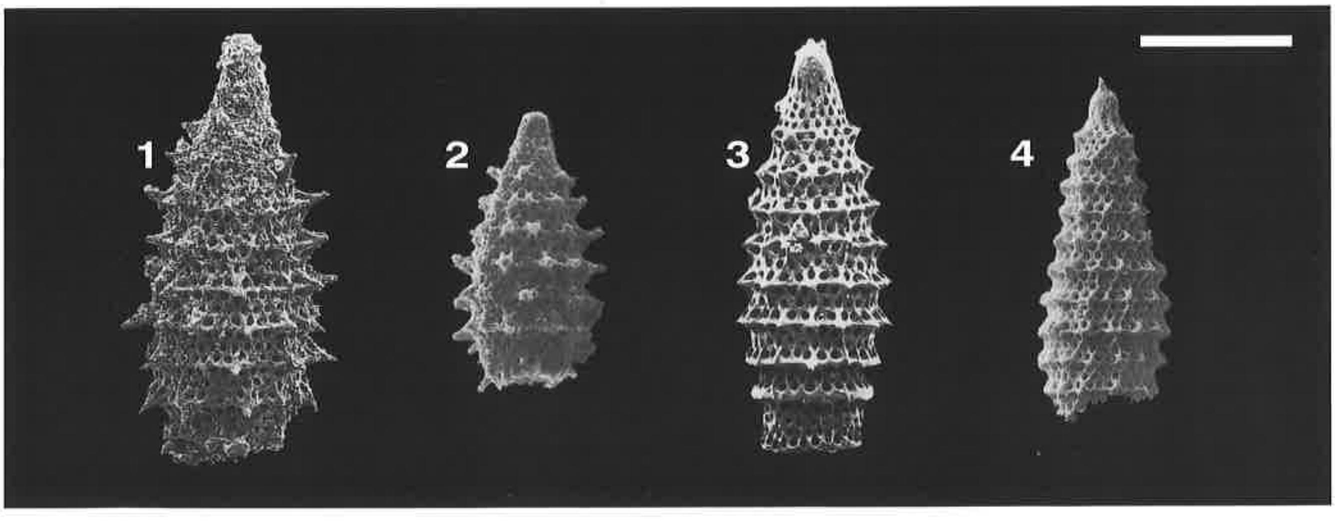


Plate 4071. ***Parvicingula dhimenaensis*** **ssp. A.** Magnification x200. **Fig. 1.** POB79/4424, IN7. **Fig. 2.** GO890138, ZB28. **Fig. 3.** POB81/9214, A.125-5-72. **Fig. 4.** DU2777, DR77.

PARVICINGULA ELEGANS AFF. — *3188*

Parvicingula sp. aff. *P. elegans* PESSAGNO & WHALEN

Synonymy.-
Parvicingula elegans PESSAGNO & WHALEN
cf. PESSAGNO & WHALEN 1982, p. 138, pl. 10, figs. 7, 16, 20; pl. 13, fig. 9.

Remarks.- The forms included herein differ from *Parvicingula elegans* PESSAGNO & WHALEN by having a test which is more inflated in the lower half and constricted at the base.

UAZones.- 11-11, late Kimm.-early Tith. to late Kimm.-early Tith.

PARVICINGULA LONGA — *5578*

Parvicingula longa JUD

Synonymy.-
Parvicingula longa JUD
JUD 1994, p. 92, pl. 16, figs. 4-5.

Original Definition.- Long, slender, conical test consisting of 20-22 segments. Cephalis, thorax and probably abdomen forming a smooth, poreless subcylindrical portion with rounded apex. Postabdominal segments gradually increasing in width and having 3 rows of alternately arranged pores. Segmental sutures marked by nodose ridges. All segments equal in height. No terminal tube observed.

Original Remarks.- *Parvicingula longa* n.sp. differs from *Parvicingula cosmoconica* (FOREMAN) by its very characteristic, large subcylindrical apical portion, by the greater number of segments and by the less pronounced circumferential ridges. We included also in this species long, slender, conical forms of practically similar length but with a less prominent apical portion and only slightly pronounced ridges on segmental sutures. These specimens were considered to be ancestral forms of *Parvicingula longa* n.sp.

Etymology.- From the Latin longus, long.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Total height:	343	346	75	448
Height apical part:	47	46	40	53
Maximum width test:	119	120	102	131

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 13-20, latest Tith. to late Haut.

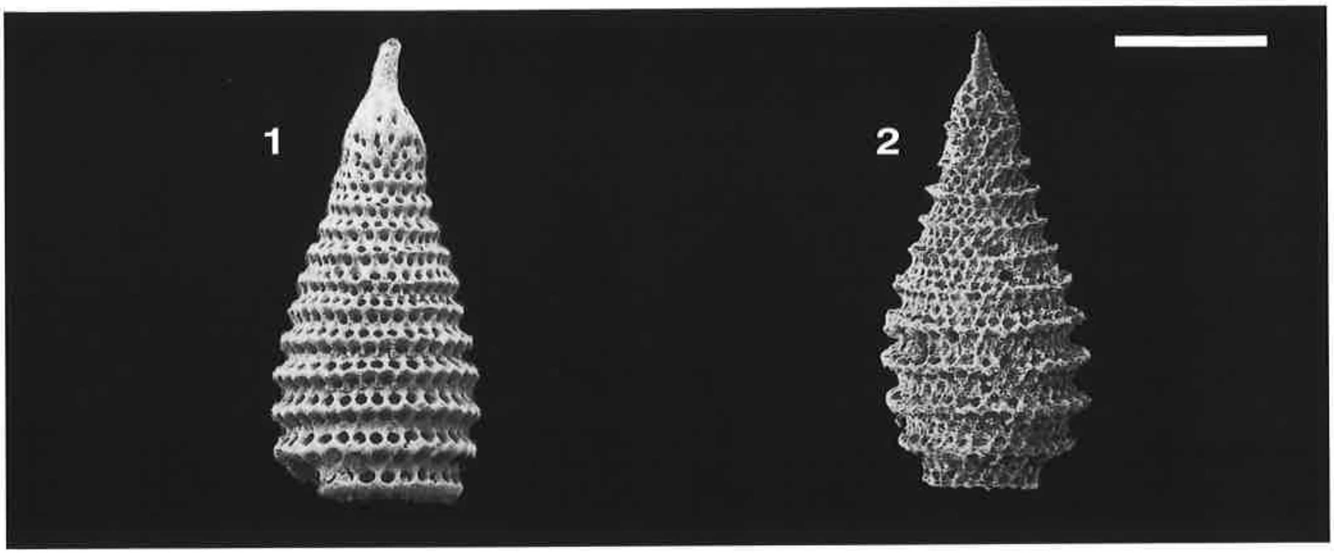


Plate 3188. *Parvicingula* sp. aff. *P. elegans* PESSAGNO & WHALEN. Magnification x200. **Fig. 1.** POB79/1687, POB79.5 J.86. **Fig. 2.** POB78/7607, POB986.51.

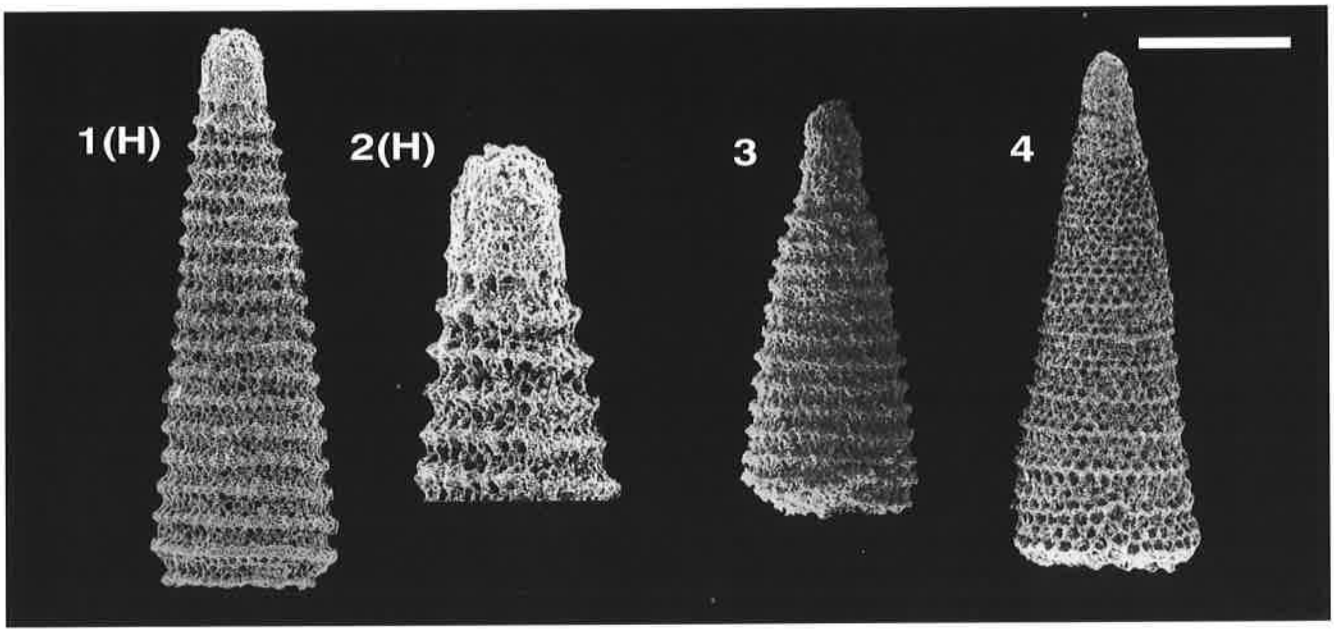


Plate 5578. *Parvicingula longa* JUD. Magnification x200, except Fig. 2(H) x350. **Fig. 1(H).** RJ36, Bo449.5. **Fig 2(H).** RJ 36, Bo449.5. **Fig. 3.** RJ204, Bo449.5. **Fig. 4.** RJ303, Br28.85.

PARVICINGULA MASHITAENSIS — *3245*

Parvicingula mashitaensis MIZUTANI

Synonymy.-
Parvicingula boesii (PARONA) group
BAUMGARTNER et al. 1980, p. 58, pl. 5, fig. 15; pl. 6, fig. 8.
Parvicingula mashitaensis MIZUTANI
MIZUTANI 1981, p. 176, pl. 57, fig. 7; pl. 58, figs. 1-2; pl. 61, fig. 7.
ADACHI 1982, pl. 1, figs. 5-7.
YAO 1984, pl. 3, fig. 21.
MATSUOKA & YAO 1985, pl. 2, fig. 1.

Original Definition.- Exclusive of last few postabdominal chambers, test form is conical; cephalis smooth with irregularly spaced and sized pores. The cephalis usually elongated conical in shape, the apex angle ranging 32°-42° (average of 24 specimens, 38°). Pores in frames of postabdominal chambers regularly arranged in three rows; two outer rows found on the edge of circumferential ridges bounding chambers; middle row situated on concaved test wall with elliptical pores.

Original Remarks.- Although this species has a pore frame similar to that of *P. hsui* PESSAGNO (1977a, p. 85, pl. 8, figs. 15, 16; pl. 9, figs. 1-5), P. *jonesi* PESSAGNO (1977b, p. 48, pl. 8, fig. 14) or *P. citae* PESSAGNO (1977b, p. 48, pl. 8, fig. 19), it differs from all of them in having higher circumferential ridges; furthermore, the conical form of the test is much more slender in the present species; apex angle of conical cephalis is smaller in *P. mashitaensis* averaging 38°, while *P. hsui, P. citae*, and *P. jonesi* have a blunt apex (apex angle 50° or larger). *P. mashitaensis* differs from *Dictyomitra boesii* PARONA (Parona, 1890, p. 41, pl. 6, fig. 9) by its slender conical form, but very similar to *P. boesii* (PARONA) of Baumgartner et al. (1980, p. 58, pl. 5, fig. 15; pl. 6, fig. 8). Under the name of *Parvicingula boesii* (PARONA) group, Baumgartner et al. (1980) included various morphotypes of *Parvicingula* such as *Dictyomitra boesii* PARONA (1890, p. 41, pl. 6, fig. 9), *D. boesii* PARONA (Foreman, 1975, p. 613, pl. 2H, figs. 10, 11; pl. 7, fig. 9), *P. boesii* (PARONA) (Pessagno), 1977b, p. 48, pl. 8, fig. 5) and *Mirifusus boesii* (PARONA) (Foreman, 1978, p. 746, pl. 2, fig. 6). *Parvicingula mashitaensis* may quite well be included in this *P. boesii* (PARONA) group.

Etymology.- The specific name is derived from Mashita-gun, Gifu Prefecture, provincial name of the type locality of the Mazegawa Formation, central Japan.

Measurements (in μm).-
Based on 3 specimens.

	HT	min.	max.
Total height:	284	301	330
Maximum width:	142	169	172

Type Locality.- Sample 158, Mazegawa formation, Gifu Prefecture, central Japan.

UAZones.- 8-15, mid. Call.-early Oxf. to late Berr.-earliest Val.

PARVICINGULA SCHOOLHOUSENSIS GR. — *3184*

Parvicingula schoolhousensis gr. PESSAGNO & WHALEN

Synonymy.-
Parvicingula schoolhousensis PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 140, pl. 11, figs. 1-2, 9, 14, 15, 18; pl. 13, fig. 5.

Original Definition.- Test elongate, conical, quite pointed apically; usually with 10 to 12 post-abdominal chamers. Cephalis small, imperforate, subconical externally, hemispherical internally with sharply pointed, relatively short horn; thorax sparsely perforate, trapezoidal in outline. Cephalis and thorax usually with layer of microgranular silica that tends to bury the pore frames beneath. Abdomen and post-abdominal chambers trapezoidal in outline, gradually increasing in width and only slightly in length as added. Abdomen and first one or two post-abdominal chambers sometimes separated by rows of massive nodes rather than discrete circumferential ridges. Remaining post-abdominal chambers with thin circumferential ridges connecting less massive nodes. Nodes on a given circumferential ridge yielding rays that often interconnect with nodes on adjacent ridges to form an outer layer of triangular pore frames (pl. 11, figs. 9, 14, 18). Pore frames of most postabdominal chambers arranged in three rows; center row with smaller hexagonal pore frames with elliptical pores, stagered with respect to those of two flanking rows; two flanking rows comprised of large pentagonal pore frames with larger circular pores.

Original Remarks.- *Parvicingula schoolhousensis* n.sp. differs from *P. burnsensis* n.sp. by having a thinner, more pointed test with thinner, less prominent circumferential ridges which tend to be quite nodose. It is conceivable that this species arose from either *P. burnsensis* or *P. media.*

Etymology.- *Parvicingula schoolhousensis* is named for School House Gulch near Izee.

Measurements (in μm).-
Based on 10 specimens.

	HT	max.	min.	av.
Maximum length:	350	475	275	392
Maximum width:	125	150	112	136

Type Locality.- OR 501B, east-central Oregon.

UAZones.- 3-3, early-mid Baj. to early-mid Baj.

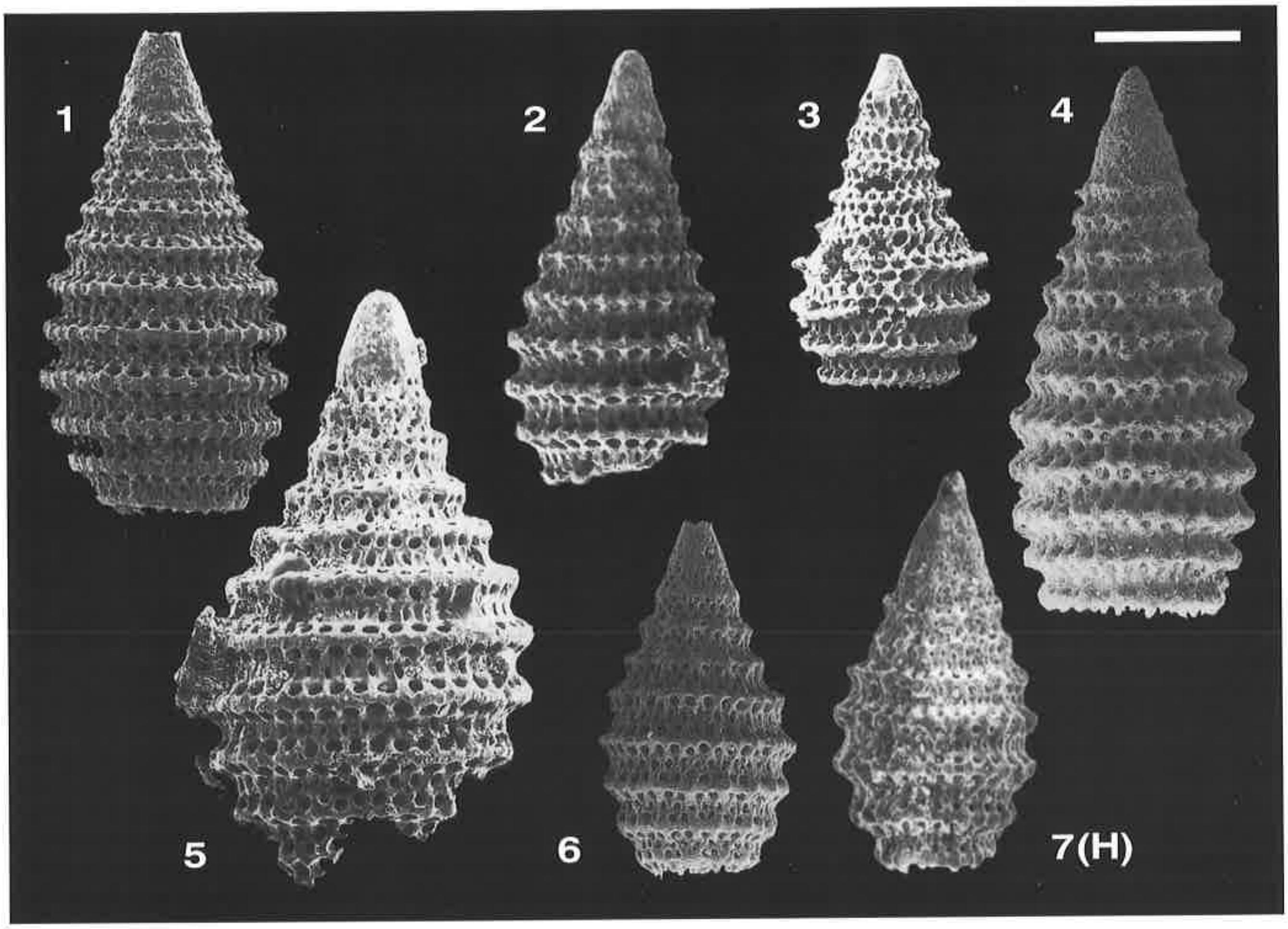


Plate 3245. *Parvicingula mashitaensis* MIZUTANI. Magnification x200. **Fig. 1.** POB78/3511, POB28.61. **Fig. 2.** POB77/2976, POB137.53. **Fig. 3.** POB78/8166, POB986.52. **Fig. 4.** DU1895, R102. **Fig. 5.** POB81/9096, 76.534A.81.2.3. **Fig. 6.** DU3370, Mo37. **Fig. 7(H).** MIZUTANI 1981, pl. 58, fig. 1.

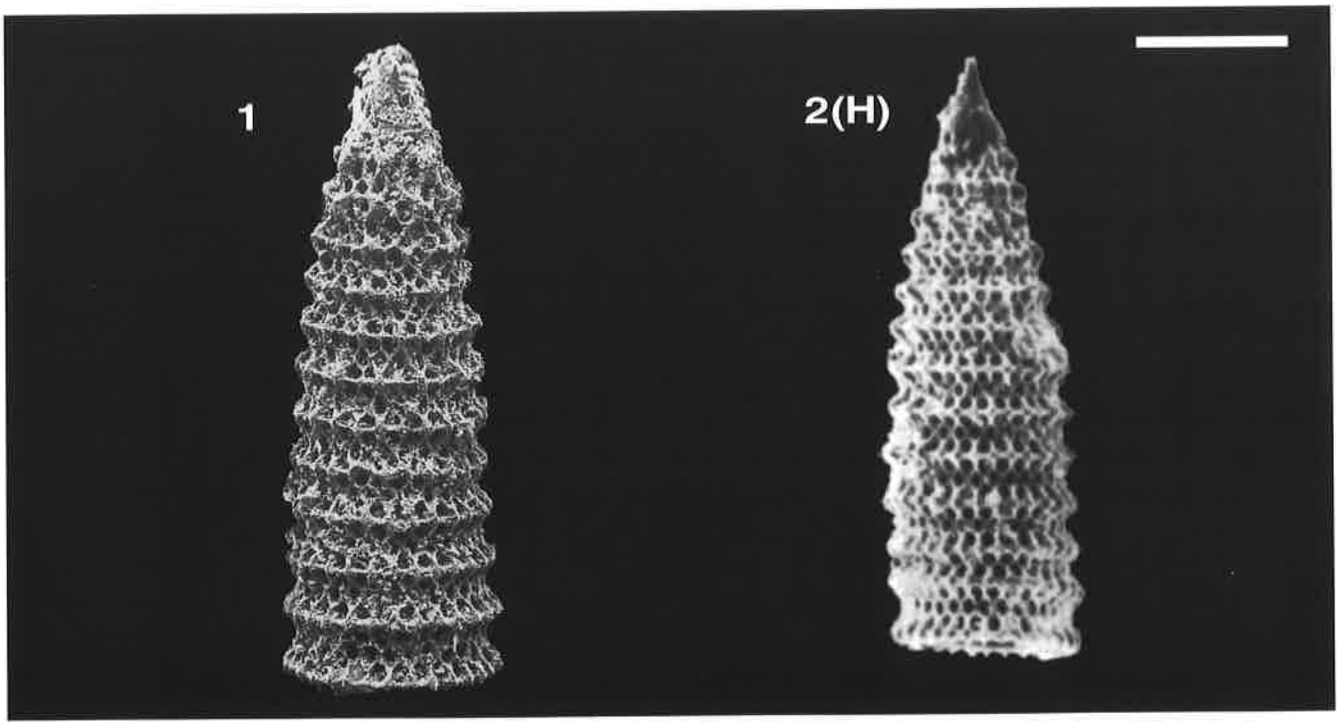


Plate 3184. *Parvicingula schoolhousensis* gr. PESSAGNO & WHALEN. Magnification x200. **Fig. 1.** POB79/4417, IN7. **Fig 2(H).** PESSAGNO & WHALEN 1982, pl. 11, fig. 1.

PARVICINGULA SPHAERICA 3717

Parvicingula sphaerica STEIGER

Synonymy.-
Parvicingula sphaerica STEIGER
STEIGER 1992, p. 86, pl. 24, figs. 1-2.
JUD 1994, p. 92, pl. 16, figs. 6-7.
Mirifusus mediodilatatus (RÜST)
VELLEDITS et al. 1986, pl. 3, fig. 1.
Parvicingula boesii (PARONA)
STEIGER 1992, p. 86, pl. 23, figs. 6, not 1-5, 7.
Parvicingula sp.
VISHNEVSKAYA 1993, pl. 8, fig. 2.
Parvicingula ananassa (RÜST)
VISHNEVSKAYA 1993, pl. 8, fig. 4.

Original Definition.- "Spherical test with approximately 10 segments. The cephalis is smooth and poreless. The segments are separated by ridges. Each segment contains a triple row of rounded alternating pores."

Original Remarks.- "*Parvicingula sphaerica* differs from *Parvicingula boesii* (PARONA) by the globulous form of the test."

Remarks.- Well preserved specimens in our material prove that the test of the species is distally closed and has a long slender terminal spine. A similar specimen was erroneously illustrated by Steiger (1992, pl. 23, fig. 6) as *Parvicingula boesii* (PARONA). *Parvicingula sphaerica* STEIGER is however distinctly larger and broader than *P. boesii* and cannot be confused with it.

Etymology.- *Sphaera* (Latin), sphere. The spherical form of the test should be expressed.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Height of test:	368	361	286	415
Maximum width of test:	284	298	258	340
Height of equatorial seg.:	33	49	33	40

Type Locality.- Gartenau, quarry near St. Leonhard, Salzburg.

UAZones.- 13-16, latest Tith. to early Val.

PARVICINGULA (?) SPINATA 3187

Parvicingula (?) *spinata* (VINASSA)

Synonymy.-
Lithocampe spinata VINASSA
VINASSA 1899, p. 237, pl. 2, fig. 40.

Original Definition.- "Rather thick shell, bell-shaped, narrow in the lower part, having quite numerous segments. Externally, at segmental divisions, there are short spine-shaped slightly curved protuberances. Pores round, relatively small, forming three linear regularly alternating rows."

Measurements (in μm).-
Height: 160; width without spines: 90.

Type Locality.- Carpena, Spezia, Italy.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

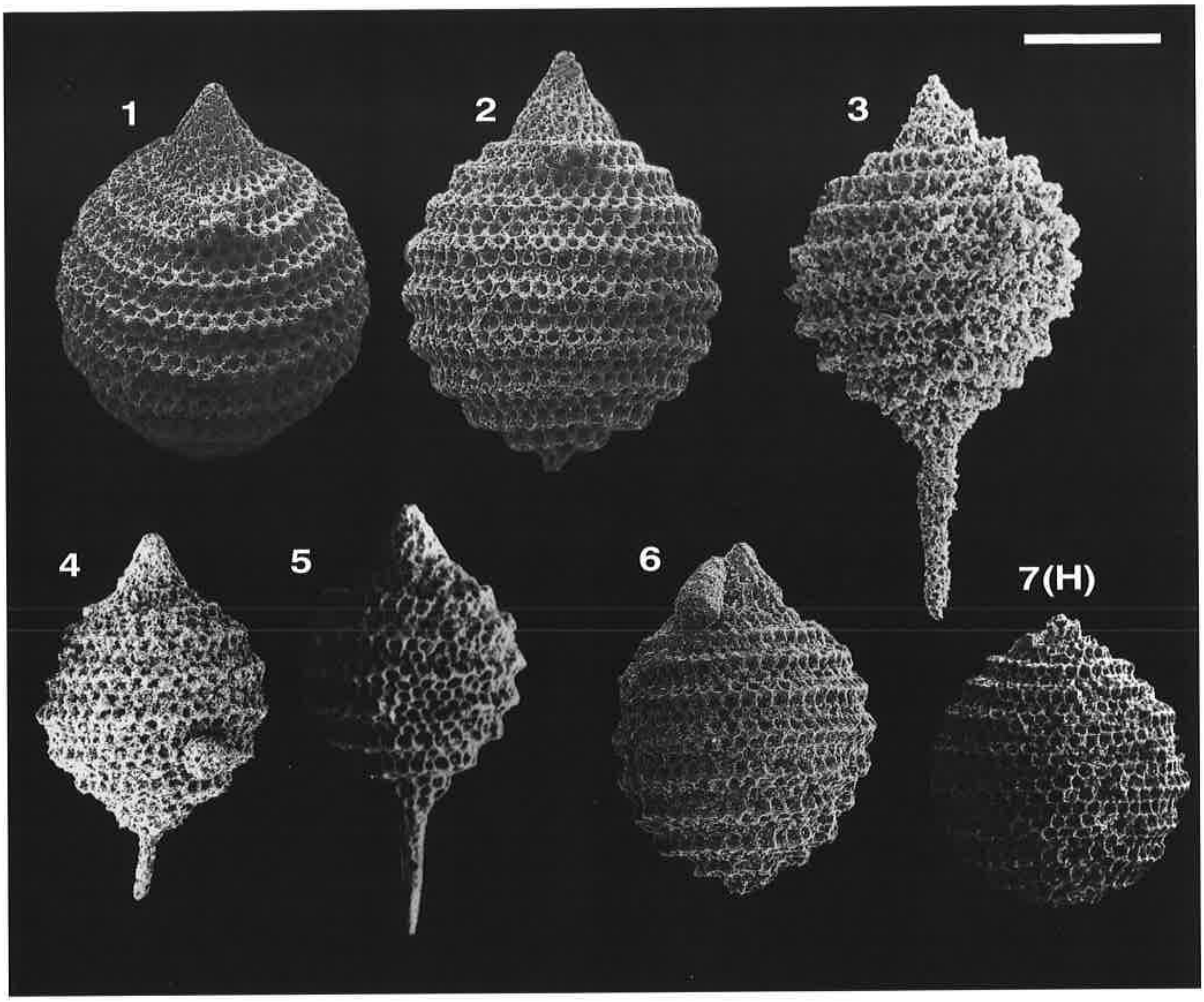


Plate 3717. *Parvicingula sphaerica* STEIGER. Magnification x150. **Fig. 1.** POB79/5271, POB1205.3. **Fig. 2.** POB79/5272, POB1205.3. **Fig. 3.** RJ28, Pi67.7. **Fig. 4.** RJ430, Br1330. **Fig. 5.** RJ859, Pi40.20. **Fig. 6.** TS19, Ga40/1. **Fig. 7(H).** STEIGER 1992, pl. 24, fig. 1.

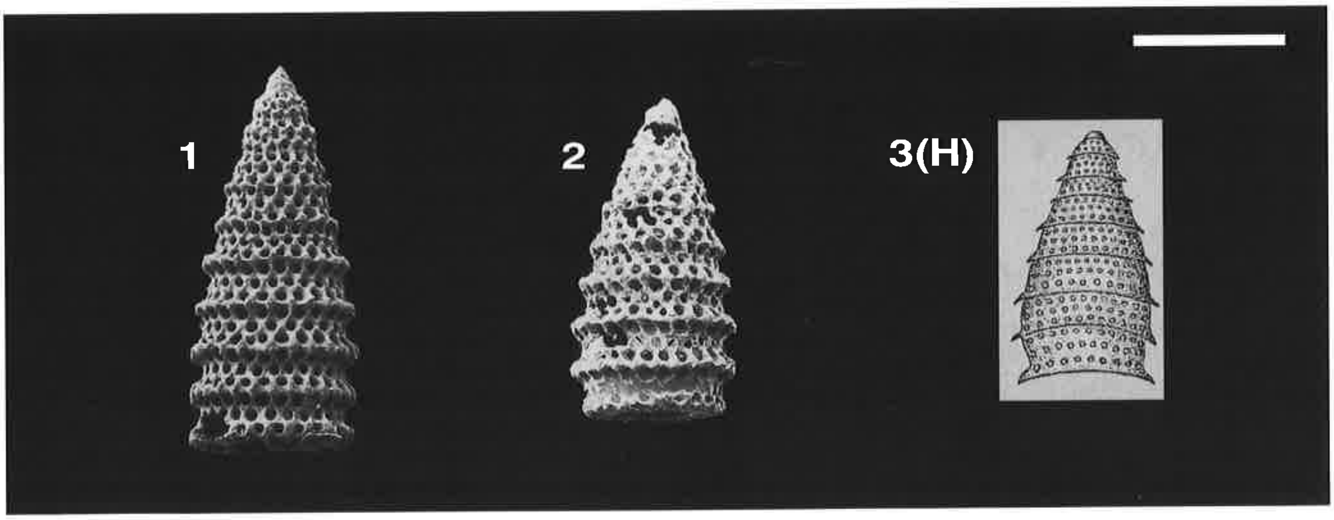


Plate 3187. *Parvicingula* (?) *spinata* (VINASSA). Magnification x200. **Fig. 1.** POB78/8217, POB986.51. **Fig. 2.** POB78/8169, POB986.52. **Fig. 3(H).** VINASSA 1899, pl. 2, fig. 40.

PARVICINGULA USOTANENSIS 5712

Parvicingula usotanensis TUMANDA

Synonymy.-
Lithocampe ananassa RÜST
MOORE 1973, p. 828, pl. 4, figs. 7-9.
MUZAVOR 1977, p. 99, pl. 8, fig. 6.
? *Amphipyndax* (?) sp.
FOREMAN 1973b, pl. 9, fig. 3, not figs. 4-5.
Parvicingula boesii (PARONA)
SCHAAF 1981, p. 436, pl. 3, figs. 13a, b; pl. 18, figs. 6 a-b.
OKADA et al. 1982, pl. 1, fig. 5.
? *Parvicingula* sp. B
AITA 1982, pl. 2, fig. 14.
Parvicingula sp.
SUYARI 1986b, pl. 3, fig. 2.
Eucyrtis cf. *E. elido* SCHAAF
THUROW 1987, pl. 10, fig. 78.
Parvicingula usotanensis TUMANDA
TUMANDA 1989, p. 30, pl. 4, fig. 4; pl. 10, figs. 11a-b.
JUD 1994, p. 92, pl. 16, fig. 8.

Original Definition.- Spindle-shaped *Parvicingula* with nodose circumferential ridges and small constricted peristoma. Test spindle-shaped tapering apically into hemispherical cephalis; with 6-7 postabdominal chambers. Poorly developed, faintly nodose circumferential ridges separate thorax from abdomen and last two postabdominal chambers. Horizontal rows of slightly pointed nodes between postabdominal chambers become prominent centrally from apical and distal portions. Nodes interconnected by ridges or bars resulting to triangular frames within chamber wall except for the last postabdominal chamber, and less prominent in first few postabdominal chambers. Abdomen and proximal postabdominal chambers increasing gradually in length and width as added, but decreasing gradually in last three postabdominal chambers. Thorax, abdomen and proximal chambers with four rows of linearly arranged subcircular pore frames becoming hexagonal or pentagonal in succeeding postabdominal chambers; pore opening becoming bigger centrally from apical and distal portions. Final chamber with tubular neck and small peristome.

Original Remarks.- This species resembles *Parvicingula dhimenaensis* in having nodose circumferential ridges but differs in 1) its pronounced spindle-shaped form rapidly constricting on both ends, 2) generally lesser number of chambers and 3) having a smaller constricted peristome.

Remarks.- In our material there are also found specimens with a wide terminal tube. Two such specimens measured, had a total length, with tube, of 239 μm and 389 μm respectively, a maximum width of 130 μm and 188 μm, a length of the tube of 58 μm and 88 μm and a distal width of 44 μm and 90 μm.

Etymology.- This species is named after Usotan River, Shimotonbetsu, northern Hokkaido.

Measurements (in μm).-
Holotype overall height: 230, maximum width 146, width of last chamber 100.

Type Locality.- Eashi Mountains, northern Hokkaido, Japan.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

PARVICINGULA (?) | A 3239

Parvicingula (?) sp. A

Synonymy.-
Parvicingula ? sp.
YAMAMOTO et al. 1985, p. 37, pl. 6, figs. 4a-b, 6.

Original Definition.- Test conical, pointed apically. Apical horn strong, circular in cross-section. Shell latticed, pores large, circula,r set in polygonal pore-frames. Circumferential ridges indistinct. Last segment slightly wider than second last and all others, with a basal constriction and wide aperture.

Remarks.- This species is questionably assigned to *Parvicingula* because of its indistinct circumferential ridges and the pore pattern which does not show a regular arrangement of three linear rows of pores per segment.

UAZones.- 7-7, late Bath.-early Call.

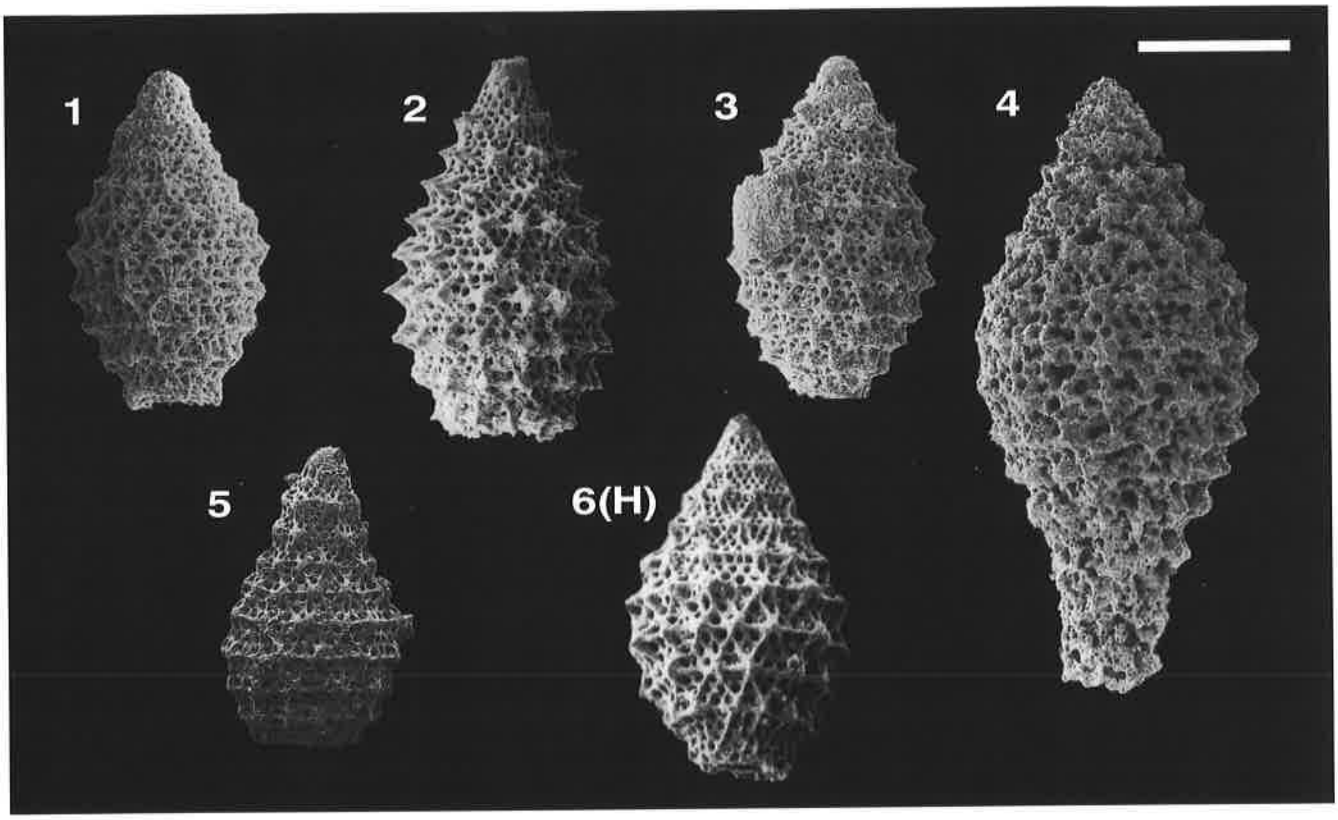


Plate 5712. *Parvicingula usotanensis* TUMANDA. Magnification x200. **Fig. 1.** RJ10, Pr225.3. **Fig. 2.** RJ108, Bo619.9. **Fig. 3.** RJ94, Bo619.9. **Fig. 4.** RJ68, Bo569.6. **Fig. 5.** POB80/2653, POB1134. **Fig. 6(H).** TUMANDA 1989, pl. 4, fig. 4.

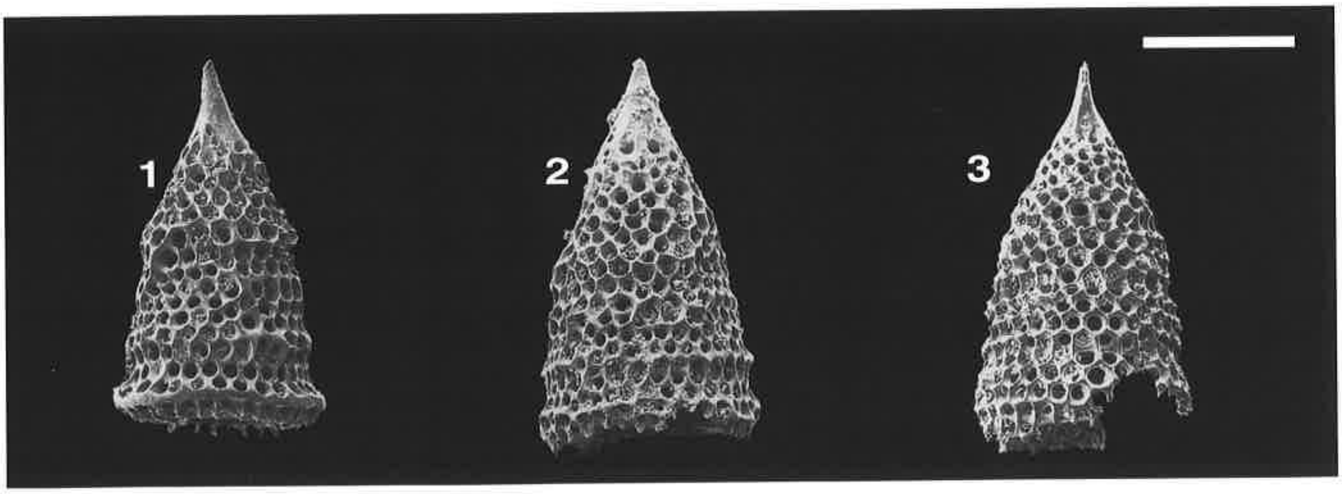


Plate 3239. *Parvicingula* (?) sp. A. Magnification x300. **Fig. 1.** POB81/1439, 534A.125.2.36. **Fig. 2.** POB81/1435, 534A.125.2.36. **Fig. 3.** POB81/2663, 534.124.1.52.

PARVIVACCA 3673

Genus: *Parvivacca* PESSAGNO & YANG

Synonymy.-
Parvivacca PESSAGNO & YANG
PESSAGNO et al. 1989, p. 244.

Type Species.-*Parvivacca blomei* PESSAGNO & YANG 1989.

Original Definition.- Cortical shell cylindrical to subcylindrical, flattened on two opposed surfaces. Opposed flattened surfaces with two distinct layers of latticed meshwork. Outer layer of latticed meshwork missing on sides of test (pl. 1, fig. 7). Cortical shell with two asymmetrically placed, curved to straight primary spines which are triradiate in axial section. Spines with three longitudinal ridges alternating with three longitudinal grooves.

Original Remarks.- *Parvivacca* n.gen. differs from *Lanubus* n.gen. by having a cylindrical to subcylindrical cortical shell with two flattened surfaces and by developing two layers of latticed meshwork only on the two flattened test surfaces. (e.g., pl. 8, fig. 10).

Etymology.- From *parvus, -a, -um* (Latin, adj.) = small *vacca* (Latin, n.) = cow. Test resembling head of cow.

Included Taxa.-
3288 *Parvivacca magna* JUD

PARVIVACCA MAGNA 3288

Parvivacca magna JUD

Synonymy.-
Parvivacca magna JUD
JUD 1994, p. 93, pl. 16, figs. 9-12.

Original Definition.- Flattened globular to slightly subcylindrical test, bearing on its side two strong three-bladed spines, not touching each other at their base. They are placed within one quarter of the equatorial plane of test and usually enclose angles of 70-85 degrees, rarely wider. Test with very large hexagonal pores arranged in transverse rows with small spines at junctions of pore bars. Lateral sides of test slightly cylindrical and thinner-walled. Spines robust, with curved distal ends which may bear one or several short spines.

Original Remarks.- *Parvivacca magna* n.sp. differs from *Parvivacca blomei* PESSAGNO & YANG and *Parvivacca simplex* PESSAGNO & YANG by its robust central test, bearing 2 shorter spines having more or less spiny ends.

Etymology.- From the Latin *magnus,* big.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Diameter of test:	160	181	144	211
Max. length spines:	133	157	133	181

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 14-20, early-early late Berr. to late Haut.

patricki >> *ARCHAEOSPONGOPRUNUM PATRICKI* 5042

pauliani >> *PSEUDOAULOPHACUS PAULIANI* 5332

perampla >> *SPONGOCAPSULA PERAMPLA* 3267

periosa >> *DICROA PERIOSA* 5046

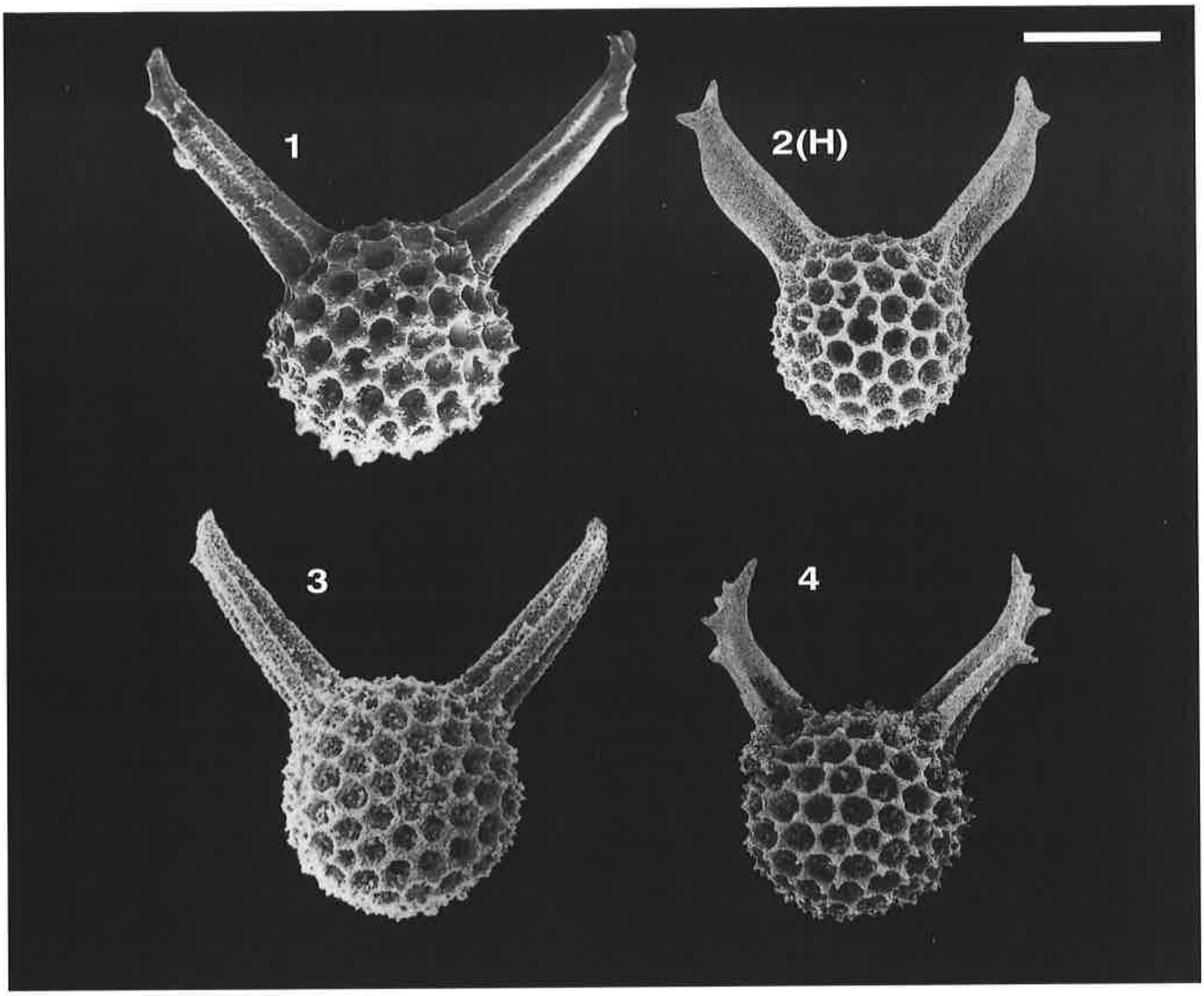


Plate 3288. ***Parvivacca magna*** **JUD.** Magnification x200. **Fig. 1.** POB79/3708, MO1 46. **Fig. 2(H).** RJ230, Br28.85. **Fig. 3.** RJ23, Ca146.5 2. **Fig. 4.** RJ586, Bo566.5.

PERISPYRIDIUM 3675

Genus: *Perispyridium* DUMITRICA

Synonymy.-
Perispyridium DUMITRICA
DUMITRICA 1978, p. 35.

Type species.- *Trilonche* (?) *ordinaria* PESSAGNO 1977a.

Original Definition.- Flat eptingiids with cephalis small, surrounded in frontal plane by a triangular to subcircular peripheral latticed shall; sagital ring inserted in the cephalic wall; arches more or less distinct.

Original Remarks.- *Perispyridium* seems to be the last survivor of the family. It bears the most advanced spumellarian morphology among the eptingiids, the cephalis being able to be easily confused with the microsphere and the peripheral latticed shell with the cortical shell.

Included Taxa.-
3100 *Perispyridium ordinarium* gr. (PESSAGNO)

PERISPYRIDIUM ORDINARIUM GR. 3100

Perispyridium ordinarium gr. (PESSAGNO)

Synonymy.-
Trilonche (?) *ordinaria* PESSAGNO
PESSAGNO 1977a, p. 79, pl. 6, fig. 14.
Perispyridium ordinarium (PESSAGNO)
DUMITRICA 1978, p. 35, pl. 3, figs. 1, 2, 5; pl. 4, fig. 9.
KOCHER 1981, p. 83, pl. 15, fig. 15.
PESSAGNO & BLOME 1982, p. 294, pl. 6, figs. 4, 12, 15.
NISHIZONO et al. 1982, pl. 2, fig. 9.
AITA 1982, pl. 3, fig. 23.
BAUMGARTNER 1984, p. 779, pl. 7, figs. 5-6.
PESSAGNO et al. 1984, p. 24, pl. 1, fig. 7.
DE WEVER et al. 1985, pl. 1, fig. 25, not fig. 23.
DE WEVER & CORDEY 1986, pl. 1, fig. 18.
DE WEVER et al. 1986, pl. 6, fig. 9.
AITA 1987, p. 66, pl. 6, figs. 1a-b; pl. 12, fig. 13.
MATSUOKA 1992, pl. 3, fig. 8; pl. 4, fig. 12.
Trigonocyclia sp.
OZVOLDOVA 1979, p. 253, pl. 3, fig. 2.
Perispyridium (?) *ordinarium* (PESSAGNO)
DE WEVER & CABY 1981, pl. 2, fig. A.
Perispyridium cf. *tamanense* PESSAGNO & BLOME
OZVOLDOVA 1988, p. 385, pl. 1, fig. 6.
Perispyridium aff. *tamanense* PESSAGNO & BLOME
WIDZ 1991, p. 252, pl 3, fig. 5.
Perispyridium sp. A
WIDZ 1991, p. 252, pl. 3, fig. 4.

Original Definition.- Cortical shell flat, triangular in outline with three equidistant, triradiate, massive primary spines; meshwork coarse with large, predominantly pentagonal, irregular pore frames; pore frames having nodes at vertices; meshwork absent in center in area over first medullary shell by three primary radial beams and numerous secondary radial beams. Primary radial beams continuous with three primary spines. Secondary radial beams connecting medullary shell to meshwork of cortical shell. First medullary shell subcircular in outline; ellipsoidal in cross section. Meshwork with small, predominantly pentagonal pore frames.

Actualized Definition.- (DUMITRICA, 1978) Shell flat of triradial symmetry. Cephalis small, subglobular or ellipsoidal with a slight constriction corresponding to the sagital ring. Pores small, subcircular of rather regular size. Collar plate with well distinct MB, l and L. Apical spine A and the two primary lateral spines L straight and rod-like inside the peripheral shall, triradiate and with one or two verticils of nodes outside. Distal ends of the three spines pointed or nodulous. The spines are equal and disposed at 120 degrees in the frontal plane. They bear, inside the peripheral shell, a verticil of two spines perpendicular to the frontal plane and connected to the peripheral shell. The latter is triangular in shape, with convex or straight sides. It envelops the cephalis only in frontal plane and is connected to it by commonly six bars on each side, forming six large pores; three of them have as diameter the radial spines A and L, the other three are intermediate. Frequently this arrangement is disturbed by appearance of additional connecting bars. Wall of the cortical shell has large unequal pores which are pentagonally framed and have nodes at corners.

Original Remarks.- *Trilonche* (?) *ordinaria* n.sp. differs from *T. vetusa* HINDE in having a triangular cortical shell with partially developed meshwork. Because of the presence of this meshwork, *T.* (?) *ordinaria* is questionably assigned to *Trilonche*.

Etymology.- This species is named from the Latin adjective *ordinarius*, meaning ordinary.

Measurements (in μm).-
Based on 10 specimens. Test (cortical shell) an equilateral triangle in outline. Length of side: 100 to 160; length of spines: 40 to 70; diameter of first medullary shell: 40 to 50 (Pessagno, 1977a). Diameter of cephalis 50-60, distance between the distal ends of two spines 290-300 (Dumitrica, 1978).

Type Locality.- NSF 908 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 5-11, latest Baj.-early Bath. to late Kimm.-early Tith.

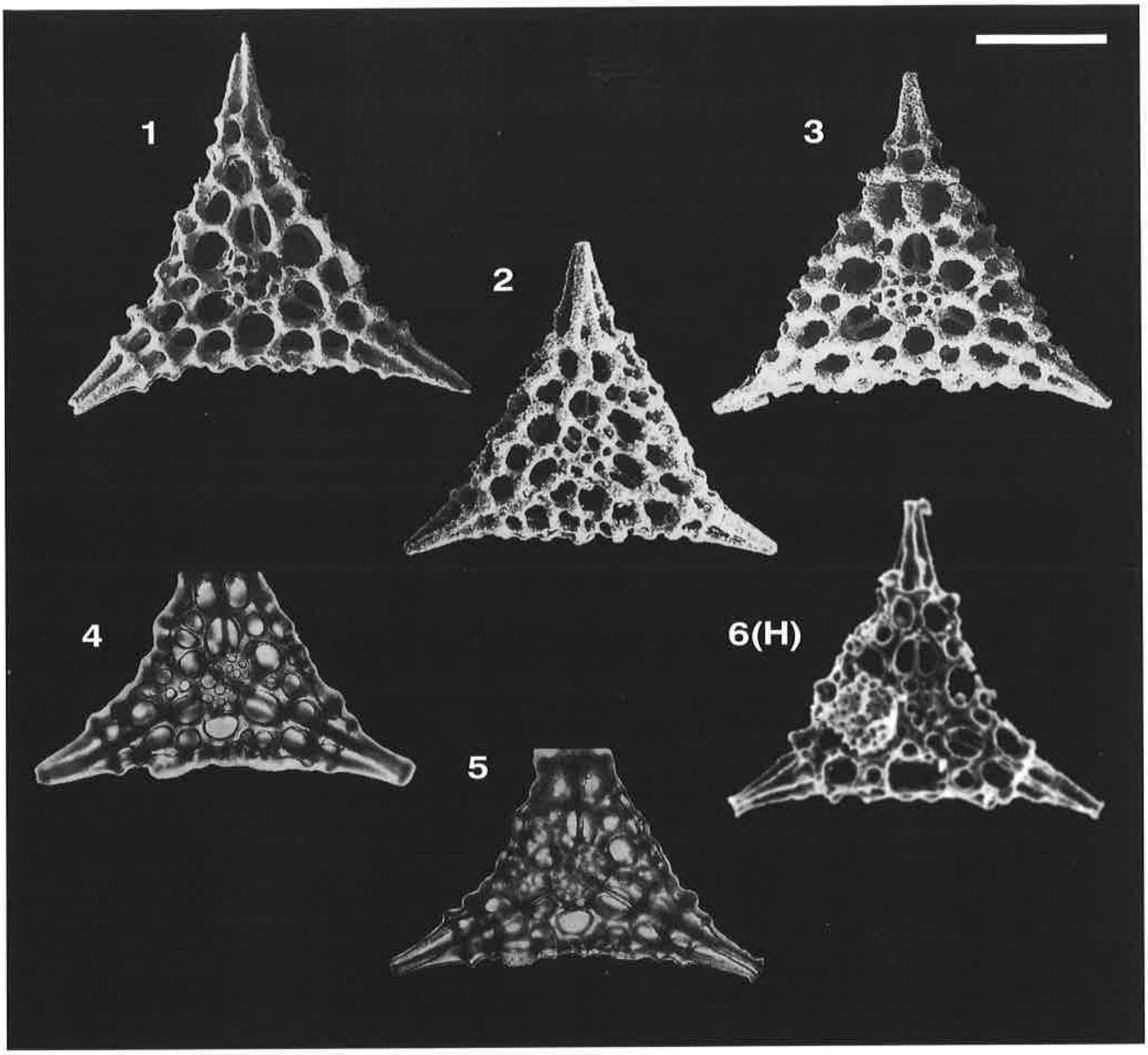


Plate 3100. ***Perispyridium ordinarium*** **gr. (PESSAGNO).** Magnification x200. **Fig. 1.** POB78/8147, POB986.52. **Fig. 2.** POB78/6432, POB899.53. **Fig. 3.** POB78/6433, POB899.53. **Fig. 4.** DU51/5, DR7. transmitted light. **Fig. 5.** DU51/4, DR7. same specimen as 4, focussed on internal structure. **Fig. 6(H).** PESSAGNO 1977a, pl. 6, fig. 14.

pessagnoi >> *EMILUVIA PESSAGNOI MULTIPORA* *3226*

pessagnoi >> *EMILUVIA PESSAGNOI PESSAGNOI* *4017*

pessagnoi >> *EMILUVIA PESSAGNOI S.L.* *3066*

peteri >> *HOMOEOPARONAELLA PETERI* *5267*

petzholdti >> *MIRIFUSUS PETZHOLDTI* *5703*

PHASELIFORMA 6130

Genus: *Phaseliforma* PESSAGNO

Synonymy.-
Phaseliforma PESSAGNO
PESSAGNO 1972, p. 274.

Type Species.- *Phaseliforma carinata* PESSAGNO 1972.

Original Definition.- Test as with family. Meshwork composed of irregular polygonal frames lacking nodes at vertices. Test varying in width; often markedly compressed at posterior end, developing an angled periphery or keel. Some species with V-shaped indentations close to center of one side.

Original Remarks.- *Phaseliforma* n.gen. differs from *Spongurus* HAECKEL by its more flattened test, by its lack of spines, and by its possession of concentric meshwork internally.

Etymology.- *Phaselus, -i* Latin (m.) = kidney bean *forma, -ae* Latin (f.) = form, shape.

Included Taxa.-
5362 *Phaseliforma ovum* JUD

PHASELIFORMA OVUM 5362

Phaseliforma ovum JUD

Synonymy.-
Phaseliforma ovum JUD
JUD 1994, p. 93, pl. 16, figs. 13-14.

Original Definition.- Egg-shaped or subtriangular and slightly flattened test consisting of spongy meshwork. Anterior end rounded, posterior end truncate. Spongy meshwork dense with irregular pore frames.

Original Remarks.- *Phaseliforma ovum* n.sp. may be compared with *Phaseliforma laxa* PESSAGNO, but differs from the latter in having a truncate end permitting to recognize an anterior and a posterior end. By this character it could be also assigned to the Senonian genus *Parvicuspis* PESSAGNO, but the posterior end of this new species lacks the V-shaped notch characteristic of the two species so far described.

Etymology.- From the Latin *ovum* = egg.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Maximum length of test:	256	265	235	287
Maximum width of test:	222	215	180	222

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 20-22, late Haut. to late Barr.-early Apt.

planum >> CYCLASTRUM (?) PLANUM 5903

plenoides >> MONOTRABS (?) PLENOIDES GR. 3152

plicarum >> TRICOLOCAPSA PLICARUM PLICARUM 4053

plicarum >> TRICOLOCAPSA PLICARUM S.L. 3051

plicarum >> TRICOLOCAPSA PLICARUM | A 4052

podbielensis >> PALINANDROMEDA PODBIELENSIS 3008

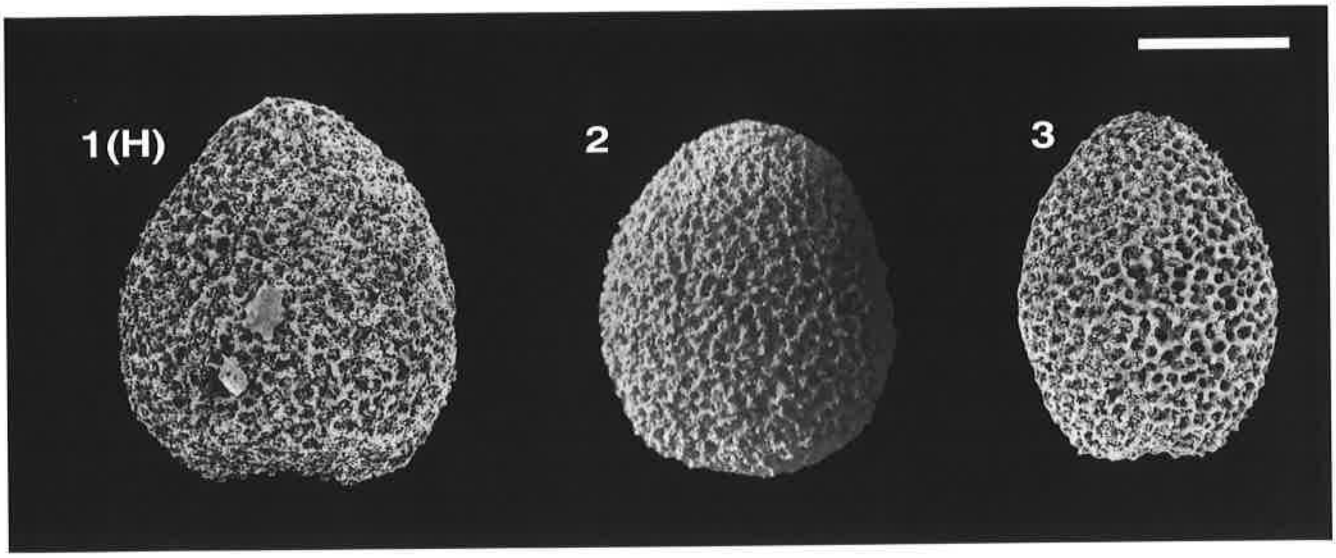


Plate 5362. *Phaseliforma ovum* JUD. Magnification x200. **Fig. 1(H).** RJ83, Bo566.50. **Fig. 2.** RJ1106, Bo561.5. **Fig. 3.** RJ267, Bo566.50.

PODOBURSA 3677

Genus: *Podobursa* WISNIOWSKI, emend. FOREMAN

Synonymy.-
Podobursa WISNIOWSKI 1889.
WISNIOWSKI 1889, p. 686.
emend. FOREMAN 1973b, p. 266.

Type Species.- *Podobursa dunikowskii* WISNIOWSKI 1889, by monotypy.

Original Definition.- "Archiperida vel Monocyrtida triradiata clausa, without inner columella and without an apical spine, with an apical latticed extension."

Actualized Definition.- (FOREMAN, 1973b) Although Wisniowski considered *P. dunikowskii* to be a monocyrtid with three lateral spines on the cephalis and a porous extension apically, it is apparent that the apical porous extension is actually the terminal tube of the distalmost segment and that the small proximal part of the shell, comprising the cephalis, thorax and perhaps a small post thoracic segment, is missing. The generic definition of *Podobursa* is thus emended as follows: Shell of three to four segments, the small proximal part made up of all but the distalmost segment which is large, globose, and bears three or more outward-directed spines and a porous terminal tube. This genus differs from *Podocapsa* RÜST emend. FOREMAN in having appendages developed as three or more solid spines rather than as three porous cones or tubes. Assigned to this genus are all Mesozoic forms with a small proximal part and a large, globose terminal segment with three or more solid spines (wings) and a terminal tube.

Remarks.- Species have been distinguished on the overall shape of the test, the number of segments, the nature of surface ornamentation, the character of the apical horn and the number and character of the laterally directed spines.

Etymology.- That beautiful radiolarian was specificly named after Prof. Dunikowsky at Lemberg, a well known scientist on fossil sponges and Radiolaria.

Included Taxa.-
3169 *Podobursa helvetica* (RÜST)
5427 *Podobursa multispina* JUD
3174 *Podobursa polyacantha* (FISCHLI)
3289 *Podobursa* (?) sp. aff. *P. quadriaculeata* (STEIGER)
3230 *Podobursa spinosa* (OZVOLDOVA)

PODOBURSA HELVETICA 3169

Podobursa helvetica (RÜST)

Synonymy.-
Theosyringium helveticum RÜST
RÜST 1885, p. 309, pl. 37, fig. 14.
Podobursa helvetica (RÜST) emend. BAUMGARTNER et al.
BAUMGARTNER et al. 1980, p. 60, pl. 3, fig. 11; pl. 6, fig. 5.
? KOCHER 1981, p. 84, pl. 15, fig. 17.
DE WEVER & CABY 1981, pl. 2, fig. O.
ORIGLIA-DEVOS 1983, p. 186, pl. 21, fig. 8, ? fig. 9.
BAUMGARTNER 1984, p. 779, pl. 7, fig. 7.
EL KADIRI 1984, p. 234, pl. 18, figs. 1, 3.
DE WEVER & MICONNET 1985, p. 389, pl. 4, figs. 16-17.
AITA 1987, p. 66.
OZVOLDOVA 1988, pl. 6, fig. 7.
DANELIAN 1989, p. 177, pl. 7, figs. 2-3.
WIDZ 1991, p. 252.
Podobursa helvetica
CONTI & MARCUCCI 1991, pl. 3, fig. 9.
Podobursa nonhelvetica YANG & WANG
YANG & WANG 1990, p. 209, pl. 4, figs. 2, 4, ? fig. 16.

Original Definition.- "The first segment is sphaerical, with a dented outline and is connected to the second segment by a narrow neck-like constriction. The second segment is much larger and broadly romboidal. The third segment is a long conical tube with a small basal aperture. The pores are small and placed in irregular longitudinal rows."

Actualized Remarks.- (BAUMGARTNER et al., 1980) The specimen illustrated by Rüst is obviously an internal mould as showed by the proximal part. However the general shape and the characteristic outline of the inflated segment closely correspond to the specimens included under this name. The cephalis bears a stout apical horn with several thorn ridges ending in "clove-like" small spines.

The apical spine may be slightly twisted. The inflated segment is composed of a narrower proximal and distal part and a wider median part forming a "shoulder" as illustrated by Rüst. The median part bears 8 to 10 outward directed small spines. The long terminal tube ends in a similar "clove-like" structure as the apical horn.

Measurements (in μm).-
Maximum length, 408; maximum width, 233.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

PODOBURSA MULTISPINA 5427

Podobursa multispina JUD

Synonymy.-
Podobursa multispina JUD
JUD 1994, p. 93, pl. 16, figs. 15-17.

Original Definition.- Test of probably 3-5 segments with the middle part large, spherical and the proximal and distal parts conical. Proximal part with very short, broad horn the base of which includes probably all or a part of cephalic cavity. Middle part with 8-10 strong conical spines radiating in all directions. Wall of this part probably two-layered, the external layer composed of a coarse meshwork of ridges forming usually triangular frames. Test terminating with a short conical tube with very large, irregular pores and a short distal spine. Boundary between inflate middle chamber and conical proximal and distal portions usually well marked by a change in outline.

Original Remarks.- *Podobursa multispina* n.sp. differs from the other species of the genus by having numerous radiating spines developed on the spherical segment and by its rough and slightly spiny irregular pore-frames developed all over the test but especially on the inflate chamber.

Etymology.- From the Latin *multus* = many and *spina* = spine.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Total height:	366	354	274	385
Width spher. part:	162	155	140	167
Height prox. con. part:	83	91	66	109
Height dist. con. part:	121	121	86	142

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 20-20, late Haut.

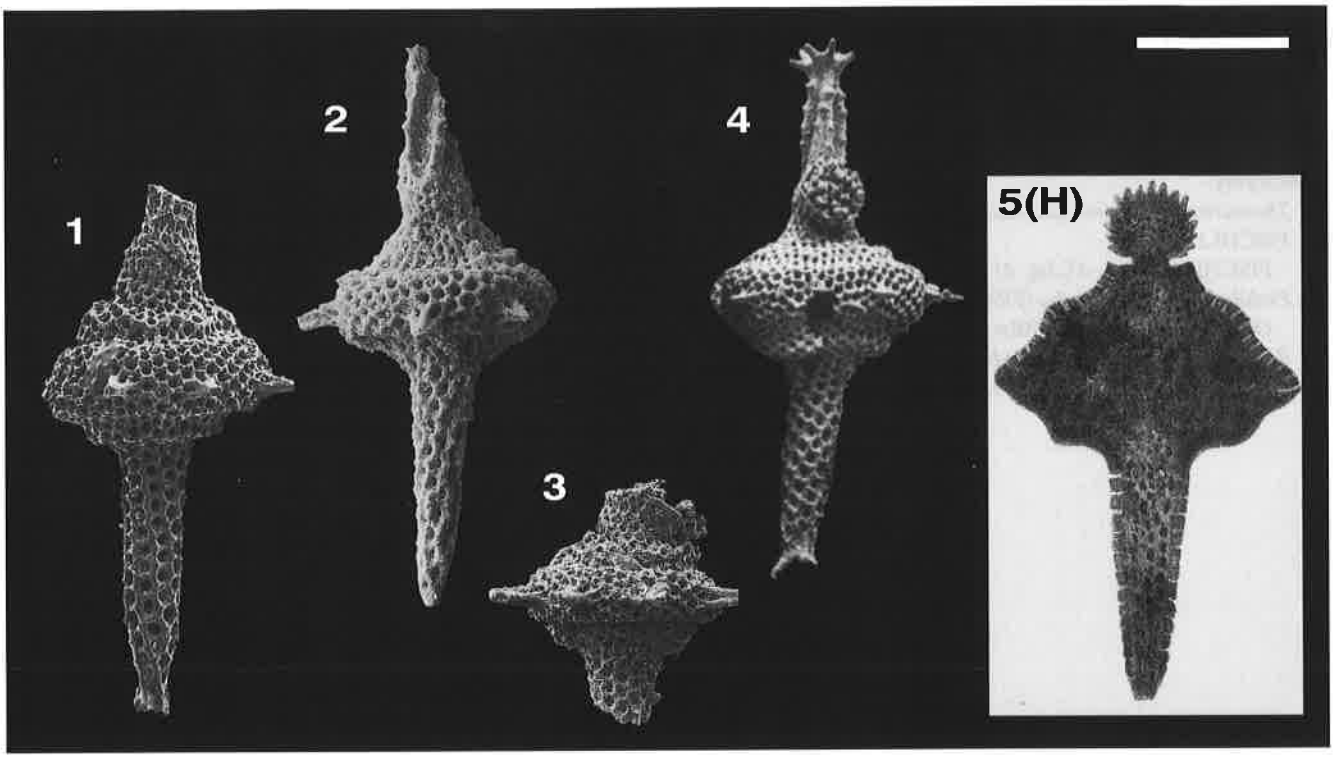


Plate 3169. *Podobursa helvetica* (RÜST). Magnification x150. **Fig. 1.** POB78/3551, POB28.63. **Fig. 2.** DU3139, PJ8. **Fig. 3.** POB81/1398, 534A.125.2.36. **Fig. 4.** POB78/6686, POB899. **Fig. 5(H).** RÜST 1885, pl. 37, fig. 14.

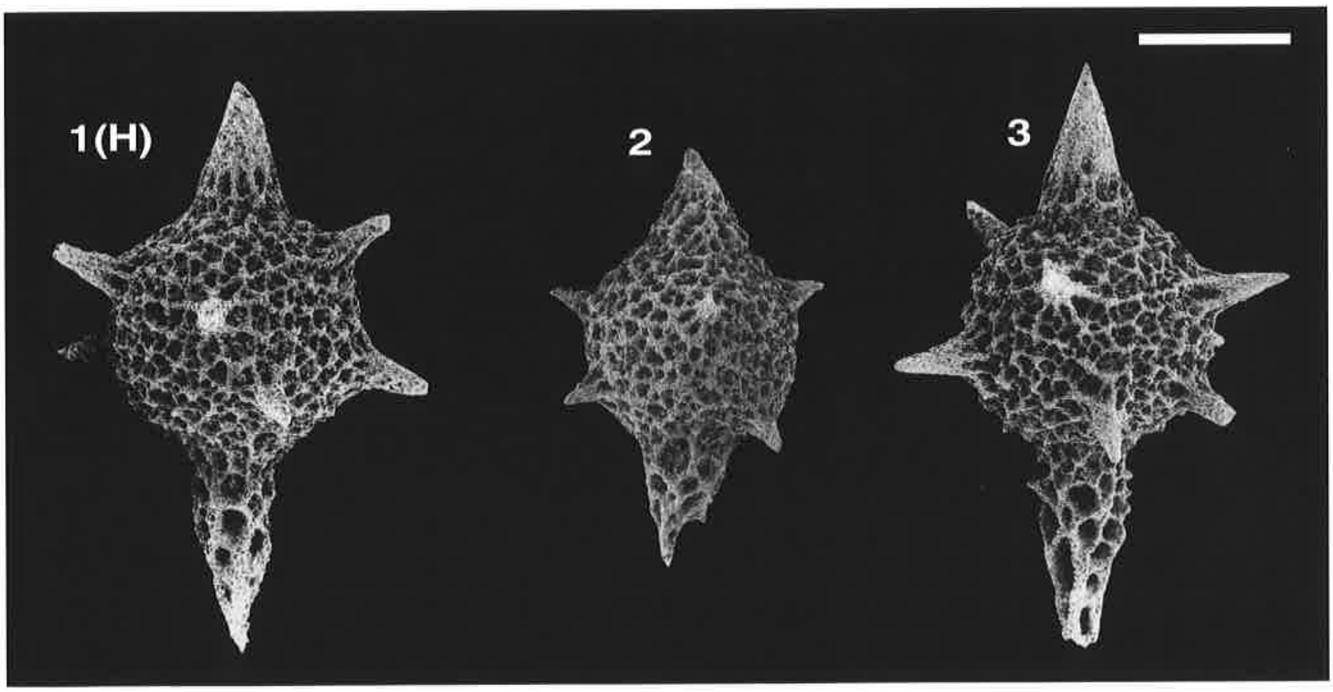


Plate 5427. *Podobursa multispina* JUD. Magnification x200. **Fig. 1(H).** RJ509, Bo566.5. **Fig. 2.** RJ525, Bo566.5. **Fig. 3.** RJ587, Bo566.50.

PODOBURSA POLYACANTHA 3174

Podobursa polyacantha (FISCHLI)

***Synonymy*.-**
Theosyringium acanthophorum RÜST var. *polyacanthus* FISCHLI
FISCHLI 1916, p. 47, fig. 41.
Podobursa aff. *triacantha* (FISCHLI)
OZVOLDOVA & SYKORA 1984, p. 269, pl. 12, figs. 1-3.
Podobursa triacantha hexaradiata STEIGER
STEIGER 1992, p. 73, pl. 20, figs. 4-5.
Podobursa triacantha octaradiata STEIGER
STEIGER 1992, p. 74, pl. 20, figs. 6-7.

***Remarks*.-** All forms of *Podobursa* having 6 to 9 equal well developed lateral spines are included.

***Type Locality*.-** Riginagelfluh, Switzerland.

***UAZones*.-** 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

PODOBURSA (?) QUADRIACULEATA AFF. 3289

Podobursa (?) sp. aff. *P. quadriaculeata* (STEIGER)

***Synonymy*.-**
Favosyringium quadriaculeatum STEIGER
STEIGER 1992, p. 81, pl. 22, figs. 1-5.

***Remarks*.-** This species differs from *Podobursa quadriaculeata* (STEIGER) by having a shorter and thinner apical horn and lateral spines. The shell surface is rather smooth instead of being rough, nodose as with *Podobursa quadriaculeata*.

***UAZones*.-** 9-17, mid-late Oxf. to late Val.

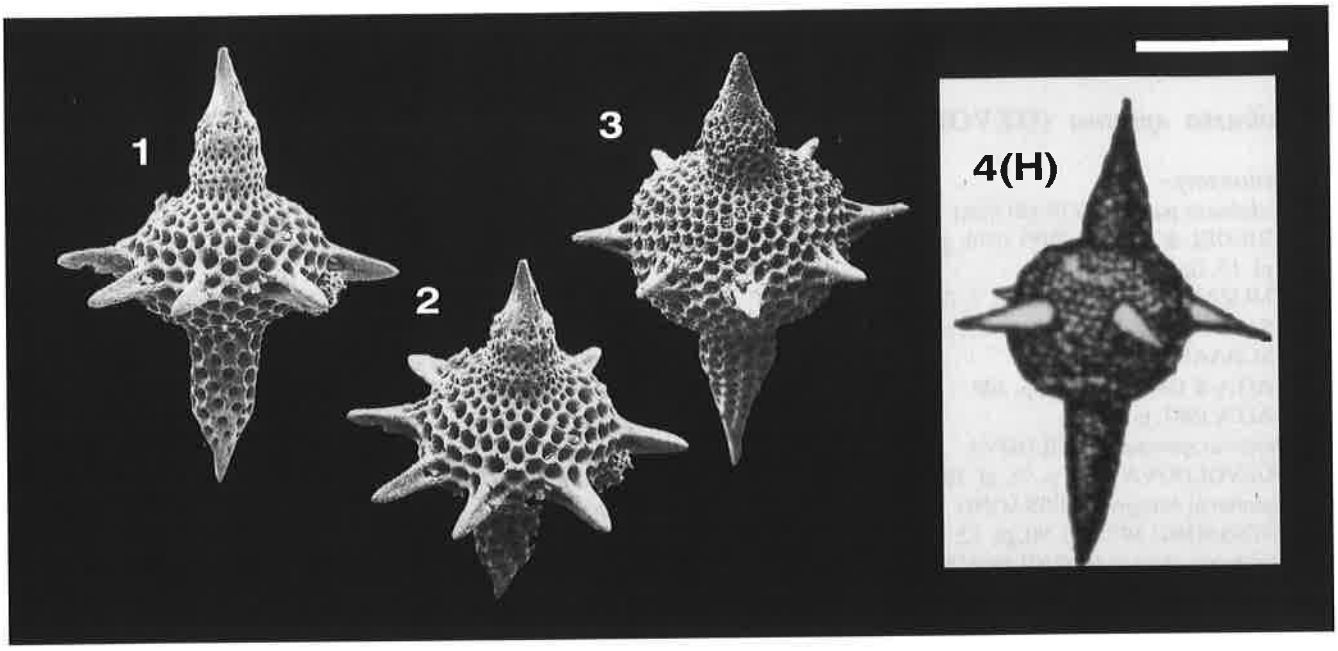


Plate 3174. *Podobursa polyacantha* (FISCHLI). Magnification x150. **Fig. 1.** POB78/8161, POB986.52. **Fig. 2.** POB78/8162, POB986.52. **Fig. 3.** POB80/1861, MO26. **Fig. 4(H).** FISCHLI 1916, fig. 41.

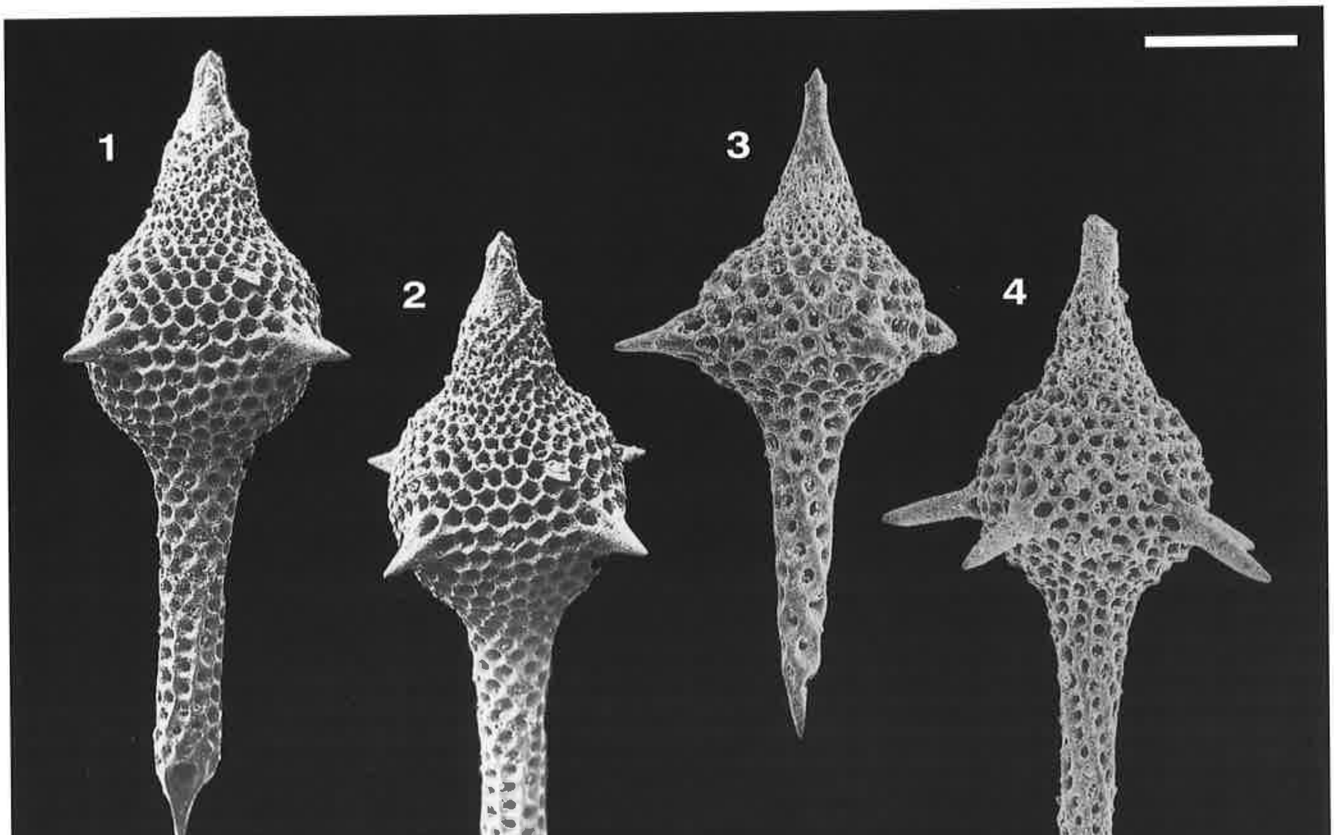


Plate 3289. *Podobursa* (?) sp. aff. *P. quadriaculeata* (STEIGER). Magnification x150. **Fig. 1.** POB80/1866, MO26. **Fig. 2.** POB80/1865, MO26. **Fig. 3.** DU3569, Mo25. **Fig. 4.** DU3572, Mo25.

PODOBURSA SPINOSA 3230

Podobursa spinosa (OZVOLDOVA)

Synonymy.-

Podobursa pantanellii (PARONA)
RIEDEL & SANFILIPPO 1974, p. 779, pl. 8, fig. 5; pl. 13, fig. 6.
MUZAVOR 1977, p. 108, pl. 7, fig. 5.
SANFILIPPO & RIEDEL 1985, p. 661, figs. 11.2 a-b.
SCHAAF 1985, p. 266.
AITA & OKADA 1986, p. 108.
AITA 1987, p. 66.
Heitzeria spinosa OZVOLDOVA
OZVOLDOVA 1975, p. 78, pl. 101, fig. 2.
Podobursa berggreni PESSAGNO
PESSAGNO 1977a, p. 90, pl. 12, figs. 1-5.
Podobursa spinosa (OZVOLDOVA)
OZVOLDOVA 1979, p. 256, pl. 2, fig. 4.
BAUMGARTNER et al. 1980, p. 60, pl. 3, fig. 10.
KOCHER 1981, p. 85, pl. 15, fig. 18.
BAUMGARTNER 1984, p. 779, pl. 7, fig. 8.
OZVOLDOVA 1988, pl. 8, fig. 5.
OZVOLDOVA 1990, pl. 2, fig. 6.
CONTI & MARCUCCI 1991, p. 802, pl. 3, fig. 6.
OZVOLDOVA 1992, pl. 5, fig. 10.
PESSAGNO et al. 1993, p. 157, pl. 8, fig. 1.
JUD 1994, p. 94, pl. 17, fig. 1.
Podobursa spinosa (OZVOLDOVA) gr.
DE WEVER et al. 1986, pl. 10, figs. 5, 6, 8, 10.

Original Definition.- The shell is divided into three chambers. The first chamber-cephalis is conical; the second chamber-thorax is broad, and the third chamber-abdomen is tubular. The first and the third chambers terminate with a horn with 3-4 short spines on their ends. On the second chamber are three radially arranged apophyses with the same spinal termination. The first chamber of the latticed shell is short, conical, terminated with a thick apical horn ending with 3-4 short spines. The second chamber is broad, oval, slightly depressed in longitudinal sense, downwards passing into narrow, long, conical third chamber. This one ends with a terminal spine, splitted into 3-4 short spines at its end. In the middle of the second chamber 3 thick non-perforated apophyses run out radially. They are of equal length and of quadrangular section. At their ends they split into 3-4 short spines. On the first chamber are pores of a half-diameter of those on the other two. The pores are irregularly hexagonal. On the second and third chamber are large, regularly hexagonal pores. The bars of the hexagonal meshwork are connected with the prominent sharp nodes.

Actualized Definition.- (OZVOLDOVA, 1979) Test consists of a conical proximal part and wide oval abdomen slightly compressed in the vertical direction, terminated by narrow conical terminal tube. Proximal part begins with smooth, non-porous cephalis with apical horn at its end split into 3-4 lateral little spines. Postcephalic segments are difficult to distinguish one from another. In the optical microscope it is possible to observe inconspicuous outline of 3-4 segments. Their pores are oval, about half the size of those on abdomen. From wide abdomen, three massive three-bladed spines run symmetrically radially, at their ends splitting into 3-4 small, laterally diverging spines. Terminal tube is closed by similar spine. Pores of terminal tube and abdomen are about the same size and they are of a rounded hexagonal shape. Meshwork of both parts is hexagonal, with slightly protruding nodes.

Actualized Remarks.- (OZVOLDOVA, 1979) On the basis of generic features, our specimens can be ranked to the genus *Podobursa* WISNIOWSKI, emended definition of which was given by Foreman (1973b). Therefore, it has been necessary to state a new combination of the generic name. In the above description, we use Foreman's terminology (1973b). The original description is supplemented by the number of proximal part segments.

Measurements (in μm).-
Shell height HT 520, PT 480-600; second chamber width HT 230, PT 220-270; height of the first chamber with apical horn HT 160, PT 140-160; height of the third chamber with terminal spine HT 270, PT 250-270; length of radial apophyses HT 90, PT 90-120; pore diameter on the second and third chambers HT 11, PT 11-16.

Type Locality.- Podbiel, Pieniny Group of the Klippen Belt, Slovakia.

UAZones.- 8-13, mid Call.-early Oxf. to latest Tith.

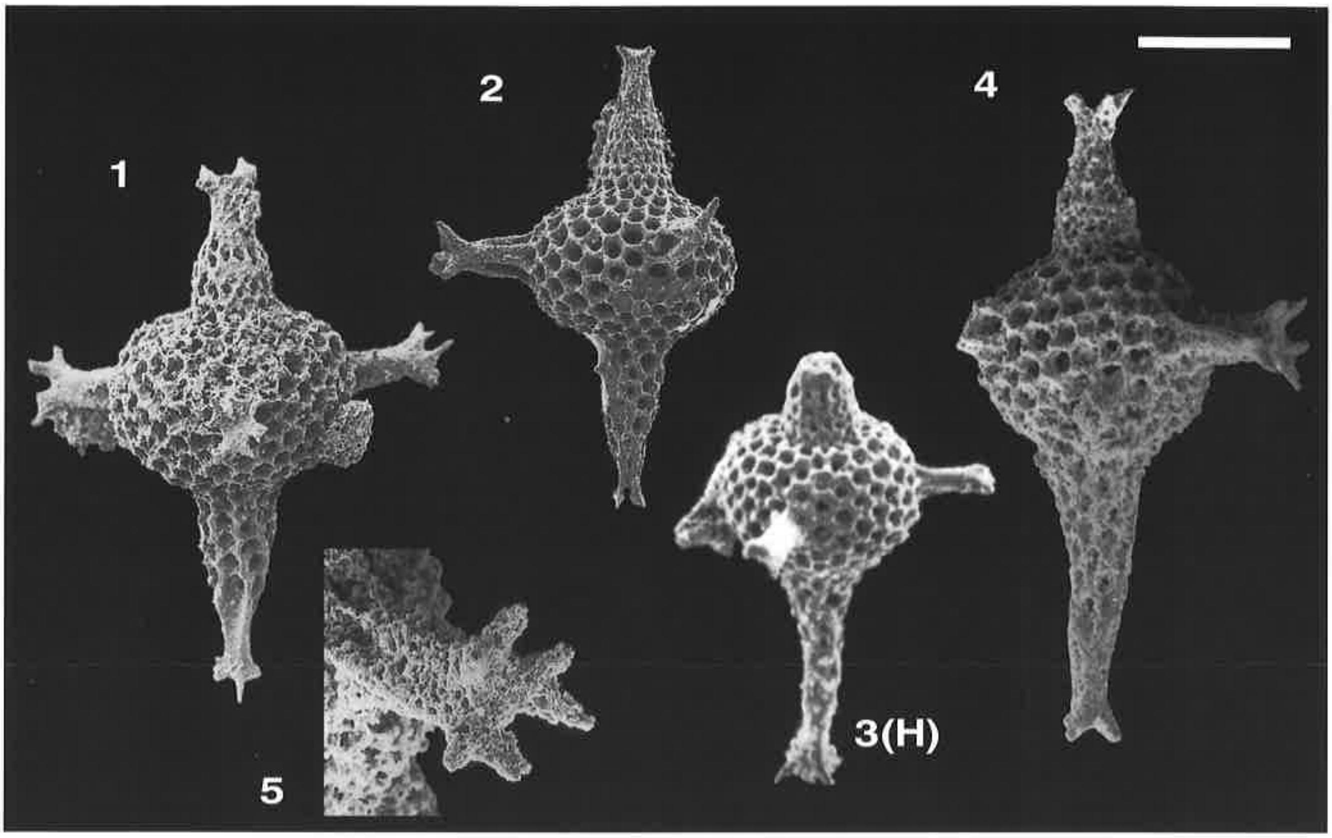


Plate 3230. *Podobursa spinosa* (OZVOLDOVA). Magnification x150, except Fig. 5 x300. **Fig. 1.** POB79/4721, POBS4. **Fig. 2.** POB78/3757, POB28.66.**Fig.3(H).** OZVOLDOVA 1975, pl. 101, fig. 2. **Fig. 4.** RJ41, Pi10.00. **Fig. 5.** RJ42, Pi10.00.

PODOCAPSA	*3678*

Genus: *Podocapsa* RÜST, emend. FOREMAN

Synonymy.-
Podocapsa RÜST
RÜST 1885, p. 304.
emend. FOREMAN 1973b, p. 267.

Type Species.- *Podocapsa guembeli* RÜST 1885, subsequent designation by Campbell (1954).

Original Definition.- "The three following species required the definition of a new genus. A diagnosis would be: *Monocyrtida clausa eradiata, testa subsphaerica, appendicibus tribus vel pluribus ubique clathratis*, and it would have its analogue in the genera Heakel's dyocyrtid genus *Sethrochytris* and Ehrenberg's *Lithochytris*. Of the two latticed extensions the two opposite ones, which could be named basal extensions, are always equal, while the third one, the apical extension, is developed different".

Actualized Definition.- (FOREMAN, 1973b) When Campbell (1954, p. D122) subsequently designated *Podocapsa guembeli* RÜST, 1885 as the type species of *Podocapsa*, he did not, in the absence of a type designation by Rüst, indicate which of the two entirely different specimens illustrated by Rüst was to be considered as the lectotype of *P. guembeli*. He did reproduce one of Rüst's illustrations, fig. 5 on pl. 36. However, since he very frequently selected a specimen other than the one or more which were eligible to be the type of the species designated as type species of the genera he treated, this illustration by Campbell is not considered to be a designation. We therefore designate Rüst's specimen (pl. 36, fig. 6) as the lectotype of *Podocapsa guembeli*. Although Rüst considered this specimen to be a monocyrtid with two porous wings and a porous apical extension, it is apparent that the latter is actually the terminal tube of the distalmost segment and that the proximal segments have been broken off. The generic definition of *Podocapsa* is thus emended as follows: Shell of at least three segments, the proximal part small, made up of all but the distalmost segment which is large, globose, and bears three porous wings and a porous terminal tube.

Remarks.- This genus can be distinguished from the genus *Podobursa* by the nature of the laterally directed porous wings as opposed to laterally directed spines on *Podobursa*.

Included Taxa.-
3171 *Podocapsa amphitreptera* FOREMAN
4033 *Podocapsa* (?) *hexaptera* CONTI & MARCUCCI
5397 *Podocapsa imperialis* JUD

PODOCAPSA AMPHITREPTERA 3171

Podocapsa amphitreptera FOREMAN

Synonymy.-
Podocapsa amphitreptera FOREMAN
FOREMAN 1973b, p. 267, pl. 13, fig. 11.
FOREMAN 1975, p. 617, pl. 6, fig. 15.
MUZAVOR 1977, p. 112, pl. 7, fig. 4.
FOREMAN 1978, p. 749, pl. 1, fig. 16.
BAUMGARTNER et al. 1980, p. 61, pl. 3, figs. 8-9.
KOCHER 1981, p. 86, pl. 15, fig. 20.
DE WEVER & CABY 1981, p. 470, pl. II, fig. 2L.
YAO et al. 1982, pl. 4, fig. 29.
BAUMGARTNER 1984, p. 780, pl. 7, figs. 9-10.
SCHAAF 1984, p. 90-91, figs. 1-3b.
OZVOLDOVA & SYKORA 1984, p. 269, pl. 11, figs. 2-3, 6.
YAO 1984, pl. 3, fig. 14.
MATSUOKA & YAO 1985, pl. 2, fig. 10.
DE WEVER & MICONNET 1985, p. 390, pl. 2, fig. 6.
SANFILIPPO & RIEDEL 1985, p. 612, fig. 11.5.
MATSUOKA & YAO 1986, pl. 2, fig. 17.
DE WEVER et al. 1986, pl. 10, figs. 2-3.
AITA & OKADA 1986, p. 114, pl. 3, figs. 6-7.
AITA 1987, p. 66, pl. 12, fig. 3.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, fig. 8.
OZVOLDOVA 1988, pl. 4, fig. 1.
DOSTZALY 1988, pl. 1, fig. 2.
KITO et al. 1990, pl. 2, fig. 3.
YAO 1991, pl. 4, fig. 26.
WIDZ 1991, pl. 3, fig. 14.
BAUMGARTNER 1992, p. 324, pl. 10, fig. 9.
MATSUOKA 1992, pl. 2, fig. 6.
STEIGER 1992, p. 61, pl. 17, fig. 1.
JUD 1994, p. 94, pl. 17, figs. 2-3.
Nassellaria gen. et sp. indet.
NAKASEKO & NISHIMURA 1981, pl. 8, figs. 12a-b.
Podocapsa sp.
OZVOLDOVA 1987, pl. 2, fig. 9.

Original Definition.- The shell is, probably, of three segments, a hemispherical, small, proximal part composed of cephalis and thorax, although no segmental division has been observed, and a large globose abdomen with terminal tube. The cephalis lacks a horn, and the pores of the first two segments are small and irregular in shape and arrangement. The large globose abdomen has large fairly uniform pores in circular to subangular pore frames; frequently, they are scalloped and sometimes subdivided in their lower margins. Three conical porous wings, terminating in a spine, extend outwards. Pores on the wings are irregularly arranged, rounded, only slightly smaller than those of the abdomen. The terminal tube is very variable in length, bears pores similar to those of the abdomen, and on one specimen was observed to end in a short blunt spine.

Original Remarks.- Although this species is very rare in the material studied, it is described because of its distinctive easily recognizable form and because it is present only in 196-5, CC.

Remarks.- In *Podocapsa amphitreptera* FOREMAN two morphotypes were included for biostratigraphic data: a) a morphotype with a small, slightly inflated abdomen and 3 small, slender, short extensions and b) a morphotype with a large, inflated abdomen and rather thick, long extensions as illustrated by Foreman (1973b).

Etymology.- Greek *amphitres* = porous plus *pteron* (n.) = wing; *amphitrepterus, -a, -um* porous winged.

Measurements (in μm).-
Based on 10 specimens. Lenght 372; L. of wings 175; width of abdomen, 221; W. of wing near base, 73.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 9-18, mid-late Oxf. to latest Val.-earliest Haut.

PODOCAPSA (?) HEXAPTERA 4033

Podocapsa (?) *hexaptera* CONTI & MARCUCCI

Synonymy.-
Podocapsa (?) *hexaptera* CONTI & MARCUCCI
CONTI & MARCUCCI 1991, p. 803, pl. 3, figs. 12-14, 16-18.

Original Definition.- The shell shows two distinct parts: a hemispherical small proximal part without apparent segmental division but possibly including cephalis and thorax, and a large and flat abdomen with six porous wings, lacking a terminal tube. None of the available specimens show a horn on the proximal part referable to cephalis. The proximal part presents loosely scattered pores smaller than those of the abdomen and wings. The abdomen shows circular uniformly distributed pores. Six conical wings are seated along the equatorial zone of the abdomen: they show pores similar to those of abdomen.

Original Remarks.- This species differs from *P. amphitreptera* in the flat rather than globose shape of the distalmost segment, in having six equatorial wings and lacking a terminal tube. Its tentative assignment to genus *Podocapsa* is based on the presence of porous wings and of a broad distalmost segment.

Etymology.- Greek, *heksa* = six plus *pteron* = wing.

Measurements (in μm).-
Based on 5 specimens. Lenght wings, M=90-160, H=100. Width wings: M=30-50, H=35. Diameter abdomen: M=125-200, H=135.

Type Locality.- Ponte di Lagoscuro, Liguria, Italy.

UAZones.- 7-7, late Bath.-early Call.

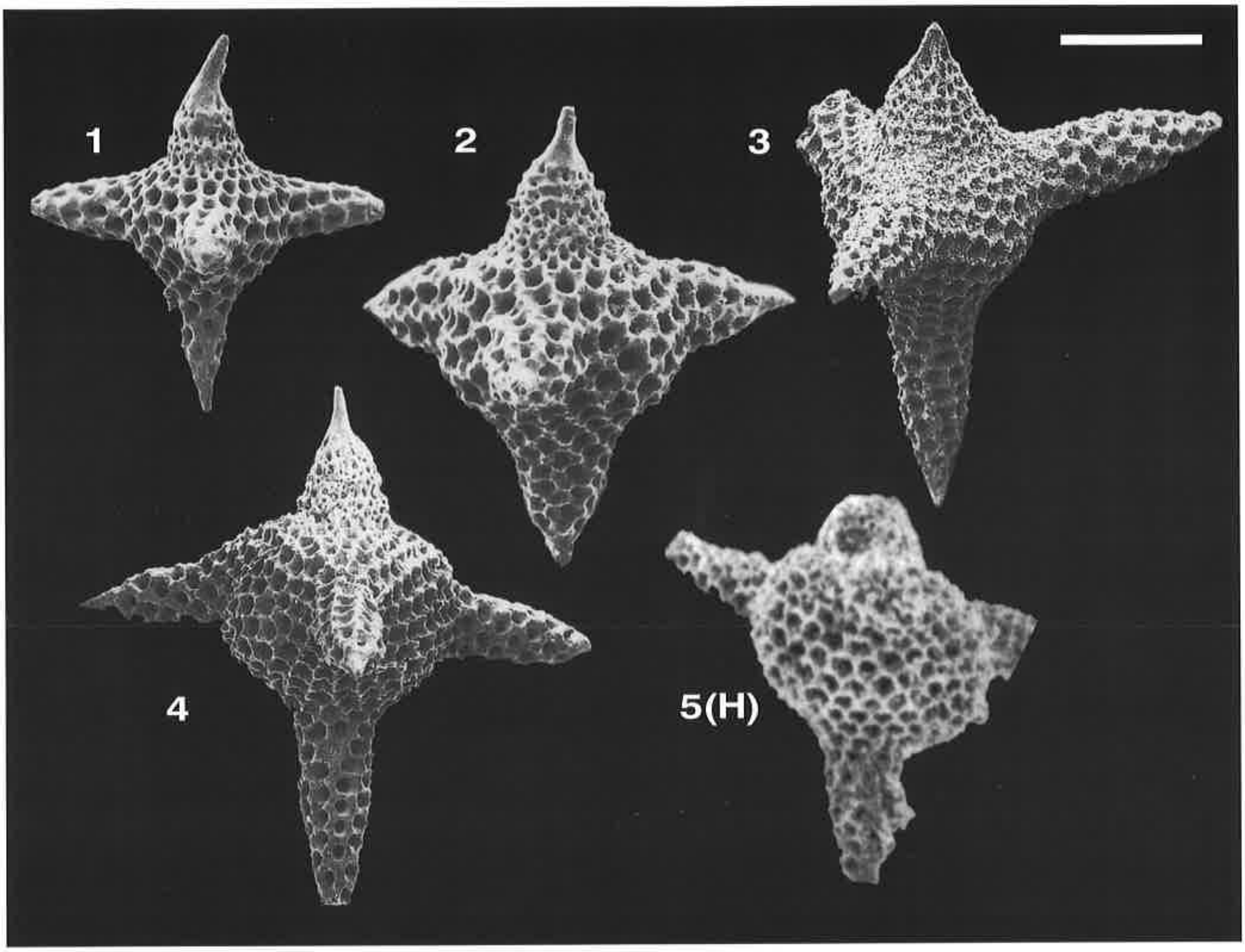


Plate 3171. *Podocapsa amphitreptera* FOREMAN. Magnification x150. **Fig. 1.** POB78/8160, POB986.52. **Fig. 2.** POB81/9009, 76.534A.106.1.29. **Fig. 3.** POB78/7610, POB986.51. **Fig. 4.** POB80/3004, POB1205. **Fig. 5(H).** FOREMAN 1973b, pl. 13, fig. 11.

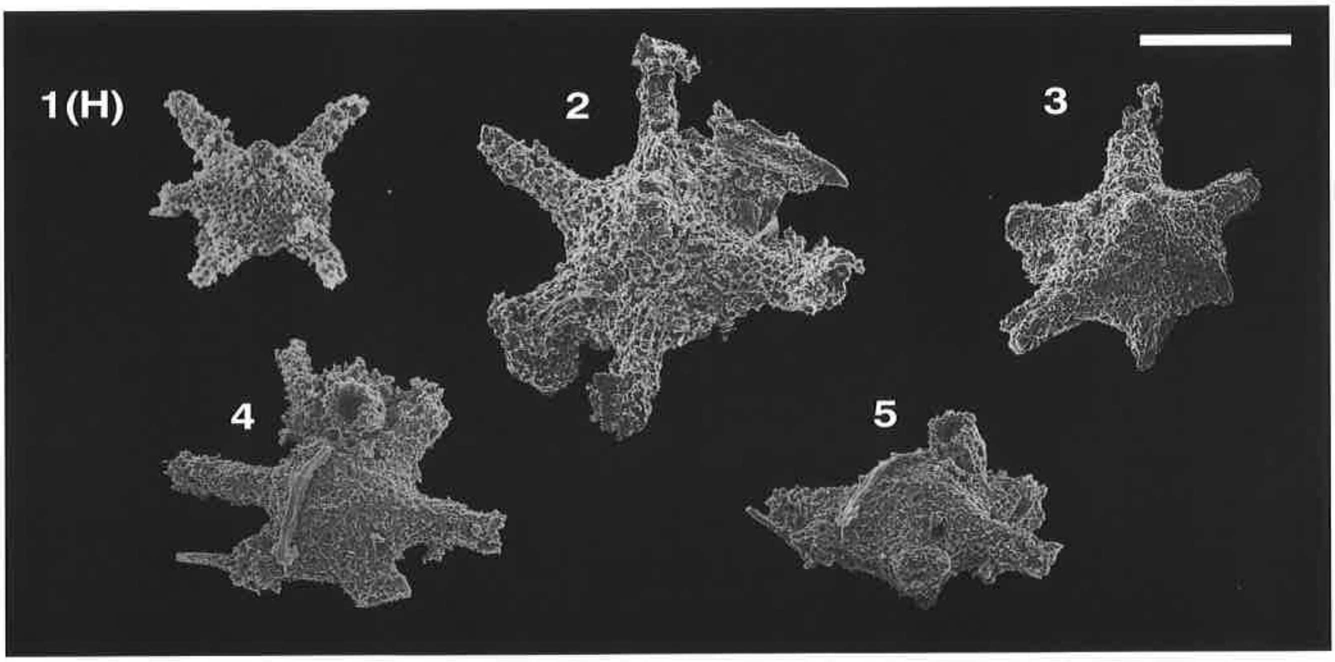


Plate 4033. *Podocapsa* (?) *hexaptera* CONTI & MARCUCCI. Magnification x150. **Fig. 1(H).** CONTI & MARCUCCI 1991, pl. 3, fig. 12. **Fig. 2.** MC50/89, GR6. **Fig. 3.** MC52/89, GR6. **Fig. 4 .** MC06/02, GR6. **Fig. 5.** MC07/02, GR6.

PODOCAPSA (?) IMPERIALIS 5397

Podocapsa (?) *imperialis* JUD

Synonymy.-
Podocapsa (?) *imperialis* JUD
JUD 1994, p. 95, pl. 17, figs. 4-5.

Original Definition.- Large spherical test with 4 equal, long, conical extensions of which 3 can be considered as lateral and one distal, all of them forming the corners of a tetrahedron. A shorter, slender, conical extension arises at what could be considered as apical part. One very short spine is disposed on surface of the spherical test in the center of each triangular area formed by two of the three lateral cones and the distal cone. Pores of spherical test large, circular, hexagonally, rarely pentagonally framed. Conical extensions with the same kind of pores arranged in longitudinal rows. Apical cone with a long spine and a few pores at its base.

Original Remarks.- The assignment of this species to *Podocapsa* and even to Nassellaria is questionable as so far no cephalic structure was observed in the so-called apical cone.

Etymology.- From the Latin *imperialis*, imperial.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Diameter spine only:	220	200	170	236
Length of apical horn:	40	57	40	73
Max. lenght extensions:	147	154	110	147
Max. width extensions:	60	53	41	67

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 18-20, latest Val.-earliest Haut. to late Haut.

polyacantha >> *PODOBURSA POLYACANTHA* 3174

polyhedra >> *OBESACAPSULA POLYHEDRA* 5565

portmanni >> *ANGULOBRACCHIA (?) PORTMANNI PORTMANNI* 3285

portmanni >> *ANGULOBRACCHIA (?) PORTMANNI S.L.* 6121

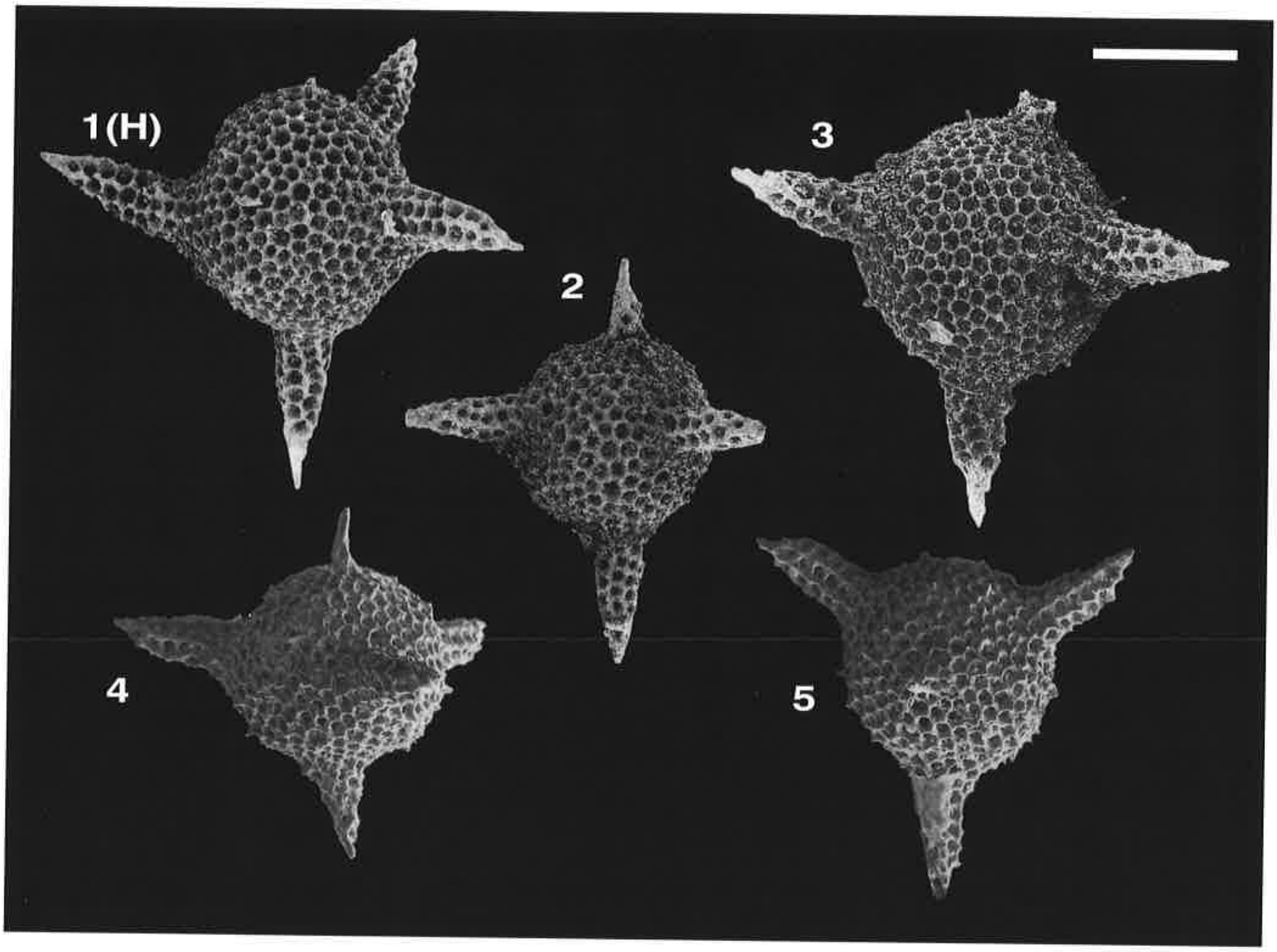


Plate 5397. *Podocapsa* (?) *imperialis* JUD. Magnification x150. **Fig. 1(H).** RJ535, Bo566.5. **Fig. 2.** RJ534, Bo566.5. **Fig. 3.** RJ519, Bo566.5. **Fig. 4.** DU760, MO46. **Fig. 5.** DU762, Mo46.

POULPUS 3680

Genus: *Poulpus* DE WEVER

Synonymy.-
Poulpus DE WEVER 1979
DE WEVER et al. 1979, p. 94
Parapoulpus KOZUR & MOSTLER 1979
KOZUR & MOSTLER 1979, p. 88.

Type Species.- *Poulpus piabyx* DE WEVER 1979.

Original Definition.- Spyroid-like radiolarians with hemispherical cephalis including three arches (AV and two Al), six normal collar pores, and three well-developed feet. Cephalis subspheric to hemispheric with a wide six-pored collar-opening and three divergent feet representing prolongation of actines D, Lr and Ll. Arches Al and AV always present, included in the cephalic wall and diverging from the same point of the apical spine. V attached to collar plane and not prolonged outside, very short or absent outside shell-wall. Cephalic wall more or less perforated. Feet three-bladed, with the odd grooves external, sometimes tubular on the proximal portion of feet.

Actualized Remarks.- (DE WEVER, 1982b) "*Poulpus* resembles closely *Saitoum* PESSAGNO 1977a by the presence of three elements: similar cephalis, three feet and initial cephalic skeleton with the same type of arches (see De Wever, 1981b) but differs from this genus by the position of the actine V. This actine is subhorizontal and attached to the collar border with *Poulpus* whereas with *Saitoum* it is obliquely upward directed and reaches the cephalic wall above the collar border. Moreover, with *Poulpus* the arches AV, All and Alr are usually visible on the surface of cephalis either as ribs or constrictions, whereas with *Saitoum* they are visible only at the inner face of cephalis.

Poulpus resembles also *Parapoulpus* KOZUR & MOSTLER 1979 (p. 88, type-species *P. oertlii* KOZUR & MOSTLER) from which it differs only by the absence of a postcephalic velum developed from the cephalic border. However this skeletal formation does not seem at all to be of generic order. Kozur & Mostler (1979, p. 86) distinguished *Poulpus* from *Saitoum* on the basis of the apical horn which would be developed with the latter and absent with the former. This character does not seem justified because if it is not developed with *P. piabyx*, *P. pansus* and *P. phasmatodes*, it exists under the shape of a button. The position of the cephalic actine V seems a more important distinctive character as the relationship between the initial skeletal elements are at the basis of nassellarian classification.

Eonapora KOZUR & MOSTLER (1979, p. 89) is defined by these authors as dicyrtid and for this reason assigned to the Ultranaporidae Pessagno. However it is known at present that the type-species of this genus (*Eonapora pulchra* KOZUR & MOSTLER, 1979, p. 90, pl. 19, fig. 1) is monocyrtid as the authors themselves recognized and close to *Poulpus* (Dumitrica et al., 1980). The type-species of *Eonapora* being assigned to another genus, the genus *Eonapora* loses its validity. The other species of the genus, *E. curvata* KOZUR & MOSTLER (1979, p. 90, pl. 13, fig. 5) should be assigned to another genus, most probably to *Hinedorcus* as the authors recognized (Dumitrica et al., 1980, p. 21). In fact this species is so briefly described and too poorly illustrated that it is almost impossible to recognize.

As mentioned above the distinction between *Poulpus* and *Parapoulpus* does not seem to be of generic order. It is, for example, difficult -if not arbitrary- to choose between the two genera when the distal velum is thin or very weakly developed or not yet developed. The two genera seem therefore synonymous".

Included Taxa.-
3028 *Poulpus* sp. aff. *P. oculatus* DE WEVER

POULPUS OCULATUS AFF. 3028

Poulpus sp. aff. *P. oculatus* DE WEVER

Synonymy.-
Poulpus oculatus DE WEVER
aff. DE WEVER 1982a, p. 191, pl. 1, figs. 6-10.
aff. DE WEVER 1982b, p. 325, pl. 49, figs. 4-8.
Saitoum pagei PESSAGNO
DE WEVER & CABY, 1981, pl. II, 2-H.
Poulpus sp.
TAKEMURA 1986, p. 41, pl. 1, fig. 11.

Remarks.- We herein differentiate *P.* aff. *oculatus* from *P. oculatus* by the smaller pores, specially at base of feet, and by the smaller apical horn.

UAZones.- 3-7, early-mid Baj. to late Bath.-early Call.

praecrassa >> *PALINANDROMEDA PRAECRASSA* 3007

praeguadalupensis >> *MIRIFUSUS F. PRAEGUADALUPENSIS* 2026

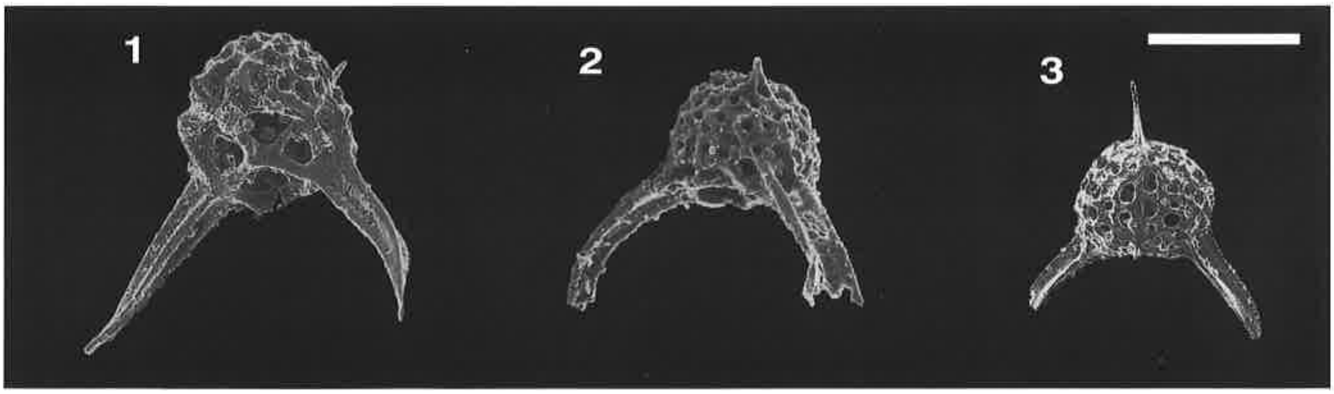


Plate 3028. *Poulpus* sp. aff. *P. oculatus* DE WEVER. Magnification x300. **Fig. 1.** POB81/3032, IN7. **Fig. 2.** DE WEVER & CABY 1981, pl. 2, fig. H. **Fig. 3.** POB81/2709, 534.124.1.52.

PROTUNUMA 3682

Genus: *Protunuma* ICHIKAWA & YAO

Synonymy.-
Protunuma ICHIKAWA & YAO
ICHIKAWA & YAO 1976, p. 114.

Type Species.- *Protunuma fusiformis* ICHIKAWA & YAO 1976.

Original Definition.- Spindle shaped, multisegmented form with inversely subconical last segment which has a small aperture at its base. No indentation at surface junction of segments. Numerous small circular pores on surface aligned in longitudinal rows and in diagonal aspect. Numerous longitudinal plicae on surface generally running continuously through segments. Apical horn not present or, if present, insignificant.

Original Remarks.- This genus differs from *Unuma* in the last segment, which has no basal appendage with large pores but has a constricted, small, terminal aperture. At present, no spiny form like *Unuma* (*Spinunuma*) has been observed in the genus *Protunuma*.

Remarks.- *Protunuma* differs from *Unuma* by lacking a basal appendage with large pores.

Included Taxa.-
3292 *Protunuma japonicus* MATSUOKA & YAO
3290 *Protunuma* (?) *ochiensis* MATSUOKA
4034 *Protunuma turbo* MATSUOKA

PROTUNUMA JAPONICUS 3292

Protunuma japonicus MATSUOKA & YAO

Synonymy.-
Protunuma fusiformis ICHIKAWA & YAO
MIZUTANI 1981, p.181, pl. 63, figs. 1, 8; pl. 64, fig. 3.
ADACHI 1982, pl. 3, figs. 9-10.
OZVOLDOVA & SYKORA 1984, p. 270, pl. 8, figs. 6-7.
? NISHIZONO & MURATA 1983, pl. 4, fig. 15.
STEIGER 1992, p. 90, pl. 27, figs. 2-3.
Protunuma (?) sp.
IMOTO et al. 1982, pl. 3, fig. 10.
Protunuma sp. D.
YAO et al. 1982, pl. 4, fig. 24.
YAO 1984, pl. 3, figs. 12, 17.
Protunuma costata (HEITZER)
BAUMGARTNER 1984, p. 781, pl. 7, fig. 15.
Protunuma japonicus MATSUOKA & YAO
MATSUOKA & YAO 1985, p. 130, pl. 1, figs. 11-15; pl. 3, figs. 6-9.
MATSUOKA 1986a, pl. 2, fig. 7.
MATSUOKA & YAO 1986, pl. 3, fig. 22.
? WAKITA 1988, pl. 5, fig. 13, pl. 6, fig. 19.
KITO 1989, p.213, pl. 24, fig. 15.
YAO 1991, pl. 4, fig. 24.
KIESSLING 1992, pl. 1, fig. 10.
MATSUOKA 1992, pl. 3, fig. 5.
Protunuma sp.
WIDZ 1991, pl. 3, figs. 15-16.

Original Definition.- Spindle-shaped shell with three stable internal septa and two unstable internal septa between which the former is put. According to the number of unstable septa, segments varying in number from 5 to 7. External segmental division indistinct except for collar stricture. Cephalis spherical internally without pores. Six to 8 longitudinal plicae visible in lateral view. Most of plicae running from cephalic surface to distal end. Two to 4 rows of pores present between neighbouring two longitudinal plicae. Pores very small, circular, uniform in size, arranged diagonally. Aperture small, circular, constricted.

Original Remarks.- *Protunuma japonicus* n.sp. is similar to *Protunuma fusiformis* ICHIKAWA & YAO and *Protunuma turbo* MATSUOKA in outer shape, but differs from them in certain points. *P. japonicus* consists of 5 to 7 segments, while *P. fusiformis* is composed of 5 segments and *P. turbo* is composed of 3 segments. *P. japonicus* with 5 segments, which occurs rarely, is distinguished from *P. fusiformis* in size of the second segment, namely that of the former is larger than that of the latter. External segmental division is indistinct in *P. japonicus* except for collar stricture, while lumbar stricture is recognizable in *P. fusiformis* and *P. turbo* because abdomen expands more strongly than thorax in the latter two species.

The known ranges of these species are different, that is, the occurrence of *P. japonicus* is restricted in the *Gongylothorax sakawaensis-Stichocapsa naradaniensis*, the *Tricolocapsa* sp. O and the *Pseudodictyomitra primitiva-P.* sp A Assemblage-zones (Upper Jurassic) whereas *P. fusiformis* and *P. turbo* are found in the *Unuma echinatus* and/or *Lithocampe* (?) *nudata* Assemblage-zones (Middle Jurassic).

Remarks.- In the present catalogue the species of *Protunuma*, established by Matsuoka (1982a, 1983a) and Matsuoka & Yao (1985) are presented. In the previous zonation (Baumgartner, 1984) they were joined together under the name *Protunuma costata*, the illustrated form corresponding to *P. japonicus* MATSUOKA & YAO. The name *P. costata* is now omitted.

Etymology.- Latin adj. *japonicus*, meaning Japanese.

Measurements (in μm).-
Based on 21 specimens. Height overall, 150-217 (av. 176); width of shell, 75-130 (av. 106); diameter of cephalis, 17-22 (av. 20).

Type Locality.- Yura Fm., Wakayama Pref., SW Japan.

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

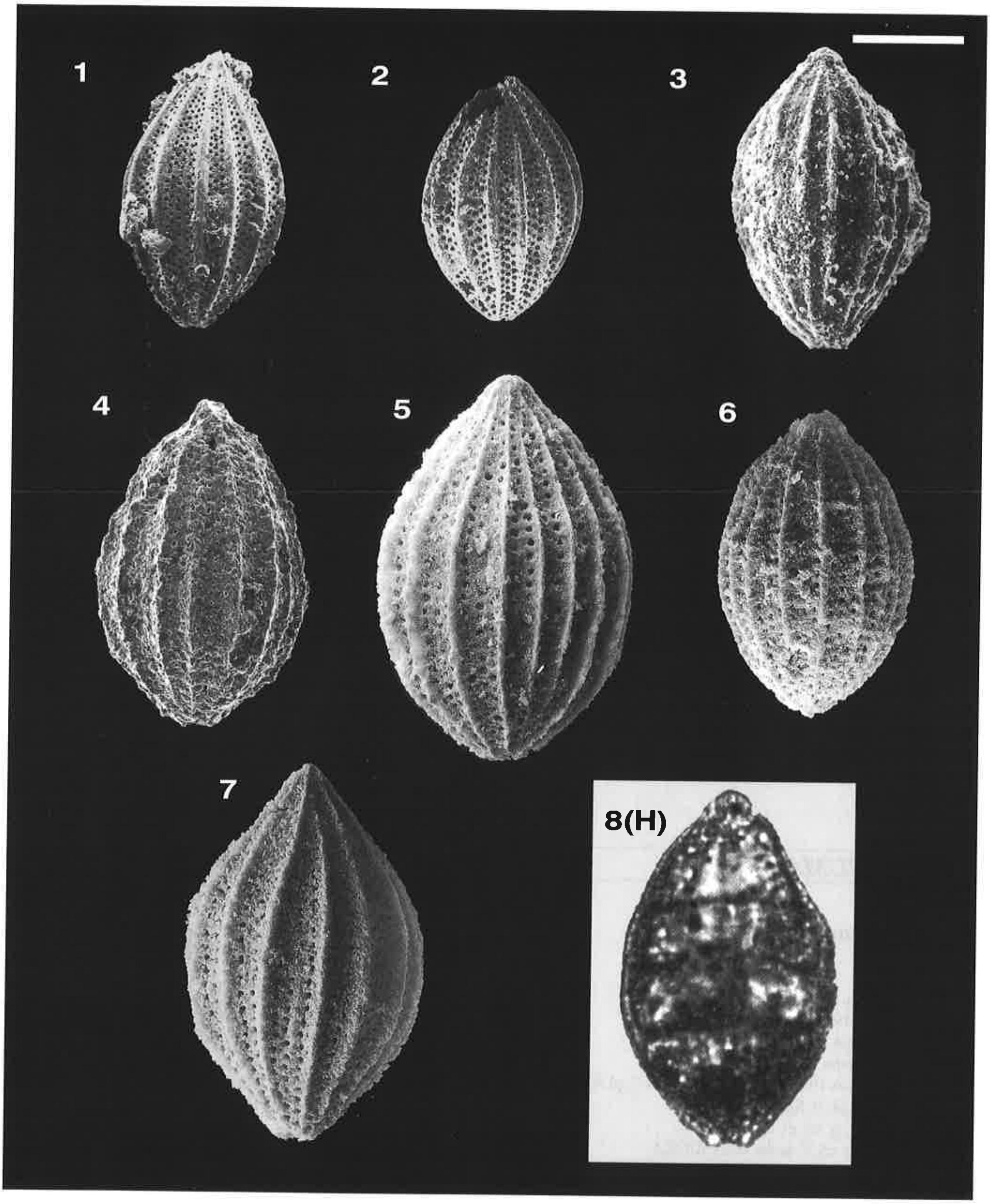


Plate 3292. ***Protunuma japonicus*** **MATSUOKA & YAO.** Magnification x400, except Figs. 1-2 x200. **Fig. 1.** POB81/9037, 76.534A.106.1.29. **Fig. 2.** POB81/9038, 76.534A.106.1.29. **Fig. 3.** GO892532, PK9. **Fig. 4.** GO891336, BM6. **Fig. 5.** DU1713, C1620. **Fig. 6.** DU2033, R102. **Fig. 7.** DU2814, DR77. **Fig. 8(H).** MATSUOKA & YAO 1985, pl. 3, fig. 6.

PROTUNUMA (?) OCHIENSIS 3290

Protunuma (?) *ochiensis* MATSUOKA

Synonymy.-
Protunuma sp. B
YAO et al. 1982, pl. 4, fig. 6.
MATSUOKA 1982a, pl. 2, figs. 6, 7, 18.
Protunuma sp.
SATO et al. 1982, pl. 4, fig. 6.
Protunuma sp. A
ISHIDA 1983, pl. 8, fig. 3.
Protunuma (?) *ochiensis* MATSUOKA
MATSUOKA 1983a, p. 26, pl. 4, figs. 8-11; pl. 9, figs. 3-7.
MATSUOKA 1986a, pl. 1, figs. 13-14.
MATSUOKA & YAO 1986, pl. 2, fig. 2; pl. 3, fig. 16.
Protunuma (?) cf. *ochiensis* MATSUOKA
YAMAMOTO et al. 1985, pl. 6, fig. 9.
Protunuma ochiensis MATSUOKA
ISHIDA 1985, pl. 2, fig. 1.
AITA 1987, p. 66, pl. 6, figs. 3a-b; pl. 11, fig. 3.

Original Definition.- Shell of four segments, spindle-shaped, without aperture. Cephalis spherical internally, bearing somewhat pointed proximal end externally. Some specimens possessing a small apical horn. Thorax truncate conical. Abdomen large, barrel-shaped with inverse subconical last segment. Longitudinal plicae running continuously through segments; some of them extending from proximal end to distal end, others edging out or converging to adjacent plicae proximally and distally. Nine to 13 longitudinal plicae visible in lateral view. One row to 3 rows of pores present between neighbouring two longitudinal plicae. Pores relatively large, circular, arranged diagonally and increasing in size distally.

Original Remarks.- This species is doubtfully assigned to *Protunuma* by reason of lacking aperture. This species is distinguished from *Protunuma fusiformis* ICHIKAWA & YAO (1976, p. 116, pl. 2, figs. 1-4) and *Protunuma turbo* n.sp. by lacking aperture, by consisting of four segments and by possessing pores increasing in size distally.

Etymology.- This species is named for its type locality, Ochi Town, Kochi Prefecture, southwest Japan.

Measurements (in μm).-
Based on 18 specimens. Total height (TH), 118-183 (mean, 148); maximum width of shell (MW), 85-126 (mean, 105); diameter of cephalis (DC), 12-16 (mean, 14); height of thorax (HT), 22-30 (mean, 28); of abdomen (HA), 48-95 (mean, 76); of fourth segment (HF), 33-55 (mean, 44).

Type Locality.- Sample S-17, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 5-14, latest Baj.-early Bath. to early-early late Berr.

PROTUNUMA TURBO 4034

Protunuma turbo MATSUOKA

Synonymy.-
Protunuma sp. J
YAO et al. 1982, pl. 4, fig. 5.
MATSUOKA 1982a, pl. 2, figs. 5a-b.
Protunuma turbo MATSUOKA
MATSUOKA 1983a, p. 24, pl. 4, figs. 4-7; pl. 8, figs. 16-18; pl. 9, figs. 1-2.
AITA 1987, p. 66, pl. 6, figs. 4a-5b.
Protunuma sp. cf. *P. turbo* MATSUOKA
MATSUOKA 1990, pl. 1, fig. 4.

Original Definition.- Shell of three segments, spindle-shaped. Cephalis spherical internally, rounded externally, without pores. A very small apical horn possibly present, but usually absent. Thorax truncate conical, perforate. Junction between thorax and abdomen represented externally by a narrow zone of imperforate or sporadically pored wall. Abdomen subspherical with longitudinal plicae, numerous pores and a small, constricted aperture. Seven to nine longitudinal plicae visible in lateral view, increasing in number through insertion and extending to thoracic and often cephalic surface. One row to four rows of pores present between neighboring two longitudinal plicae. Pores small, circular, uniform in size, arranged diagonally.

Original Remarks.- This species differs from *Protunuma fusiformis* ICHIKAWA & YAO 1976 (p. 116, pl. 2, figs. 1-4) by consisting of three segments and from *Tricolocapsa plicarum* YAO by possessing more than two rows of pores between two neighboring longitudinal plicae and by lacking basal appendage.

Etymology.- This specific name is derived from Latin *turbo* = spin.

Measurements (in μm).-
Based on 19 specimens. Total height (TH), 102-130 (mean 118); maximum width of shell (MW), 71-95 (mean 84); diameter of cephalis (DC), 13-20 (mean 16); height of thorax (HT), 20-28 (mean 23); of abdomen (HA), 78-96 (mean 89); diameter of aperture (DA), 3-7 (mean 4).

Type Locality.- Sample S-02, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 4-7, late Baj. to late Bath.-early Call.

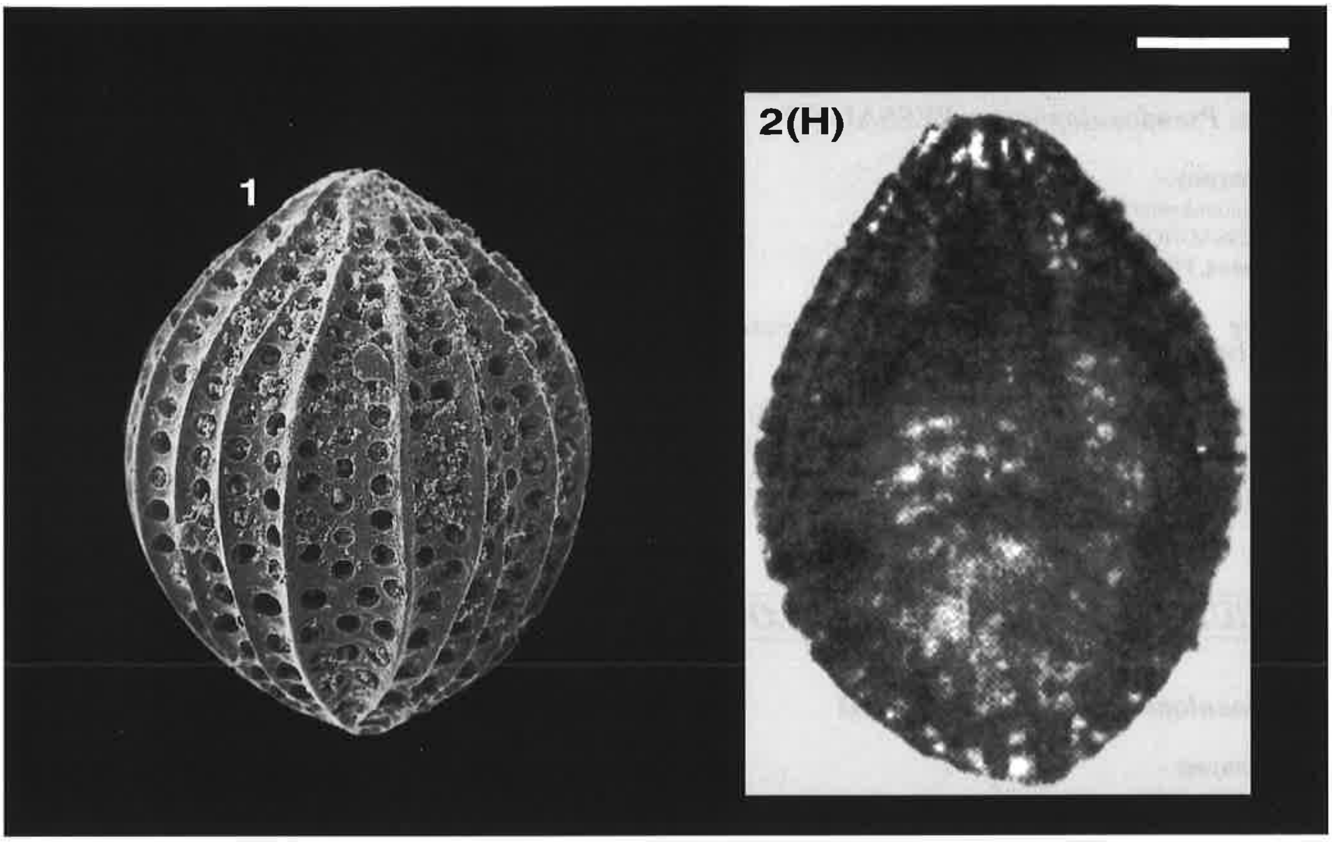


Plate 3290. *Protunuma* (?) *ochiensis* MATSUOKA. Magnification x600. **Fig. 1.** POB81/1448, 534A.125.2.36. **Fig. 2(H).** MATSUOKA 1983a, pl. 9, fig. 6a.

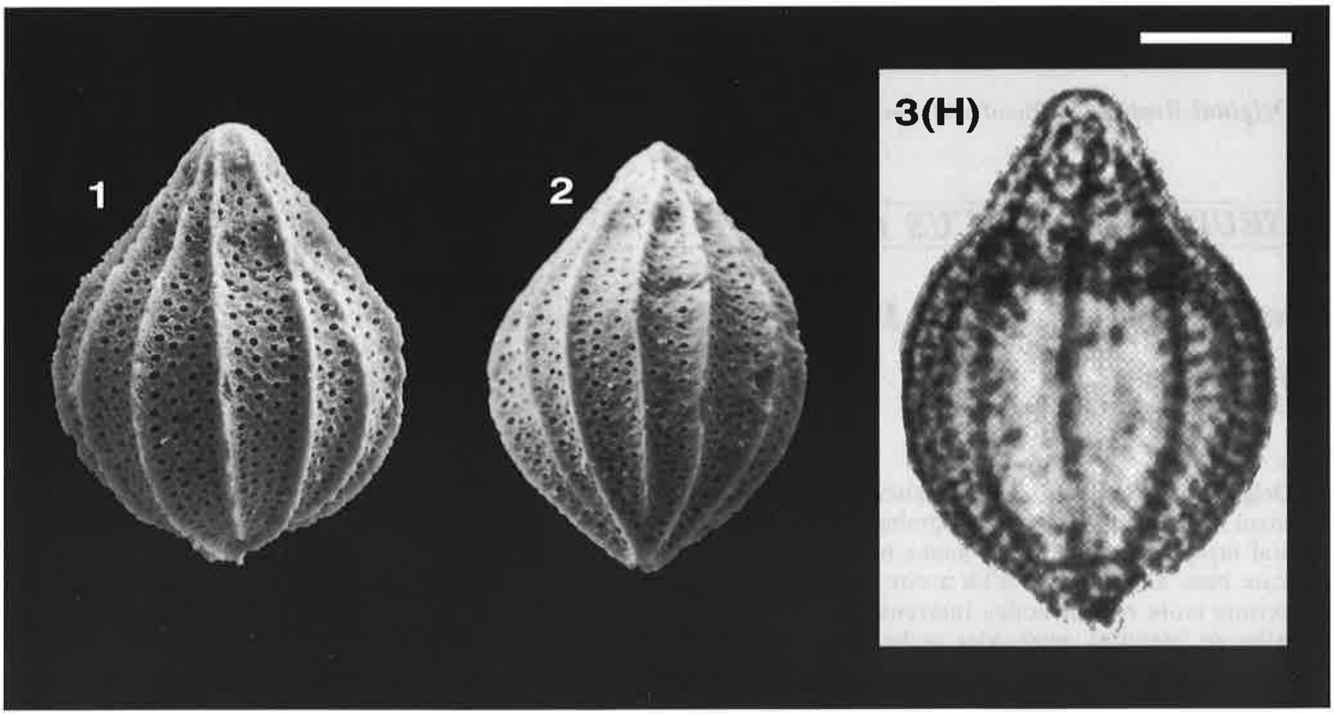


Plate 4034. *Protunuma turbo* MATSUOKA. Magnification x600. **Fig. 1.** MA1127, OCUMR2675, S-02. **Fig. 2.** MA1111, OCUMR2673, S-02. **Fig. 3(H).** MATSUOKA 1983a, pl. 8, fig. 17a.

PSEUDOAULOPHACUS 6026

Genus: *Pseudoaulophacus* PESSAGNO

Synonymy.-
Pseudoaulophacus PESSAGNO
PESSAGNO 1963, p. 200.
emend, PESSAGNO 1972, p. 303.

Type Species.- *Pseudoaulophacus floresensis* PESSAGNO 1972.

Actualized Definition.- (PESSAGNO, 1972) Test elliptical, circular, or subtriangular in outline with centrally placed tholi. Meshwork comprised of larger, more massive pore frames than those of remainder of test.

Actualized Remarks.- (PESSAGNO, 1972) *Pseudoaulophacus* differs from *Alievium* n.gen. by possessing tholi. Furthermore, whereas the meshwork of *Alievium* possesses pore frames or relatively uniform size, *Pseudoaulophacus* possesses pore frames of two different sizes: large, massive pore frames restricted to the tholi and much smaller pore frames comprising the remainder of the test. *Pseudoaulophacus* appears to have evolved from *Alievium* during middle Turonian times. Transitional forms with poorly developed tholi are common in this age.

Included Taxa.-
5334 *Pseudoaulophacus* (?) *florealis* JUD
5332 *Pseudoaulophacus* (?) *pauliani* JUD

PSEUDOAULOPHACUS (?) FLOREALIS 5334

Pseudoaulophacus (?) *florealis* JUD

Synonymy.-
gen. et sp. indet.
SCHAAF 1981, pl. 10, figs. 8a-b.
Godia (?) sp. D
THUROW 1988, p. 401, pl. 9, fig. 15.
Pseudoaulophacus (?) *florealis* JUD
JUD 1994, p. 95, pl. 17, figs. 6-8.

Original Definition.- Circular, lenticular test with rim of delicate latticed tissue. Central part of test with a circle of 8-10 large nodes around one single robust node in centre. Test consisting of several layers, each one having very small, short nodes, which are interconnected by delicate bars, forming triangular or hexagonal patterns. Periphery of test with a delicate latticed tissue in the equatorial plane or with numerous bladed spines.

Original Remarks.- *Pseudoaulophacus* (?) *florealis* n.sp. differs from *P.* (?) *pauliani* n.sp. by possessing a circle of nodes around a central node and commonly a delicate peripheral latticed tissue. For biostratigraphic data we included also in this species specimens similar to the holotype but having developed in the central part of test thick nodes connected by bars forming irregular, triangular or hexagonal meshwork as in *P.* (?) *pauliani*.

Etymology.- From the Latin *florealis* = floral.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Diameter of test:	230	222	210	256
Diameter circle nodes:	93	95	93	100

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 16-22, early Val. to late Barr.-early Apt.

PSEUDOAULOPHACUS (?) PAULIANI 5332

Pseudoaulophacus (?) *pauliani* JUD

Synonymy.-
Pseudoaulophacus (?) *pauliani* JUD
JUD 1994, p. 95, pl. 17, fig. 9.

Original Definition.- Circular, lenticular test with rim of broad bladed spines. Test-wall probably consisting of several layers with very small nodes interconnected by delicate bars. Central area with a circular elevation of numerous more robust nodes interconnected by bars, forming an irregular, triangular or hexagonal pattern. Periphery of test armed with 7-8 broad, flat, bladed spines connected at their basal portion by a wide, poreless membrane.

Original Remarks.- *P.* (?) *pauliani* n.sp. differs from *Pseudoaulophacus* (?) *florealis* n.sp. as herein ilustrated by lacking the peripheral latticed plate and the central cercle of nodes, and by possessing broad, flat, bladed spines.

Etymology.- This species is named for Paulian Dumitrica (Institute of Geology, Bucharest, Romania).

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Diameter of test:	300	260	200	300
Maximum length of spine:	125	99	80	125

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-21, latest Tith. to early Barr.

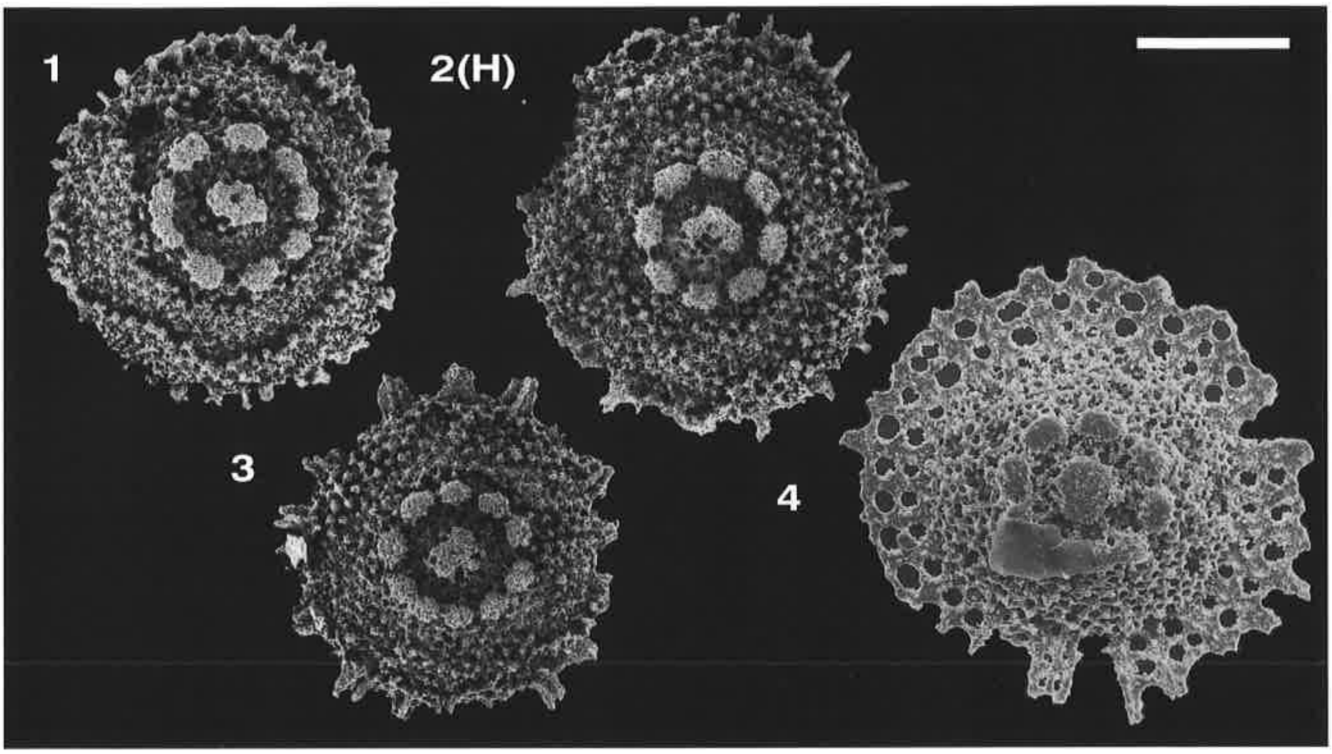


Plate 5334. *Pseudoaulophacus* (?) *florealis* JUD. Magnification x200. **Fig. 1.** RJ429, Bo566.5. **Fig. 2(H).** RJ434, Bo566.5. **Fig. 3.** RJ438, Bo566.5. **Fig. 4.** DU3522, Mo46a'.

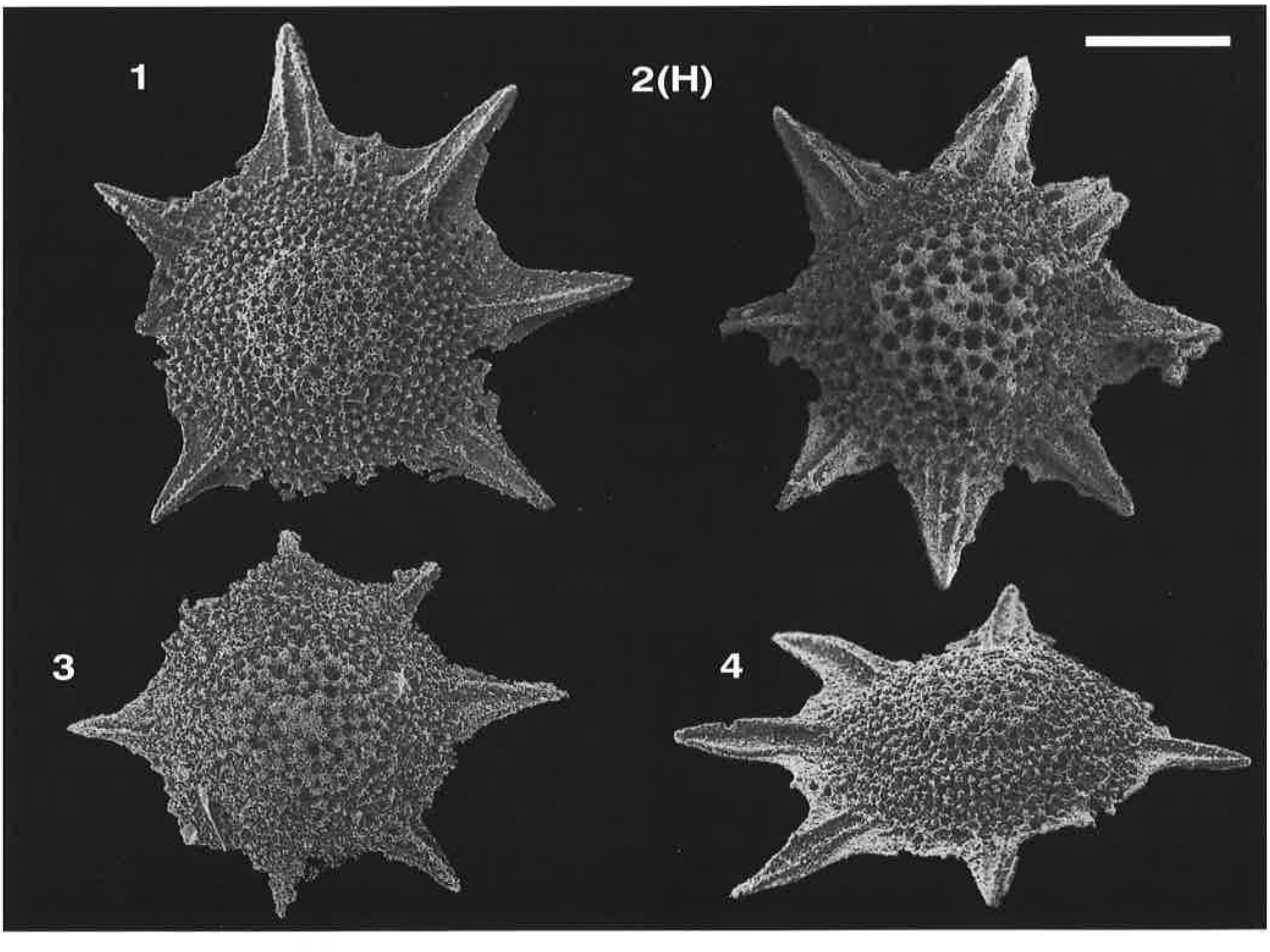


Plate 5332. *Pseudoaulophacus* (?) *pauliani* JUD. Magnification x150. **Fig. 1.** POB79/5245, POB1205.3. **Fig. 2(H).** RJ218, Br28.85. **Fig. 3.** RJ182, Br28.85. **Fig. 4.** POB 79/5026, POB 1205.3.

PSEUDOCROLANIUM 3806

Genus: *Pseudocrolanium* JUD

Synonymy.-
Pseudocrolanium JUD
JUD 1994, p. 96.

Type Species.- *Pseudocrolanium fluegeli* JUD 1994.

Original Definition.- Test conical, multicyrtid. Apical part conical, comprising cephalis, thorax and abdomen, generally poreless, separated from one another by a single row of pores, without constriction between segments. Post-abdominal segments, except the last one, separated from one another by poreless, slightly nodular ridges and formed of a concave, slightly costate and poreless band. Boundaries between this band and the adjoining ridges marked by a row of pores. Costae longitudinal or diagonal, continuous or discontinuous along central part of test. Last segment longer than the previous ones, with several transverse rows of pores and three regularly disposed, radially protruding spines.

Original Remarks.- By the presence of the 3 spines this genus resembles *Crolanium* PESSAGNO, from which it differs by the external structure of the segments of the middle part of test. This structure reminds very well of the structure of the genus *Wrangellium* PESSAGNO & WHALEN, to which it could be closely related.

Etymology.- Greek *pseudo*, false and *Crolanium*.

Included Taxa.-
5521 *Pseudocrolanium cristatum* JUD
5522 *Pseudocrolanium fluegeli* JUD

PSEUDOCROLANIUM CRISTATUM 5521

Pseudocrolanium cristatum JUD

Synonymy.-
Pseudocrolanium cristatum JUD
JUD 1994, p. 96, pl. 17, fig. 10.

Original Definition.- Shell conical, consisting of 3 main parts, the last one terminating with 3 cristate distal apophyses. Proximal and middle parts similar to those of the type species in shape and structure. Middle part formed of 4-6 segments. Distal part triangular in cross-section, perforated by pores disposed in transverse rows and bearing 3 stout, short, cristate tubes. These tubes seem to be closed distally and bear a coarse network of large meshes at the base of crests. Terminal segment probably closed but difficult to say because of poor preservation of this part with all specimens.

Original Remarks.- *Pseudocrolanium cristatum* n.sp. differs from *Pseudocrolanium fluegeli* n.sp. by having distal cristate tubes instead of bladed spines.

Etymology.- From the Latin *cristatus*, having a crest.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Maximum height:	240	261	240	282
Maximum width:	120	128	120	140

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

PSEUDOCROLANIUM FLUEGELI 5522

Pseudocrolanium fluegeli JUD

Synonymy.-
Pseudocrolanium fluegeli JUD
JUD 1994, p. 96, pl. 17, figs. 11-12.

Original Definition.- Conical test of 9-10 segments. Proximal part conical, smooth, consisting of cephalis, thorax and abdomen and probably the first post-abdominal segment, separated from one another by a single row of pores. Middle part of 5 segments with slightly nodose high circumferential ridges corresponding to internal partition. Segments are depressed, concave in outline, formed of a poreless band which is connected at surface to upper and lower ridges by a row of 12-16 pores per half the diameter. Surface of poreless bands with slight costae, connecting diagonally or longitudinally the nodes of the adjoining ridges. Distal part triangular in cross-section, completely perforated by pores disposed in transverse rows in the upper part and irregular in the lower part, which is closed and bears a short spine. The three edges of the last segment bear three obliquely directed bladed spines.

Etymology.- This species is dedicated to Prof. Dr. Erik Fluegel, Institute of Paleontology, University of Erlangen.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
H. test to spine-base:	195	237	189	300
Width at spine base:	111	123	103	141
Length of spines:	51	61	39	83

Type Locality.- Fiume Bosso, Umbria Marche, Italy.

UAZones.- 20-21, late Haut. to early Barr.

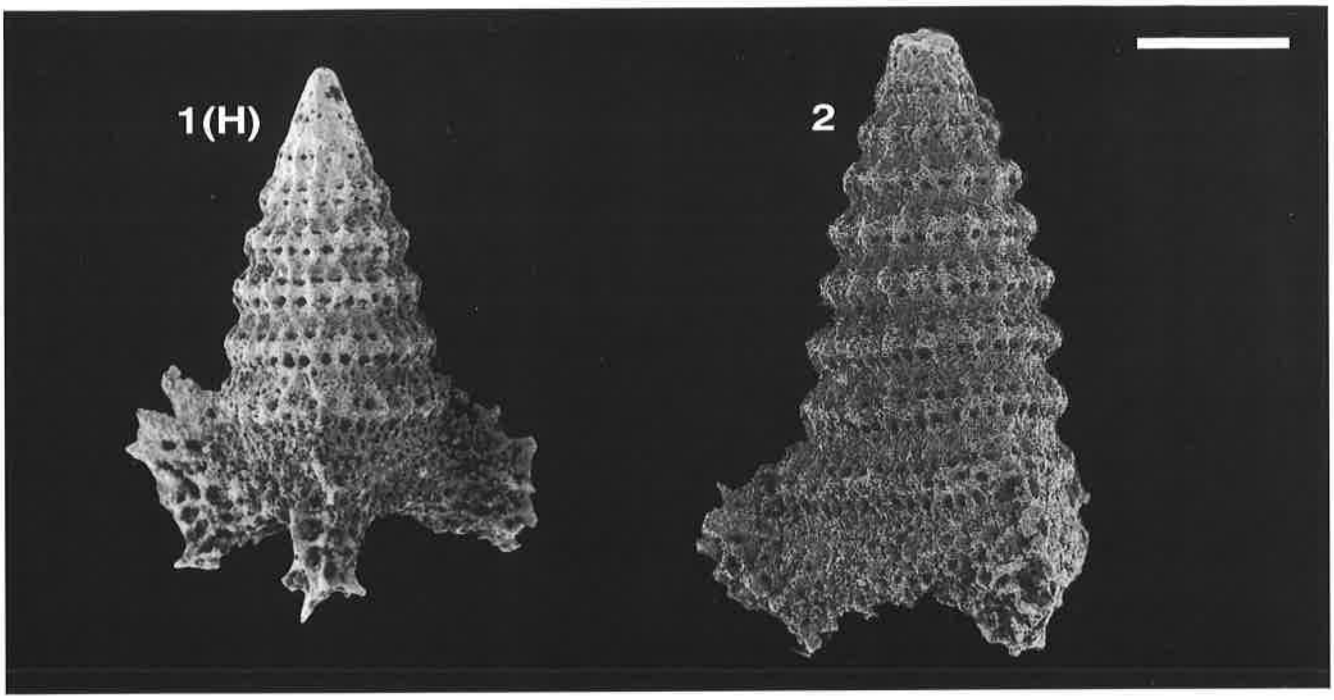


Plate 5521. ***Pseudocrolanium cristatum*** **JUD.** Magnification x250. **Fig. 1(H).** RJ119, Bo566.5. **Fig. 2.** RJ125, Bo566.5.

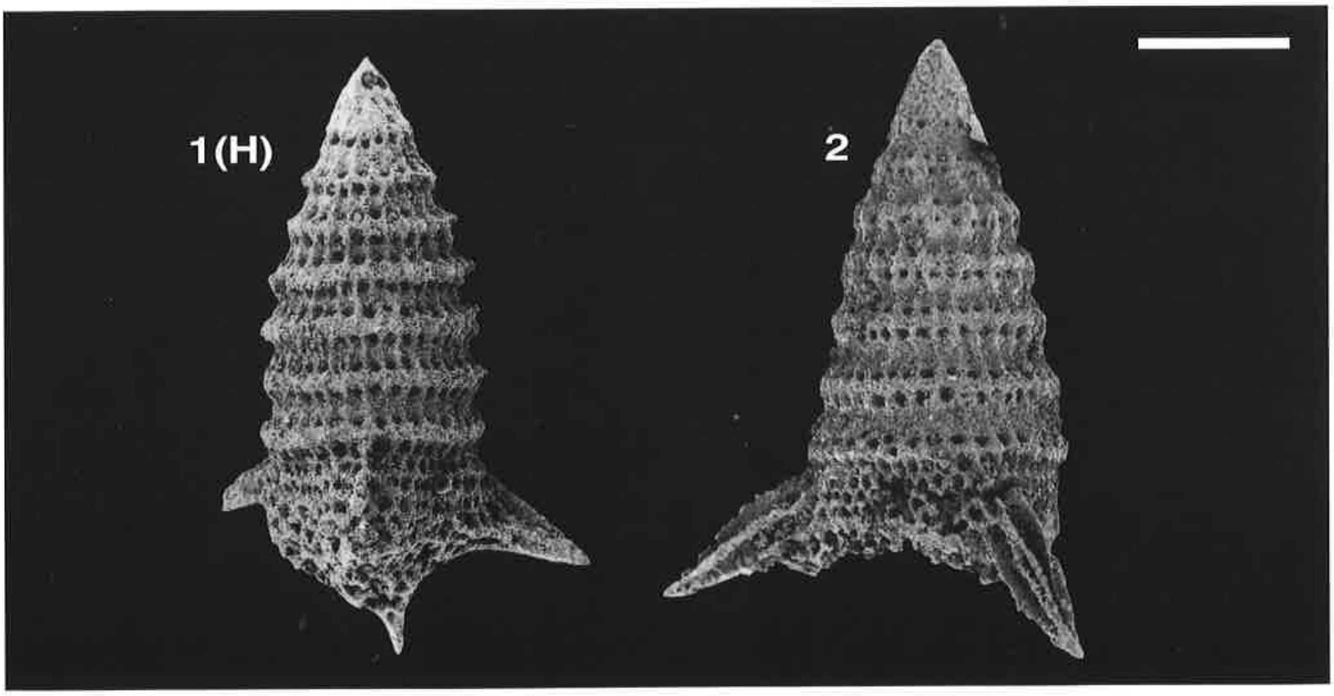


Plate 5522. ***Pseudocrolanium fluegeli*** **JUD.** Magnification x250. **Fig. 1(H).** RJ118, Bo566.5. **Fig. 2.** RJ117, Bo566.5.

PSEUDOCRUCELLA 3683

Genus: *Pseudocrucella* BAUMGARTNER

Synonymy.-
Pseudocrucella BAUMGARTNER
BAUMGARTNER 1980, p. 291.
DE WEVER 1982b, p. 239.
BLOME 1984a, p. 351.
KITO 1989, p. 124.

Type Species.- *Crucella sanfilippoae* PESSAGNO 1977a.

Original Definition.- Test as with subfamily composed of 4 rays at right angles, usually with tapering tips and long triradiate central spines. Cortical shell composed of 2 lateral and 1 to 3, sometimes merging, median external beams on each side connected by transverse bars with more or less developed nodes at intersections. Pores circular, rectangular or parallelogram-shaped in 2 or more partly continuous rows. Central area with irregular meshwork, nodose with smaller pores, or with a depression exposing the medullary shell. Lateral sides exposing the medullary rays with 2 or 3 paired or alternating rows of circular or rectangular pores. Cross section of rays rectangular or square.

The discoidal medullary shell is on one side axially attached to the cortical shell. On the other side it is surrounded by cortical space. Primary canals are large, with a vertical axis of symmetry, surrounded by small, less regularly distributed canals which connect with the cortical space (see text-fig. 4K).

Original Remarks.- *Pseudocrucella* n.gen. differs from other four-rayed hagiastrids by its inner structure, by a rectangular cross section of rays and less regularly arranged pore rows on top and bottom sides. The described internal structure has been reconfirmed in topotypes of *P. sanfilippoae* from Point Sal (NSF 907, Pessagno collection) (pl. 8, figs. 23-24).

Remarks.- Species are distinguished by the shape of the rays and the size of the rays in relation to the overall test size. The characteristics of pores and pore frames also vary between species.

Included Taxa.-
3129 *Pseudocrucella adriani* BAUMGARTNER
3947 *Pseudocrucella* (?) *elisabethae* (RÜST)
3126 *Pseudocrucella sanfilippoae* (PESSAGNO)
3127 *Pseudocrucella* sp. B

PSEUDOCRUCELLA ADRIANI 3129

Pseudocrucella adriani BAUMGARTNER

Synonymy.-
Pseudocrucella adriani BAUMGARTNER
BAUMGARTNER 1980, p. 291, pl. 8, figs. 4, 8, 12, 15-16.
KOCHER 1981, p. 88, pl. 15, fig. 23.
BAUMGARTNER 1984, p. 781, pl. 7, fig. 16.
DE WEVER et al. 1986, pl. 8, fig. 3.
OZVOLDOVA 1988, pl. 3, fig. 6.

Original Definition.- Test as with genus composed of long, slender rays with 4 or 5 external beams on top and bottom sides, connected by irregularly distributed oblique bars forming 3 or 4 rows of lengthened pores. Central spines sturdy, with 6 grooves proximally and 3 grooves distally. Rays rectangular in cross section, sides slightly concave, with 2 rows of large pores and 1 irregular row of small pores. External beams and nodes may be only weakly developed.

Original Remarks.- This species differs from *P. sanfilippoae* by having more slender rays with parallel lateral sides and by having irregularly distributed bars instead of bars forming square pore frames.

Etymology.- Named in honor of Adrianos Ntantis, Drepanon, Greece, for his hospitality during my field work.

Measurements (in μm).-
Based on 10 specimens.

	HT	av	min.	max.
Length of rays:	146	150	117	170
Width of rays:	45	43	39	54
Length of spines:	71	68	50	126

Type Locality.- 3 km east of Angelokastron, Province Korinthos, Greece.

UAZones.- 4-10, late Baj. to late Oxf.-early Kimm.

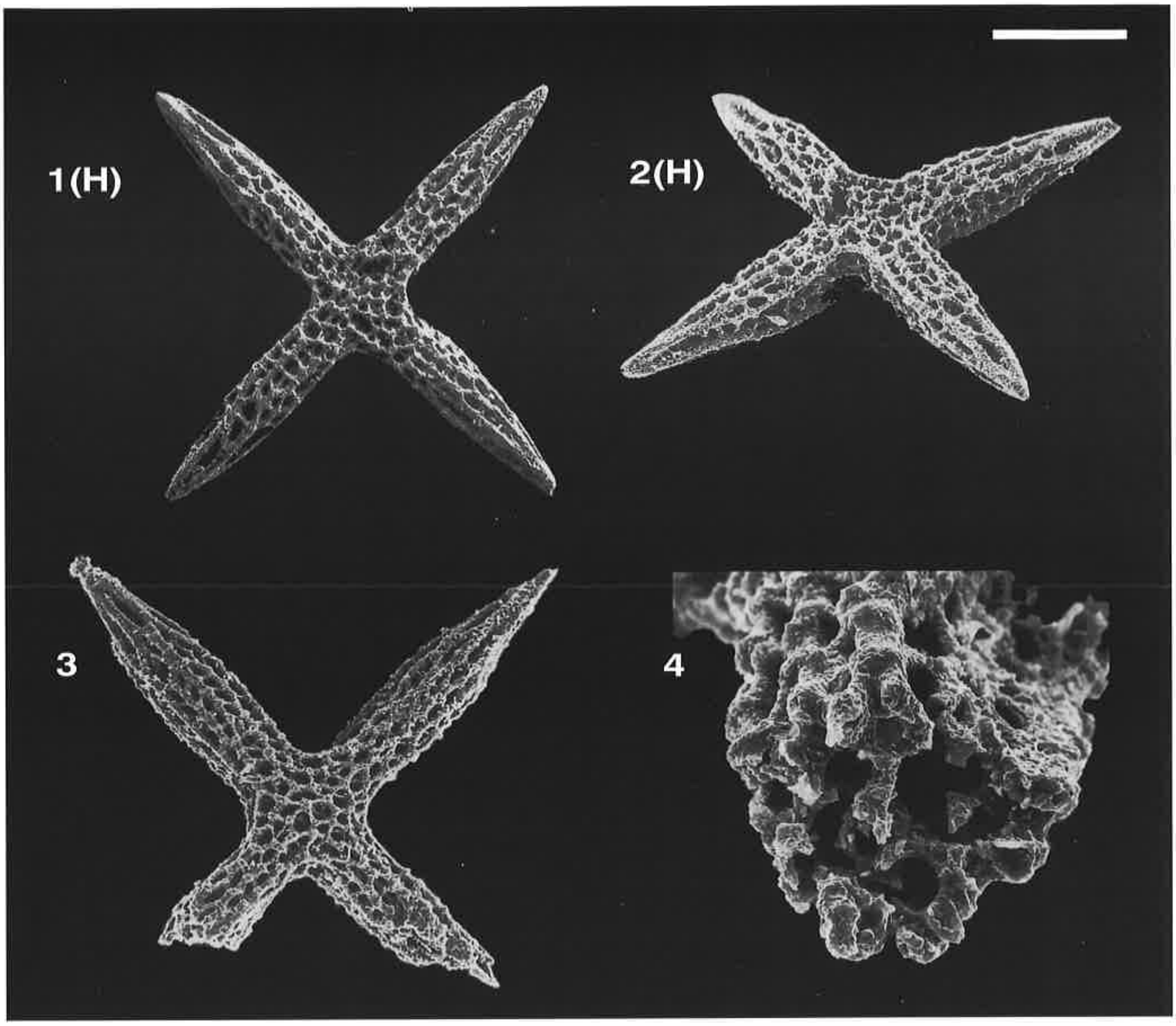


Plate 3129. ***Pseudocrucella adriani*** **BAUMGARTNER.** Magnification x200, except Fig. 4 x800. **Fig. 1(H).** POB78/6208, POB899.52. **Fig. 2(H).** POB78/6477, POB899.52. **Fig. 3.** POB79/0391, POB899.60. **Fig. 4.** POB79/0389, POB899.60.

PSEUDOCRUCELLA (?) ELISABETHAE 3947

***Pseudocrucella* (?) *elisabethae* (RÜST)**

Synonymy.-
Histiastrum elisabethae RÜST
RÜST 1898, p. 30, pl. 10, fig. 8.
Crucella sp.
PESSAGNO 1971a, pl. 19, fig. 7.
Pseudocrucella (?) *elisabethae* (RÜST)
JUD 1994, p. 97, pl. 17, fig. 13; pl. 18, figs. 1-2.

Original Definition.- "Flat, slightly rhomboid, large, latticed test, with smaller central area of which the 4 equal rays, enlarged in their middle portion, protrude. Rays terminating with rather slender spines. Surface of rays covered with 4 mostly longitudinal regular rows of pores of middle size. Patagium large, of loose tissue."

Actualized Definition.- Test square in face view, four-rayed with interradial patagium. In lateral view test is rhombic to pillow-shaped. Rays composed of generally 3-4 or more well visible beams, connected by thinner transverse bars forming a network of longitudinal and transverse rows of pores which generally is not regularly developed in the central area. The rays are slightly sigmoidal, decrease in height and enlarge slightly from center of test towards tips, where they terminate with a short spine. Patagium generally present in interradial area, decreasing in thickness from center of test towards sides of test, which are more or less concave in outline.

Actualized Remarks.- (JUD, 1994) Depending on preservation or age of the specimen the patagium may be more or less developed or even absent. Our specimens have an average length of rays (based on 6 specimens) of 350 (min. 278, max. 328), which is rather similar to the values mentioned by Rüst.

Measurements (in μm).-
Length of rays 225, max. width of rays 78, length of spines 85.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

PSEUDOCRUCELLA SANFILIPPOAE 3126

***Pseudocrucella sanfilippoae* (PESSAGNO)**

Synonymy.-
Crucella sanfilippoae PESSAGNO
PESSAGNO 1977a, p. 72, pl. 2, figs. 15-16.
AITA 1982, pl. 3, fig. 9.
Pseudocrucella sanfilippoae (PESSAGNO)
BAUMGARTNER 1980, p. 291, pl. 8, figs. 1, 23-24.
KOCHER 1981, p. 88, pl. 16, fig. 1.
not DE WEVER & CABY 1981, pl. 2, fig. 2J.
BAUMGARTNER 1984, p. 781, pl. 7, fig. 17.

Original Definition.- "Meshwork with linearly arranged square pore frames having massive nodes at their corners. Spines triradiate in axial section proximally and circular in axial section distally".

Original Remarks.- "*Crucella sanfilippoae* n.sp. differs from *C. messinae* by virtue of its linearly arranged square pore frames and the structure of its spines".

Etymology.- This species is named for Annika Sanfilippo (Scripps Institution of Oceanography) in honor of her contributions to the study of Jurassic Radiolaria.

Measurements (in μm).-
Based on 10 specimens. Length of ray: 100 to 170; width of ray: 50 to 60, length of spines: 55 to 120.

Type Locality.- Point Sal, Santa Barbara County.

UAZones.- 7-10, late Bath.-early Call. to late Oxf.-early Kimm.

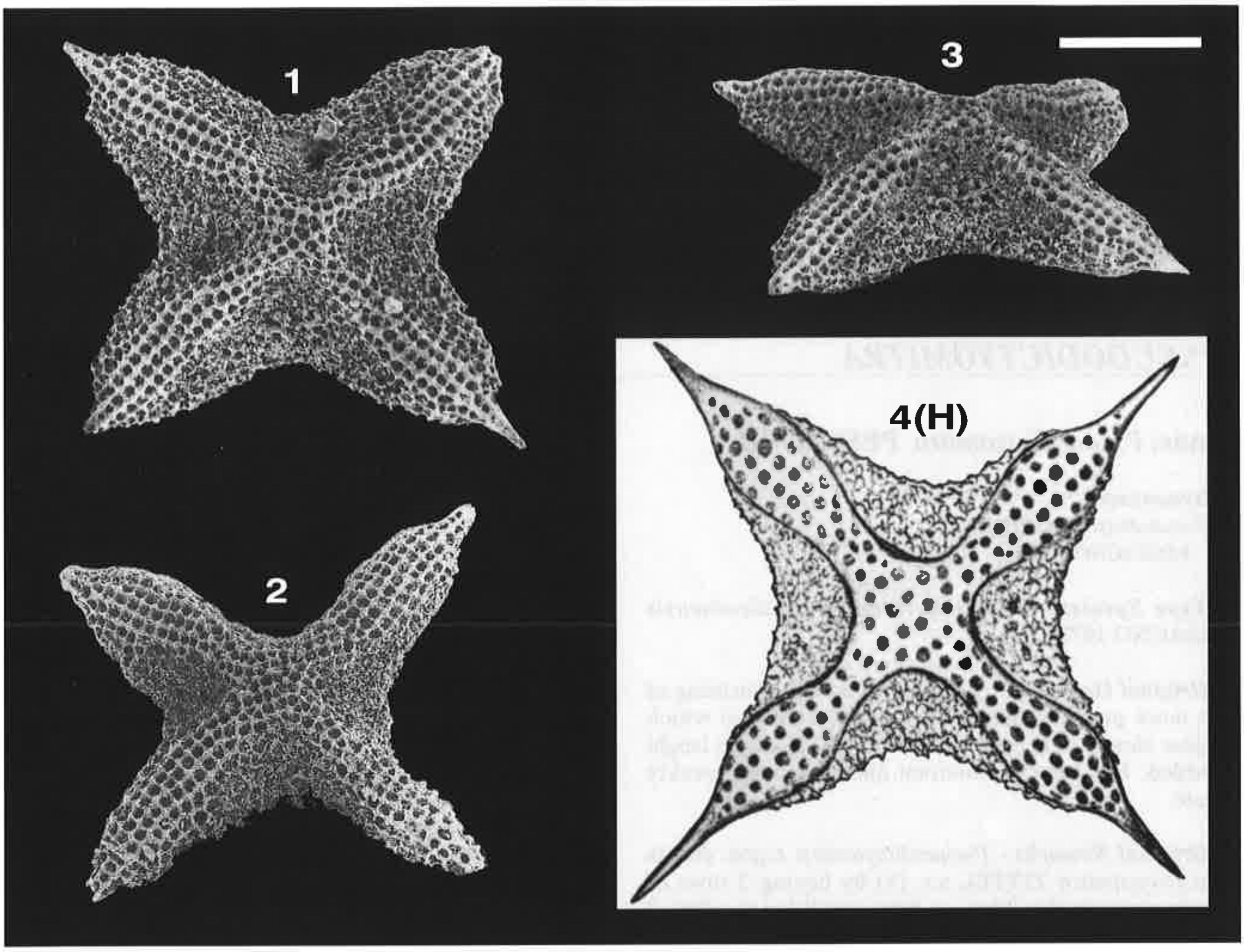


Plate 3947. *Pseudocrucella* (?) *elisabethae* (RÜST). Magnification x150. **Fig. 1.** RJ9, Br28.85. **Fig. 2.** RJ89, Br28.85. **Fig. 3.** RJ41, Br28.85. **Fig. 4(H).** RÜST 1898, pl. 10, fig. 8.

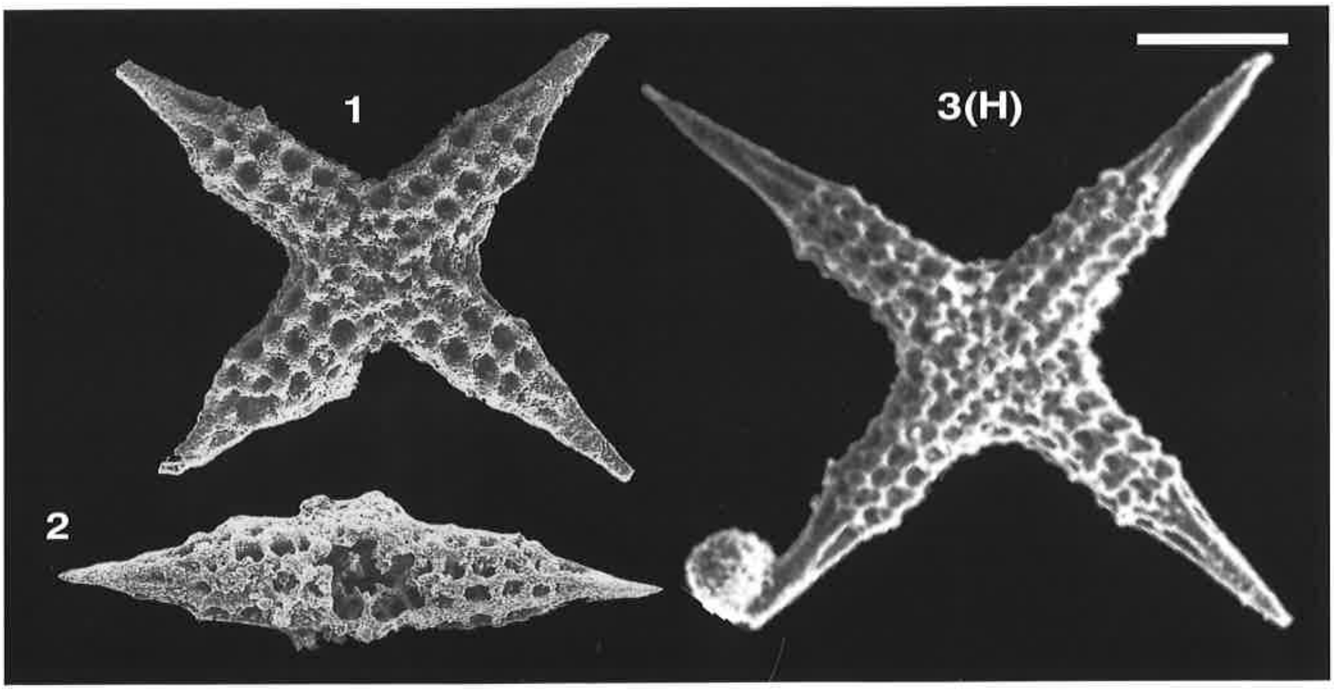


Plate 3126. *Pseudocrucella sanfilippoae* (PESSAGNO). Magnification x200. **Fig. 1.** POB79/1695, POB79.5NSF907. **Fig. 2.** POB79/1698, POB79.5NSF907. **Fig. 3(H).** PESSAGNO 1977a, pl. 2, fig. 15.

PSEUDOCRUCELLA \ B 3127

Pseudocrucella sp. B

Synonymy.-
Pseudocrucella sp. B
BAUMGARTNER 1980, p. 292, pl. 8, figs. 2, 6.
NAGAI 1985, pl. 3, fig. 3a.

Original Remarks.- A form with a depression in the central area and tapering conical rays.

UAZones.- 8-9, mid Call.-early Oxf. to mid-late Oxf.

PSEUDODICTYOMITRA 3684

Genus: *Pseudodictyomitra* PESSAGNO

Synonymy.-
Pseudodictyomitra PESSAGNO
PESSAGNO 1977b, p. 50.

Type Species.- *Pseudodictyomitra pentacolaensis* PESSAGNO 1977b.

Original Definition.- Test as with family; consisting of 6 or more post-abdominal chambers (segments) which increase slowly in height and moderately rapidly in height as added. Final post-abdominal chamber more weakly costate.

Original Remarks.- *Pseudodictyomitra* n.gen. differs from *Dictyomitra* ZITTEL s.s. (1) by having 2 rows of primary pores in the strictures between all but the final 2 post-abdominal chambers and (2) by having discontinuous costae which do not traverse the strictures of the post-abdominal chambers. Both genera display relict pores between costae. With *Dictyomitra* and all of the Archaeodictyomitridae each new post-abdominal chamber is formed via secretion of costal projections (see Pessagno, 1976, p. 49). However, with *Pseudodictyomitra* the costal projections are absent because the costae are discontinuous. It is likely that the costae in this case play no important role in test secretion.

Remarks.- *Pseudodictyomitra* is distinguished from *Archaeodictyomira* and *Dictyomitra* by possessing costae which are discontinuous, and not usually aligned, over segmental divisions. Species are determined on the basis of the overall shape of the test, the surface ornamentation and the number and distribution of pores.

Included Taxa.-
3293 *Pseudodictyomitra carpatica* (LOZYNIAK)
5641 *Pseudodictyomitra lanceloţi* SCHAAF
5642 *Pseudodictyomitra* sp. aff. *P. lancelotti* SCHAAF
5973 *Pseudodictyomitra leptoconica* (FOREMAN)
5625 *Pseudodictyomitra lilyae* (TAN)
5647 *Pseudodictyomitra nuda* (SCHAAF)
3189 *Pseudodictyomitra primitiva* MATSUOKA & YAO

PSEUDODICTYOMITRA CARPATICA 3293

Pseudodictyomitra carpatica (LOZYNIAK)

Synonymy.-
Dictyomitra carpatica LOZYNIAK
LOZYNIAK 1969, p. 38, pl. 2, figs. 11-12.
FOREMAN 1973b, p. 263, pl. 10, figs. 1-3; pl. 16, fig. 5.
FOREMAN 1975, p. 614, pl. 2G, figs. 12-14, not fig. 11; pl. 7, fig. 7, not fig. 6.
Pseudodictyomitra carpatica (LOZYNIAK)
SCHAAF 1981, p. 436, pl. 3, fig. 2, not figs. 1a-c; pl. 20, ? fig. 4a-b.
NAKASEKO & NISHIMURA 1981, p. 158, pl. 9, figs. 6, 11.
not DE WEVER & THIEBAULT 1981, p. 590, pl. 2, fig. 2.
MATSUYAMA et al. 1982, pl. 1, fig. 7.
YAO 1984, pl. 4, fig. 14.
BAUMGARTNER 1984, p. 782, pl. 8, fig. 1.
SCHAAF 1984, p. 94-95, fig. 1, not figs. 2a-b; ? fig. 3.
ISHIDA 1985, pl. 6, figs. 1-2.
AITA & OKADA 1986, pl. 1, figs. 13, 14; pl. 7, fig. 10.
KITO 1987, pl. 3, fig. 4.
KAWABATA 1988, pl. 2, fig. 7.
OZVOLDOVA & PETERCAKOVA 1992, pl. 4, fig. 13.
MATSUOKA 1992, pl. 2, figs. 2, 3.
STEIGER 1992, p. 87, pl. 25, figs. 1-3, 7.
TAKETANI & KANIE 1992, fig. 4.12.
JUD 1994, p. 97, pl. 18, figs. 3-5.
Pseudodictyomitra sp. cf. *P. carpatica* (LOZYNIAK)
NISHIZONO et al. 1982, pl. 3, fig. 9.
MATSUOKA 1986b, pl. 4, figs. 1-3.
Pseudodictyomitra aff. *carpatica* LOZYNIAK
DE WEVER et al. 1986, pl. 11, fig. 3.
Pseudodictyomitra sp.
KANIE et al. 1981, pl. 1, fig. 18.
KANIE et al. 1984, pl. 4, fig. 14.

Original Definition.- The conical skeleton gradually widens toward the apertural end. It consists of 7-10 chambers, which gradually increase in size toward the apertural end. The initial conical chamber has a tapering apex and the aperture of the last is open and round. The chambers are separated by thick septa. On the surface of the skeleton are visible wide septa which in some of the specimens exceed the height of the chamber; the small

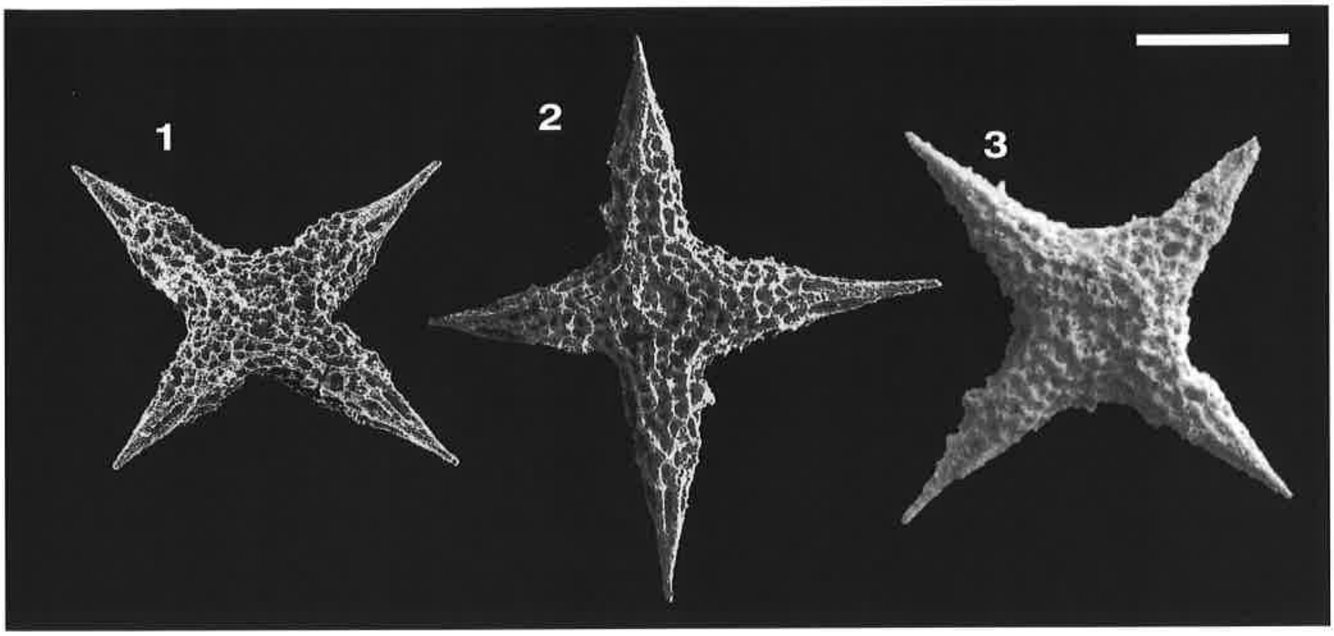


Plate 3127. *Pseudocrucella* sp. B. Magnification x200. **Fig. 1.** POB78/6480, POB899.52. **Fig. 2.** POB78/6209, POB899.52. **Fig. 3.** GO900407, BM 102.

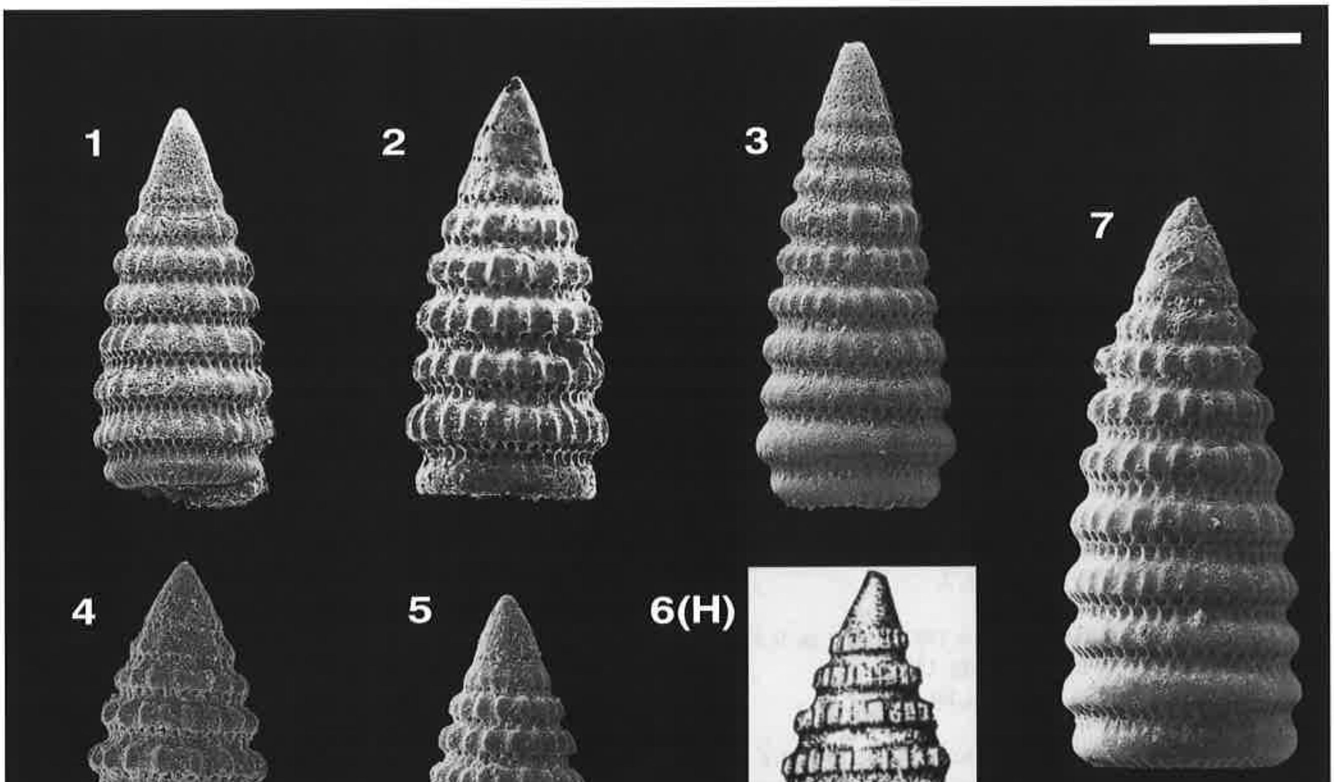


Plate 3293. *Pseudodictyomitra carpatica* (LOZYNIAK). Magnification x200. **Fig. 1.** POB79/1714, POBCR2. **Fig. 2.** POB81/9121, 76.534A.81.2.64. **Fig. 3.** DU3508, Mo46. **Fig. 4.** DU3549, Mo46. **Fig. 5.** DU2331, Mo22. **Fig. 6(H).** LOZYNIAK 1969, pl. 2, fig. 11. **Fig. 7.** DU1347, V40.

round pores on them are slightly visible. Along the entire height of the skeleton, the chambers are penetrated by shallow grooves. Thick-walled skeleton.

Original Remarks.- Variability. The skeleton varies considerably in height and width. The number of chambers varies within the range of 7-10. On the surface of the skeleton of some of the forms, round or oval small pores are slightly visible in the intercamerate septa. Closely related species were not encountered.

Actualized Remarks.- (JUD, 1994) Because of the poor illustrations and description of *Dictyomitra carpatica* LOZYNIAK this species is used herein in the sense used by most authors. Most of our specimens found resemble the specimen illustrated by Baumgartner (1984), being rather short forms of 9-11 segments only. These specimens do not correspond very well to what Lozyniak illustrated under this species. They are less wide conical, slightly inflated, having a different shape of the apical part and the last segment constricted. Other forms found, also assigned at present to *Pseudodictyomitra carpatica* LOZYNIAK but not exactly corresponding to the type illustrations, are longer, with the post-abdominal segments possessing slightly nodose or tuberculated costae and with the distalmost segments having costae much less prominent than on proximal part of test. The latter forms seem to resemble the holotype of *Pseudodictyomitra leptoconica* FOREMAN 1973b, species to which most authors assigned quite different specimens. Thus much more investigations are needed to classify properly all this variety of specimens.

Measurements (in μm).-
Height of skeleton 224, width 126, height of chamber I: 28, II: 14, III: 14, IV: 14, V: 14, VI: 14, VII: 14, VIII: 14; diameter of chamber I: 28, II: 42, III: 56, IV: 84, V: 112, VI: 112, VII: 126, VIII: 126. Height of septa 14, number of grooves 28-30 (on the last chamber). The height of the septa approximately equals the height of the chambers, 14. Diameter of aperture 42, diameter of pores 8.

Type Locality.- Neocomian of Svalyavskaya series Pieniny zone of the Ukrainian Carpathians.

UAZones.- 11-21, late Kimm.-early Tith. to early Barr.

PSEUDODICTYOMITRA LANCELOTI *5641*

***Pseudodictyomitra lanceloti* SCHAAF**

Synonymy.-
Dictyomitra carpatica LOZYNIAK (?)
FOREMAN 1975, p. 614, pl. 2G, figs. 11-13, not 14.
Dictyomitra sp. B (= *Pseudodictyomitra* sp. B)
NAKASEKO et al. 1979, pl. 6, fig. 21.
Pseudodictyomitra lanceloti SCHAAF
SCHAAF 1981, p. 436-437, pl. 18, figs. 9a-b.
JUD 1994, p. 98, pl. 18, fig. 6.
Pseudodictyomitra pachicostata WU & LI
WU & LI 1982, pl. 2, figs. 3-4.
Pseudodictyomitra sp.
MATSUYAMA et al. 1982, pl. 1, fig. 9.
? OKAMURA & MATSUGI 1986, pl. 1, fig. 11.
Pseudodictyomitra carpatica (LOZYNIAK)
? SUYARI & ISHIDA 1985, pl. 3, fig. 3.
? SUYARI 1986b, pl. 1, fig. 2.
THUROW 1988, p. 404, pl. 6, fig. 12.
AGUADO et al. 1991, pl. 7, fig. 2.
Pseudodictyomitra lilyae (TAN)
? NAKASEKO & NISHIMURA 1981, p. 159, pl. 9, fig. 12.
? MURATA et al. 1982, pl. 2, fig. 15.
? THUROW 1988, p. 405, pl. 6, fig. 14.

Original Definition.- Conical shell, tending to be cylindrical or contracted below the eighth segment. Constrictions between the segments pronounced, each associated with a transverse row of pores and a row of alternating dimples (perhaps closed pores) distal to them. Discontinuous costae are present on all segments except the first three or four and the last, which are smooth. Costae are pronounced, but narrow, separated by wide depressions, about half as numerous as the pores in their transverse rows.

Original Remarks.- *Pseudodictyomitra lanceloti* is distinguished from *P. carpatica* by the latter having wide costae, and more of them on a diameter.

Remarks.- The specimens found in our material and assigned to *Pseudodictyomitra lanceloti* SCHAAF differ clearly from those assigned to *Pseudodictyomitra carpatica* (LOZYNIAK) by having costae pronounced on the upper part of the segments giving them a rectangular shape which contrasts to the trapezoidal one of *P. carpatica* (LOZYNIAK). Specimens differ further by having less costae, but deep intercostal depressions which on some younger specimens are very distinct. The last segment is inverted trapezoidal and costae are less pronounced or even absent.

Etymology.- This species is named for Dr. Yves Lancelot, in honour of his contributions to the sedimentology of the North Pacific.

Measurements (in μm).-
Based on 5 specimens. Length of the 6 first segments 140 to 160; number of costae per half circumference 7 to 8.

Type Locality.- DSDP Leg 62 Site 463, Mid-Pacific Mountains.

UAZones.- 20-22, late Haut. to late Barr.-early Apt.

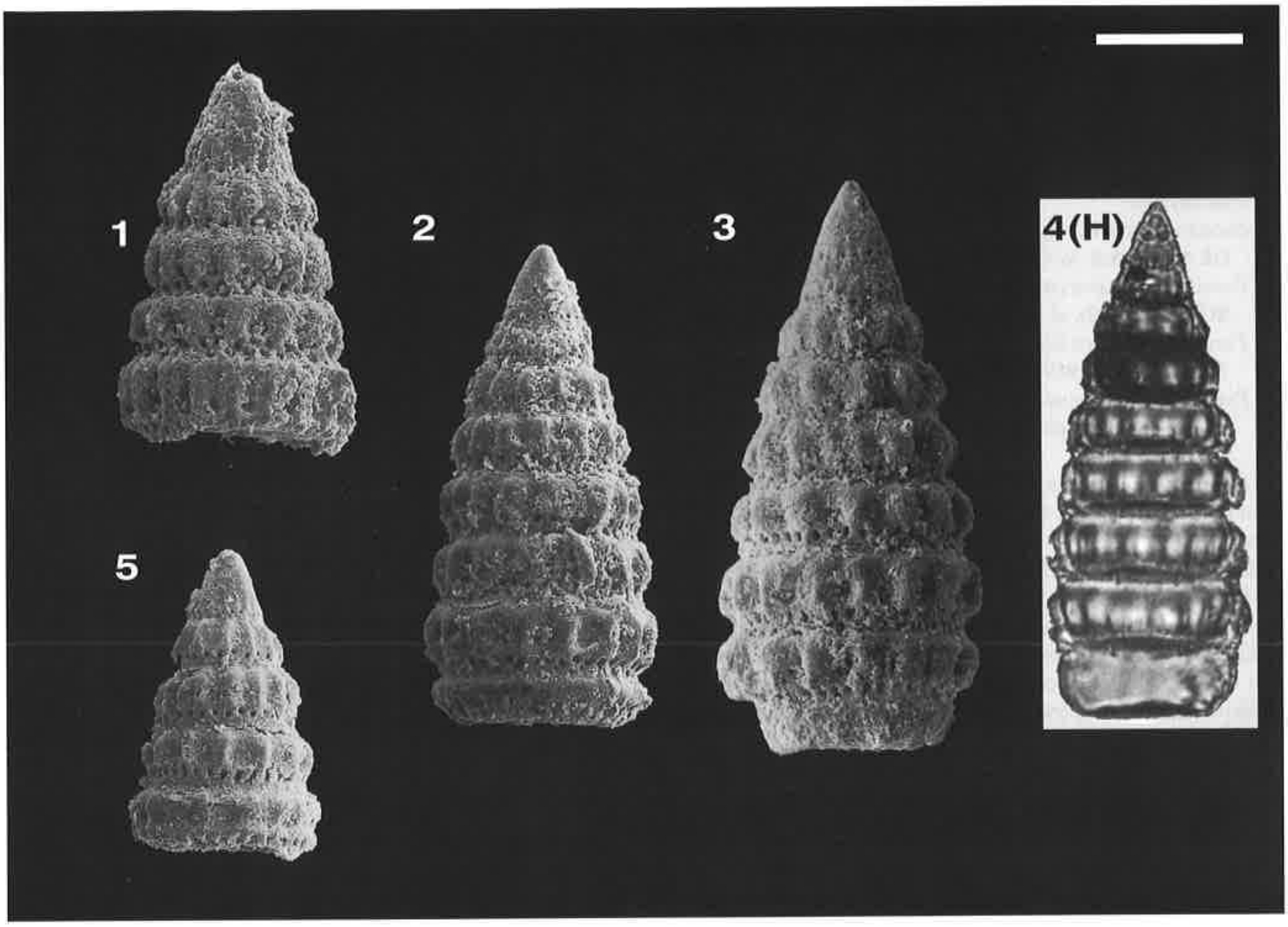


Plate 5641. ***Pseudodictyomitra lanceloti*** **SCHAAF.** Magnification x250. **Fig. 1.** RJ20, Bo619.9. **Fig. 2.** RJ13, Bo619.9. **Fig. 3.** RJ53, Bo619.9. **Fig. 4(H).** SCHAAF 1981, pl. 18, fig. 9b. **Fig. 5.** RJ1, Bo619.9.

PSEUDODICTYOMITRA LANCELOTI AFF. 5642

Pseudodictyomitra sp. aff. *P. lanceloti* SCHAAF

Synonymy.-
Pseudodictyomitra sp.
OKAMURA & MATSUGI 1986, p. 124, pl. 1, fig. 11.
Pseudodictyomitra carpatica (LOZYNIAK)
SUYARI 1986b, pl. 1, fig. 3.
Pseudodictyomitra lilyae (TAN SIN HOK)
? TUMANDA 1989, p. 38, pl. 2, fig. 15.
Pseudodictyomitra sp. aff. *P. lanceloti* SCHAAF
JUD 1994, p. 98, pl. 18, fig. 7.

Definition.- Test conical to slightly inflated, consisting of at least 8 segments. Cephalo-thorax conical and poreless, separated by one row of a few, round, small pores from abdominal segment, which has 8-9 longitudinal costae per half a diameter. Post-abdominal segments gradually increasing in width, the test becoming subconical, slightly inflated. Segments separated from one another by a single row of round, small pores on first two segments and by an additional second row of relict pores on the following segments. Surface of each segment with 9-10 longitudinal costae which are not continuous to the next segment and which are half-drop-shaped in outline. Terminal segment constricted and with less pronounced costae.

Remarks.- *Pseudodictyomitra* sp. aff. *P. lanceloti* SCHAAF differs from *Pseudodictyomitra carpatica* (LOZYNIAK) by having less costae and less segments and by having a half-drop-shaped outline of segments. *Pseudodictyomitra* sp. aff. *P. lanceloti* differs from *Pseudodictyomitra lanceloti* SCHAAF by having generally more costae, by the half-drop-shaped outline of the segments instead of a subrounded to trapezoidal one, and by lacking tuberculate costae on the first post-abdominal segments. The resemblance in outline of the terminal segments of *Pseudodictyomitra* sp. aff. *P. lanceloti* and *Pseudodictyomitra lanceloti* SCHAAF suggests that they are closely related. One specimen has a total length of 200 μm and a maximum width of 109 μm.

UAZones.- 21-21, early Barr. to early Barr.

PSEUDODICTYOMITRA LEPTOCONICA 5973

Pseudodictyomitra leptoconica (FOREMAN)

Synonymy.-
Dictyomitra leptoconica FOREMAN
FOREMAN 1973b, p. 264, pl. 10, fig. 4; pl. 16, fig. 6.
Pseudodictyomitra leptoconica (FOREMAN)
SCHAAF 1981, p. 437, pl. 3, fig. 3; pl. 18, figs. 3a-b.
ORIGLIA-DEVOS 1983, p. 176, pl. 20, fig. 10.
SCHAAF 1984, p. 116, figs. 1-7.
SUYARI & ISHIDA 1985, pl. 3, figs. 5, 9.
SUYARI & KUWANO 1986, pl. 1, fig. 7.
SUYARI 1986b, pl. 1, figs. 10-12.
THUROW 1988, p. 405, pl. 6, fig. 11.
TUMANDA 1989, p. 38, pl. 3, figs. 10-11.
OZVOLDOVA 1990, p. 143, pl. 2, fig. 6.
JUD 1994, p. 98, pl. 18, fig. 8.

Original Definition.- The shell is conical except for the last segment which is narrower than the next adjacent segment and tends to be cylindrical in shape. There may be 9 to 14 segments, generally 10 to 12. The first four or five segments form a smooth cone with no external segmental division. The remaining segments, except the last, are distinguished by being expanded near their lower margin. A row of small closely spaced pores is present at the segmental division. Slightly irregular, vertical costae extend from the center margin of some of the pores to join the center margin of the next row of pores. These costae are closely spaced, a single costa arising from the margin of each pore on the median and distal segments, and are more widely spaced proximally. Because they do not extend vertically between the pores they are discontinuous on each segment.

Actualized Definition.- (JUD, 1994) Test conical consisting of at least 9 segments. Cephalis and thorax form a smooth, poreless cone, separated by one row of very small pores from abdomen, which is poreless, but has several longitudinal ribs. Partition between the following 2-3 postabdominal segments not very pronounced, but between the following ones deeply concave. The postabdominal segments are slightly increasing in width, except for the last one which is constricted. The first few postabdominal segments are trapezoidal in shape with 10-14 longitudinal costae, and the segments are separated from each other by 2 rows of alternate pores of which the upper one has oval small pores placed between or just below the distal ends of the costae and the lower one has large relict pores being developed alternate to the upper row. The next following postabdominal segments are rounded in outline, smooth or with only slightly pronounced ribs. The last segment is smooth, subrounded in outline.

Original Remarks.- This species is distinguished from *D. carpatica* by lacking the rectangular appearing ridge and by its more closely spaced costae. Not included at this time is a related younger form with more widely spaced costae (pl. 16, fig. 7). *D. leptoconica* may be compared with *D. turritella* PARONA. However, the larger size and lack of costae of *D. turritella* do not allow certain identification at this time. *D. turritella* is reported from the Upper Jurassic of Cittiglio, northern Italy.

Actualized Remarks.- (JUD, 1994) The specimens found in our material are similar to all those assigned by other authors to *Pseudodictyomitra leptoconica* (FOREMAN). The apical portion of all these spesimens corresponds neither to the original description nor to the holotype. They resemble rather the specimen illustrated by Foreman (1973b, pl. 16, fig. 6). It must be mentioned that

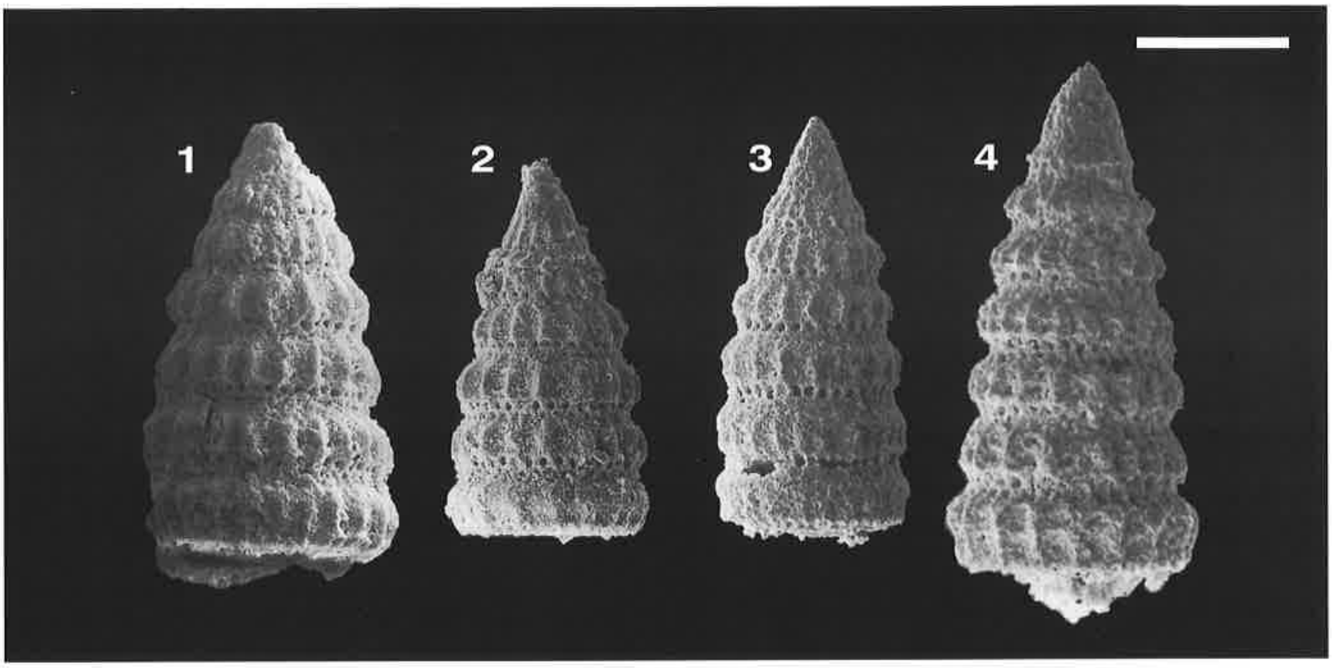


Plate 5642. ***Pseudodictyomitra* sp. aff. *P. lanceloti* SCHAAF.** Magnification x250. **Fig. 1.** RJ30, Bo619.9. **Fig. 2.** RJ103, Bo685.2. **Fig. 3.** RJ169, Pr225.30. **Fig. 4.** RJ5, Bo704.20.

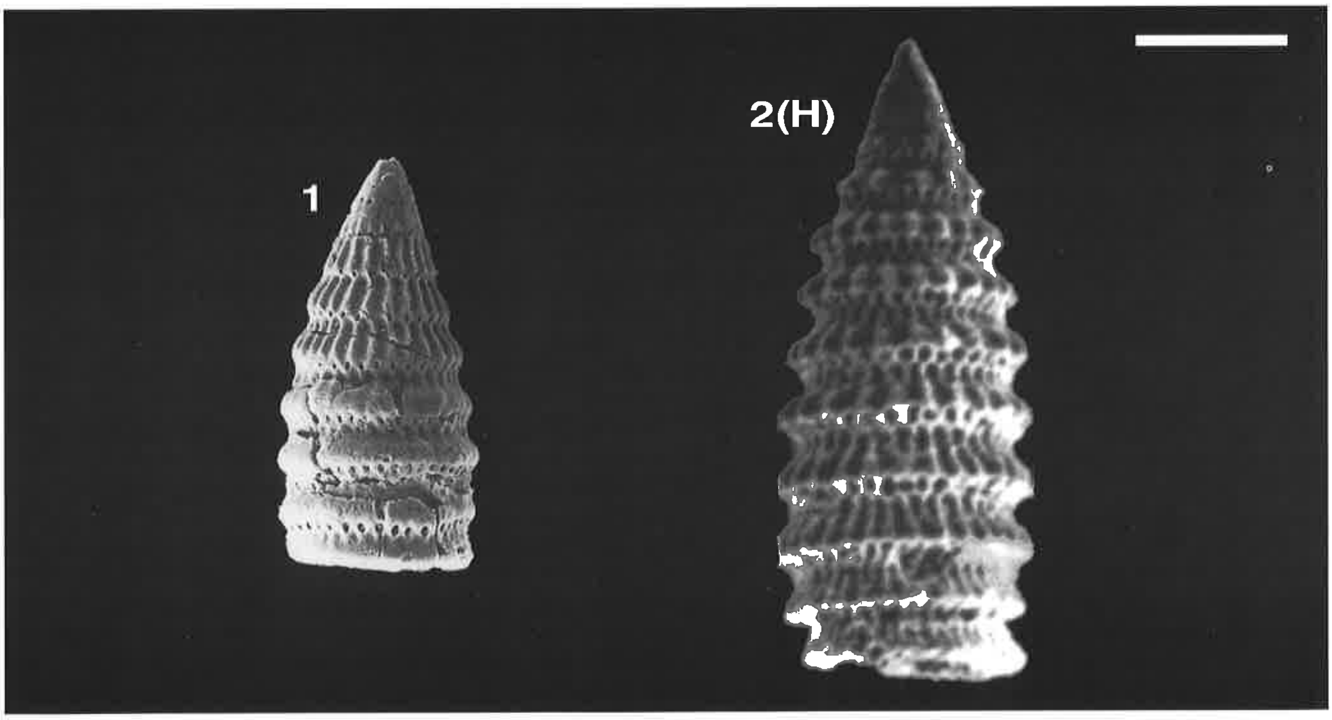


Plate 5973. ***Pseudodictyomitra leptoconica* (FOREMAN).** Magnification x250. **Fig. 1.** RJ883, GC887.00. **Fig. 2(H).** FOREMAN 1973b, pl. 10, fig. 4.

the specimen illustrated as holotype seems to have a slightly tuberculate surface on the first postabdominal segments and it thus resembles some of our specimens which we and others have assigned to *P. carpatica* LOZYNIAK. More investigations are therefore needed to properly classify all these morphotypes.

Measurements (in μm).-
Based on 15 specimens. Total length max. 340, min. 175, av. 226; greatest width, 95-150.

Type Locality.- Leg 20, Site 195, NW Pacific basin.

UAZones.- 22-22, late Barr.-early Apt.

PSEUDODICTYOMITRA LILYAE 5625

Pseudodictyomitra lilyae (TAN)

Synonymy.-
Dictyomitra lilyae TAN
TAN 1927, p. 55, pl. 10, fig. 83.
RIEDEL & SANFILIPPO 1974, p. 778, pl. 4, figs. 7-9; pl. 12, fig. 13.
RENZ 1974, p. 791, pl. 8, figs. 1-4; pl. 11, fig. 33.
Pseudodictyomitra lilyae (TAN SIN HOK)
SCHAAF 1981, p. 437, pl. 3, fig. 8; pl. 18, figs. 5a-b.
ORIGLIA-DEVOS 1983, p. 177, pl. 20, figs. 8-9.
Pseudodictyomitra (?) *lilyae* (TAN SIN HOK)
DE WEVER & THIEBAULT 1981, p. 591, pl. 1, figs. 1-4.
Archaeodictyomitra carpatica (LOZYNYAK)
OKAMURA & UTO 1982, pl. 2, fig. 4.
Pseudodictyomitra carpatica (LOZYNYAK)
SUYARI & KUWANO 1986, pl. 1, figs. 5-6.
Pseudodictyomitra sp.
? TERAOKA & KURIMOTO 1986, pl. 3, fig. 5.
Parvicingula sp.
? TERAOKA & KURIMOTO 1986, pl. 2, fig. 22.
Pseudodictyomitra lilyae (TAN)
JUD 1994, p. 99, pl. 18, figs. 9-11.

Original Definition.- "Slender, conical shell of 8 segments with deep septal constrictions. Cephalis conical, poreless, with internal skeleton. Second and third segment truncated cones. All following segments with thick shell-wall, the thickenings above the segmental constrictions. The fourth segment with a massive, thick wall, with costae. Each segment with one row of pores placed on the constrictions, the shell seeming to be very massive."

Definition.- Test conical, consisting of 9-12 segments. Cephalis and thorax conical, smooth, poreless, separated from one another and from abdomen by one row of small pores. Abdomen with slightly visible costae. Postabdominal segments rounded in outline, with deeply concave segmental partitions, with two rows of alternate pores, of which the lower one are relict pores, the rows placed just above the constrictions. The proximal postabdominal segments have one single row of 8 or more tubercles per segment. Distal segments are smooth or with only slightly visible costae. The last segment is on some specimens slightly constricted.

Original Remarks.- "This form is, with regard to the intersection very similar to *Dictyomitra* spec. indet. HINDE 1900, but different within the dimensions."

Remarks.- *Pseudodictyomitra lilyae* (TAN) differs from all other species of *Pseudodictyomitra* by having on the upper part of test segments with tubercles and on the lower part segments with smooth surface. Our specimens assigned to *Pseudodictyomitra lilyae* (TAN) possess generally more segments and have a length of 240-290 μm being therefore longer than those described by Tan (1927).

Measurements (in μm).-
Maximum length 195, maximum width 90.

Type Locality.- Moluccas Archipelago, Indian Ocean.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

PSEUDODICTYOMITRA NUDA 5647

Pseudodictyomitra nuda SCHAAF

Synonymy.-
Archaeodictyomitra nuda SCHAAF
SCHAAF 1981, p. 432, pl. 3, fig. 6.
Pseudodictyomitra nuda (SCHAAF)
JUD 1994, p. 99, pl. 18, figs. 12-13.

Original Definition.- Smooth, conical form with approximately eight widely separated transverse rows of small pores at the internal septa. The scanning electron microscope reveals low, rather irregular ribs on the surface.

Original Remarks.- This species differs from all other species of the genus by the indistinct costae.

Remarks.- The specimens herein assigned to *P. nuda* SCHAAF differ in that they have not exactly ribs but rather slightly marked, irregularly disposed tubercles.

Etymology.- *Nuda* (Latin, adj.), naked.

Measurements (in μm).-
Based on 8 specimens. Length of the first 6 segments 155-190.

Type Locality.- Leg 62 Site 463, Mid-Pacific Mts.

UAZones.- 16-22, early Val. to late Barr.-early Apt.

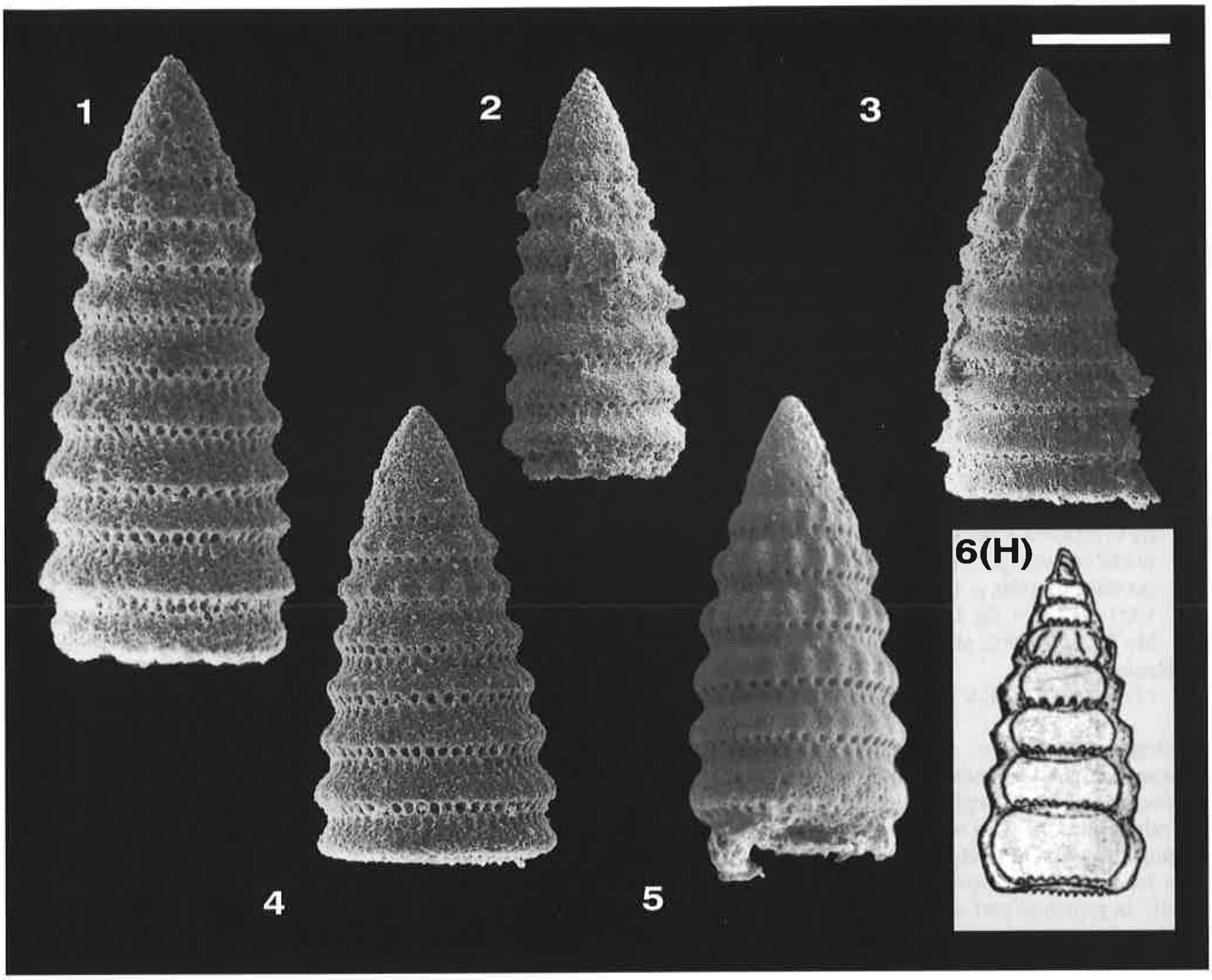


Plate 5625. *Pseudodictyomitra lilyae* (TAN). Magnification x250. **Fig. 1.** RJ8, Bo566.50. **Fig. 2.** RJ13, Bo619.90. **Fig. 3.** RJ110, Bo619.9. **Fig. 4.** RJ32, Bo566.5. **Fig. 5.** KI25-14, NK81062829. **Fig. 6(H).** TAN 1927, pl. 10, fig. 83.

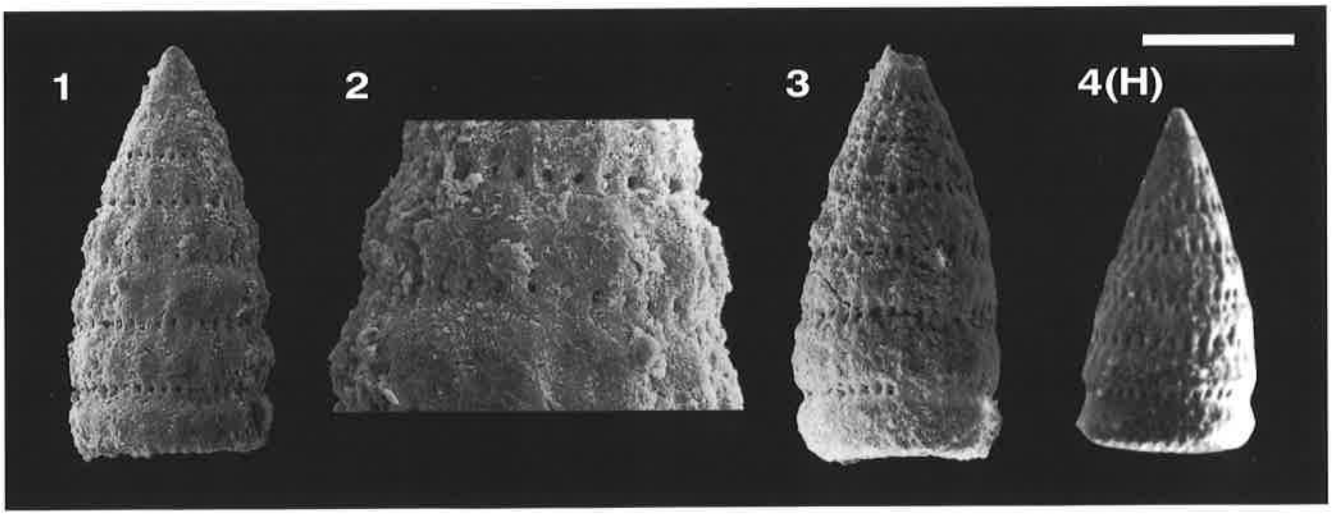


Plate 5647. *Pseudodictyomitra nuda* SCHAAF. Magnification x250, except Fig. 2 x500. **Fig. 1.** RJ5, Bo619.9. **Fig. 2.** RJ6, Bo619.9. **Fig. 3.** RJ 106, BO 619.9. **Fig. 4(H).** SCHAAF 1981, pl. 3, fig. 6.

PSEUDODICTYOMITRA PRIMITIVA 3189

Pseudodictyomitra primitiva MATSUOKA & YAO

Synonymy.-
Dictyomitra sp. B
YAO et al. 1982, pl. 4, fig. 27.
YAO 1983, figs. 3-14.
YAO 1984, pl. 3, figs. 1, 3, not fig. 2.
Unnamed multicyrtoid nassellaria
ADACHI 1982, pl. 2, fig. 4.
Pseudodictyomitra primitiva MATSUOKA & YAO
MATSUOKA & YAO 1985, p. 131, pl. 1, figs. 1-6; pl. 3, figs. 1-4.
MATSUOKA 1986c, pl. 4, figs. 8, ? 7.
MATSUOKA & YAO 1986, pl. 2, fig. 19.
KAWABATA 1988, pl. 2, fig. 8.
OZVOLDOVA 1988, pl. 2, fig. 6.
WAKITA 1988, pl. 5, fig. 3, pl. 6, figs. 6-7.
DANELIAN 1989, p. 184, pl. 7, fig. 14.
YAO 1991, pl. 4, fig. 18.
MATSUOKA 1992, pl. 3, fig. 1.
Hsuum sp.
? IWATA & TAJIKA 1989, pl. 5, fig. 8.

Original Definition.- Shell elongate, conical with 7 to 10 postabdominal segments. Cephalis small, dome-shaped without apical horn. Cephalis and thorax imperforate with smooth surface, or with weakly developed costae. Each of subsequent segment excluding 1 or 2 final postabdominal ones truncate cone-shaped. Width of segment expanding rapidly in proximal part and gradually in distal part except for last 1 or 2 segments which become narrow and subcylindrical. Abdomen and postabdominal segments separated from each other by a single row of small, circular to elliptical pores situated in strictures at joints; occasionally double rows of pores, which are arranged diagonally, present in 1 or 2 final strictures. Abdomen and postabdominal segments costate with about 30-40 costae (15-20 visible laterally) which do not transverse the strictures of the postabdominal segments.

Original Remarks.- Although *Pseudodictyomitra primitiva* n.sp. lacks two rows of primary pores in strictures at joints except for final 1 or 2 ones in some specimens, it is assigned to *Pseudodictyomitra* because other morphological features such as its lobate form and presence of discontinuous costae agree with definition of the genus. *P. primitiva* can be a primitive form of *Pseudodictyomitra* because forms related to this genus are not found in lower zones than the *Pseudodictyomitra primitiva* - *Pseudodictyomitra* sp. A Assemblage-zone so far as is known. *P. primitiva* differs from other species of *Pseudodictyomitra* by lacking two rows of primary pores in the position of the strictures except for 1 or 2 final strictures in some specimens. *P. primitiva* is similar to *Pseudodictyomitra* (?) sp. D (pl. 2, figs. 6-7) in shape but differs from the latter species by having stronger strictures and lacking complicated ornamentation on outer surface by combination of ridges and depressions. The first occurrence of *P.* (?) sp. D, which is within the *Gongylothorax sakawaensis* - *Stichocapsa naradaniensis* Assemblage-zone (early Late Jurassic; Matsuoka, 1984), is prior to that of *P. primitiva*.

Etymology.- This species is named from the Latin adjective *primitivus*, meaning primitive.

Measurements (in μm).-
Based on 15 specimens. Height overall, 185-258 (av. 225); maximum width of shell, 80-98 (av. 87).

Type Locality.- Sample Y-VI906-14, Yura Formation, Wakayama Prefecture, southwest Japan.

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

PSEUDOEUCYRTIS 3685

Genus: *Pseudoeucyrtis* PESSAGNO

Synonymy.-
Pseudoeucyrtis PESSAGNO
PESSAGNO 1977b, p. 58.

Type Species.- *Eucyrtis* (?) *zhamoidai* FOREMAN 1973b.

Original Definition.- Test elongate, spindle shaped, multisegmented termination in a closed (?) tube. Cephalis imperforate with short, often massive horn. Remaining chambers coarsely perforate with polygonal pore frames; pore frames often spinose. Post-cephalic chambers (exclusive of terminal tube) increasing gradually in height, but somewhat more rapidly in width to middle of test where they begin to decrease in width. Test devoid of strictures.

Original Remarks.- *Pseudoeucyrtis* n.gen. differs from *Eucyrtis* HAECKEL (type species = *E. conoidea* RÜST, 1885; see Foreman, 1973b, p. 264) by lacking strictures, by having a more coarsely and densely perforate test, and by being spindle shaped.

Included Taxa.-
5572 *Pseudoeucyrtis acus* JUD
5576 *Pseudoeucyrtis* (?) *aspera* JUD
5408 *Pseudoeucyrtis* (?) *fusus* JUD
5407 *Pseudoeucyrtis* sp. cf. P. *hanni* (TAN)
3177 *Pseudoeucyrtis reticularis* MATSUOKA & YAO
5577 *Pseudoeucyrtis sceptrum* JUD
3176 *Pseudoeucyrtis* sp. J

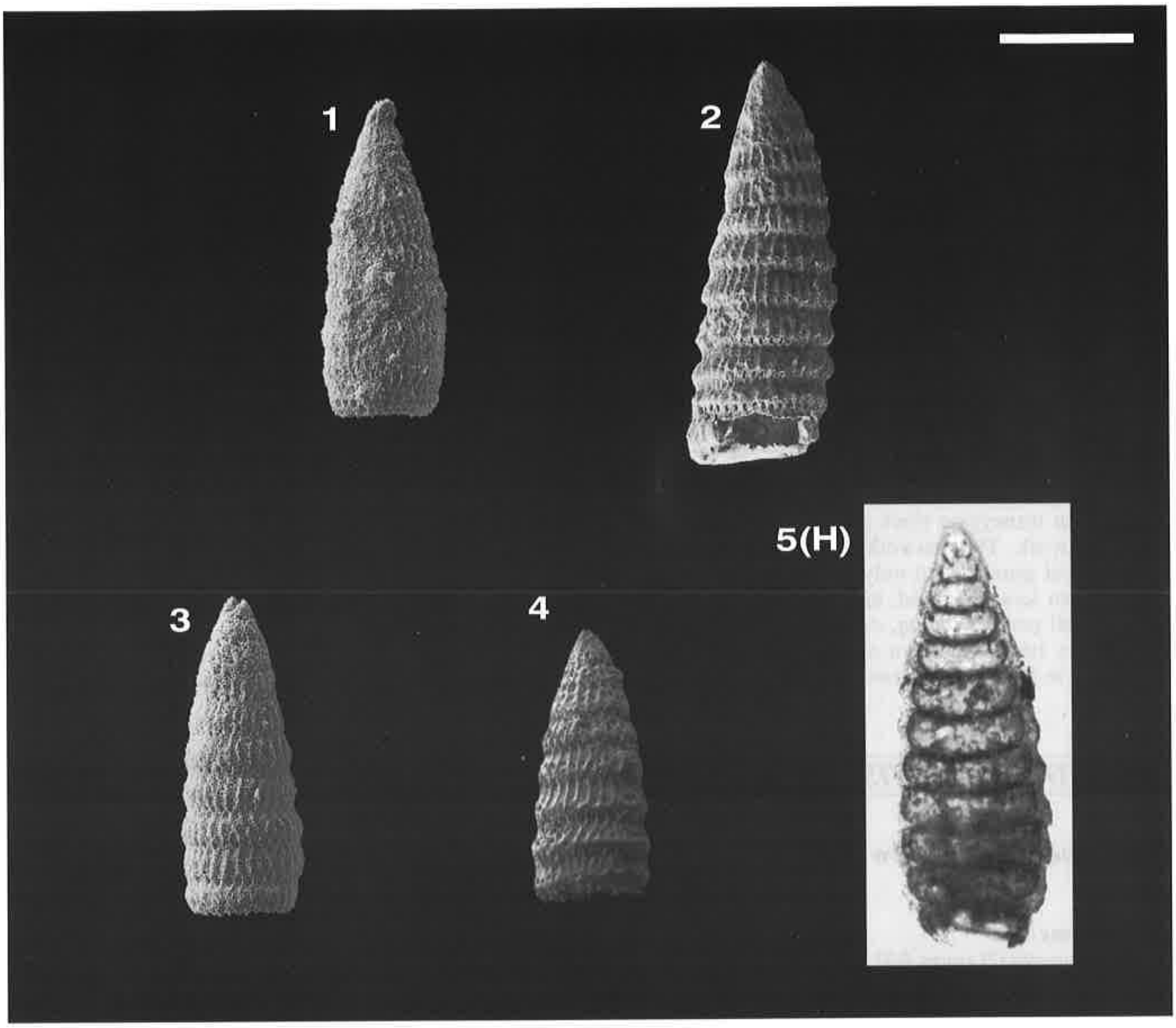


Plate 3189. ***Pseudodictyomitra primitiva*** **MATSUOKA & YAO.** Magnification x250. **Fig. 1.** DU2569, PJ21. **Fig. 2.** MA J1. **Fig. 3.** DU2477, PJ25. **Fig. 4.** POB81/1453,76,534A,125.2.036. **Fig. 5(H).** MATSUOKA & YAO 1985, pl. 3, fig. 4.

PSEUDOEUCYRTIS ACUS 5572

Pseudoeucyrtis acus JUD

Synonymy.-
Pseudoeucyrtis acus JUD
JUD 1994, p. 99, pl. 18, figs. 14-15.

Original Definition.- Long, slender, cylindrical test consisting of 2 main parts: a shorter apical part and a very long distal one. Apical part as long as about one fifth the length of test and formed by several segments the number of which cannot be determined at present. Cephalis bears a short bladed apical horn and cannot be distinguished externally from thorax, as well as the latter from the abdomen or postabdominal segments. Upper portion of apical part conical, lower part cylindrical, all of them with double-layered wall: an inner layer of very small pores arranged in transverse rows and an outer layer with a coarse network. This network is always present on the upper apical portion and only partly on the lower one where, when less developed, may render visible the inner layer. Distal part very long, cylindrical, non segmented, with pores larger than on apical part and arranged alternately in longitudinal rows. Number of rows of pores on half a diameter varies between 6 and 8. Terminal portion conical, closed by a very short spine.

Original Remarks.- *Pseudoeucyrtis acus* n.sp. differs from all the other species of this genus so far known by the evident differentiation of the two parts of test. Most of the specimens found have the distal part broken off.

Etymology.- From the Latin *acus*, needle.

Measurements (in μm).-
Based on 2 specimens.

	HT	av.	min	max.
Total length:	788	-	-	-
Min. width:	55	-	-	-
Max. width:	73	78	73	84
Height ap. part:	152	174	152	197
Length ap. spine:	30	38	30	47

Type Locality.- Breggia Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 15-21, late Berr.-earliest Val. to early Barr.

PSEUDOEUCYRTIS (?) ASPERA 5576

Pseudoeucyrtis (?) *aspera* JUD

Synonymy.-
Pseudoeucyrtis (?) *aspera* JUD
JUD 1994, p. 100, pl. 18, fig. 16.

Original Definition.- Long, slender test, lacking visible segmentation. Apical portion approximately hemispherical with irregular pore frames, bearing a small, circular, crown-like, porous elevation. Remaining part, if well preserved, without visible segmental constrictions, cylindrical or slightly increasing in width. Whole test consists of a spongy and slightly spiny meshwork.

Original Remarks.- *Pseudoeucyrtis* (?) *aspera* n.sp. was questionably assigned to the genus *Pseudoeucyrtis* PESSAGNO because of its unknown internal structure. It differs from all species herein included in *Pseudoeucyrtis* in having spongy wall and test which increases slightly in width distally.

Etymology.- From the Latin *asper*, rough.

Measurements (in μm).-
Based on 1 specimens. Max. length: 635; Length ap. infl. part: 135; Maximum width: 130; Height ap. horn: 29.

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 16-21, early Val. to early Barr.

PSEUDOEUCYRTIS (?) FUSUS 5408

Pseudoeucyrtis (?) *fusus* JUD

Synonymy.-
Pseudoeucyrtis (?) *fusus* JUD
JUD 1994, p. 100, pl. 18, figs. 17-19.

Original Definition.- Long, slender, spindle-shaped multicyrtid test of 5-7 segments with a long, bladed, sturdy spine on apical portion. Test lacks obvious external partition, although vague segmentation may be visible on proximal portion. Central part slightly inflated, with approximately linear arrangement of small, subcircular pores in lower area. Distal part gradually decreasing in size, forming a long tube with longitudinally arranged pores that are bigger than on central portion. Tube ending with a short, poreless spine.

Original Remarks.- *Pseudoeucyrtis* (?) *fusus* n.sp. differs from *Pseudoeucyrtis acus* n.sp. by its long slender, spindle-shaped test, by possessing a long, strong bladed apical horn and a conical terminal segment.

Etymology.- From the Latin *fusus*, spindle.

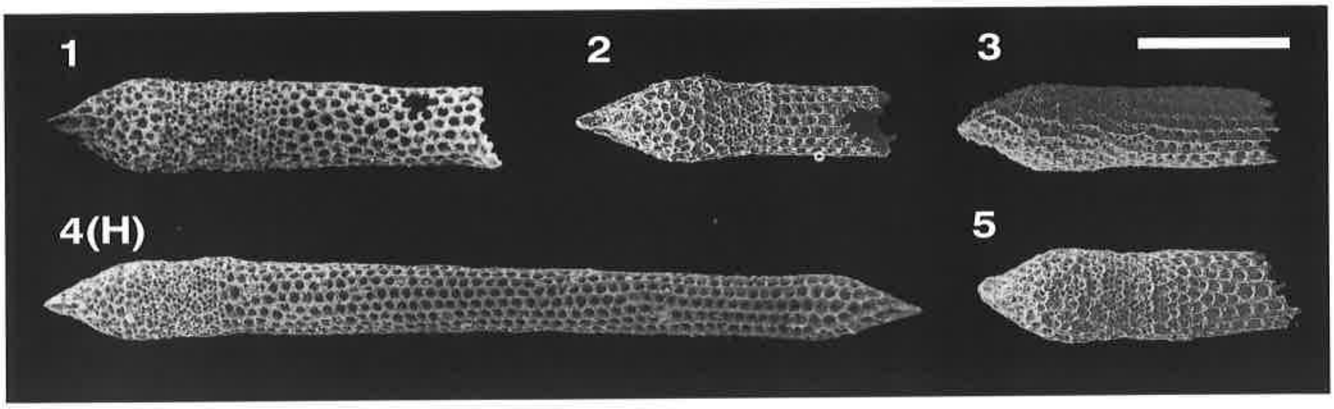


Plate 5572. *Pseudoeucyrtis acus* JUD. Magnification x150. **Fig. 1** RJ274, Br28.85. **Fig.2**. POB79/4128, MO2 22. **Fig. 3.** DU2324, Mo22. **Fig. 4(H).** RJ109, Br28.85. **Fig. 5.** PD2223, Mo22.

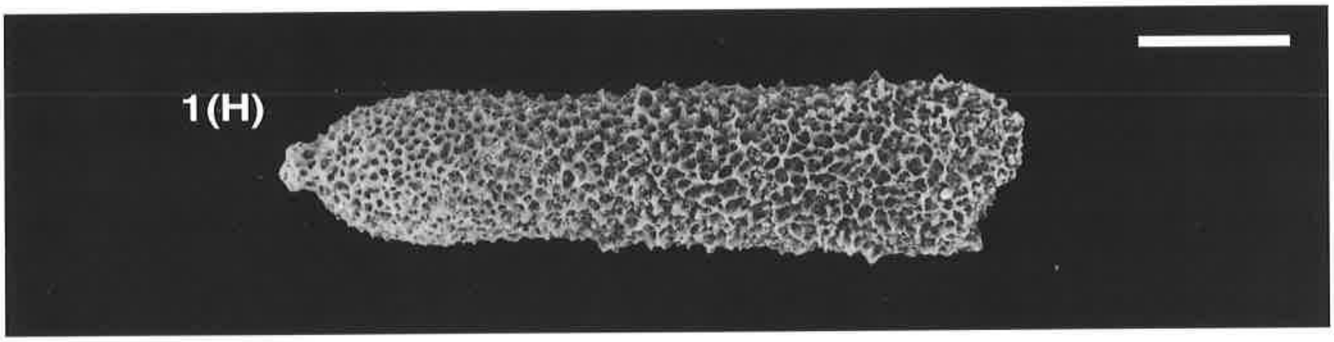


Plate 5576. *Pseudoeucyrtis* (?) *aspera* JUD. Magnification x150. **Fig. 1(H).** RJ2, Bo566.5.

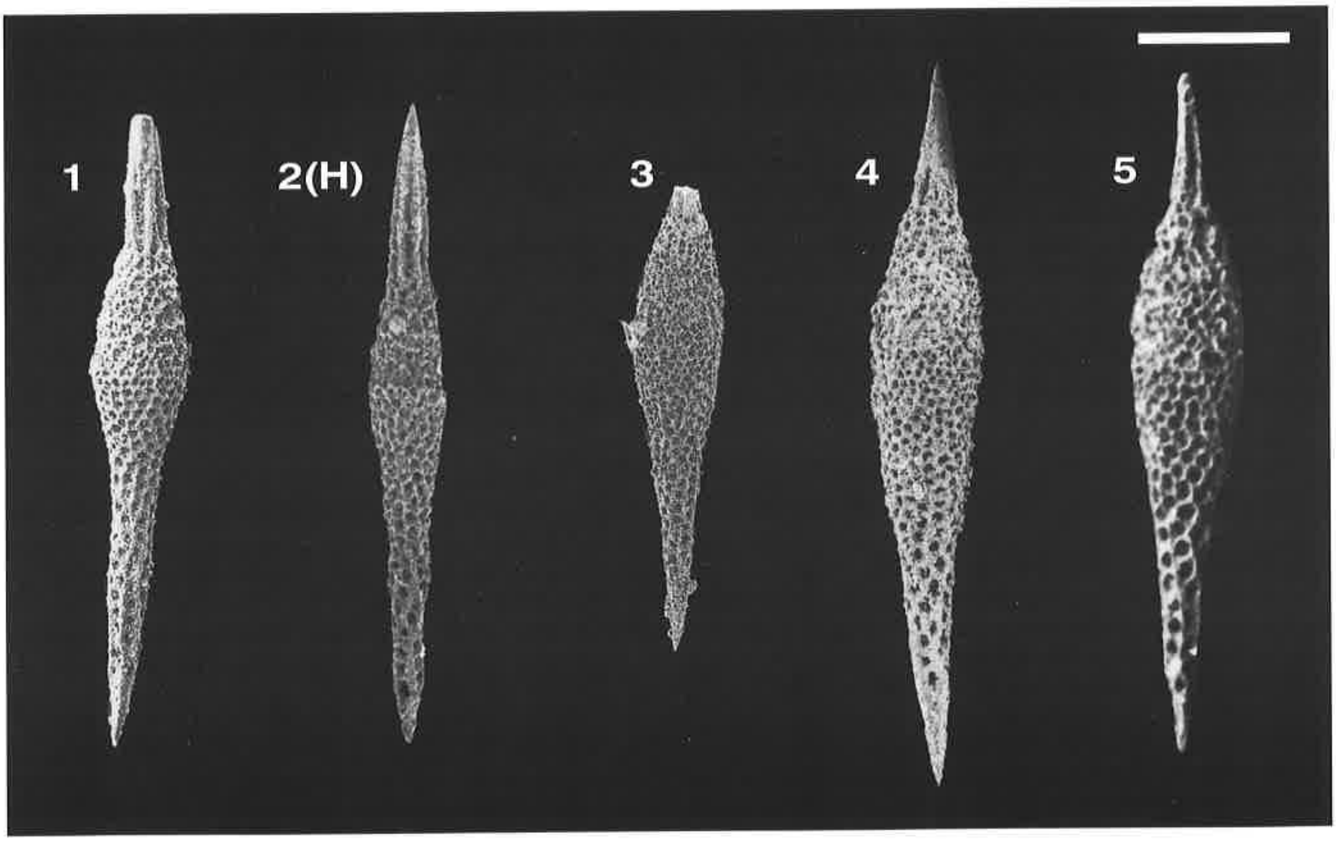


Plate 5408. *Pseudoeucyrtis* (?) *fusus* JUD. Magnification x150. **Fig. 1.** POB79/5079, POB1205.2. **Fig. 2(H).** RJ128, Br1330. **Fig. 3.** RJ278, Br28.85. **Fig. 4.** RJ287, Br28.85. **Fig. 5.** RJ852, Pi40.20.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Total length:	565	595	565	620
Lenght excl. apical spine:	409	495	386	503
Maximum width:	70	86	70	100
Lenght apical spine:	161	131	116	161

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-17, latest Tith. to late Val.

PSEUDOEUCYRTIS HANNI CF. — *5407*

Pseudoeucyrtis sp. cf. *P. hanni* (TAN)

Synonymy.-
Lithocampe hanni TAN
? TAN 1927, p. 64, pl. 13, fig. 109.
Eucyrtis hanni (TAN SIN HOK)
RENZ 1974, p. 792, pl. 7, figs. 21-25; pl. 12, fig. 16a-b.
? RIEDEL & SANFILIPPO 1974, p. 779, pl. 5, figs. 9-14; pl. 12, figs. 16-18.

Remarks.- The true status of this species remains questionable in the present state of knowledge. It seems to be closely related to *Lithocampe hanni* TAN but differs from it in the absence of a tubercular surface. It differs also from the form that Riedel and Sanfilippo (1974) illustrated as *Eucyrtis hanni*. Renz (1974) is the only author that undoubtedly illustrated specimens co-specific with ours. They have in common the shape of shell, and size and distribution of pores on the entire skeleton.

UAZones.- 17-18, late Val. to latest Val.-earliest Haut.

PSEUDOEUCYRTIS RETICULARIS — *3177*

Pseudoeucyrtis reticularis MATSUOKA & YAO

Synonymy.-
Ellipsoxiphus elongatus HEITZER
? HEITZER 1930, p. 389, pl. 27, fig. 18.
Pseudoeucyrtis sp.
MIZUTANI 1981, pl. 61, figs. 5-6.
OZVOLDOVA & SYKORA 1984, p. 270, pl. 10, figs. 5, 6, 8; pl. 13, fig. 2.
WAKITA 1988, pl. 6, fig. 15.
Pseudoeucyrtis sp. A
YAO et al. 1982, pl. 4, fig. 25.
YAO 1983, fig. 3.15.
YAO 1984, pl. 3, fig. 18.
WIDZ 1991, p. 253, pl. 3, fig. 21.
Eucyrtiidae ?
ORIGLIA-DEVOS 1983, pl. 18, fig. 7.
Pseudoeucyrtis reticularis MATSUOKA & YAO
MATSUOKA & YAO 1985, p. 132, pl. 1, figs. 16-21; pl. 3, figs. 14-17.
MATSUOKA & YAO 1986, pl. 2, fig. 15.
DANELIAN 1989, p. 184, pl. 7, fig. 15.
Eucyrtis aff. *tenuis* (RÜST)
DE WEVER et al. 1986, pl. 11, fig. 10.
Pseudoeucyrtis sp.
WAKITA 1988, pl. 6, fig. 15.
Eucyrtis sp.
? AITA 1987, pl. 12, fig. 6.
Pseudoeucyrtis sp. B
? WIDZ 1991, p. 253, pl. 3, fig. 22.

Original Definition.- Shell slender, spindle-shaped with a stout apical horn and stout basal spine. Proximal part segmented by internal septa while distal part lacking them and forming a large cavity. Segments varying in number from 4 to 7, according to the number of internal septa. Cephalis spherical or subcylindrical internally and relatively large, The remaining segments except for the last large one cylindrical and same in height. Pores circular, diagonally arranged and densely spaced. Pore frames polygonal in outline. Pores and pore frames increasing in size distally.

Original Remarks.- Height of shell of *Pseudoeucyrtis reticularis* n.sp. varies among specimens. Short specimens are slender biconical in outline, while long specimens are cylindrical in the middle part. *Pseudoeucyrtis* sp. from the Western Carpathians (Ozvoldova & Sykora, 1984; pl. 10, fig. 6) may correspond to the longest form of this species. *P. reticularis* differs from *Pseudoeucyrtis zhamoidai* (FOREMAN) and *Pseudoeucyrtis paskentaensis* PESSAGNO by having a smaller number of segments, by having pores and pore frames increasing in size distally and by having a stout basal spine.

Etymology.- This species is named from the Latin adjective *reticularis*, meaning reticular.

Measurements (in μm).-
Based on 18 specimens. Height overall, 282-380 (340); maximum width of shell, 63-100 (82); diameter of cephalis, 22-34 (28).

Type Locality.- Sample Y-VI906-14, Yura Formation, Wakayama Prefecture, southwest Japan.

UAZones.- 8-11, mid Call.-early Oxf. to late Kimm.-early Tith.

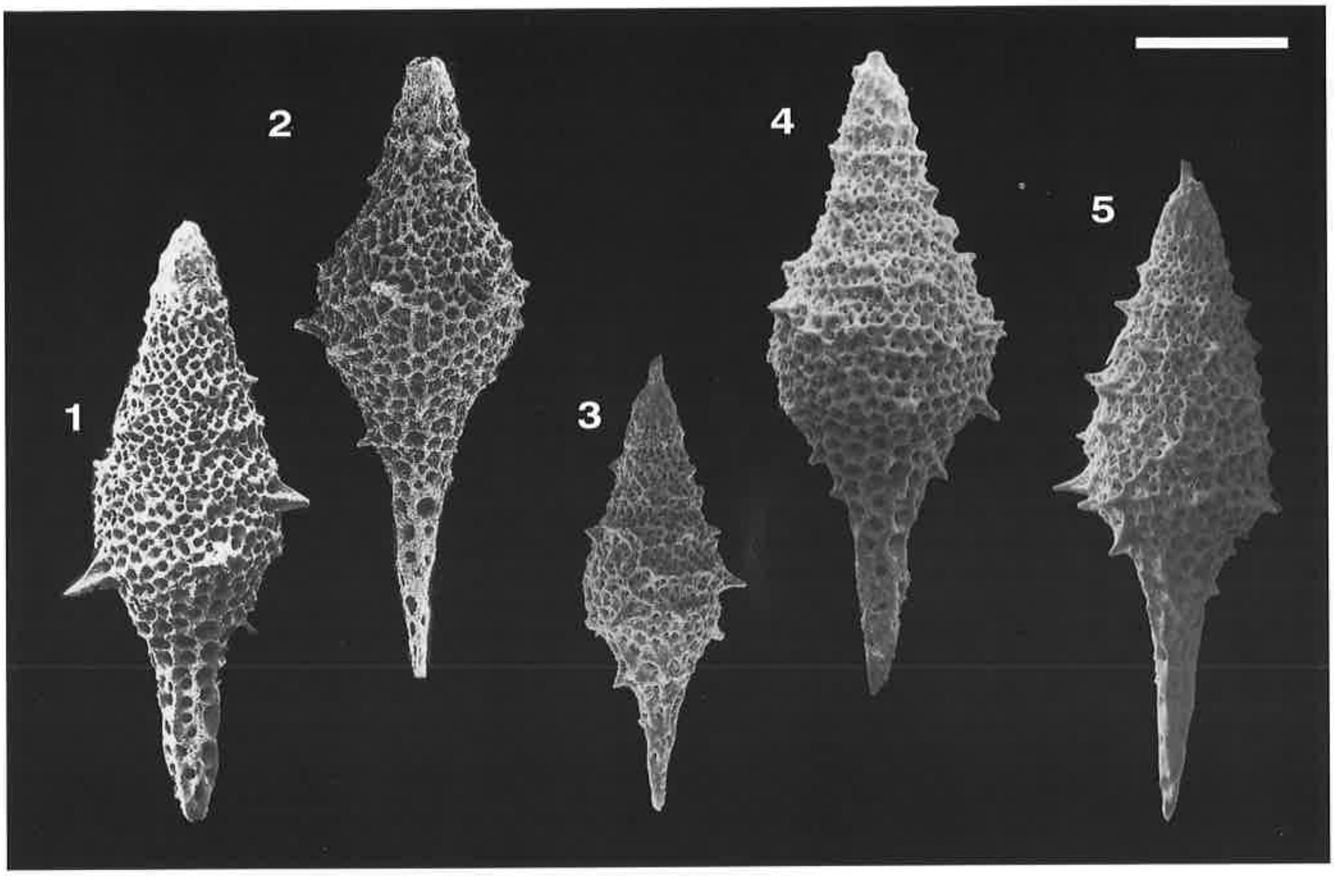


Plate 5407. ***Pseudoeucyrtis*** **sp. cf.** ***P. hanni*** **(TAN).** Magnification x200. **Fig. 1.** POB80/2692, V-37. **Fig. 2.** RJ586, Bo566.5. **Fig. 3.** DU561, Mo46. **Fig. 4.** DU348, Mo46. **Fig. 5.** PD793, Mo46.

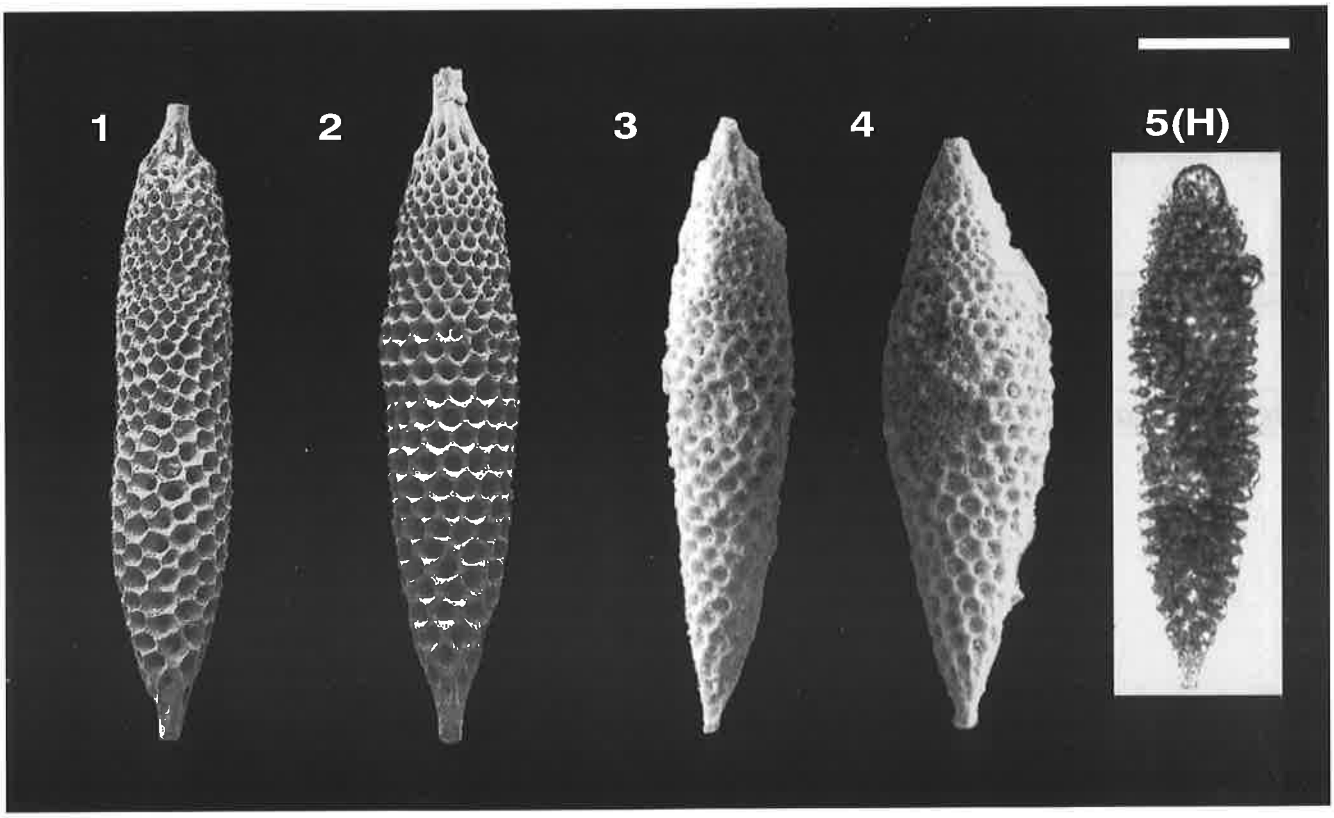


Plate 3177. ***Pseudoeucyrtis reticularis*** **MATSUOKA & YAO.** Magnification x200. **Fig. 1.** POB79/1661, POB79.5 J.86. **Fig. 2.** POB78/8196, POB986.51.**Fig. 3.** GO9005334, BM 106 **Fig. 4.** GO 900533, BM 106 **Fig. 5(H).** MATSUOKA & YAO 1985, pl. 3, fig. 15.

PSEUDOEUCYRTIS SCEPTRUM 5577

Pseudoeucyrtis sceptrum JUD

Synonymy.-
Pseudocyrtis sp.
SCHAAF 1984, p. 155, figs. 7a-b.
Pseudoeucyrtis sceptrum JUD
JUD 1994, p. 101, pl. 18, fig. 20.

Original Definition.- Long, slender, inverted conical test of 3 or more segments with short, sturdy, bladed, apical horn, and a long conical distal tip. Apical portion inflated, with pores of variable size and shape. Starting from this part, test is gradually tapering to the distal end, but a few slightly inflated portions can sometimes be observed indicating probably the presence of some inner partitions. Terminal part, which is approximately as long as half of the overall test, long, conical, without external constrictions and closed by a distal spine. Pores irregularly arranged on most part of test, and in longitudinal rows on the terminal portion.

Original Remarks.- *Pseudoeucyrtis sceptrum* n.sp. differs from *Pseudoeucyrtis* (?) *fusus* n.sp. by lacking a very long apical bladed horn and by having a maximum diameter at the apical part. It differs from *Pseudoeucyrtis acus* n.sp. by its distinct inverted conical shape, more inflated apical part which bears a longer horn, and by the irregular arrangement of pores on most part of test.

Etymology.- From the Latin *sceptrum*, scepter.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Maximum length:	723	719	619	814
Maximum width:	100	97	90	100
Length of horn:	71	63	71	71

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 13-15, latest Tith. to late Berr.-earliest Val.

PSEUDOEUCYRTIS \ *J* 3176

Pseudoeucyrtis sp. J

Synonymy.-
Pseudoeucyrtis sp.
WAKITA 1988, pl. 4, fig. 24.
Eucyrtis sp. J aff. *E. micropora* (SQUINABOL)
CONTI & MARCUCCI 1991, p. 800, pl. 2, fig. 1, ? fig. 2.

Original Definition.- This form presents thin spines at the segmental divisions. Pores are round and regularly spaced in transverse rows. Pores of the distal part are larger than those of the proximal part; in the median part of the shell, where the diameter begins to diminish in a distal direction, there is a row of still larger, round pores.

Original Remarks.- This form differs from *E. micropora* (FOREMAN) in having thin spines arranged in transverse rows, probably corresponding to the segmental division, and by more regular arrangement of pores.

UAZones.- 5-10, latest Baj.-early Bath. to late Oxf.-early Kimm.

pseudoewingi >> *HOMOEOPARONAELLA (?) PSEUDOEWINGI* 3150

pseudoplena >> *TETRADITRYMA PSEUDOPLENA* 3123

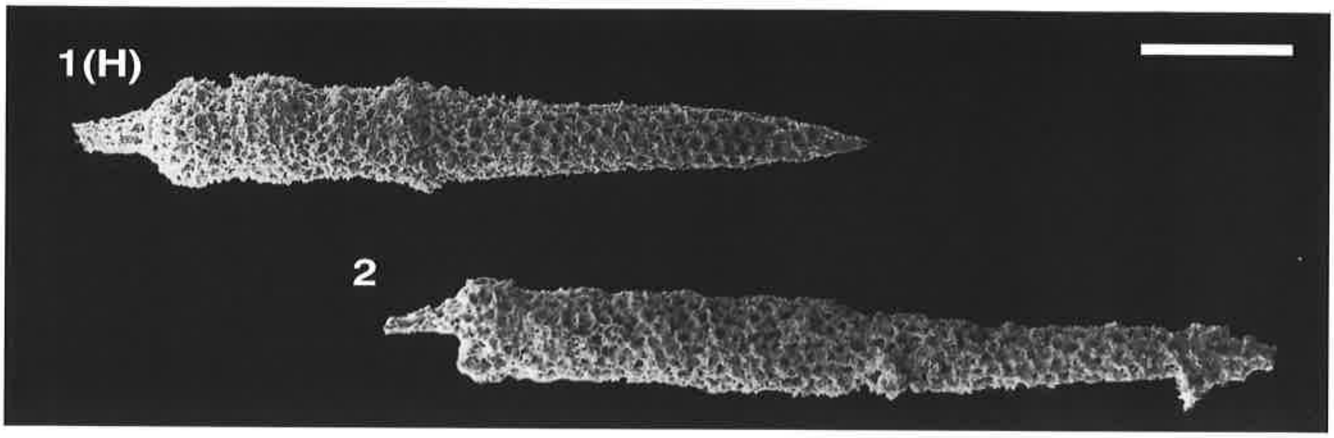


Plate 5577. *Pseudoeucyrtis sceptrum* JUD. Magnification x150. **Fig. 1(H).** RJ222, V-6. **Fig. 2.** RJ97, Bo311.2.

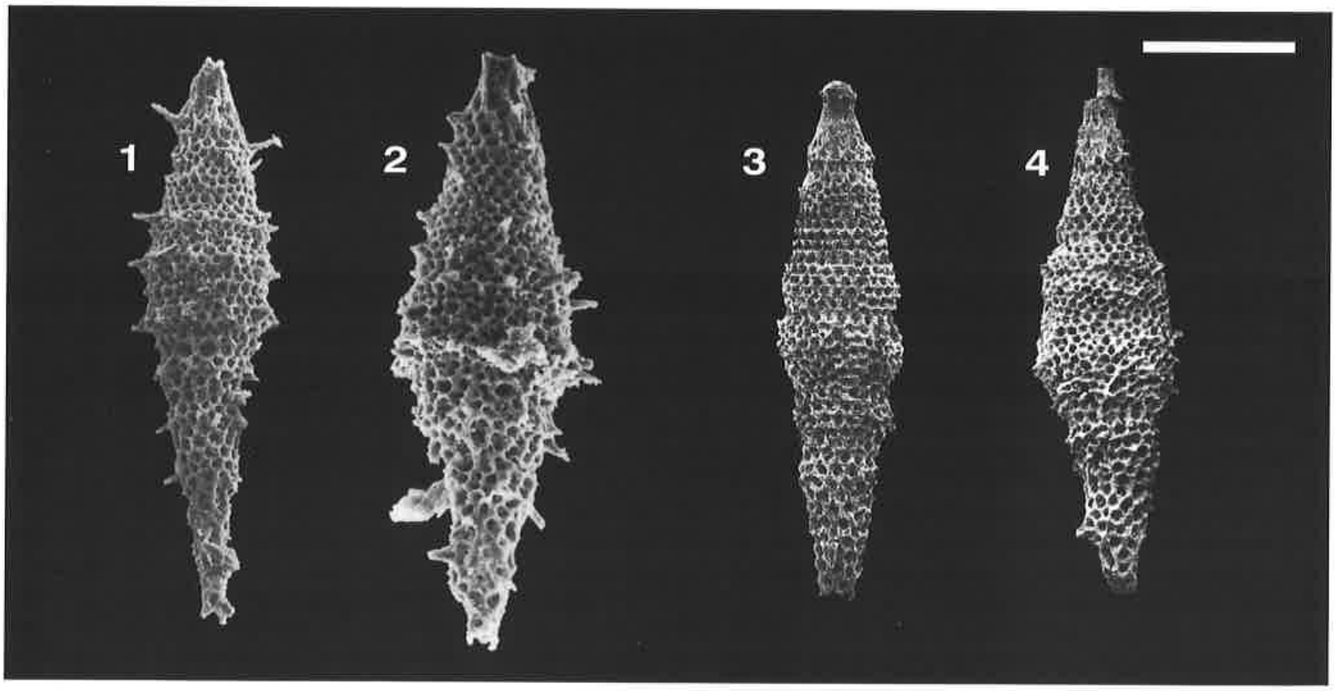


Plate 3176. *Pseudoeucyrtis* sp. J. Magnification x150. **Fig. 1.** MC, GR6. **Fig. 2.** MC, GR6. **Fig. 3.** POB 78/7605, POB 916.51. **Fig. 4.** POB 79/1683, POB 79.5.

PSEUDOPOULPUS 3822

Genus: *Pseudopoulpus* TAKEMURA

Synonymy.-
Pseudopoulpus TAKEMURA 1986
TAKEMURA 1986, p. 39.

Type Species.- *Pseudopoulpus yamatoensis* TAKEMURA 1986.

Original Definition.- Shell of one segment, cephalis with apical horn and three feet. Cephalis subspherical, large and perforated by many irregularly or hexagonally arrangemed pores. Cephalis subdivided usually slightly into two parts by longitudinal grooves on cephalic surface, which accords with arches Al. Apical horn, which is a prolongation of A, usually triradiate and thinner than the three feet. Three feet, prolongations of two L and D, triradiate and strong. MB, A, V, D, two L and two L as cephalic skeletal elements and two arches Al existing. VL, Ll, and LD at collar portion. Arch AV not existing. V not on the same plane defined by MB and two L.

Original Remarks.- *Pseudopoulpus* n.gen. differs from the genera *Saitoum* PESSAGNO and *Poulpus* DE WEVER, which belong to the subfamily Poulpinae DE WEVER, in lack of arch AV, which is the sagittal ring (text-fig. 3). Although *Pseudopoulpus* n.gen. has a thick and latticed cephalic shell, this new genus is tentatively assigned to the family Plagoniidae HAECKEL, emend. RIEDEL in the present paper, because of its tripod skeleton and considerably large cephalis. Cephalic skeletal structures of Cenozoic Plagoniids, however, have not yet been clarified sufficiently.

Etymology.- The genus name, is derived from *pseudo* and the genus name *Poulpus* DE WEVER.

Included Taxa.-
2007 *Pseudopoulpus acutipodium* TAKEMURA

PSEUDOPOULPUS ACUTIPODIUM 2007

Pseudopoulpus acutipodium TAKEMURA

Synonymy.-
Pseudopoulpus acutipodium TAKEMURA
TAKEMURA 1986, p. 40, pl. 1, figs. 5-8.

Original Definition.- Cephalis large and subspherical, with irregularly or hexagonally arranged usually circular pores and pore frames. Apical horn thin, short and triradiate proximally. Three feet strong, straight, triradiate and sharply pointed.

Original Remarks.- *P. acutipodium* n.sp. is distinguished from *P. yamatoensis* by its sharply pointed feet.

Etymology.- *Acutipodium*, means sharpened foot.

Measurements (in μm).-
Based on 5 specimens. Length of shell including horn and feet, 175-240; Height of cephalis, 85-100; Maximum width of shell including feet, 180-215; Width of cephalis, 95-120.

Type Locality.- Sample TKN-105, Gujo-Hachiman area in the Mino terrane, central Japan.

UAZones.- 1-2, early-mid Aal. to late Aal.

pseudoscalaris >> *DICTYOMITRA PSEUDOSCALARIS* 5927

ptyctum >> *EUCYRTIDIELLUM PTYCTUM* 3017

puga >> *WRANGELLIUM PUGA* 5636

pulchella >> *STICHOCAPSA PULCHELLA* 5744

pulcher >> *XITUS PULCHER AFF.* 3258

pulchra >> *THANARLA PULCHRA* 5073

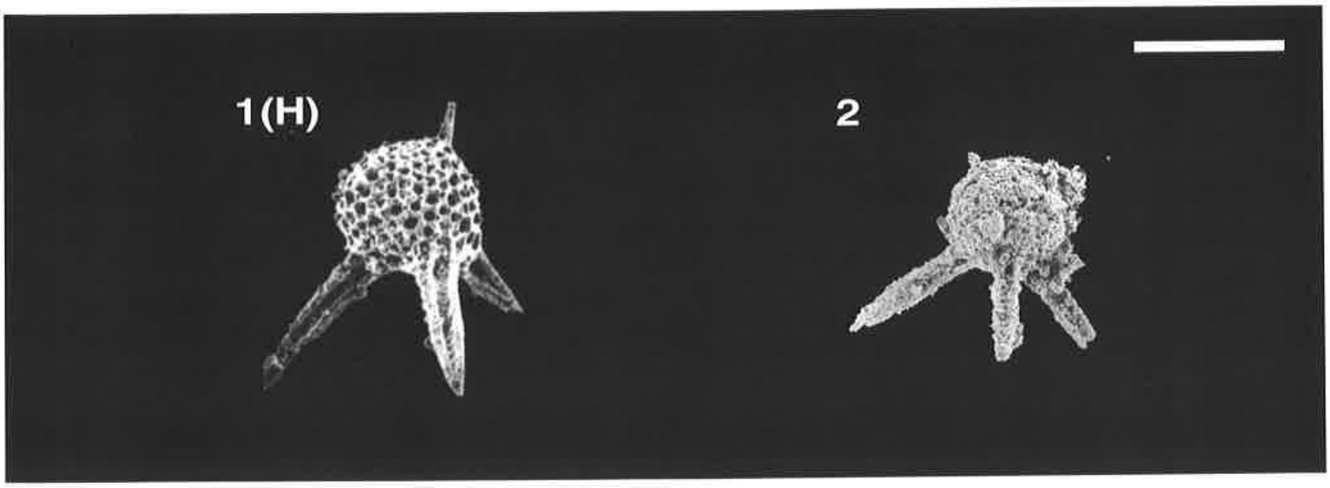


Plate 2007. ***Pseudopoulpus acutipodium*** **TAKEMURA.** Magnification x200. **Fig. 1(H).** TAKEMURA 1986, pl. 1, figs. 5-8. **Fig. 2.** AB139, TM48.35.b53.

purisimaensis >> *ANGULOBRACCHIA PURISIMAENSIS* 3144

pusillus >> *LITHATRACTUS PUSILLUS AFF.* 5041

pustulatum >> *EUCYRTIDIELLUM UNUMAENSE PUSTULATUM* 3013

pygmaea >> *PARONAELLA PYGMAEA* 3133

pyramidalis >> *NAPORA PYRAMIDALIS* 3033

pyramis >> *EUCYRTIDIELLUM PYRAMIS* 3019

PYRAMISPONGIA 6018

Genus: *Pyramispongia* PESSAGNO

Synonymy.-
Pyramispongia PESSAGNO
PESSAGNO 1973, p. 78.
Nodotetraedra STEIGER
STEIGER 1992, p. 32.

Type Species.- *Pyramispongia magnifica* PESSAGNO 1973.

Original Definition.- Cortical shell spongy, subpyramidal in shape with cupolae situated at four corners of shell (pl. 19, figs. 5-6; pl. 13, figs. 2, 4); cupolae arising from shelf-like ring. Cortical shell often spinose with massive spines arising from centre of cupolae. Cortical shell moulded around peculiar spongy cortical frame (pl. 20, figs. 2-6; pl. 21, fig. 1; text-fig. 4). Latticed medullary shell spherical in shape connected to cortical shell by radially arranged solid beams which appear to be continuous with solid spines of cortical shell.

Remarks.- Species have been distinguished by Pessagno 1973 on the basis of the general test shape and by the number, character and position of the spines.

Etymology.- *Pyramis* (Latin, f.) = a pyramid plus *spongia* (Latin, f.) = sponge.

Included Taxa.-
6109 *Pyramispongia barmsteinensis* (STEIGER)

PYRAMISPONGIA BARMSTEINENSIS 6109

Pyramispongia barmsteinensis (STEIGER)

Synonymy.-
Nodotetraedra barmsteinensis STEIGER
STEIGER 1992, p. 33, pl. 4, figs. 9-14.

Original Definition.- "Tetrahedral nodose cortical shell with four primary spines and numerous secondary spines. The primary spines are solid and arise at the apices of the tetrahedron. They are thin, of approximately the same length as the diameter of the shell, with smooth surface. Spine-tips usually pointed. In one case a differentiation of a single spine could be demonstrated: the spine-tip is surrounded by a collar-like crown of secondary spines.

So far no other species have been described although there are big differences in surface ornamentation, considering especially the presence of secondary spines on the cortical shell. Therefore *Nodotetraedra barmsteinensis* cannot be compared to any other known form."

Original Remarks.- "Since more species have not been distinguished, the equal structure of primary spines is considered a higher value differential character than the existence of secondary spines. The examination of surface characteristics clearly points to diagenetic processes like dissolution and recrystallisation which influence the preservation of secondary spines. *Nodotetraedra barmsteinensis* is thus defined on the basis of solid spines and a spongy cortical shell, whereas secondary spines may or may not be present."

Etymology.- Named after the type locality , Barmsteine near Hallein.

Measurements (in μm).-
Diameter of shell: 145-180, length of spines: 120-165, diameter of spines in the middle: 18-30.

Type Locality.- Kaltenhausen section, sample Ka 7, Schneiderwald Anticline (Salzburg, Austria).

UAZones.- 13-20, latest Tith. to late Haut.

pythiae >> *CROLANIUM PYTHIAE* 5532

quadrangularis >> *HILARISIREX QUADRANGULARIS* 3002

quadriaculeata >> *PODOBURSA QUADRIACULEATA AFF.* 3289

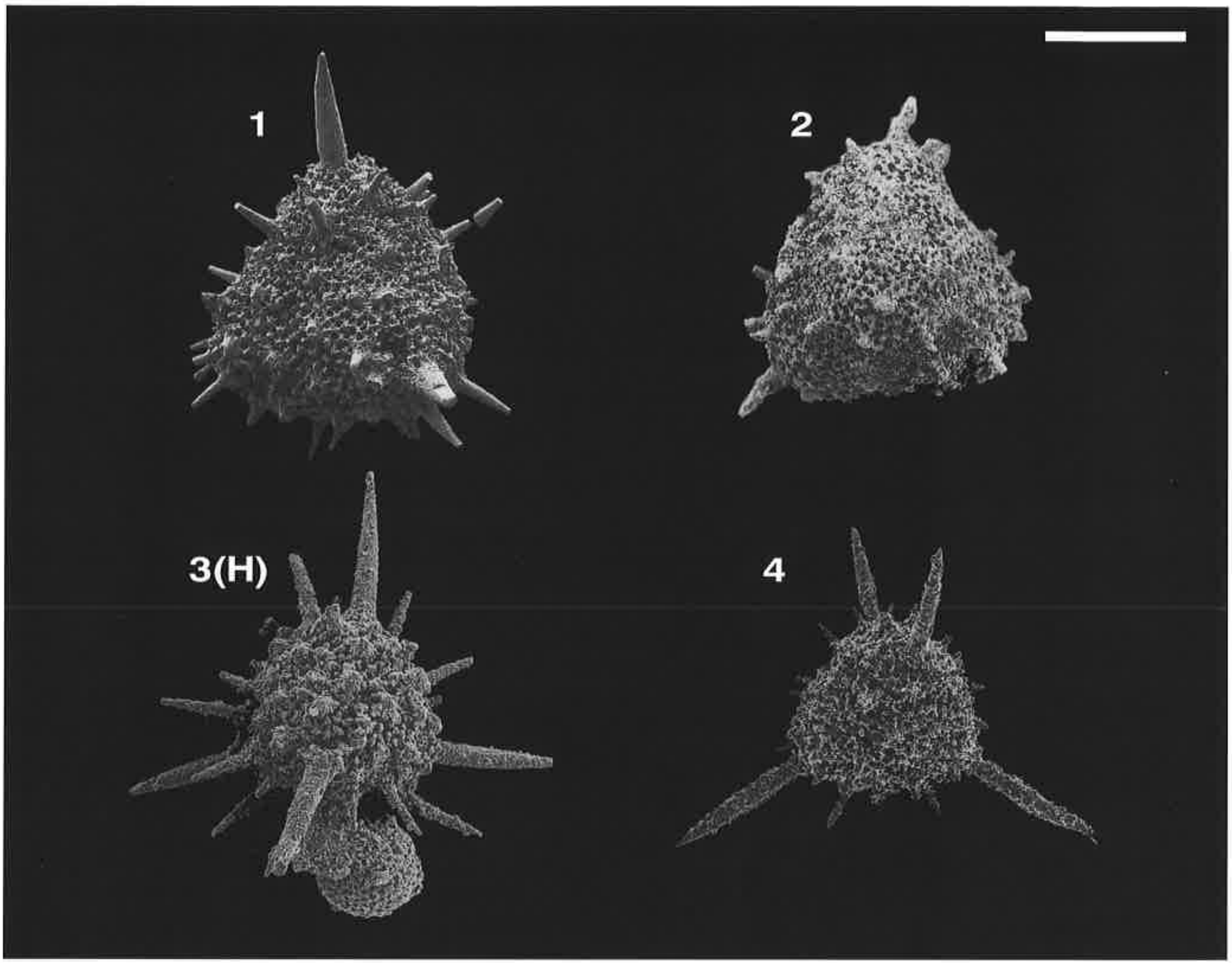


Plate 6109. ***Pyramispongia barmsteinensis*** **(STEIGER).** Magnification x150. **Fig. 1.** POB79/4152, MO2 46. **Fig. 2.** RJ206, Bo566.5. **Fig. 3(H).** TS18, TE4/4. **Fig. 4.**TS9, Ka7/1

QUARTICELLA 3808

Genus: *Quarticella* TAKEMURA

Synonymy.-
Quarticella TAKEMURA
TAKEMURA 1986, p. 58.

Type Species.- *Quarticella ovalis* TAKEMURA 1986.

Original Definition.- Shell conical, oval or spindle-shaped, usually not closed, with four or five segments. The proximal three segments conical, usually with weak collar and lumbar strictures. Cephalis small, spherical and poreless, with or without apical horn. Thorax and abdomen truncated-conical with pores or relict pores. Thoracic pores irregularly distributed and abdominal pores irregularly or transversely arranged. The fourth segment inflated and subspherical, ellipsoidal or cylindrical, with small pores and large aperture, and with or without spines. The fifth segment, when existing, cylindrical and smaller than the fourth segment, with medium sized aperture. Aperture of some segments larger than that of the more proximal ones, except that of the fifth segment. Nodes or some secondary out growths may occur on the shell surface. MB, A, V, D, two L and two l as cephalic skeletal elements and VB on the inner surface of the cephalis.

Original Remarks.- *Quarticella* n.gen. differs from the genera of the subfamily Syringocapsinae in its *Amphipyndax*-type cephalic skeletal structure. This genus is also different from *Yamatoum* n.gen. in the possession of an inflated fourth segment with smaller pores and large aperture, no terminal spines, and usually poreless spherical cephalis. *Quarticella* is distinguished from *Parvifavus* n.gen. by its structure of the shell wall with smooth or rough surface bearing nodes and/or spines and smaller pores, without transversely arranged pores and pore frames, and by its inflated fourth segment.

Etymology.- The generic name *Quarticella* means the fourth chamber.

Included Taxa.-
4078 *Quarticella ovalis* TAKEMURA

QUARTICELLA OVALIS 4078

Quarticella ovalis TAKEMURA

Synonymy.-
Quarticella ovalis TAKEMURA
TAKEMURA 1986, p. 58, pl. 8, figs. 17-21.

Original Definition.- Cephalis small, spherical and poreless, with no apical horn, but in some specimens with a small node. Thorax truncated-conical to ellipsoid shaped with irregularly distributed circular pores. Abdomen truncated-conical with circular pores which are usually arranged in four transverse lines, or irregularly distributed. The fourth segment large, inflated and subspherical to ellipsoid shaped with usually irregularly distributed circular pores, with many small nodes on the surface, and with or without usually thin, short and many irregularly distributed spines. The height of the fourth segment usually larger than that of the proximal three segments. Strictures existing at the boundaries of each segments. The fifth segment usually broken off, but wall around aperture.

Original Remarks.- *Quarticella ovalis* n.sp. is distinguished from the other species of this genus by the absence of an apical horn and strong spines on the fourth segment.

Etymology.- Latin noun, *ovalis*, means oval.

Measurements (in μm).-
Based on 12 specimens. Length of shell, 125-165; Height of proximal 3 segments, 55-65; Height of the fourth segment, 60-100; Width of the fourth segment, 105-130.

Type Locality.- Maganese carbonate ore deposit, TKN-105. Gujo-Hachiman area, Mino Terrane, central Japan.

UAZones.- 4-4, late Baj. to late Baj.

quinatum >> *EUCYRTIDIELLUM (?) QUINATUM* 3048

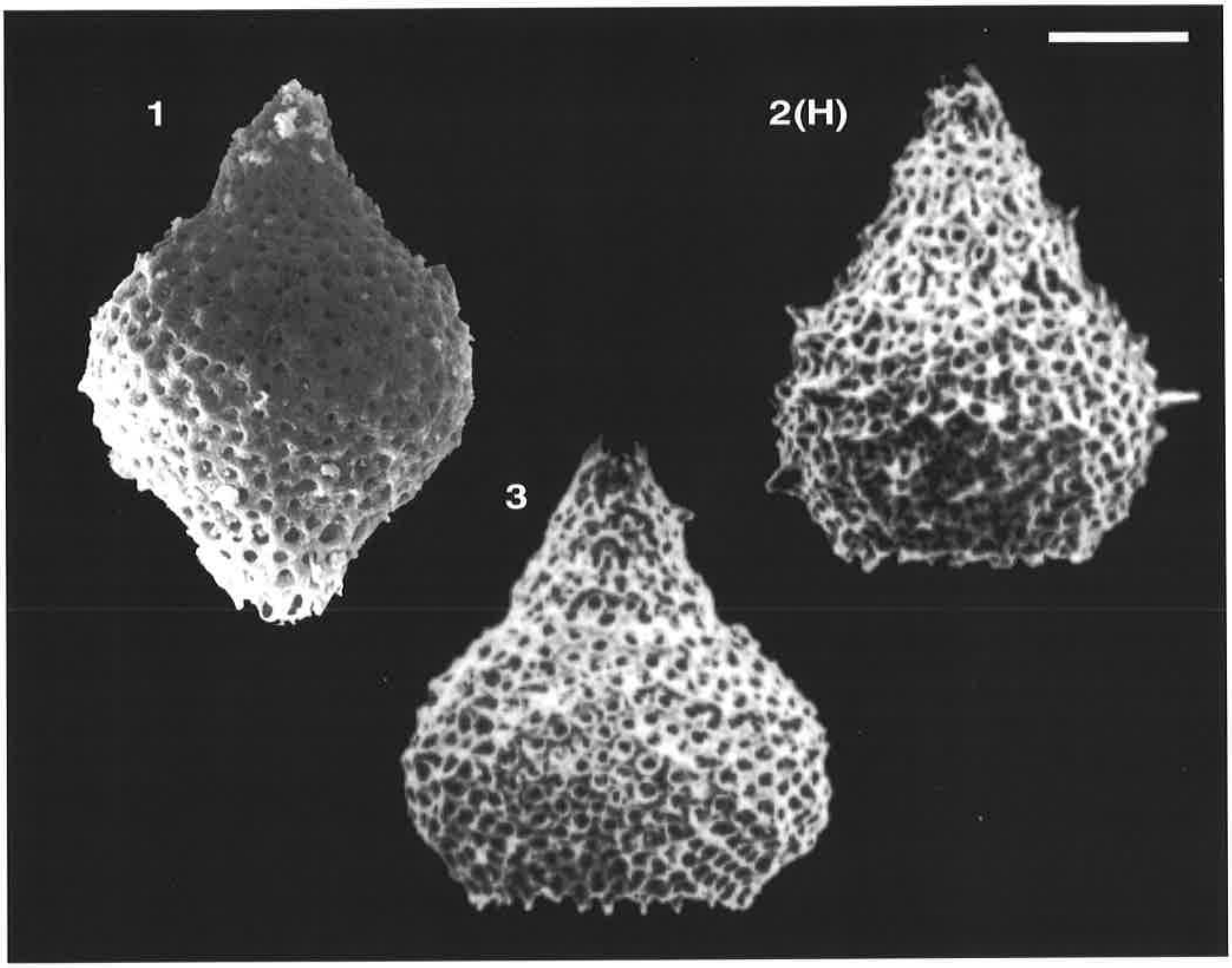


Plate 4078. ***Quarticella ovalis*** **TAKEMURA.** Magnification x 500. **Fig. 1.** MA1. **Fig. 2(H).** TAKEMURA 1986, pl. 8, fig. 17. **Fig. 3.** TAKEMURA 1986, pl. 8, fig. 20.

QUINQUECAPSULARIA 3814

Genus: *Quinquecapsularia* PESSAGNO

Synonymy.-
Quinquecapsularia PESSAGNO
PESSAGNO 1971b, p. 362.

Type Species.- *Quinquecapsularia spinosa* PESSAGNO 1971b.

Original Definition.- Three concentric lattice shells, all displaying marked pentagonal symmetry. Cortical shell with two pentagonal faces and five square faces; first medullary shell with same shape, but connected to cortical shell by seven buttresses; five of these buttresses connecting first medullary shell to central portions of five square faces of cortical shell; remaining two buttresses connecting first medullary shell to central portions of two pentagonal faces of cortical shell; second (innermost) medullary shell with same basic symmetry as outer shell, but attached to first medullary shell by spines rather than by latticed buttresses.

Original Remarks.- The marked pentagonal symmetry of its three lattice shells and the presence of latticed buttresses connecting the first medullary shell to the cortical shell make *Quinquecapsularia* quite dissimilar to any known genus of spheroid Spumellariina. It is likely that future studies will indicate that this genus should be placed in a new family group.

Etymology.- *Quinque* (Latin) = five plus *capsula* (Latin f.) = a small box or chest.

Included Taxa.-
3081 *Quinquecapsularia megasphaerica* n.sp. DUMITRICA & BAUMGARTNER

QUINQUECAPSULARIA MEGASPHAERICA 3081

Quinquecapsularia megasphaerica n.sp. DUMITRICA & BAUMGARTNER

Synonymy.-
Cenosphaera hirta PARONA
RIEGRAF 1986, p. 14, pl. 3, fig. 16.

Type Designation.- 78/ 3583, POB 28.64.

Original Definition.- Cortical shell large, armed with ten long three-bladed spines connected to each other on the surface of shell by well marked ribs which mark by their disposition the edges of a short pentagonal prism, with two opposite pentagonal faces and four squarish or subsquarish faces. Spines arise from the corner of such a skeleton and are directed along the diagonals of this pentagonal prism. Cortical shell developed within the system of arches small surfaced, convex, with polygonal (quadrangular to heptagonal) pore-frames. Internal skeleton not visible, but judging from some remains of central capsule membranes found by one of us (Fig. 5) in a Kimmeridgian limestone, it would consist of two concentric pentagonal prisms connected to one another and to the cortical shell by the inner prolongations of the spines.

Original Remarks.- Externally *Quinquecapsularia megasphaerica* n.sp. differs from *Q. spinosa* PESSAGNO in having larger size, much longer spines, convex surface, irregular polygonal pores, and well defined ribs marking the edges of the pentagon.

Etymology.- From the Greek *mega* = large and *sphaerica* = spherical.

Measurements (in μm).-
Based on 6 Specimens.

	HT	av.	min.	max.
Diameter of shell:	560	551	470	650
Length of spines :	493	561	488	613

Type Locality.- POB 28.64, see locality description in Baumgartner (1984).

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

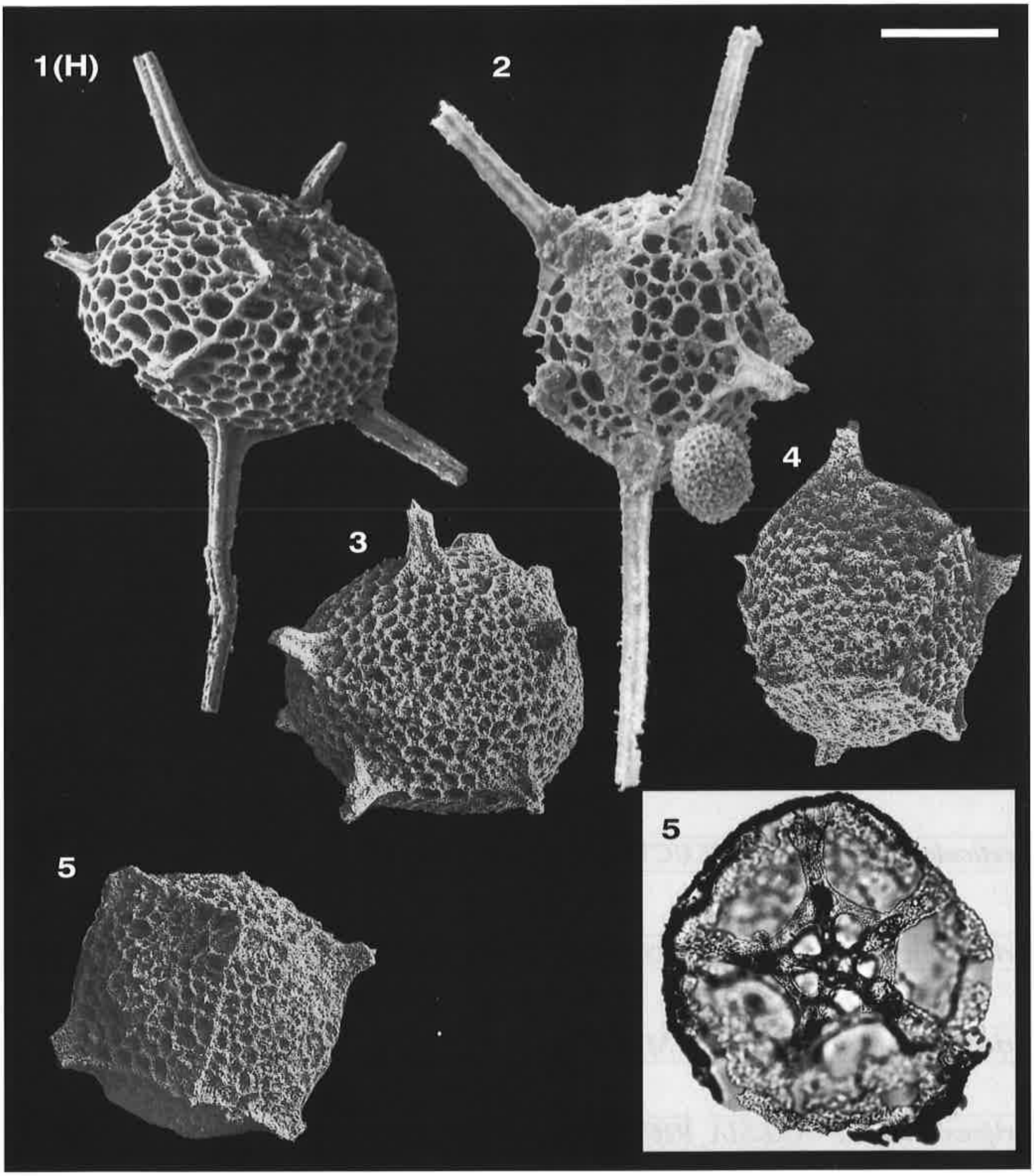


Plate 3081. ***Quinquecapsularia megasphaerica*** **n.sp. DUMITRICA & BAUMGARTNER.** Magnification x100. **Fig. 1(H).** POB78/3583, POB28.64. **Fig. 2.** MA10306, MKM-1. **Fig. 3.** DU3745, SV16. **Fig. 4.** DU 3748, SV16. **Fig. 5.** DU3750, SV16. **Fig. 6.** DU, TAT 1.

radix >> *TETRATRABS RADIX*	*5209*

raricostatum >> *HSUUM RARICOSTATUM*	*3591*

rarum >> *CYCLASTRUM RARUM*	*5290*

rectispinus >> *BERNOULLIUS RECTISPINUS DELNORTENSIS*	*3222*

rectispinus >> *BERNOULLIUS RECTISPINUS LEPORINUS*	*4064*

rectispinus >> *BERNOULLIUS RECTISPINUS RECTISPINUS*	*4011*

rectispinus >> *BERNOULLIUS RECTISPINUS S.L.*	*4010*

reticularis >> *BERNOULIUS RECTISPINUS \ B*	*2017*

remanei >> *CRUCELLA REMANEI*	*5143*

reticularis >> *PSEUDOEUCYRTIS RETICULARIS*	*3177*

rhododactylus >> *TRITRABS RHODODACTYLUS*	*3118*

riedeli >> *PANTANELLIUM RIEDELI*	*3078*

rifensis >> *LINARESIA RIFENSIS*	*2022*

RISTOLA	*3687*

Genus: *Ristola* PESSAGNO & WHALEN sensu BAUMGARTNER

Synonymy.-
Ristola PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 148.
emend. BAUMGARTNER 1984, p. 783.

Type Species.- *Parvicingula* (?) *procera* PESSAGNO 1977a.

Original Definition.- Test multicyrtid, conical to cylindrical, lacking a horn; some species with over 33 post-abdominal chambers. Post-abdominal chambers with three rows of symmetrical pore frames between two given circumferential ridges. Final post-abdominal chambers, when preserved, with tubular extension.

Actualized Definition.- (BAUMGARTNER, 1984) Pessagno & Whalen (1982) erected this genus to include all forms questionably assigned to *Parvicingula* lacking a horn. It is herein emended to include only species which have a conical proximal portion, a very long cylindrical portion with several tens of postabdominal segments and in addition have an outer layer, which, similar as with *Mirifusus* tends to obscure the regular hexagonal pore frames of the inner layer in the proximal portion of the test (see pl. 8, figs. 3, 9, 10). Conical forms lacking this outer layer are included with *Parvicingula*, whether they have a horn or not.

Original Remarks.- *Lithocampe altissima* RÜST was placed by Pessagno (1977a, p. 85) in *Parvicingula*. Since this species lacks a horn it should be reassigned to *Ristola* n.gen. *Ristola* differs from *Parvicingula* by lacking a horn.

Remarks.- Species are distinguished on overall shape and on surface ornamentation.

Etymology.- *Ristola* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. VI, recommendation 40, p. 113).

Included Taxa.-
3164 *Ristola altissima* s.l. (RÜST)
3241 *Ristola altissima altissima* (RÜST)
3238 *Ristola altissima major* n.ssp. BAUMGARTNER & DE WEVER
5575 *Ristola asparagus* JUD
3165 *Ristola cretacea* (BAUMGARTNER)
5766 *Ristola martae* JUD
2014 *Ristola* (?) *praemirifusus* n.sp. BAUMGARTNER & BARTOLINI
3163 *Ristola procera* (PESSAGNO)
3543 *Ristola* (?) *turpicula* PESSAGNO & WHALEN

RISTOLA ALTISSIMA S.L. 3164

Ristola altissima s. l. (RÜST)

Synonymy.-
Lithocampe altissima RÜST
RÜST 1885, p. 315 (45), pl. 40, fig. 2.

See also subspecies.

Included Taxa.-
3241 *Ristola altissima altissima* (RÜST)
3238 *Ristola altissima major* n.ssp. BAUMGARTNER & DE WEVER

UAZones.- 5-12, latest Baj.-early Bath. to early-early late Tith.

RISTOLA ALTISSIMA ALTISSIMA 3241

Ristola altissima altissima (RÜST)

Synonymy.-
Lithocampe altissima RÜST
RÜST 1885, p. 315(45), pl. 40, fig. 2.
Parvicingula altissima (RÜST)
emend. PESSAGNO 1977a, p. 85, pl. 8, figs. 9-10.
NAKASEKO et al. 1979, p. 23, pl. 1, figs. 9-10.
KOCHER 1981, p. 81, pl. 15, fig. 9.
NAKASEKO & NISHIMURA 1981, p. 156, pl. 8, fig. 14.
ADACHI 1982, pl. 1, fig. 8.
YAO 1982, pl. 4, fig. 19.
Parvicingula (?) *altissima* RÜST
BAUMGARTNER et al. 1980, p. 58, pl. 5, figs. 4-7.
OZVOLDOVA & SYKORA 1984, p. 268, pl. 11, figs. 4, 7, 8; pl. 15, fig. 3.
YAO 1984, pl. 2, fig. 25.
DE WEVER et al. 1986, pl. 9, fig. 9.
Ristola altissima (RÜST)
BAUMGARTNER 1984, p. 783, pl. 8, fig. 3, not 4, 9.
PESSAGNO et al. 1984, p. 28, pl. 3, fig. 10.
BAUMGARTNER 1985, fig. 38p.
AITA & OKADA 1986, p. 114, pl. 2, figs. 5-6.
AITA 1987, p. 66, pl. 12, fig. 11; not pl. 11, fig. 9.
KITO 1987, pl. 3, fig. 11.
OZVOLDOVA 1988, pl. 4, fig. 5.
WAKITA 1988, pl. 5, fig. 14.
DANELIAN 1989, p. 186, pl. 7, fig. 16, not figs. 17-18.
YAO 1991, pl. 4, fig. 12.
KIESSLING 1992, pl. 1, fig. 11.
Ristola altissima (RÜST) ssp. A.
WIDZ 1991, p. 253, pl. 3, fig. 24.
Ristola altissima (RÜST) ssp. B
WIDZ 1991, p. 253, pl. 3, fig. 24.
Ristola altissima altissima (RÜST)
JUD 1994, p. 101, pl. 19, fig. 1.

Original Definition.- "With 24-25 segments. Each segment with 3 rows of very small pores."

Actualized Definition.- (PESSAGNO, 1977a) Test predominantly cylindrical, quite elongate with conical cephalis and short, massive horn. Postabdominal chambers closely spaced, increasing very slowly in height, or more in number. Meshwork between two given ridges consisting of three rows of hexagonal pore frames.

Actualized Remarks.- (PESSAGNO, 1977a) Rüst's description of this species is quite brief. However, his illustration is surprisingly accurate and corresponds closely to the scanning electron micrographs and description of California specimens presented herein.

Measurements (in μm).-
Maximum length 892, maximum width 32.

Type Locality.- Jaspers from western Switzerland

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

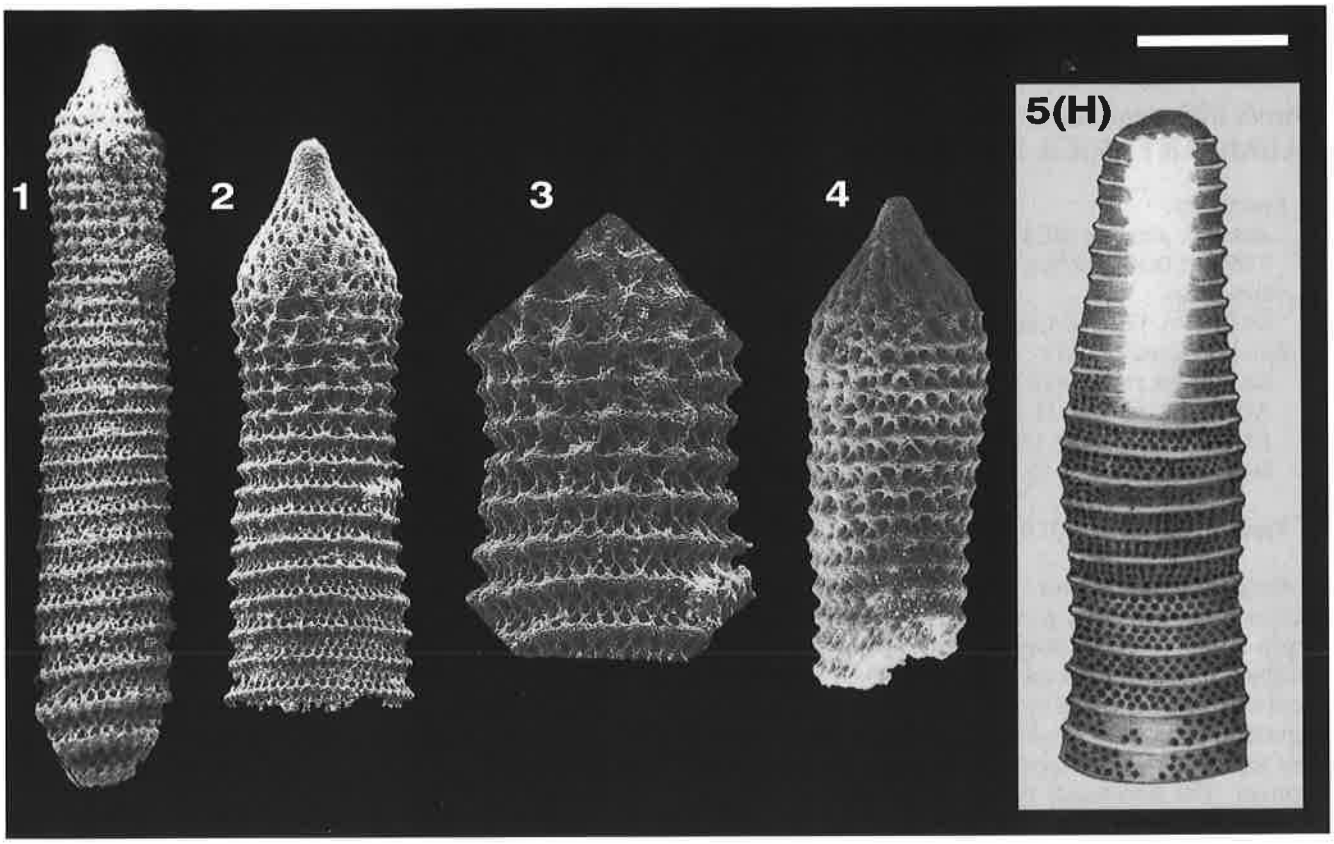


Plate 3241. ***Ristola altissima altissima* (RÜST).** Magnification, Figs. 1, 5(H) x100, Figs. 2, 4 x150, Fig. 3. x250. **Fig. 1.** POB79/4710, POBS4. **Fig. 2.** POB78/6273, POB899.53. **Fig. 3.** POB78/6274, POB899.53. **Fig. 4.** DU1847, R102. **Fig. 5(H)** RÜST 1885, pl. 40, Fig. 2.

RISTOLA ALTISSIMA MAJOR 3238

Ristola altissima major n.ssp. BAUMGARTNER & DE WEVER

***Synonymy*.-**
Lithocampe altissima (RÜST)
? OZVOLDOVA 1979, p. 258, pl. 5, fig. 1.
Mirifusus sp.
SATO et al. 1982, pl. 4, fig. 13.
Ristola altissima (RÜST)
BAUMGARTNER 1984, p. 783, pl. 8, figs. 4, 9, not fig. 3.
AITA 1987, p. 66, pl. 11, fig. 9; not pl. 12, fig. 11.
KISHIDA & HISADA 1986, pl. 2, fig. 5.
DANELIAN 1989, p.186, pl. 7, figs. 17-18, not fig. 16.

***Type Designation*.-** 81/ 9133, 76.534a.126.2.125

***Original Definition*.-** Test as with *R. altissima altissima*, but proximal portion of test is rarely bulbous. Cephalis, thorax abdomen and the first several postabdominal segments are together inflated conical. The regular hexagonal meshwork of 3 rows of pores per segment is totally obscured by broad ridges that run down from top of test and disappear gradually at the 7th to 10th segment. The horizontal ridges marking the segmental divisions are more delicate but also raised and nodes form at intersection with the vertical ridges. The result of this ornamentation is vertical or slightly transverse grooves on the first 4-5 segments and coarse rectangular frames on the following ornamented segments. Remaining part of test as with *R. altissima altissima*.

***Original Remarks*.-** This form is differentiated because it precedes in stratigraphic range the typical *R. altissima altissima*. A criterion for its distinction, even in poorly preserved material, are the vertical grooves on the proximal conical portion of test.

***Etymology*.-** *Major*, Latin for the older.

***Measurements*.-**
Based on 2 specimens.

	HT	av.	min.	max.
Total length:	-	-	-	485
Maximum width:	130	125	120	130

***Type Locality*.-** DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 126, Section 2, 125 cm.

***UAZones*.-** 5-7, latest Baj.-early Bath. to late Bath.-early Call.

RISTOLA ASPARAGUS 5575

Ristola asparagus JUD

***Synonymy*.-**
Ristola asparagus JUD
JUD 1994, p. 101, pl. 19, figs. 2-3.

***Original Definition*.-** Long, slender, conical test of 20 or more segments. Cephalis and thorax conical, smooth and apparently imperforate. Abdominal segment trapezoidal and sparsely porous. Next 4-6 postabdominal segments with thickened test-wall forming a head-shaped inflation. Remaining postabdominal segments increase slowly in width to form a long cone. Pores on all postabdominal segments disposed in 3 rows of alternate pores except for the last 3-5 segments, where only 2 rows of pores are developed. Pores of whole test increase in size distally. Outline of segments slightly trapezoidal. Sometimes small costae developed near the pores of the middle row (when 3 rows of pores are present). These costae correspond to the vertical bars separating the pores. All pores are hexagonally framed. Internal partitions marked outside by slightly developed external circumferential ridges.

***Original Remarks*.-** *Ristola asparagus* n.sp. differs from *Ristola altissima* s.l. (RÜST), *Ristola cretacea* (BAUMGARTNER) and *Ristola procera* (PESSAGNO) by probably lacking a double-layered structure in the inflated apical portion, by having pores which increase in size distally, by lacking 3 rows of pores on final 3-5 postabdominal segments, and by having hexagonally framed pores. The specimen illustrated by Schaaf (1981b, pl. 18, figs. 8a-b) resembles stratigraphically older forms. These forms have no inflated proximal portion and are suggested to be ancestors.

***Etymology*.-** From the Latin *asparagus*, asparagus.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Total length of test:	649	645	463	774
Maximum width of test:	163	160	142	171

***Type Locality*.-** Fiume Bosso, Umbria-Marche, Italy.

***UAZones*.-** 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

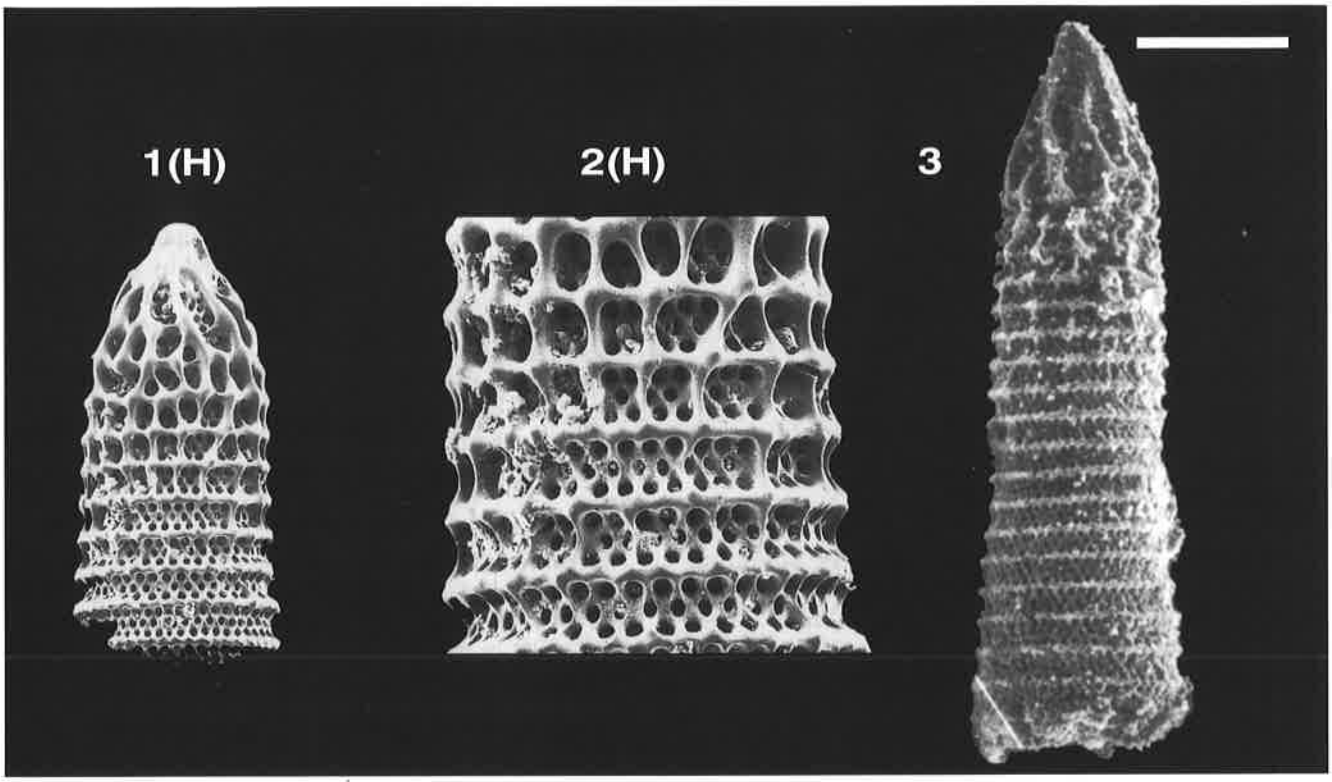


Plate 3238. *Ristola altissima major* n.ssp. BAUMGARTNER & DE WEVER. Magnification x200, except Fig. 2(H) x400. **Fig. 1(H).** POB81/9133, 76.534A.126.2.125. **Fig. 2(H).** POB81/9134, 76.534A.126.2.125. **Fig. 3.** DW A400, 8221-26.

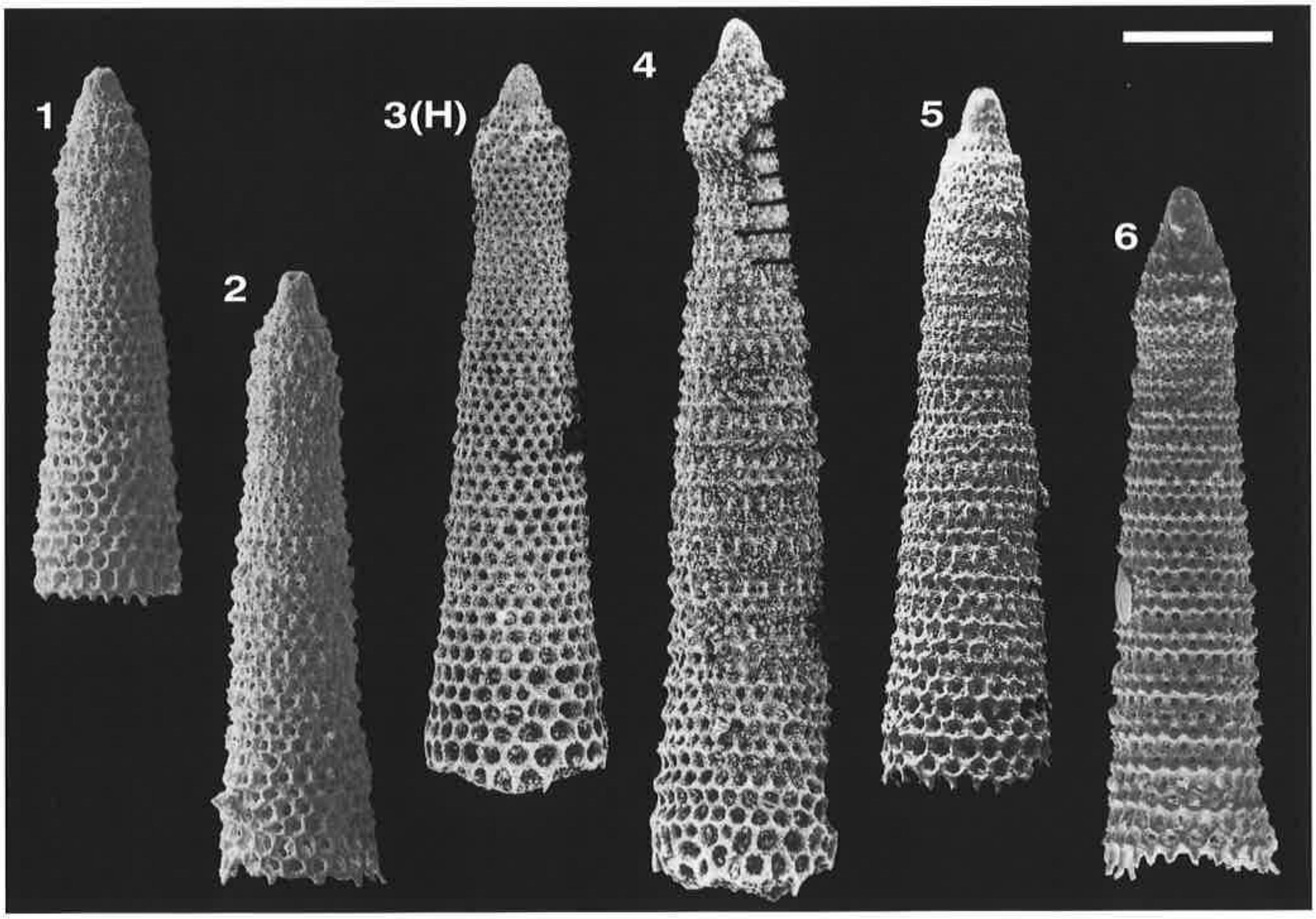


Plate 5575. *Ristola asparagus* JUD. Magnification x150. **Fig. 1.** DU842, Mo46. **Fig. 2.** DU843, Mo46. **Fig. 3(H).** RJ21, Bo566.5. **Fig. 4.** RJ67, Bo566.5. **Fig. 5.** POB81/0981, MO46a'. **Fig. 6.** DU840, Mo46.

Ristola cretacea (BAUMGARTNER)

Synonymy.-
Lithocampe altissima RÜST
MUZAVOR 1977, p. 102, pl. 8, fig. 7.
Parvicingula cretacea BAUMGARTNER
BAUMGARTNER et al. 1980, p. 59, pl. 5, figs. 1-3, pl. 6, fig. 4.
Ristola cretacea (BAUMGARTNER)
BAUMGARTNER 1984, p. 783, pl. 8, figs. 5, 10.
AITA & OKADA 1986, p. 114, pl. 2, fig. 7.
KATO & IWATA 1989, pl. 1, fig. 6.
STEIGER 1992, p. 87, pl. 24, figs. 7-8.
JUD 1994, p. 102, pl. 19, figs. 4-6.

Original Definition.- Test extremely elongate, cylindrical, multisegmented with a bulbous proximal portion. Cephalis conical, without horn. Cephalis and thorax poreless, externally smooth. The first four or five segments (including cephalis and thorax) form a broadly conical part, rapidly increasing in width. The following five to six segments increase only very gradually in width and remain constant in height. The next four to five segments decrease markedly in width and height to form a stricture terminating the proximal bulbous portion. The following segments (up to 50!) remain nearly constant in height and width to form an extremely long (up to 1 mm) cylindrical portion. Terminal (constricting) segments have not been observed, the distal end is always broken.

Shell structure: the proximal eight to ten segments are completely covered by a second layer of broad bars forming a coarse penta- to hexagonal pore pattern with one row of pores per segment. The pores are rounded penta- to hexagonal, the triple junction shows faint nodes. At the stricture this pattern seems to be compressed to nearly rectangular pores formed by the raised segmental division and by more linearly arranged bars with nodes at quadruple junctions. Only several segments below the stricture, this outer layer becomes less dense and allows to see the inner layer consisting of three rows of uniform small, hexagonally arranged pores. For the remaining segments (cylindrical portion) the outer layer is reduced to irregularly distributed bars joining moderate nodes on segmental divisions resulting in a loose, coarse triangular meshwork.

Original Remarks.- This species differs from *P. altissima* (RÜST) by the different outer layer of the proximal bulbous portion, by the more bluntly conical first four segments, by smaller dimensions and by the presence of an upper layer on all distal segments (lacking in the distal half for *P. altissima* and *P.* (?) *procera*). *P.* (?) *cretacea* is believed to be a descendant of *P. altissima* replacing this species at the Tithonian-Berriasian boundary. *P.* (?) *cretacea* is questionably assigned to *Parvicingula* (due to the absence of a horn, etc.). It should be assigned together with *P.* (?) *altissima* and *P.* (?) *procera* to a new genus.

Actualized Remarks.- (JUD, 1994) In our material some rare specimens were found possessing 60-70 segments, having a total length of 1220 μm. All others were similar in length or even smaller than those described by Baumgartner (1984).

Etymology.- Named for its first occurence at the base of the Cretaceous.

Measurements (in μm).-
Based on 11 specimens.

	HT	aver.	min.	max.
Total height of 10 segm.:	168	170(219)	154(210)	185(230)
Total height of 20 segm.:	330	353(469)	329(455)	365(500)
Width of bulbous portion:	125	117(153)	100(135)	125(165)
Width of 20th segm.:	114	118(165)	107(150)	135 (170)
Height of 20th segm.:	15	18(24)	15 (20)	21 (30)
Width/height of segm.:	76	6 (7)	5 (6)	8 (8)
Structure at segment:	11	8-9(11)	7(10)	11 (14)

The values in brackets are comparative values taken from eight specimens of *P. altissima* from samples POB899, POB28 and S4.

Type Locality.- Cava Rusconi, Cittiglio, Prov. Varese, Italy. Locality S of locality descriptions (Baumgartner et al., 1980).

UAZones.- 12-17, early-early late Tith. to late Val.

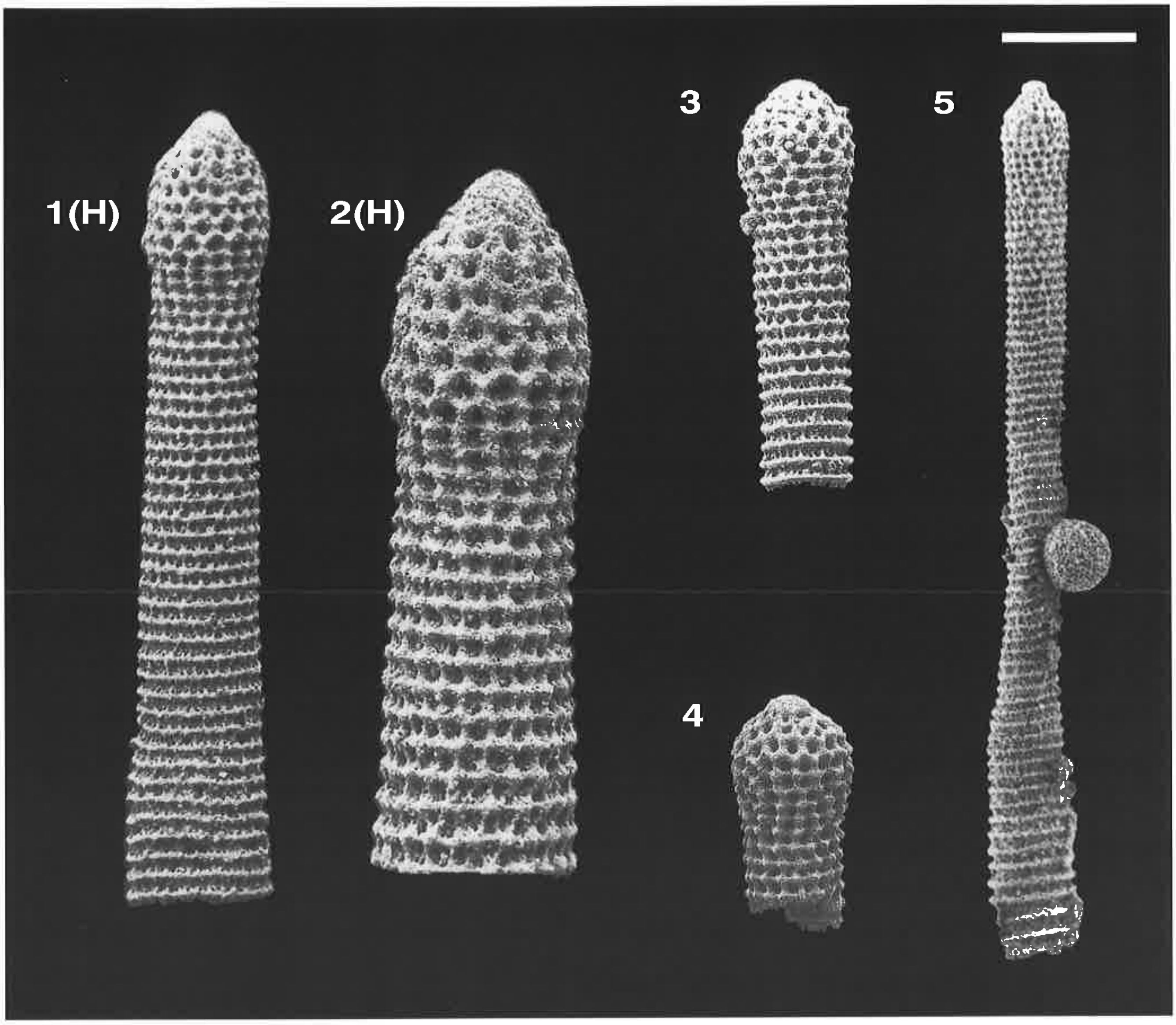


Plate 3165. ***Ristola cretacea*** **(BAUMGARTNER).** Magnification x150, unless otherwise indicated. **Fig. 1(H).** POB79/5025, POB1205.1. **Fig. 2.(H)** POB79/5024, POB1205.1, x250. **Fig. 3.** POB80/1857, POBMO19. **Fig. 4.** POB79/4127, MO2 22. **Fig. 5.** RJ263, Br1330, x100.

RISTOLA MARTAE 5766

Ristola martae JUD

Synonymy.-
Ristola martae JUD
JUD 1994, p. 102, pl. 19, figs. 7-8.

Original Definition.- Long, conical test of at least 18 segments. Cephalis, thorax and abdomen conical, smooth, imperforate. Thorax separated from abdomen by one single row of pores. Next 3 segments with thickened test-wall. Remaining postabdominal segments increasing gradually in width. First postabdominal segments with double layered structure, the outer layer forming a row of large elliptical meshes between prominent, strong nodose circumferential ridges. Remaining segments with 3 rows of alternate pores between slightly nodose circumferential ridges.

Original Remarks.- The first postabdominal segments may be more or less inflated because of the thickened test wall which consists of two layers. *Ristola martae* n.sp. differs from *Ristola altissima* (RÜST) by possessing prominent strong ridges on the first postabdominal segments, and from *Ristola cretacea* (BAUMGARTNER) in lacking a distinct bulbous apical part and in having a different superficial test structure. It differs also from *Ristola procera* PESSAGNO by having a wider conical test, by the presence of the inflated proximal postabdominal segments with prominent nodose ridges. *Ristola martae* n.sp. differs from *Ristola* (?) *asparagus* n.sp. by its distinct wider conical test and by the very prominent broad circumferential ridges.

Etymology.- This species is dedicated to Prof. Dr. Marta Marcucci, Department of Earth Sciences, University of Florence, Italy, honouring her work on Radiolaria and her friendship.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Total length:	375	369	326	408
Maximum width:	132	143	121	173

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 17-20, late Val. to late Haut.

RISTOLA (?) PRAEMIRIFUSUS 2014

Ristola (?) *praemirifusus* n.sp. BAUMGARTNER & BARTOLINI

Original Definition.- Overall test slenderly conical proximally becoming cylindrical distally, composed of at least 20 to over 30 segments. Cephalis, thorax and abdomen small, together conical, without horn and without superimosed outer layer. The first 20 segments form the slender conical proximal portion. Segmental disvisions are visible externally as narrow circumferential ridges on the whole test except for the first two segments. Circumferential ridges are slightly nodose but the test does not show a development of an outer layer like other *Ristola* sp. Segments are almost constant in height, bear 3 rows of small pores per segment except for the first few segments that may have only 2 rows. About beyond the 20th segment the test becomes cylindrical. The distal end has not been found preserved.

Original Remarks.- This species differs from other (younger) *Ristola* sp. by a virtual absence of an outer layer, even on the proximal portion of the test. Therefore, this species is doubtfully assigned to the genus *Ristola*. It may, however well be the common ancestor of both *Ristola* (sensu Baumgartner, 1984) and *Mirifusus*. In our sections, this species evolves into *Mirifusus proavus* TONIELLI, by increasing in size and inflating the median portion.

Etymology.- Named for its ancestral evolutionary relationship with the genus *Mirifusus*.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.
Total preserved height:	570	533
Height of 10 segments :	344	353
Height of 20 segments :	194	182
Width of cylindrical portion:	115	128

Type Locality.- Terminilletto Section, M. Terminillo, Rieti, Umbria-Marche-Sabina Apennines, Sample TM 64.74 (see Bartolini et al. this volume).

UAZones.- 1-2, early-mid Aal. to late Aal.

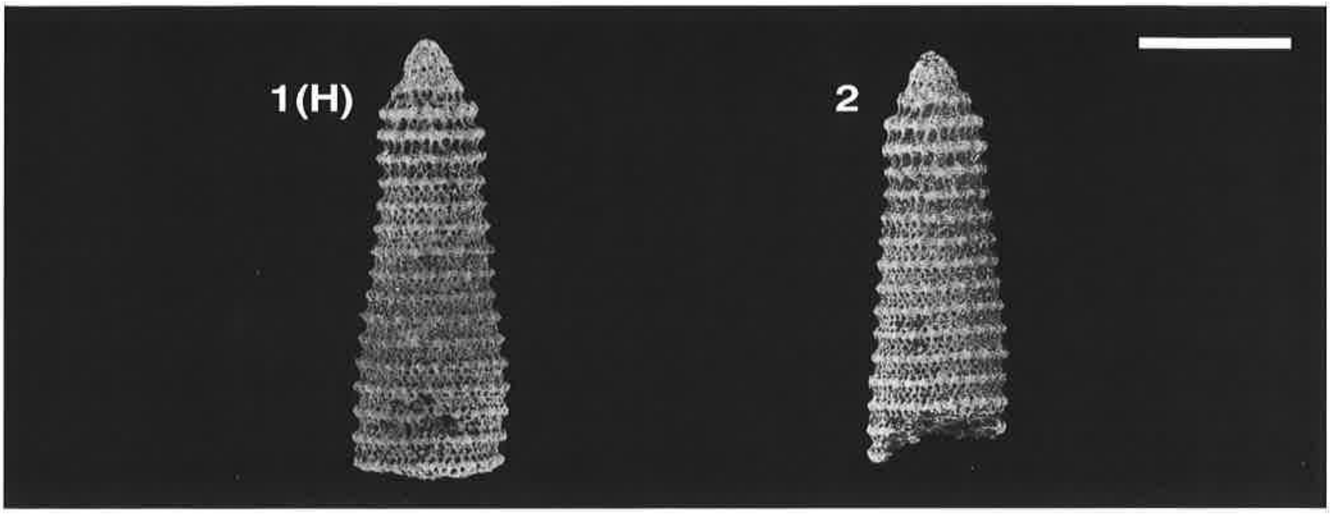


Plate 5766. ***Ristola martae* JUD.** Magnification x150. **Fig. 1(H).** RJ170, Bo566.5. **Fig. 2.** RJ53, Bo566.5.

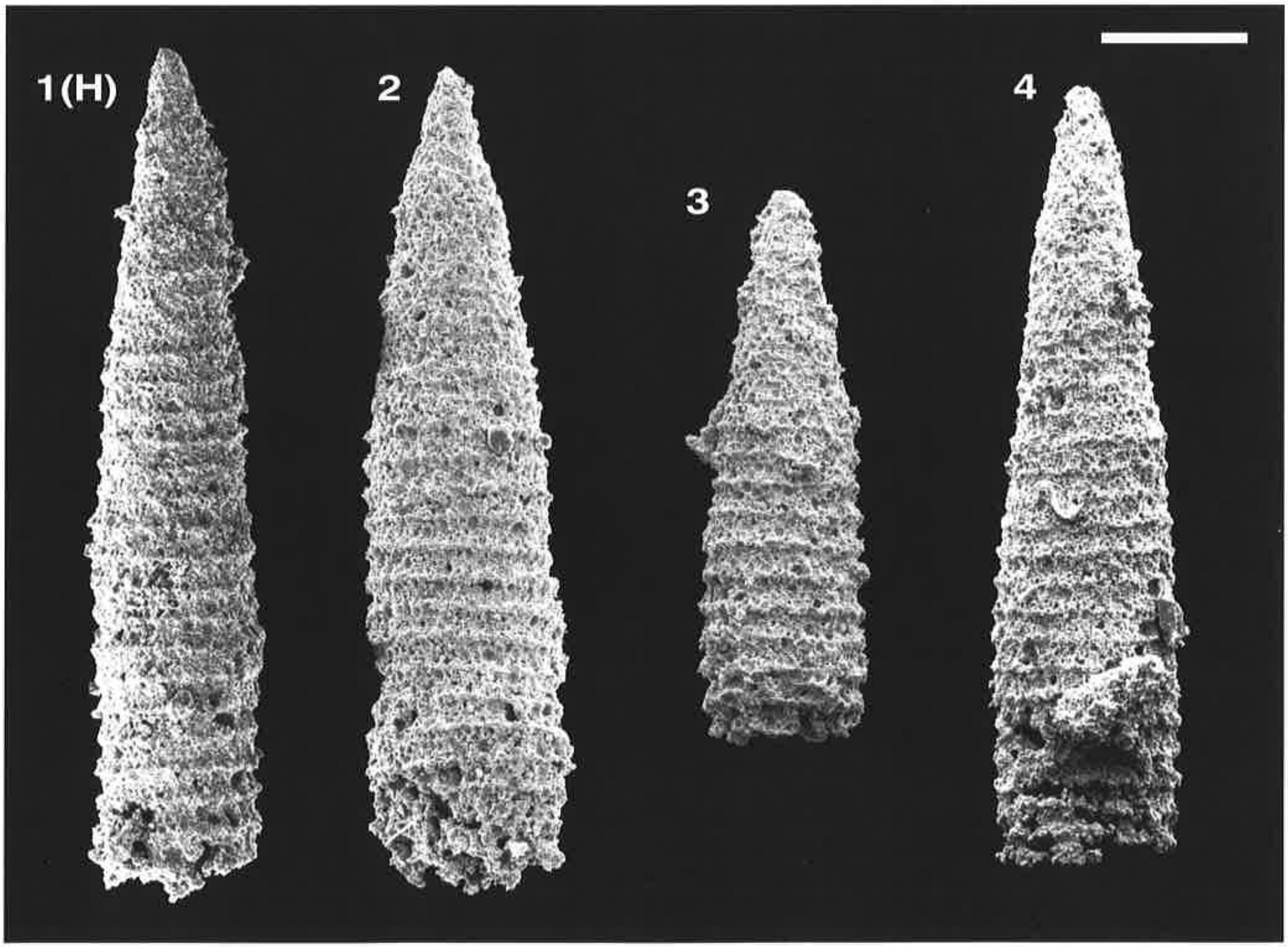


Plate 2014. *Ristola* (?) *praemirifusus* n.sp. BAUMGARTNER & BARTOLINI. Magnification x200. **Fig. 1(H)** AB 6598, TM064.74a46. **Fig. 2.** AB 28, TM048.35a28. **Fig. 3.** AB 2044, TM25.15a88. **Fig. 4.** AB6604, TM064. 74a52

RISTOLA PROCERA 3163

Ristola procera (PESSAGNO)

Synonymy.-
Parvicingula (?) *procera* PESSAGNO
PESSAGNO 1977a, p. 86, pl. 9, figs. 6-9.
Parvicingula procera PESSAGNO
BAUMGARTNER et al. 1980, p. 60, pl. 5, fig. 8.
KOCHER 1981, p. 83, pl. 15, fig. 14.
DUMITRICA & MELLO 1982, pl. 3, figs. 7-8.
Ristola procera (PESSAGNO)
BAUMGARTNER 1984, p. 783, pl. 8, fig. 6.
KISHIDA & HISADA 1986, pl. 2, fig. 6.
PESSAGNO et al. 1993, p. 154, pl. 7, fig. 4.

Original Definition.- Test extremely elongate; distal and proximal portions conical, tapering; most of test cylindrical in aspect. Cephalis low, conical (dome-shaped) with horn either absent or broken off in specimens thus far examined. Thorax and abdomen trapezoidal in shape with small hexagonal (to pentagonal ?) pore frames not arranged in discrete rows. Postabdominal chambers, about 33 or more, with three rows of uniform hexagonal pore frames; middle row staggered with respect to pores of outer rows; pores circular to elliptical. First seven postabdominal chambers increasing moderately rapidly in width and very slowly in height. Remainder of chambers (except final six or seven chambers) showing little increase in height and none in width. Final six or seven chambers decreasing moderately rapidly in width with height remaining constant.

Original Remarks.- The shape of the cephalis and the arrangement and shape of the pore frames on the postabdominal chambers suggest a close relationship between this species and *Parvicingula altissima* (RÜST). It is likely that *P. altissima* was derived from a *P. procera* stock during early Tithonian times. *Parvicingula procera* differs from *P. altissima* by the much more pronounced conical aspect of both the distal and proximal portions of its test. The assignment of this species to *Parvicingula* is questioned that it cannot be determined whether it possesses a horn.

Actualized Remarks.- (BAUMGARTNER et al., 1980) We include also slightly smaller forms than those described by Pessagno (1977a).

Etymology.- This species is named from the Latin adjective *procerus*, meaning tall, long.

Measurements (in μm).-
Based on 5 specimens. Height cephalis: 20 to 25; height thorax: 25 to 30; height abdomen: 25 to 30; Height PA1 to PA33: 20 to 25. PA= postabdominal chamber. PA1= first postabdominal chamber.

Type Locality.- Point Sal, Santa Barbara.

UAZones.- 5-9, latest Baj.-early Bath. to mid-late Oxf.

RISTOLA (?) TURPICULA 3543

Ristola (?) *turpicula* PESSAGNO & WHALEN

Synonymy.-
Ristola (?) *turpicula* PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 150, pl. 11, figs. 8, 12-13, 16, 20; pl. 13, fig. 11.
MIZUTANI & KIDO 1983, p. 259, pl. 53, fig. 5.

Original Definition.- Apical portion of test (cephalis and thorax) conical; cephalis hemispherical. Portion of test formed by abdomen and first three post-abdominal chambers cylindrical; chambers rectangular in cross section. Portion of test formed by remaining post-abdominal chambers fusiform; post-abdominal chambers trapezoidal in cross section. Nodose circumferential ridges better developed distally than proximally. Post-abdominal chambers with large, unequal-sized pentagonal and hexagonal pore frames arranged in three to four rows. Often as many as eight post-abdominal chambers visible.

Original Remarks.- *Ristola* (?) *turpicula* n.sp. differs from *R. decora* n.sp. by having a test which is, exclusive of the cephalis and thorax, cylindrical proximally and fusiform distally. The fusiform character of the distal portion of the test may suggest a phylogenetic link to species of *Mirifusus.* However, *R.* (?) *turpicula* possesses a single layered test. To date, we have not observed a tubular extension on its final post-abdominal chamber; this, however, may be a matter of poor preservation.

Etymology.- *Turpiculus -a, -um* (Latin, adj.), deformed, somewhat ugly.

Measurements (in μm).-
Based on 9 specimens.

	HT	max.	min.	av.
Maximum length:	197	260	135	209
Maximum width:	100	125	90	108

Type Locality.- East-central Oregon.

UAZones.- 5-6, latest Baj.-early Bath. to mid Bath.

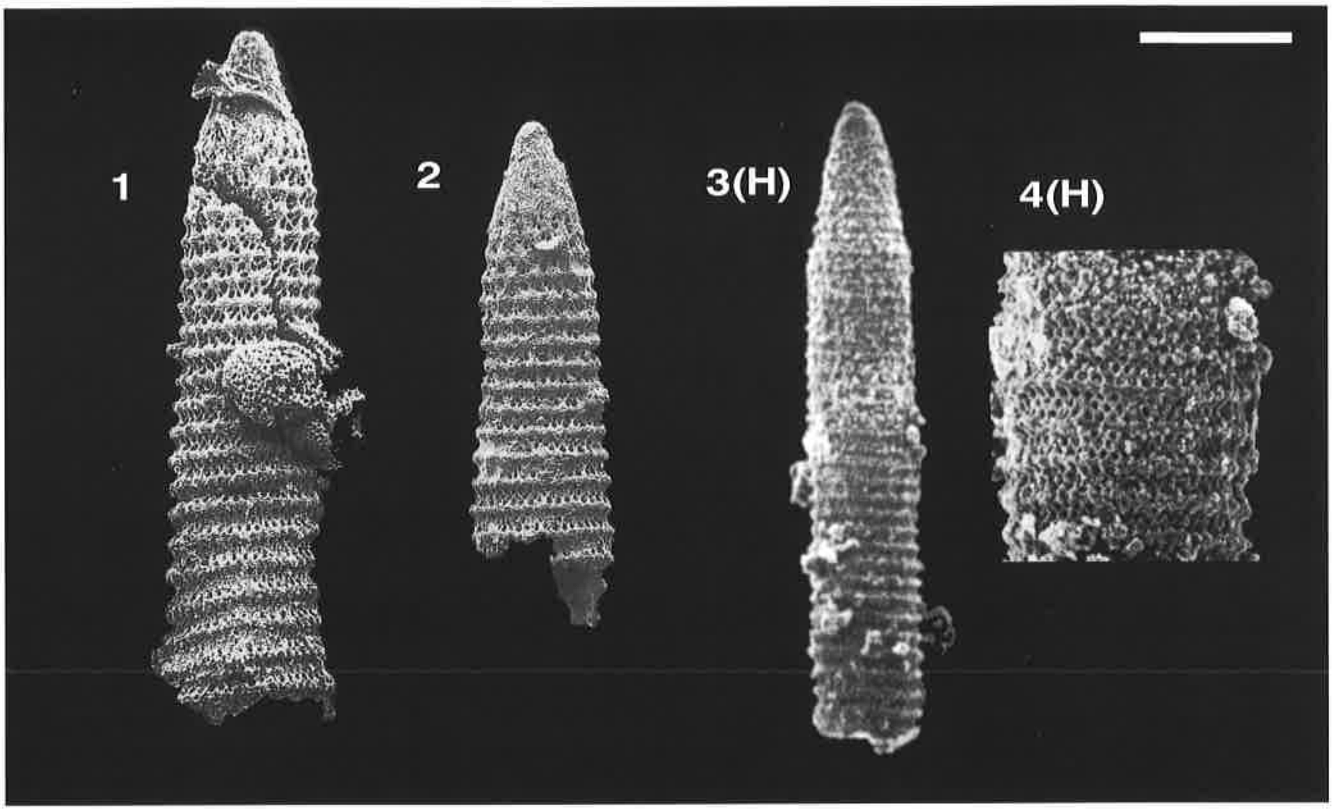


Plate 3163. *Ristola procera* (PESSAGNO). Magnification x150, unless otherwise indicated. **Fig. 1.** POB78/6275, POB899.53. **Fig. 2.** POB79/0145, POB22. **Fig. 3(H).** PESSAGNO 1977a, pl. 9, fig. 6, x 100. **Fig. 4(H).** PESSAGNO 1977a, pl. 9, fig. 8, x 400.

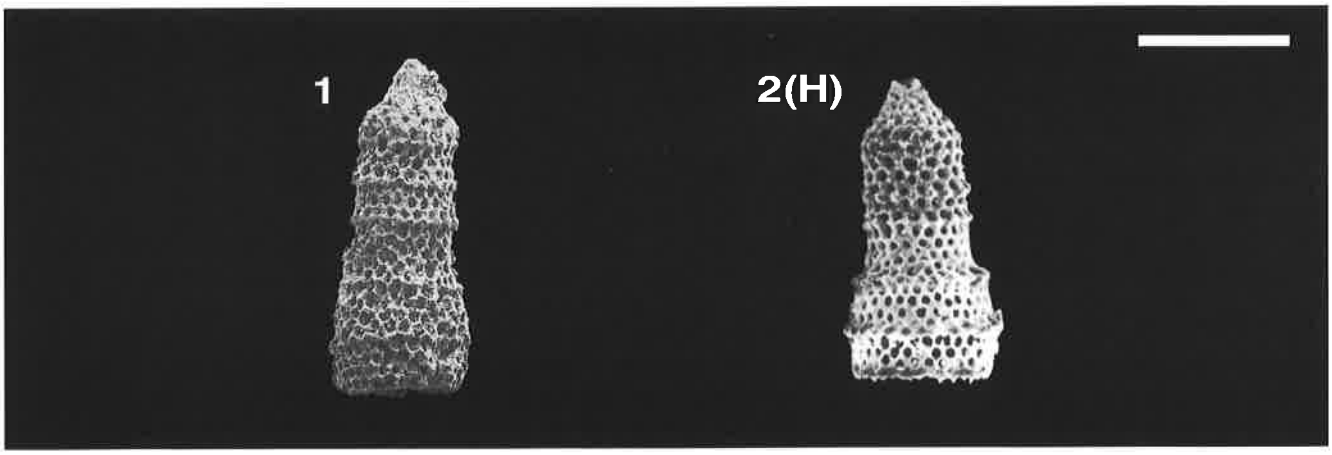


Plate 3543. *Ristola* (?) *turpicula* PESSAGNO & WHALEN. Magnification x200. **Fig. 1.** POB82/9048, 2.18.1.79. **Fig. 2(H).** PESSAGNO & WHALEN 1982, pl. 11, fig. 8.

robusta >> *STAUROLONCHE ROBUSTA*	*3220*

robusta >> *STICHOCAPSA ROBUSTA*	*3298*

rugosa >> *ANGULOBRACCHIA (?) RUGOSA*	*3911*

rusconensis >> *OBESACAPSULA RUSCONENSIS RUSCONENSIS*	*3282*

rusconensis >> *OBESACAPSULA RUSCONENSIS S.L.*	*6129*

rusconensis >> *OBESACAPSULA RUSCONENSIS UMBRIENSIS*	*5796*

saginata >> *NAPORA SAGINATA*	*3032*

SAITOUM	*3688*

Genus: *Saitoum* PESSAGNO

Synonymy.-
Saitoum PESSAGNO
PESSAGNO 1977a, p. 96.

Type Species.- *Saitoum pagei* PESSAGNO 1977a.

Original Definition.- Test small, monocyrtid with hemispherical cephalis having short horn and three prominent feet. Massive cyrtoid cephalic skeletal elements visible at base of cephalis.

Original Remarks.- Riedel & Sanfilippo (1974, p. 788, pl. 3, figs. 4-8) believed that this form may possess spyroid rather than cyrtoid cephalic skeletal elements. Specimens of the type species lack any evidence of ring structure and seem to be cyrtoid in nature.

Etymology.- *Saitoum* n.gen. is named for Dr. Tsunemasa Saito (Lamont-Doherty Geological Observatory and the American Museum of Natural History) to honor his many contributions to the understanding of the stratigraphy of the oceanic crust.

Included Taxa.-
3023 *Saitoum corniculum* DE WEVER
3022 *Saitoum elegans* DE WEVER
3024 *Saitoum levium* DE WEVER
3026 *Saitoum* sp. aff. *S. levium* DE WEVER
3020 *Saitoum pagei* PESSAGNO
3027 *Saitoum* sp. aff. *S. pagei* PESSAGNO
3021 *Saitoum trichylum* DE WEVER

SAITOUM CORNICULUM 3023

Saitoum corniculum DE WEVER

Synonymy.-
Saitoum corniculum DE WEVER
DE WEVER 1981a, p. 9, pl. 1, figs. 1-2.
Saitoum sp. B
YAMAMOTO et al. 1985, p. 38, pl. 7, figs. 2a-b.

Original Definition.- "Test imperforate. It bears three divergent feet and a very small hardly visible apical horn, surrounded by three largely open pores, situated between arches Al1, Al2 and AV. Cephalis poreless, smooth or slightly rough. A clearly distinct ditrema on a protuberance forms a very short tubule. Feet subtriangular in cross-section, having a big pore at their base; one or more other pores may exist between them. The elements of the cephalic skeleton are well visible in the collar opening. Bars of the collar structure are subrectangular in cross-section. A "collerette", more or less pronounced with different specimens, is present between the feet."

Original Remarks.- "The spine V is sometimes almost co-planar with other elements of the collar structure. It is distinguished by a well developed linguiform protuberance and by not being attached to the collar ring.

S. corniculum differs from *S. elegans*, *S. levium* and *S*. *trichylum* by its much smaller apical horn, and from *S. pagei by a* smaller apical horn and by an almost smooth and imperforate cephalic surface."

Etymology.- *Corniculum* (n.) Latin noun, small horn.

Measurements (in μm).-
Based on 3 specimens.

	av.	max.	min.
Height of cephalis:	62-80	80	71
Width of cephalis near base of feet:	56-68	68	63
Width of the base of feet:	11-20	20	17

Type Locality.- Dhimaina, Argolis, Greece.

UAZones.- 7-7, late Bath.-early Call. to late Bath.-early Call.

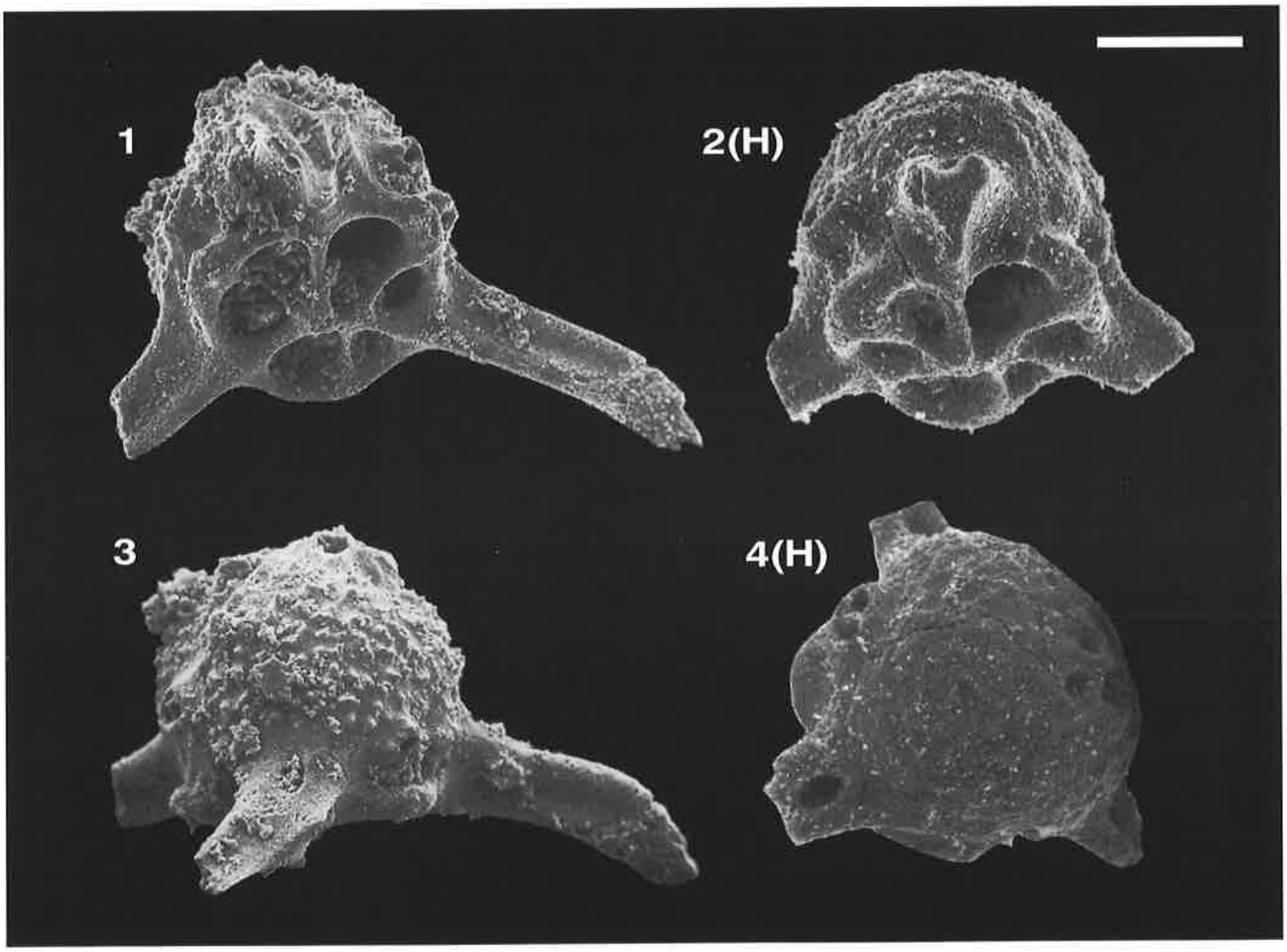


Plate 3023. *Saitoum corniculum* DE WEVER. Magnification x700. **Fig. 1.** POB81/1441, 534A.125.2.36. **Fig. 2(H).** DW C 7912.1a, ABV123. **Fig. 3.** POB81/1440, 534A.125.2.36. **Fig. 4(H).** DW C 7912.1b, ABV123.

SAITOUM ELEGANS 3022

Saitoum elegans DE WEVER

Synonymy.-
Saitoum elegans DE WEVER
DE WEVER 1981a, p. 9, pl. 1, figs. 3-4.
SCHAAF 1984, p. 153, fig. 3.
DE WEVER & CORDEY 1986, pl. 1, figs. 6-7.
JUD 1994, p. 103, pl. 19, fig. 9.

Original Definition.- "This form has a smooth cephalis bearing a strong apical horn and three long curved feet. The apical horn tapers distally. It has an overall circular to subcircular cross-section but its base is triradiate and surrounded by three pores situated in the prolongation of grooves.

The cephalis bears a protuberance which makes the ditrema visible in relief.

The collar edge is emphasized by a "collet", highly visible even on corroded specimens.

There are three curved feet, divergent in the proximal part. They are rounded in cross-section, except on the proximal part where they are subtriangular. They each have a pore at the base."

Original Remarks.- "The corroded specimens seem to be covered by minute pores but the aspect of the cephalic surface and the size of these pores cannot be confused with those of *S. pagei.*

S. elegans differs from *S. corniculum* by its general outline and especially by its well developed apical horn. This form differs from *S. levium* by the presence of a distinct "*collet*" and by longer and more slender feet. *S. pagei* has a very rough and perforated cephalis and a smaller apical horn. *S. trichylum* has an irregular "*collerette*" and not a "*collet*" and looks more massive."

Etymology.- *Elegans*, Latin elegant.

Measurements (in μm).-
Based on 3 specimens.

	av.	max.	min.
Height of cephalis:	63	81	55
Width of cephalis near base of feet:	64	79	46
Width of the base of feet:	14	20	9

Type Locality.- POB 1205, Cava Rusconi section, Cittiglio, Province of Varese, Italy.

UAZones.- 8-21, mid Call.-early Oxf. to early Barr.

SAITOUM LEVIUM 3024

Saitoum levium DE WEVER

Synonymy.-
Saitoum levium DE WEVER
DE WEVER 1981a, p. 10, pl. 1, figs. 9-10.

Original Definition.- "This form has a smooth imperforate cephalis which bears a robust apical horn and three massive feet. Apical horn massive, 20-25 μm long, triradiate in cross-section. Its base is surrounded by three pores. The partitions of pores correspond to the horn-edges which are situated in the prolongation of arches Al1, Al2 and AV. Between the feet which correspond to the D, L1 and L2, there sometimes exist two more or less regularly disposed pores. Feet massive, divergent, slightly curved. One (rarely two) large circular pore is present at the base. Feet circular to subcircular in cross-section depending on the specimen and the part of the foot concerned.

The collar structure is distinct. One or more velums are visible on some specimens, collar rim smooth. Spine V is oblique to the collar plane. Sometimes the V spine is almost coplanar but in this case a "lip" deforms the collar plane at the attachment point."

Original Remarks.- "This species differs from *S. corniculum* by its massive, well developed apical horn, and from *S. elegans* by possessing a larger apical horn, larger feet and a more massive general appearance. It differs from *S. pagei* by having a smooth imperforate cephalis and more massive feet, a larger ditrema situated on a protuberance and finally by a stronger apical horn. It differs from *S. trichylum* by the absence of a "*collerette*"."

Etymology.- *Levium*, Latin smooth (characteristics of the collar rim and cephalis).

Measurements (in μm).-
Based on 17 specimens.

	min.	max.	HT	av.
Height of cephalis:	41	94	64	58
Width of cephalis base of feet:	49	100	100	71
Width of the base of feet:	15	30	30	24
Length of feet:	43	75	55	50

Type Locality.- Dhimaina, Argolis, Greece.

UAZones.- 4-9, late Baj. to mid-late Oxf.

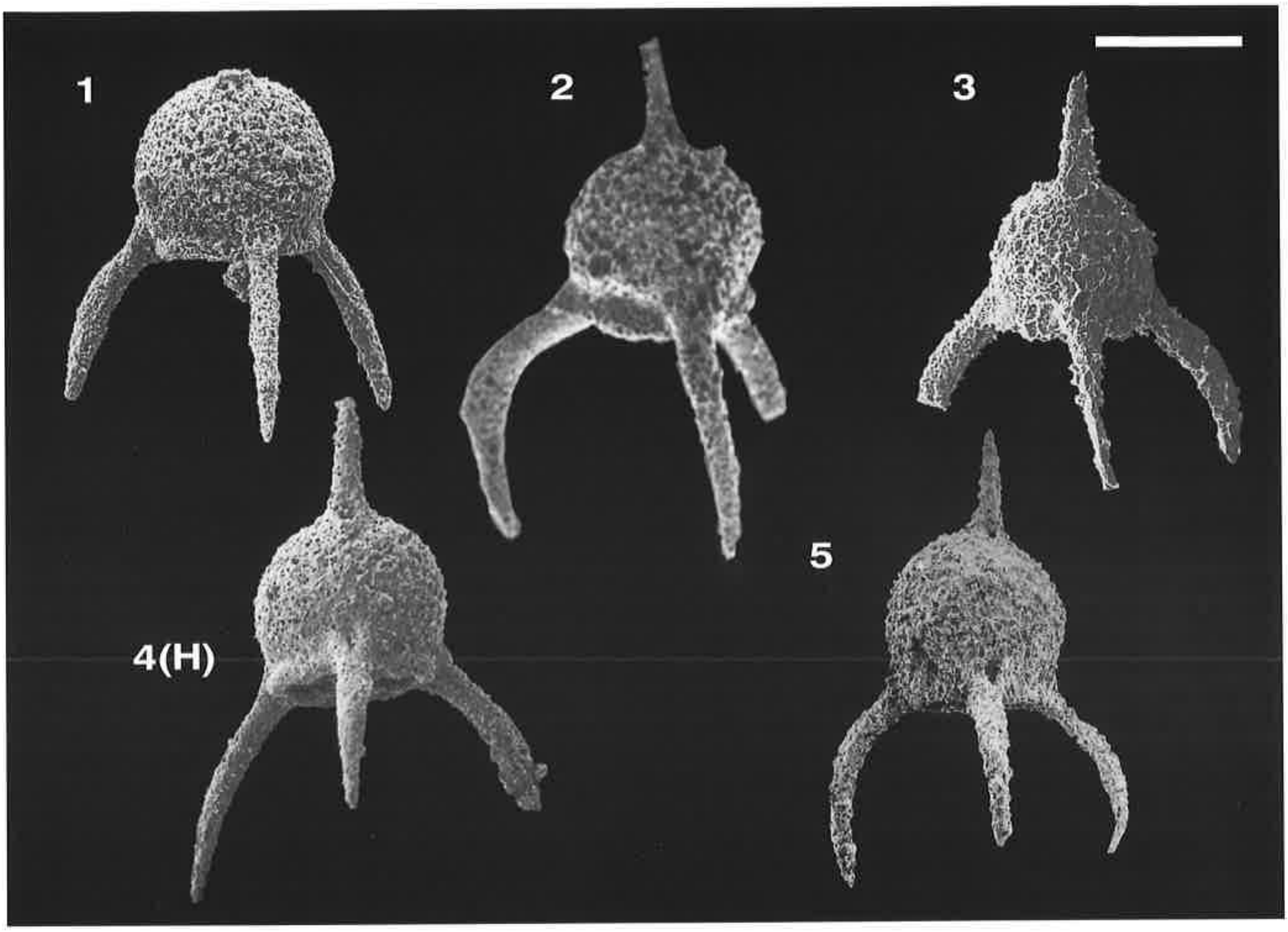


Plate 3022. *Saitoum elegans* DE WEVER. Magnification x400. **Fig. 1.** POB79/5244, POB1205.3. **Fig. 2.** De Wever 1981a, pl1, Fig. 4. **Fig. 3.** POB78/6460, POB899.53. **Fig. 4(H).** De Wever 1981a, pl1, Fig. 3. **Fig. 5.** RJ512, Br28.85.

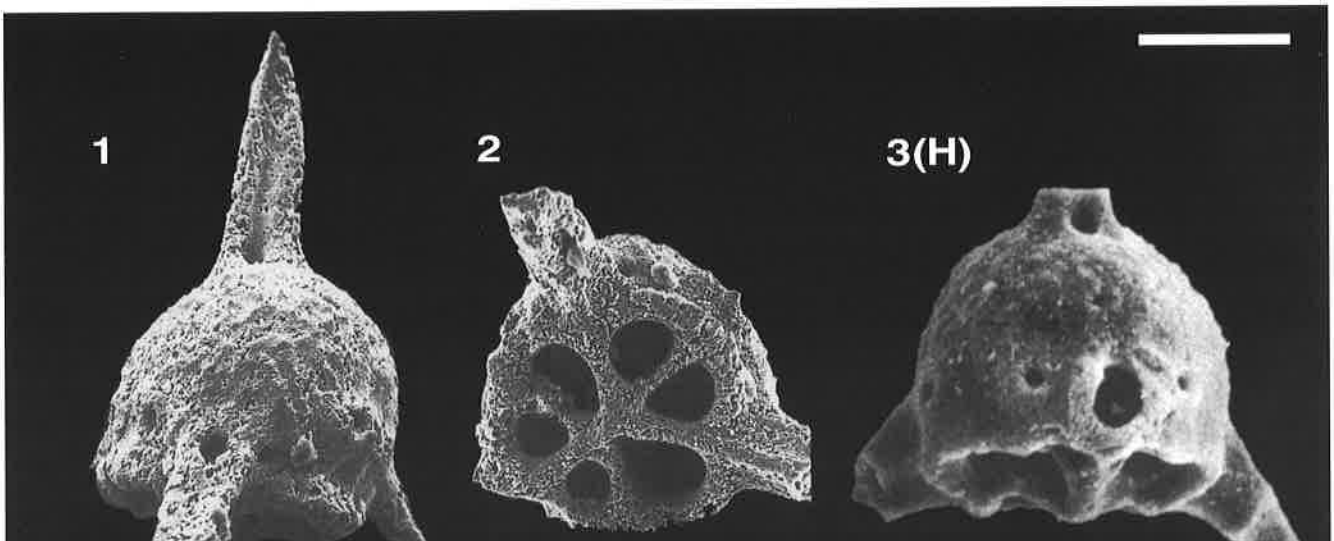


Plate 3024. *Saitoum levium* DE WEVER. Magnification x400. **Fig. 1.** POB81/2446, 534.125.3.29. **Fig. 2.** POB81/2449, 534.125.3.29. **Fig. 3(H).** DE WEVER 1981, pl. 1, fig. 9.

SAITOUM LEVIUM AFF. 3026

Saitoum sp. aff. *S. levium* DE WEVER

Synonymy.-
Saitoum sp. A
MIZUTANI & KOIKE 1982, pl. 2, fig. 3.
Saitoum sp. A
WAKITA 1982, pl. 4, fig. 4.
Saitoum levium DE WEVER
TAKEMURA 1986, p. 41, pl. 1, figs. 12-13.
Poulpus aff. *P. oculatus* TAKEMURA
? HATTORI 1987, pl. 9, figs. 14-15.

Remarks.- This morphotype differs from *S. levium* by having an almost spherical cephalis, strongly constricted at the base.

UAZones.- 3-4, early-mid Baj. to late Baj.

SAITOUM PAGEI 3020

Saitoum pagei PESSAGNO

Synonymy.-
Saitoum pagei PESSAGNO
PESSAGNO 1977a, p. 98, pl. 12, figs. 11-14.
BAUMGARTNER et al. 1981, figs. 4a-b.
DE WEVER & CABY 1981, pl. 2, fig. H.
KOCHER 1981, p. 89, pl. 16, figs. 2-3.
BAUMGARTNER 1984, p. 783, pl. 8, fig. 12.
PESSAGNO et al. 1984, p. 30, pl. 4, figs. 4, 11.
BAUMGARTNER 1985, fig. 38.k; fig. 43.f.
DE WEVER & CORDEY 1986, pl. 1, figs. 8-9.

Original Definition.- Monocyrtid test coarsely perforate with circular to subcircular pores set in irregular, widely spaced polygonal pore frames. Horn short, triradiate in axial section. Three feet triradiate in axial section, nearly two times maximum width of test.

Original Remarks.- Riedel and Sanfilippo (1974) were the first to note and figure specimens herein referred to this species. They figured specimens from Point Sal (California), Rotti, Sicily, and from DSDP Site. The specimens from Rotti and DSDP Site 99 possess shorter feet and are probably assignable to another yet unnamed species from the Lower Cretaceous (?).

Etymology.- This species is named for Dr. Benjamin M. Page (Stanford University) to honor his contributions to the geology of the California Coast Ranges.

Measurements (in μm).-
Based on 9 specimens. Height cephalis: 45 to 70; length horn: 8 to 30; length feet: 50 to 140.

Type Locality.- NSF 908 (Pessagno, 1977a). California Coast Ranges.

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

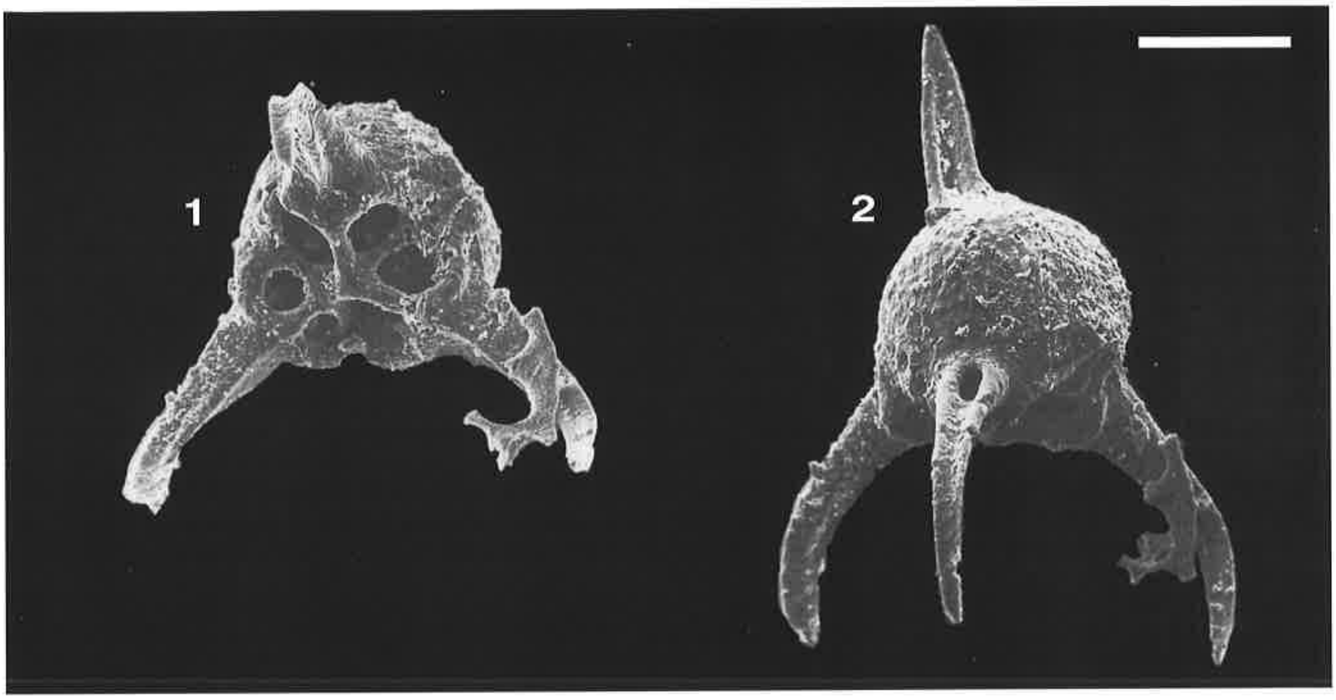


Plate 3026. ***Saitoum*** **sp. aff.** ***S. levium*** **DE WEVER.** Magnification x600. **Fig. 1.** POB81/3029, IN7. **Fig. 2.** POB81/3023, IN7.

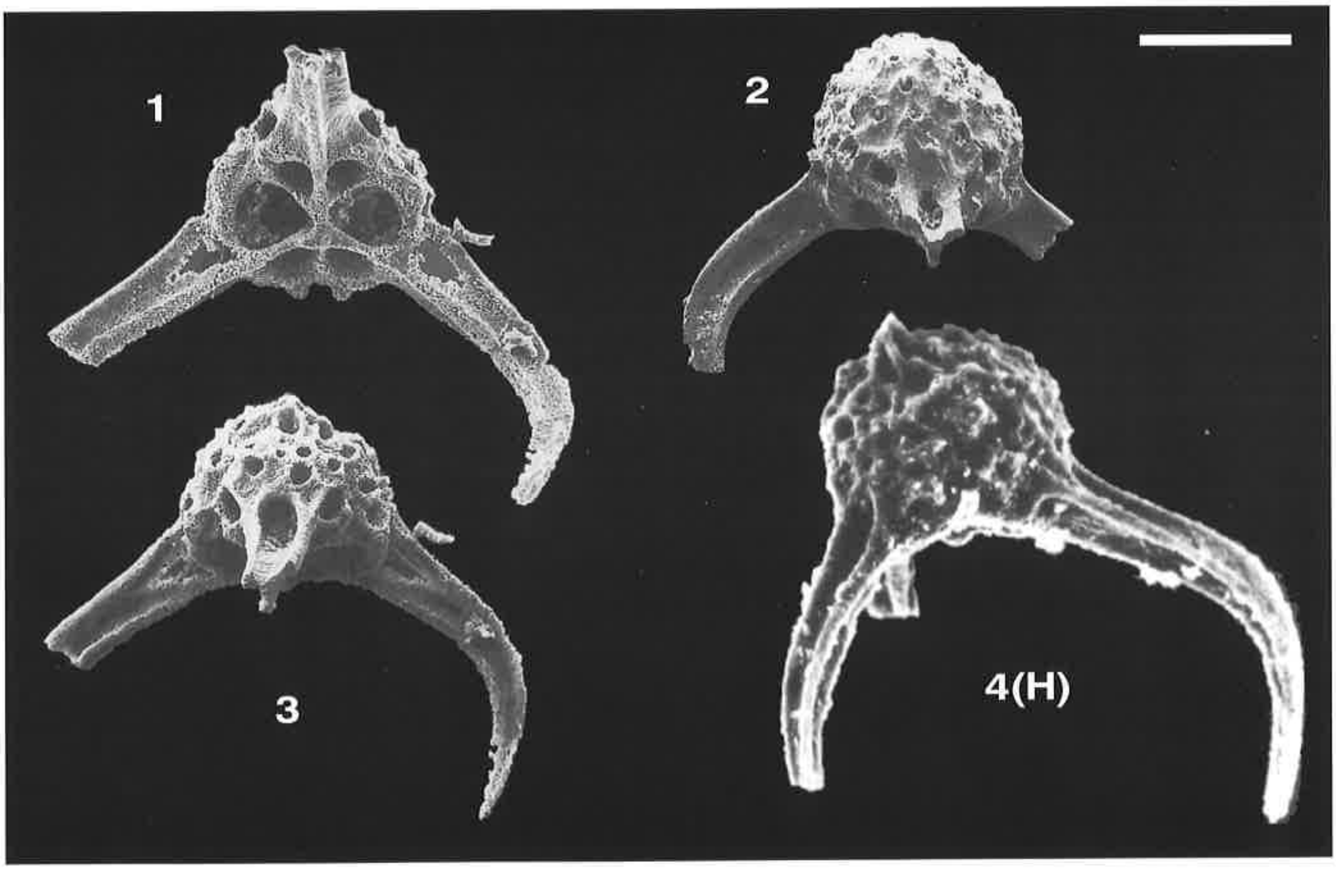


Plate 3020. ***Saitoum pagei*** **PESSAGNO.** Magnification x400. **Fig. 1.** POB78/8172, POB986.52. **Fig. 2.** POB81/2238, 534.122.1.43. **Fig. 3.** POB79/0199, POB986. **Fig. 4(H).** PESSAGNO 1977a, pl. 12, fig. 12.

SAITOUM PAGEI AFF. 3027

Saitoum sp. aff. *S. pagei* PESSAGNO

***Synonymy*.-**
Saitoum sp. D
? KIDO et al. 1982, pl. 6, fig. 8.
Saitoum sp. B
MIZUTANI & KOIKE 1982, pl. 2, fig. 4.
WAKITA 1982, pl. 4, fig. 5.
Saitoum sp.
TAKEMURA 1986, p. 41, pl. 1, fig. 14.
Saitoum aff. *pagei* PESSAGNO
GORICAN 1987, p. 186, pl. 2, fig. 2.

***Remarks*.-** Cephalis porous, smoother surface than *S. pagei*, feet curved, horn very short. On the cephalic wall slight constrictions corresponding to arches Al1, Al2 and AV of the inner spicule are observed.

***UAZones*.-** 3-3, early-mid Baj.

SAITOUM TRICHYLUM 3021

Saitoum trichylum DE WEVER

***Synonymy*.-**
Saitoum trichylum DE WEVER
DE WEVER 1981a, p. 11, pl. 1, figs. 5-8.
BAUMGARTNER et al. 1981, figs. 4c-d.
BAUMGARTNER 1985, fig. 43.e.
GORICAN 1987, p. 186, pl. 2, fig. 1.
Saitoum sp. A.
YAMAMOTO et al. 1985, p. 37, pl. 7, figs. 1a-b.
Saitoum elegans DE WEVER
BAUMGARTNER 1985, fig. 38.h.

***Original Definition*.-** "Form close to *S. levium* with cephalis occasionally somewhat rough and bearing a collar".

***Actualized Definition*.-** Test monocyrtid with three stout feet and lip-shaped collar velum in three parts between feet. Cephalis is generally poreless and hemispherical. The apical horn, robust is three bladed. The ditreme, well visible, protrude from cephalic wall. The three bladed feet are very robust and relatively short in comparison to their length, one of the three grooves is upward directed. The components of the collar structure (D, Ll, Lr) are very robust.

***Original Remarks*.-** "The collar velum of *S. trichylum* is the distinctive character which differentiate this species from others. Moreover, *S. pagei* has a porous cephalis".

Measurements (in μm).-
Based on 17 specimens.

	min.	max.	HT	av.
Height of cephalis:	45	66	53	52
Width of cephalis :	52	83	65	60
Width of the base of feet:	18	26	25	22

***Type Locality*.-** Dhimaina, Argolis, Greece.

***UAZones*.-** 7-9, late Bath.-early Call. to mid-late Oxf.

sakawaensis >> *GONGYLOTHORAX SAKAWAENSIS* 4023

salensis >> *EMILUVIA SALENSIS* 3215

sandovali >> *XITUS SANDOVALI* 5668

sanfilippoae >> *PSEUDOCRUCELLA SANFILIPPOAE* 3126

sansalvadorensis >> *DITRABS SANSALVADORENSIS* 3227

satoi >> *SPONGOTRIPUS (?) SATOI* 5262

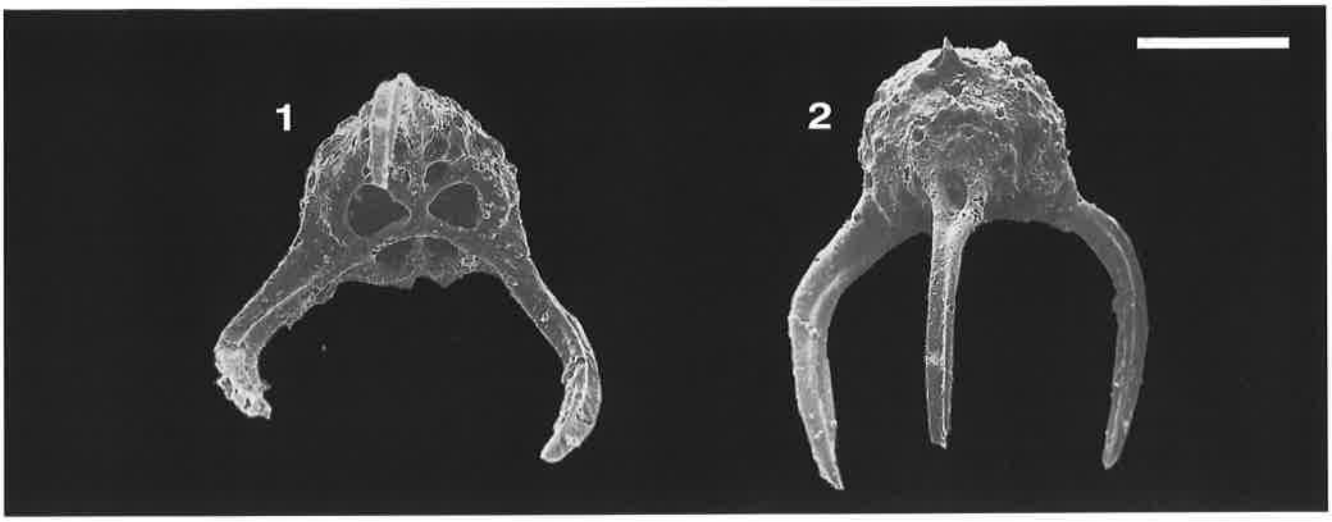


Plate 3027. *Saitoum* sp. aff. *S. pagei* PESSAGNO. Magnification x400. **Fig. 1.** POB81/3031, IN7. **Fig. 2.** POB81/3024, IN7.

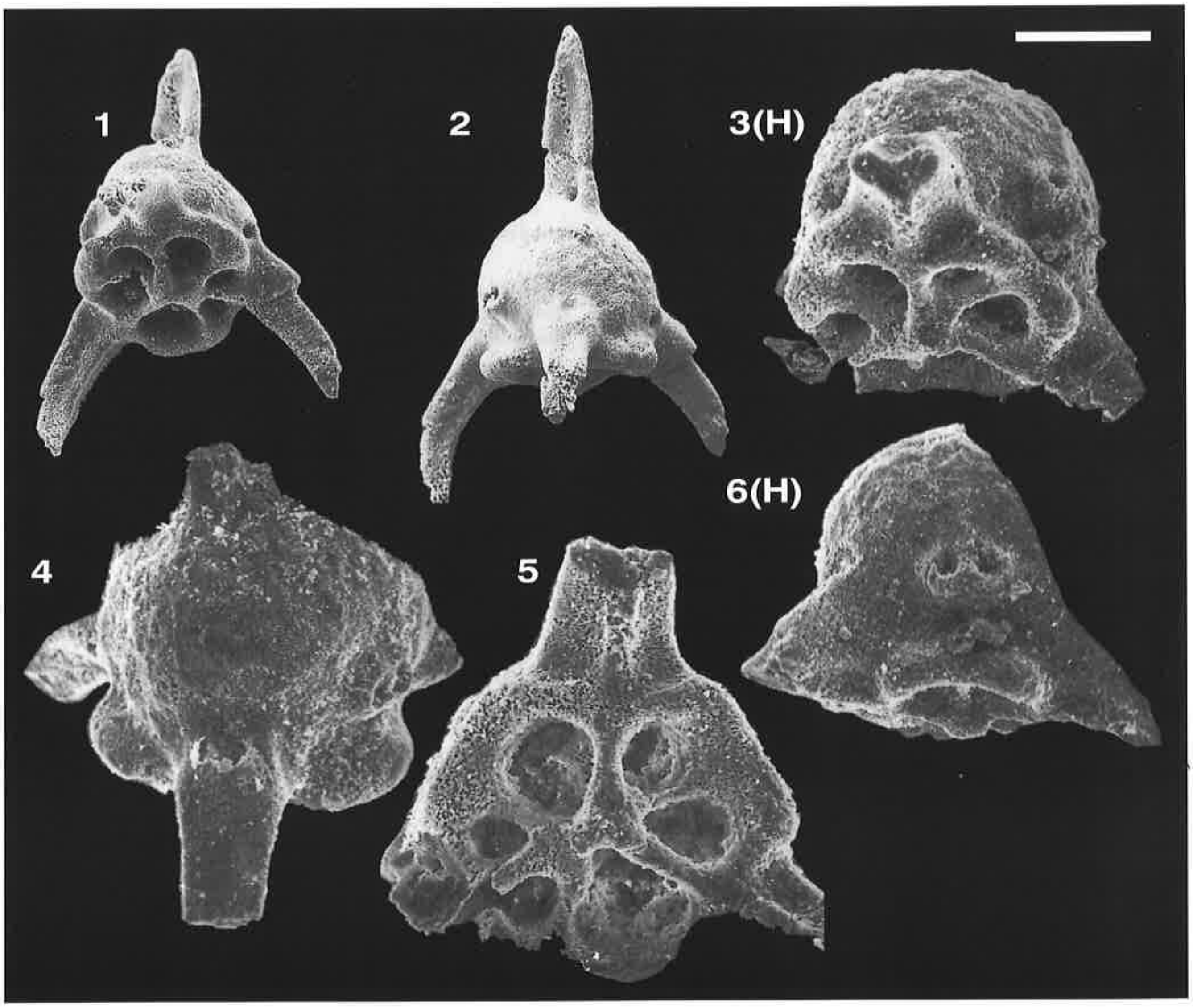


Plate 3021. *Saitoum trichylum* DE WEVER. Magnification x400, unless otherwise indicated. **Fig. 1.** POB78/8171, POB986.52. **Fig. 2.** POB78/8170, POB986.52. **Fig. 3(H).** De Wever 1981a, pl1, Fig. 6, x700. **Fig. 4.** DW, ABV124, x700. **Fig. 5.** DW, ABV124, x700. **Fig. 6(H).** De Wever 1981a, pl1, Fig. 2, x700.

SAVARYELLA 6017

Genus: *Savaryella* JUD

Synonymy.-
Savaryella JUD
JUD 1994, p. 103.

Type Species.- *Savaryella guexi* JUD 1994.

Original Definition.- Spongy test of 4 rays. Complete test of approximately uniform height. Width of rays slightly thinner at center of test and reaching a maximum thickness at their bulbous tips. Lateral sides of rays straight or slightly concave. Internal structure unknown but it seems to consist of a very delicate spongy network which is easily dissolved during fossilization.

Etymology.- *Savaryella* n.gen. is dedicated to Jean Savary, a geologist at the Institute of Geology and Paleontology, University of Lausanne, Switzerland, honouring his work on the program BIOGRAPH (Savary & Guex, 1991), his help and his friendship.

Included Taxa.-
5193 *Savaryella guexi* JUD

SAVARYELLA GUEXI 5193

Savaryella guexi JUD

Synonymy.-
Savaryella guexi JUD
JUD 1994, p. 103, pl. 19, figs. 10-11.

Original Definition.- Test with 4 rays of equal length, arranged 2 by 2 at angles of 60-70 and 110-120. Rays increasing in width from the centre and ending with club-shaped tips. Rays rectangular in cross-section, becoming elliptical at the tips. Lateral sides of rays straight or slightly concave. Test of spongy network. Thickness of test decreases very slowly distally.

Original Remarks.- *Savaryella guexi* n.sp. is well characterized by its morphology. It differs from all other Lower Cretaceous species with 4 arms and spongy shell by possessing club-like ray tips, by having rays at unequal angles (like the angles between the diagonals of a rectangle) and by the thickness of rays which decreases very slowly distally.

Etymology.- This species is dedicated to Jean Guex, Professor at Institute of Geology and Paleontology, University of Lausanne, Switzerland, honouring his work in establishing a new method for biochronological correlations and developing the computer program BIOGRAPH, and thanking him for his help and his friendship.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Lenght of rays:	292	260	238	292
Width of rays:	115	89	76	115
Maximum height of test:	160	-	-	-

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 14-21, early-early late Berr. to early Barr.

sceptrum >> *PSEUDOEUCYRTIS SCEPTRUM* 5577

schoolhousensis >> *PARVICINGULA SCHOOLHOUSENSIS GR.* 3184

sedecimporata >> *EMILUVIA SEDECIMPORATA* 3216

semifactum >> *EUCYRTIDIELLUM SEMIFACTUM* 3016

septemporatus >> *CECROPS SEPTEMPORATUS* 5229

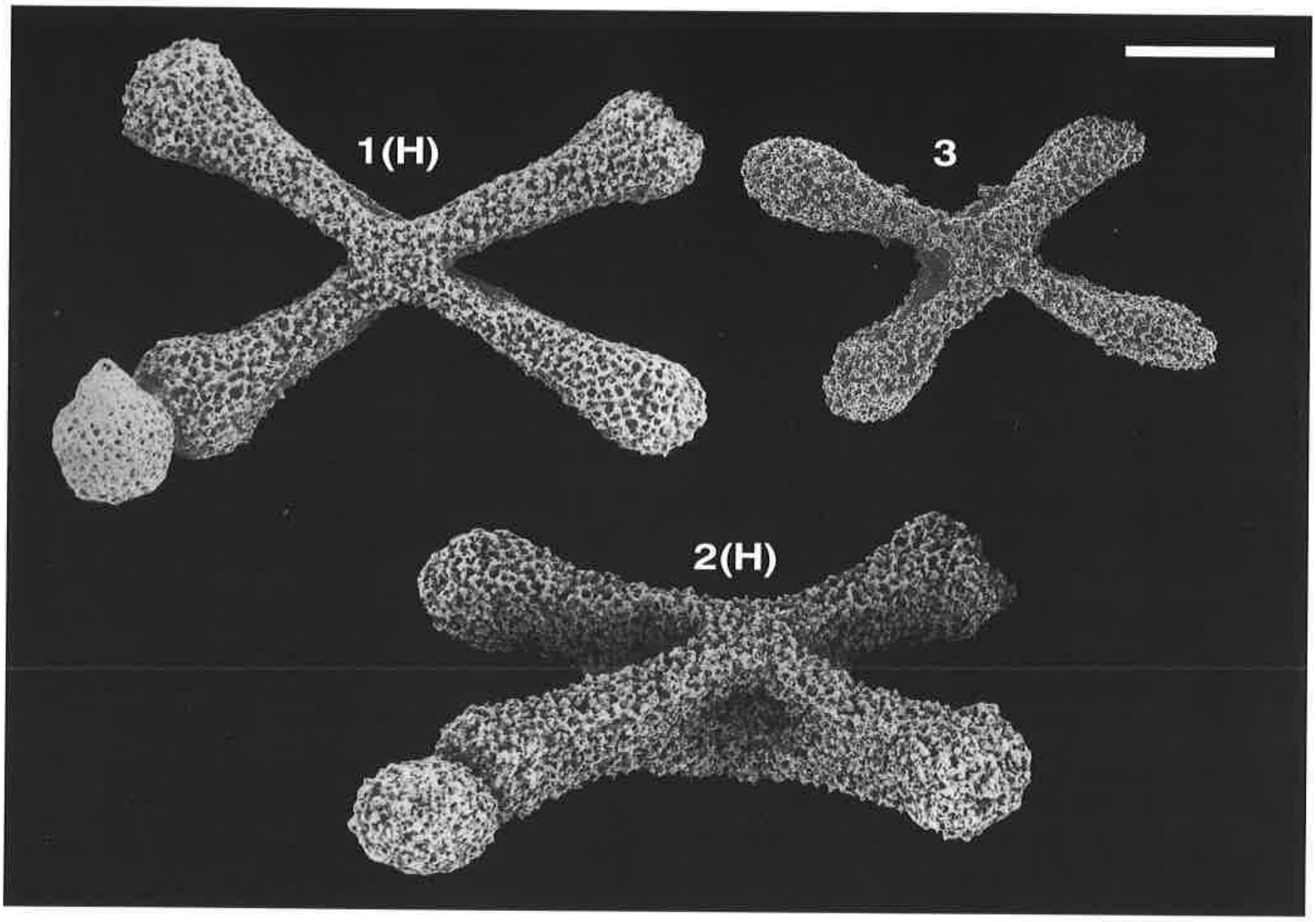


Plate 5193. ***Savaryella guexi*** **JUD.** Magnification x150. **Fig. 1(H).** RJ134, Bo449.5. **Fig. 2(H).** RJ136, Bo449.5. **Fig. 3.** RJ207, Bo370.1.

SETHOCAPSA 3689

Genus: *Sethocapsa* HAECKEL

Synonymy.-
Sethocapsa HAECKEL
HAECKEL 1881, p. 433.

Type Species.- *Sethocapsa cometa* (PANTANELLI) in Rüst 1885. Subsequent designation by Foreman 1973b.

Original Definition.- Obtuse Sethocapsida (with cephalis smooth, not spiny). With cephalis lacking a tube. With cephalis free.

Remarks.- Species are determined by overall test shape (with particular reference to the proximal segments), by surface ornamentation and by the character of spines when present.

Included Taxa.-
5544 *Sethocapsa* (?) *concentrica* (STEIGER)
5544 *Sethocapsa dorysphaeroides* NEVIANI sensu SCHAAF
3070 *Sethocapsa funatoensis* AITA
5481 *Sethocapsa* sp. aff. *S. kaminogoensis* AITA
3264 *Sethocapsa kitoi* JUD
3062 *Sethocapsa leiostraca* FOREMAN
5553 *Sethocapsa* (?) *orca* FOREMAN
5469 *Sethocapsa simplex* TAKETANI
3168 *Sethocapsa* (?) *sphaerica* (OZVOLDOVA)
3063 *Sethocapsa trachyostraca* FOREMAN
5510 *Sethocapsa tricornis* JUD
5462 *Sethocapsa uterculus* (PARAONA) sensu FOREMAN
5464 *Sethocapsa zweilii* JUD
3167 *Sethocapsa* sp. A

SETHOCAPSA (?) CONCENTRICA 5433

Sethocapsa (?) *concentrica* (STEIGER)

Synonymy.-
Podocyrtis concentrica STEIGER
STEIGER 1992, p. 68, pl. 19, figs. 6-9.
Sethocapsa (?) *concentrica* (STEIGER)
JUD 1994, p. 103, pl. 19, fig. 12.

Original Definition.- "Spherical test with 3 segments and 4 triradiate spines. The spines are arranged tetraedrically. One of them is located of the cephalis. The thorax is a ring-like segment. The large spherical last segment, the abdomen has concentrically arranged rows of hexagonal pore frames in axial view. The pores get larger from proximal to distal part. The lower surface of the test is closed. Three triradiate spines are located in one plane below the equator with an angle of 120 degrees and dipping distally."

Original Remarks.- "The species differs from *Podocyrtis globosa* (RÜST) by having a very small cephalis, by the concentric arrangement of pores and by having long triradiate spines."

Etymology.- According to the concentrically arranged pore rows on the abdomen.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Width of abdomen:	245	230	200	260
Lenght of apical spine:	180	130	85	180
Lenght of abd. spine:	160	173	100	255

Type Locality.- Schrambach, Salzburg.

UAZones.- 13-14, latest Tith. to early-early late Berr.

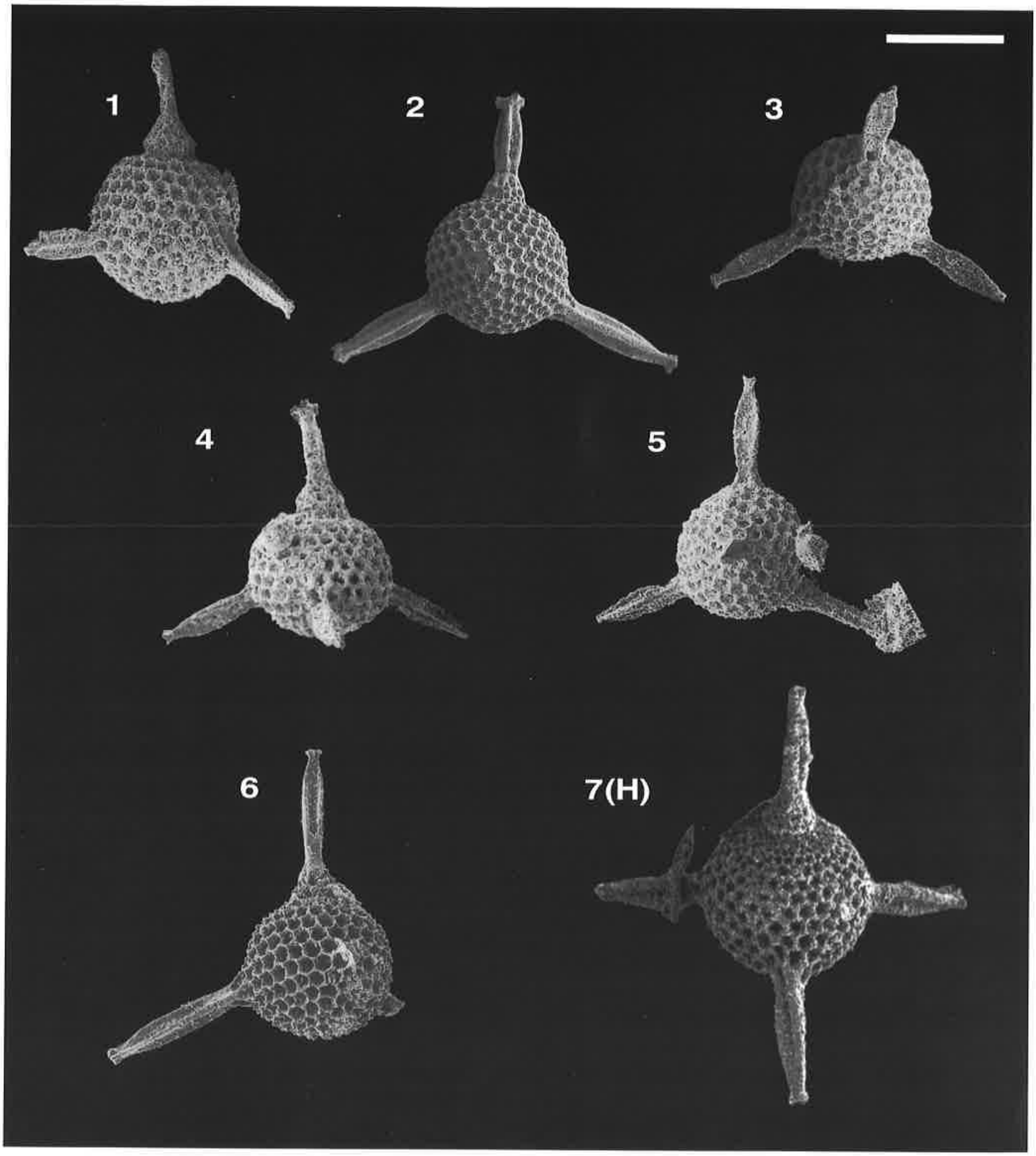


Plate 5433. *Sethocapsa* (?) *concentrica* (STEIGER). Magnification x100. **Fig. 1.** RJ77, Bo311.2. **Fig. 2.** POB80/3017. **Fig. 3.** RJ40, Pi10.0. **Fig. 4.** RJ43, Pi10.0. **Fig. 5.** RJ38, Pi10.00. **Fig. 6.** TS18, Ka43/1. **Fig. 7(H).** STEIGER 1992, pl. 19, fig. 7.

SETHOCAPSA DORYSPHAEROIDES 5544

Sethocapsa dorysphaeroides NEVIANI sensu SCHAAF

Synonymy.-
Sethocapsa dorysphaeroides NEVIANI
NEVIANI 1900, p. 660, pl. 10, fig. 14.
SCHAAF 1984, p. 155, figs. 6a-b.
STEIGER, 1992, p. 68, pl. 17, figs. 18-19.
BAUMGARTNER 1992, p. 325, pl. 12, fig. 5.
Sethocapsa dorysphaeroides NEVIANI sensu SCHAAF
JUD 1994, p. 103, pl. 19, figs. 13-14.

Original Definition.- "It differs from the preceding forms in having the thoracic segment spherical; surface smooth; test-wall thick, with large pores; the cephalic segment is relatively little smaller; by sections nothing could be found out about its perforation; the cephalic spine is very slender."

Actualized Definition.- (JUD,1994) Test of 5-7 segments, consisting of two parts: an upper slender, conical portion of 4-6 segments and a terminal large globose segment. Upper portion regularly and gradually increasing in width, with segmental partitions only slightly visible outside. First 1-3 segments probably with double-layered test wall, of which the inner one is covered sometimes completely by the external layer. Cephalic segment bearing a slender, pointed horn which on many specimens is not straight but slightly curved. Segments of the lower part of the upper portion with polygonal, spiny pore frames. Last portion of test consisting of a large, inflated, globose segment with large pores quincuncially arranged in longitudinal rows. No aperture developed but terminal end slightly pointed.

Actualized Remarks.- (JUD,1994) The specimens illustrated by Schaaf (1984) resemble the specimen illustrated by Neviani (1900). Schaaf (1984), however, did not give any actualized definition. Our forms are considerably larger than those of Neviani: the average of 6 specimens measured showing a total length (with spine) 551 μm, a length without last globose segment 240 μm, and a width of last segment of 318 μm. Forms similar to the above described species possess spines on pore junctions, and other forms with an inflated but more elongated postabdominal segment have a distal aperture. More investigations are needed to classify clearly all the mentioned morphotypes. For biostratigraphic data we included in *Sethocapsa doryspaeroides* (NEVIANI) only forms consisting of a slender proximal part bearing a cephalic horn and a globose distal part lacking a terminal aperture.

Measurements (in μm).-
Total length of test 200, length of spine 30, length of cephalis 80, width of cephalis 30, width of thoracic segment 170.

Type Locality.- Mesozoic rocks of the Bologna area, Italy.

UAZones.- 7-22, late Bath.-early Call. to late Barr.-early Apt.

SETHOCAPSA FUNATOENSIS 3070

Sethocapsa funatoensis AITA

Synonymy.-
Sethocapsa sp. A
MATSUOKA 1986a, pl. 2, fig. 8.
Sethocapsa funatoensis AITA
AITA 1987, p. 73, pl. 2, figs. 6a-7b; pl. 9, figs. 14-15.

Original Definition.- Shell of three segments, consisting of cephalis and thorax forming subconical part and large, globose terminal segment without aperture. Cephalis spherical to rarely subconical, poreless; thorax campanulate in outline, with numerous small, round to oval pores and somewhat roughened surface. Last segment closed, large, globose with porous, pointed nodes. Pores moderate in size, larger on last segment than on thorax, arranged irregularly.

Original Remarks.- This species differs from *Sethocapsa yahazuensis* n.sp. by having rather spinose or pointed nodes on the last segment.

Etymology.- This species is named for the hamlet of Funato, Higashitsuno Village, Kochi Prefecture, southwest Japan.

Measurements (in μm).-
Based on 7 specimens.

	HT	max.	min.	av.
Height of last segmment:	118	123	80	105
Overall height:	193	180	133	161
Width of last segment:	155	135	108	125

Type Locality.- Sample SOG-1, Sogatani section, Irazuyama Formation (Togano Group), Kochi Prefecture, southwest Japan.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

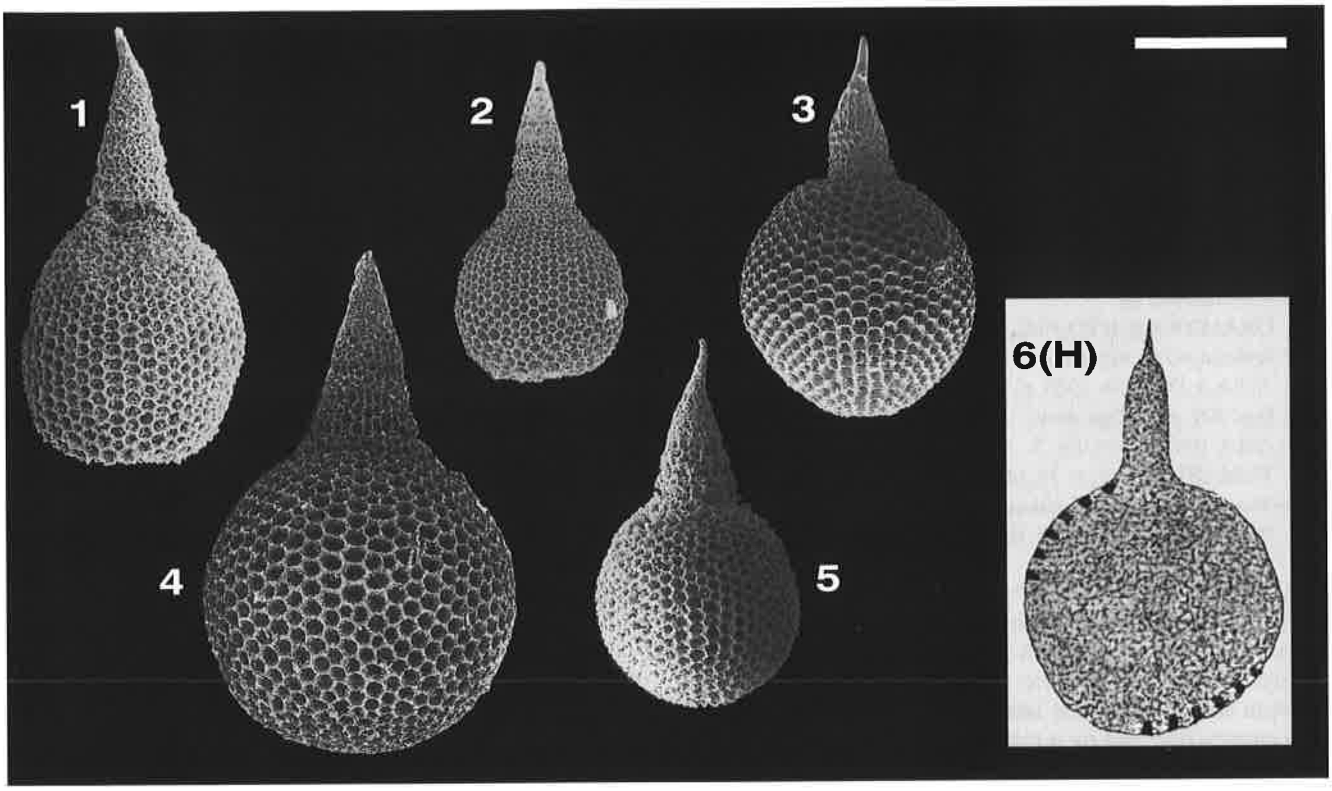


Plate 5544. *Sethocapsa dorysphaeroides* NEVIANI sensu SCHAAF. Magnification x100. **Fig. 1.** RJ71, 146.5. **Fig. 2.** RJ123, Bo566.5. **Fig. 3.** RJ73, Ru146.5. **Fig. 4.** RJ442, Br28.85. **Fig. 5.** DU1241, V40. **Fig. 6(H).** NEVIANI 1900, pl. 10, fig. 14.

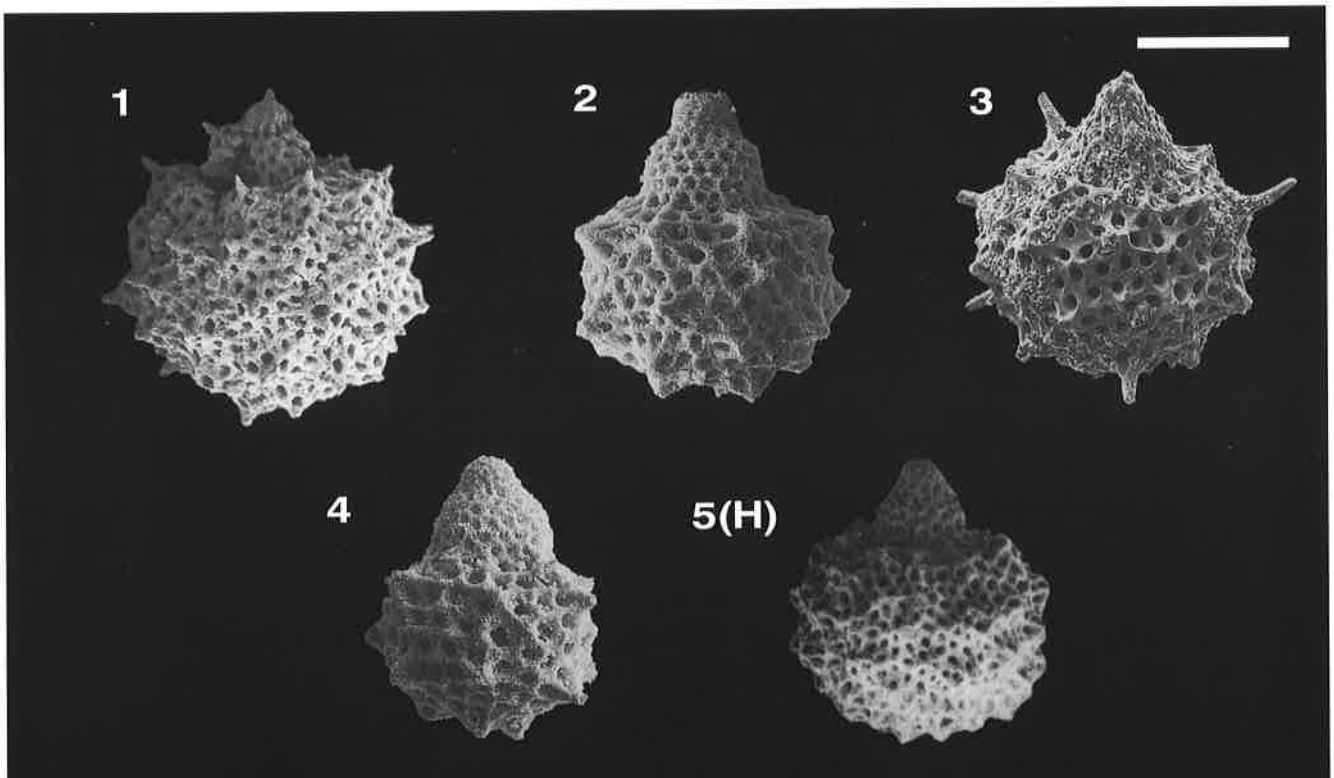


Plate 3070. *Sethocapsa funatoensis* AITA. Magnification x200. **Fig. 1.** POB76/5065, POB144.54. **Fig. 2.** DU1910, R102. **Fig. 3.** POB81/1430, 534A.125.2.36. **Fig. 4.** DU1960, R102. **Fig. 5(H).** AITA 1987, pl. 9, fig. 14.

SETHOCAPSA KAMINOGOENSIS AFF. 5481

Sethocapsa sp. aff. *S. kaminogoensis* AITA

Synonymy.-
? *Sethocapsa* sp.
OKAMURA & UTO 1982, pl. 3, fig. 12.
KITO 1987, pl. 2, fig 3.
? *Tricolocapsa* sp.
OKAMURA & UTO 1982, pl. 9, figs. 1a-b.
? *Sethocapsa kaminogoensis* AITA
AITA & OKADA 1986, p. 114, pl. 3, figs. 1-8; pl. 4, figs. 5-8; pl. 7, figs. 4a-c.
AITA 1987, pl. 14, fig. 5.
TUMANDA 1989, p. 39, pl. 4, figs. 13-14; pl. 10, fig. 12.
Sethocapsa sp. aff. *S. kaminogoensis* AITA
JUD 1994, p. 104, pl. 19, fig. 15; pl. 20, fig. 1.

Original Definition.- Pyriform test of 4 segments. Cephalis together with thorax and abdomen form a conical body which is smooth on the apical part, nodose or tuberculate on the middle and lower parts. Boundary between abdomen and the last inflate chamber well marked by a constriction and by a row of large pores, 5-6 on half a perimeter. These pores are laterally directed and belong to the lower part of abdomen, which in this part has vertical walls. Last segment inflated, subspherical, slightly flattened axially and having the surface covered with nodes or tubercles with imperforate apices. These tubercles may be interconnected by ribs forming triangular meshes.

Original Remarks.- This species resembles *S. kaminogoensis* AITA by having a tuberculate surface and a row of large pores at the stricture between abdomen and postabdominal segment, but differs in that this row of large pores is situated at the lower part of the abdomen. These pores are laterally open whereas with the latter species they are situated on the proximal part of the last segment and are upwardly directed. The holotype and the paratypes of *S. kaminogoensis* have also a row of nodes at the boundary between this row of pores and the upper part of the last segment, forming a kind of well marked shoulder.

Measurements (in μm).-
Total height of shell 161-205, height of last segment 77-120, diameter of last segment 120-152.

UAZones.- 13-21, latest Tith. to early Barr.

SETHOCAPSA KITOI 3264

Sethocapsa kitoi JUD

Synonymy.-
? *Sethocapsa* sp. A
AITA & OKADA 1986, p. 118, pl. 3, fig. 13.
Sethocapsa uterculus (PARONA)
STEIGER 1992, p. 63, pl. 17, fig. 14.
Sethocapsa kitoi JUD
JUD 1994, p. 104, pl. 20, figs. 3-4.

Original Definition.- Test composed of four segments of which the last segment is large and spherical. The first three segments form a conical part, poreless in the upper portion, and with pores on the lower one, corresponding to the abdomen. Thorax and abdomen sometimes with a transverse row of nodes. The fourth segment is very large, globose, separated from abdomen by a very deep constriction. Upper part of the inflated segment flat or slightly depressed at the contact with the abdomen. Pores of this last segment very small, circular, with regular rhombic pore frames arranged in oblique rows, giving the surface the aspect of fish-scale disposition. Small aperture developed at the distal end.

Original Remarks.- *Sethocapsa kitoi* n.sp. differs from *Sethocapsa uterculus* (PARONA) sensu FOREMAN by lacking the circumferential single row of very large pores on the uppermost part of the globose postabdominal segment, by possessing a larger number of pores on the latter segment and by having rhombic framed pores. It differs from *Sethocapsa pseudouterculus* AITA by having rhombic pore frames and a larger number of pores on the inflated postabdominal segment.

Etymology.- This species is dedicated to Norio Kito, a Japanese radiolarist, (Hakodate) honouring his contributions to the knowledge of Radiolaria and thanking him for giving us the illustration of a specimen in transmitted light.

Measurements (in μm).-
Based on 3 specimens.

	HT.	av.	min.	max.
Total height	246	239	220	251
Height prox. part:	66	71	66	75
Maximum width:	186	184	170	97

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-16, latest Tith. to early Val.

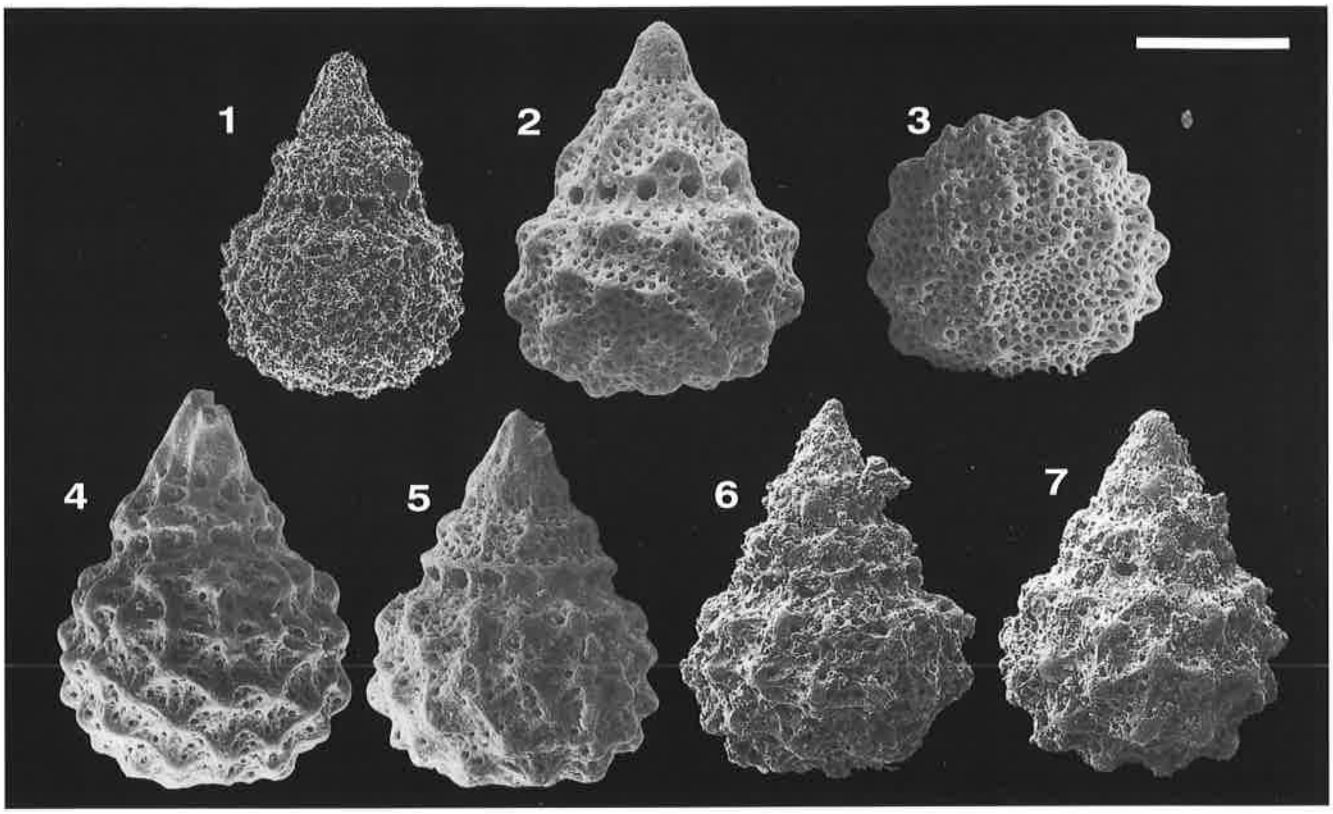


Plate 5481. *Sethocapsa* sp. aff. *S. kaminogoensis* AITA. Magnification x300. **Fig. 1.** RJ118, Bo449.5. **Fig. 2.** DU3376, Mo37. **Fig. 3.** DU3377, Mo37. **Fig. 4.** DU1275, V40. **Fig. 5.** DU3391, Mo41. **Fig. 6.** POB80/2673, POB1134. **Fig. 7**. POB80/2670, POB1134.

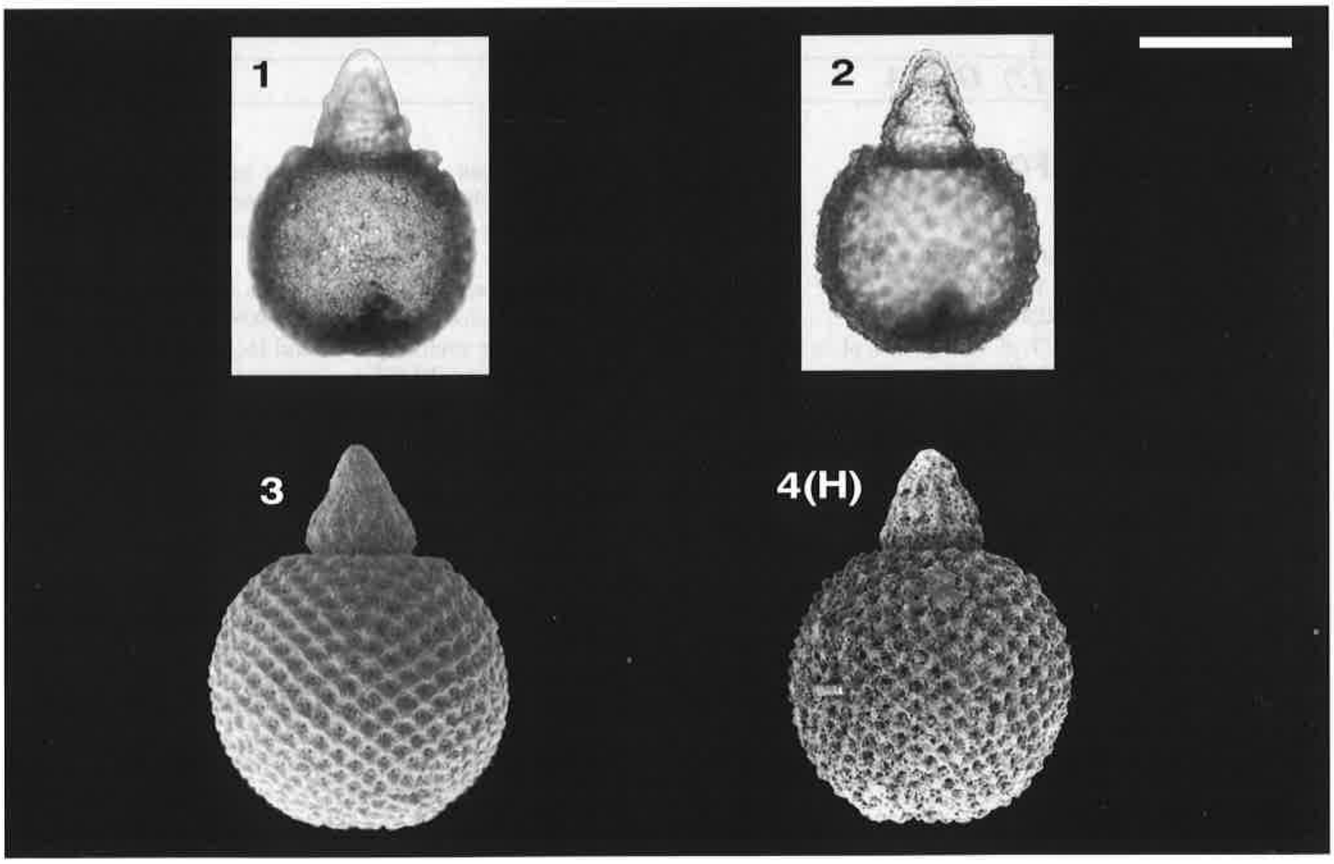


Plate 3264. *Sethocapsa kitoi* JUD. Magnification x200. **Fig. 1.** KI12-17(35), NK82090309. **Fig. 2.** KI12-18(35), NK82090309. **Fig. 3.** KI36-4, NK81072507. **Fig. 4(H).** RJ476, 1330.

SETHOCAPSA LEIOSTRACA 3062

Sethocapsa leiostraca FOREMAN

Synonymy.-
Sethocapsa leiostraca FOREMAN
FOREMAN 1973b, p. 268, pl. 12, figs. 5-6.
FOREMAN 1975, p. 617, pl. 2J, fig. 5.
KOCHER 1981, p. 89, pl. 16, fig. 6.
BAUMGARTNER 1984, p. 784.
OZVOLDOVA & SYKORA 1984, p. 271, pl. 13, fig. 4.
OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 2.
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 8.
STEIGER 1992, p. 63, pl. 17, figs. 11-12.
? BAUMGARTNER 1992, p. 325, pl. 12, figs. 2-3.
JUD 1994, p. 105, pl. 20, fig. 5.

Original Definition.- The shell is of probably three segments, a very small, conical, proximal part composed of cephalis and thorax and a large globose terminal segment without aperture. The cephalis is poreless and bears a short, conical, broad-based horn. The small thorax has a few small pores and is roughened by ridges which extend up from the abdomen. The abdomen is almost spherical, only slightly broader than high. It bears widely spaced, slender, short spines which arise from arches developed from the intervening pore bars, about five spines on a circumference. Pores are large, rounded, fairly regular, and tend to be scalloped or subdivided on their lower margins.

Original Remarks.- This species differs from *S. trachyostraca* in lacking nodes and having larger pores.

Etymology.- Greek *leios* smooth and *ostrakon* (n.) shell = *leiostracus, -a, -um* with a smooth shell.

Measurements (in μm).-
Based on 11 specimens. Length overall exclusive of apical horn, 210-325 (majority 210-285); of abdomen, 155-275 (majority 170-250); width of globose terminal segment, 165-300 (majority 165-250); diameter of pores, 15-30.

Type Locality.- DSDP Leg 20, Site 195, northwest Pacific basin.

UAZones.- 4-20, late Baj. to late Haut.

SETHOCAPSA (?) ORCA 5553

Sethocapsa (?) *orca* FOREMAN

Synonymy.-
Theoperid, Gen. and sp. indet.
FOREMAN 1973b, pl. 12, fig. 3.
Sethocapsa (?) *orca* FOREMAN
FOREMAN 1975, p. 617, pl. 2J, figs. 1-2; pl. 6, fig. 12.
JUD 1994, p. 105, pl. 20, figs. 6-7.
Sethocapsa orca FOREMAN
SCHAAF 1981, p. 437, pl. 26, figs. 3a-b.
SCHAAF 1984, p. 154, figs. 8a-b.

Original Definition.- The shell is large, of probably four segments; a cephalis and two post-cephalic segments comprising a small conical proximal part, and a large spherical terminal segment. The proximal segments have small irregular pores and the large spherical segment moderate, subcircular to angular, uniform pores, closely spaced and regularly quincuncially arranged in diagonal rows like a honeycomb. The intervening pore bars are generally narrow and smooth except for a slight raised area where they join. On their lower margin the pores are scalloped or subdivided. One specimen was observed with a small smooth rounded aperture, 25 microns in diameter.

Original Remarks.- This species is distinguished from *Sethocapsa leiostraca* FOREMAN by its larger size, proportionately smaller pores, and lack of spines, and from *Tetracapsa ixodes* RÜST by its terminal segment which is spherical and has much more closely spaced pores.

Etymology.- The specific name *orca* is the Latin feminine noun, whale or large rounded vessel.

Measurements (in μm).-
Based on 15 specimens. Length overall 310-435, of small proximal part 45-75, width of globose terminal segment 230-370, of shell wall 20-30.

Type Locality.- DSDP Leg 32, Site 305, north Pacific.

UAZones.- 19-22, early Haut. to late Barr.-early Apt.

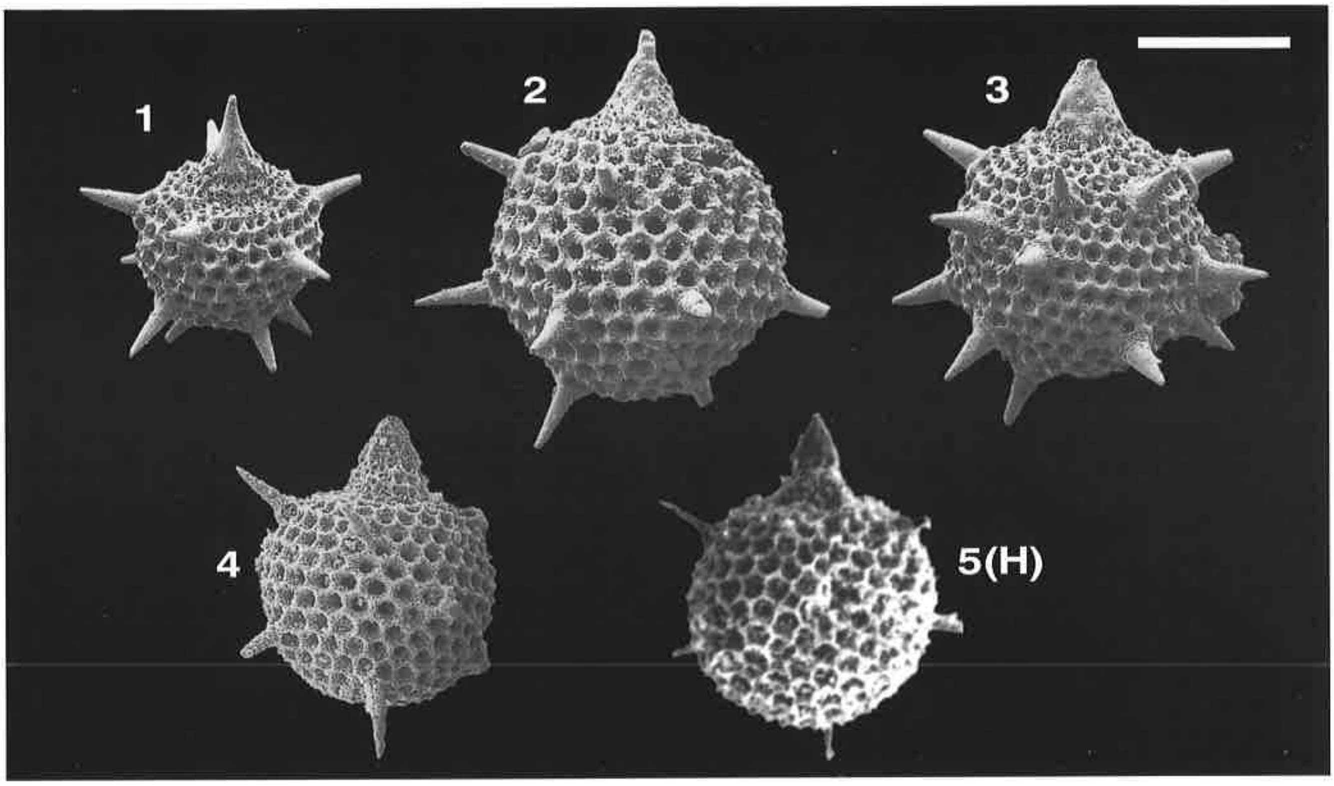


Plate 3062. *Sethocapsa leiostraca* FOREMAN. Magnification x150. **Fig. 1.** POB79/4145, MO2 46. **Fig. 2.** POB79/4151. **Fig. 3.** POB79/4150, MO2 46. **Fig. 4.** RJ634, Bo566.5. **Fig. 5(H).** FOREMAN 1973b, pl.12, fig. 5.

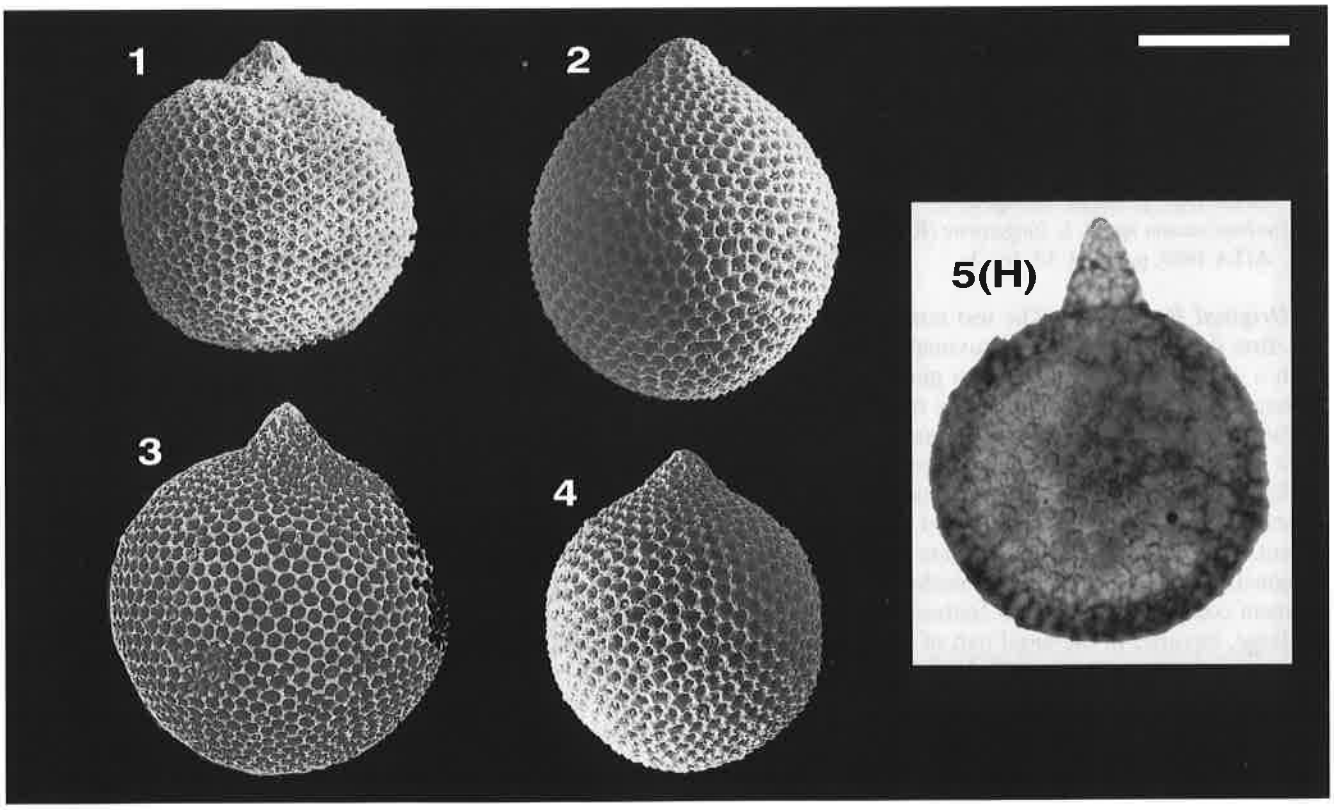


Plate 5553. *Sethocapsa* (?) *orca* FOREMAN. Magnification x150. **Fig. 1.** RJ34, Bo581.65. **Fig. 2.** DU1328, V47. **Fig. 3.** RJ79, Bo566.5. **Fig. 4.** PD1324, V47. **Fig. 5(H).** FOREMAN 1975, pl. 6, fig. 12.

SETHOCAPSA SIMPLEX 5469

Sethocapsa simplex TAKETANI

Synonymy.-
Sethocapsa sp.
FOREMAN 1975, p. 617, pl. 2I, figs. 10-12, 14.
Sethocapsa simplex TAKETANI
TAKETANI 1982, p.63, pl. 5, figs. 8a-c; pl. 13, fig. 1.
JUD 1994, p. 105, pl. 20, fig. 8.
Sethocapsa sp.
FOREMAN 1975, p. 617, pl. 2I, figs. 10-12, 14.

Original Definition.- Shell consisting of 4 segments. Cephalis with or without a short apical horn, subspherical, sparsely perforated. Thorax and abdomen subcylindrical, each with closely disposed, small circular pores. Each of the above three segments, differentiated by strictures from another, gradually increases in width. The fourth segment with several short spines projecting out of its wall, spherical to subspherical, much larger than the above three segments. Pores of the fourth segment, larger than those of the former three segments, circular, and have hexagonal pore frames. Terminal mouth fenestrated.

Original Remarks.- This species is characterized by its lobate proximal portion and large, globose last segment.

Remarks.- All specimens found in our samples lack spines on the terminal segment, being thus similar to those illustrated in Foreman (1975, pl. 2F, figs. 10-12, 14)

Etymology.- Latin adj. *simplex*, meaning unadorned.

Measurements (in μm).-
Based on 15 specimens.

	HT	av.	min.	max.
Total height:	140	145	130	173
Height 4th segment:	88	86	63	115
Width 4th segment:	103	97	80	113

Type Locality.- Obira area, Hokkaido, Japan.

UAZones.- 20-22, late Haut. to late Barr.-early Apt.

SETHOCAPSA (?) SPHAERICA 3168

Sethocapsa (?) *sphaerica* (OZVOLDOVA)

Synonymy.-
Podocapsa guembelii RÜST
RÜST 1885, p. 304, pl. 36 (11), fig. 5 only.
Podocapsa cf. *gumbelli* RÜST
? DUMITRICA & MELLO 1982, pl. 3, fig. 6.
Acotripus sphericus OZVOLDOVA
OZVOLDOVA 1988, p. 376, pl. 5, figs. 1-5, 7; pl. 8, fig. 7.
Acotripus (?) *sphericus* OZVOLDOVA
DANELIAN 1989, p.135, pl. 2, figs. 1-5.
Lychocanoma sp. cf. *L. xiphophora* (RÜST)
AITA 1987, p. 65, pl. 13, fig. 2.
Lychnocanoma sp. cf. *L. longicorne* (RÜST)
AITA 1987, p. 65, pl. 13, fig. 3.

Original Definition.- The test consists of 4 segments. The first three of them, of approximately the same height, form a cones. The final one has a globular shape, slightly flattened along the main axis and is roughly twice as high as the first three segments. Structures between the first three segments are absent. The aperture is not exposed. The cephalis surface is lined with longitudinal depressions, in which elongated pores are situated. The apical horn is absent. The thorax and abdomen are covered with small, diagonally arranged pores. The meshwork of the terminal segment consists of hexagonal frames. Pores of the frames are large, circular. In the basal part of the terminal segment 3 stout at the base three-ridged, at the terminal smooth spines branch into the sides.

Original Remarks.- Our specimens resemble the specimen *Cyrtocapsa* sp. (De Wever et al., 1986, pl. 10, fig. 4). In their diagnostic characteristics, however, they better correspond with the genus *Acotripus* PETRUSHEVSKAYA 1981.

Remarks.- The name *sphericus* is emended (ICZN, art. 33a (I)) into *sphaericus*, which is the correct Greek spelling (ICZN, annexe B). Danelian (1989) mentioned that this species cannot be attributed with certainty to *Acotripus* because this genus was defined by Haeckel (1881) as an open tetracyrtid. Nevertheless, there is no structural resemblance between this species and the type-species (*Acotripus urceolus* RÜST 1885) subsequently designated by Campbell (1954). It is interesting to notice that Haeckel (1887) has not used this genus in his well known monograph. This species is very similar to the specimen illustrated by Rüst (1885, pl. 36 (11), fig. 5, not 6) as *Podocapsa guembeli* (and could be chosen as the type-species of *Podocapsa*) but the emended definition of Foreman has changed the sense of the genus. In this situation we prefer to questionably assign this species to the genus *Sethocapsa* as it has many elements in common with the species presently included in this genus by most radiolarian paleontologists working on Mesozoic faunas.

Etymology.- *Sphaericus*- spherical, according to the spherical shape of the terminal segment.

Measurements (in μm).-
Based on 10 specimens.

	HT	min.	max.
Total test height:	260	255	290
Height of the first three segments:	90	-	-
Height of the terminal segment:	170	-	-
Max. width of the terminal segment:	200	180	215
Spine lenght :	95	80	105

Type Locality.- Myjava-Tura Luka, Myjavska Pahorkatina hills, Slovakia.

UAZones.- 9-11, mid-late Oxf. to late Kimm.-early Tith.

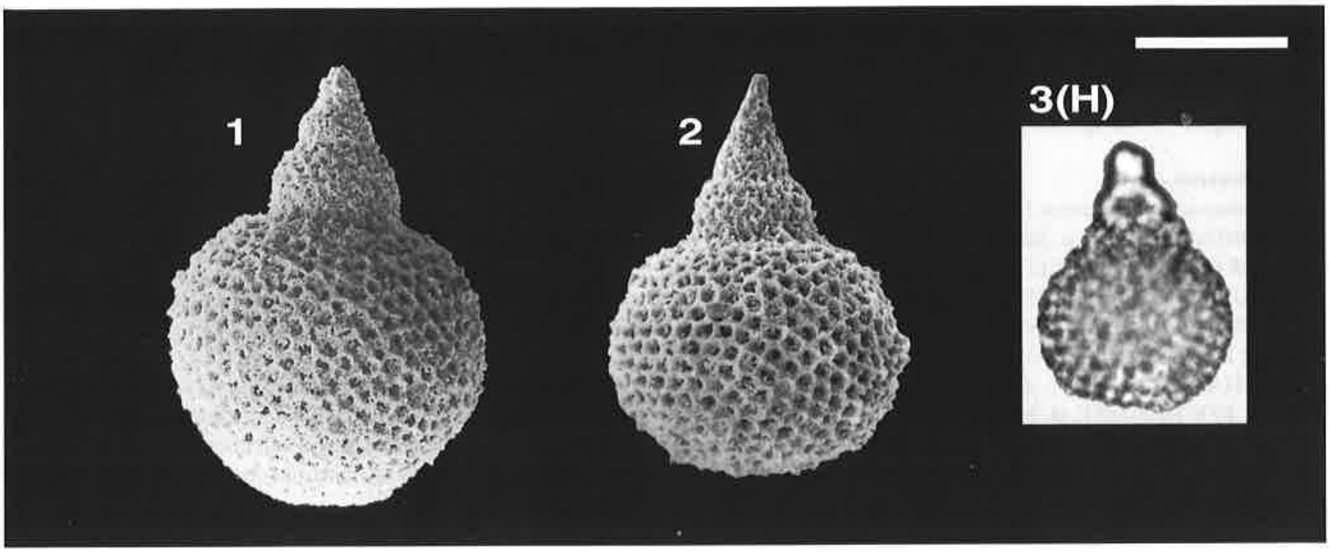


Plate 5469. *Sethocapsa simplex* TAKETANI. Magnification x250 **Fig. 1.** RJ29, Pr225.3. **Fig. 2.** RJ20, Pr225.3. **Fig. 3(H).** TAKETANI 1987, pl.5, fig.8b.

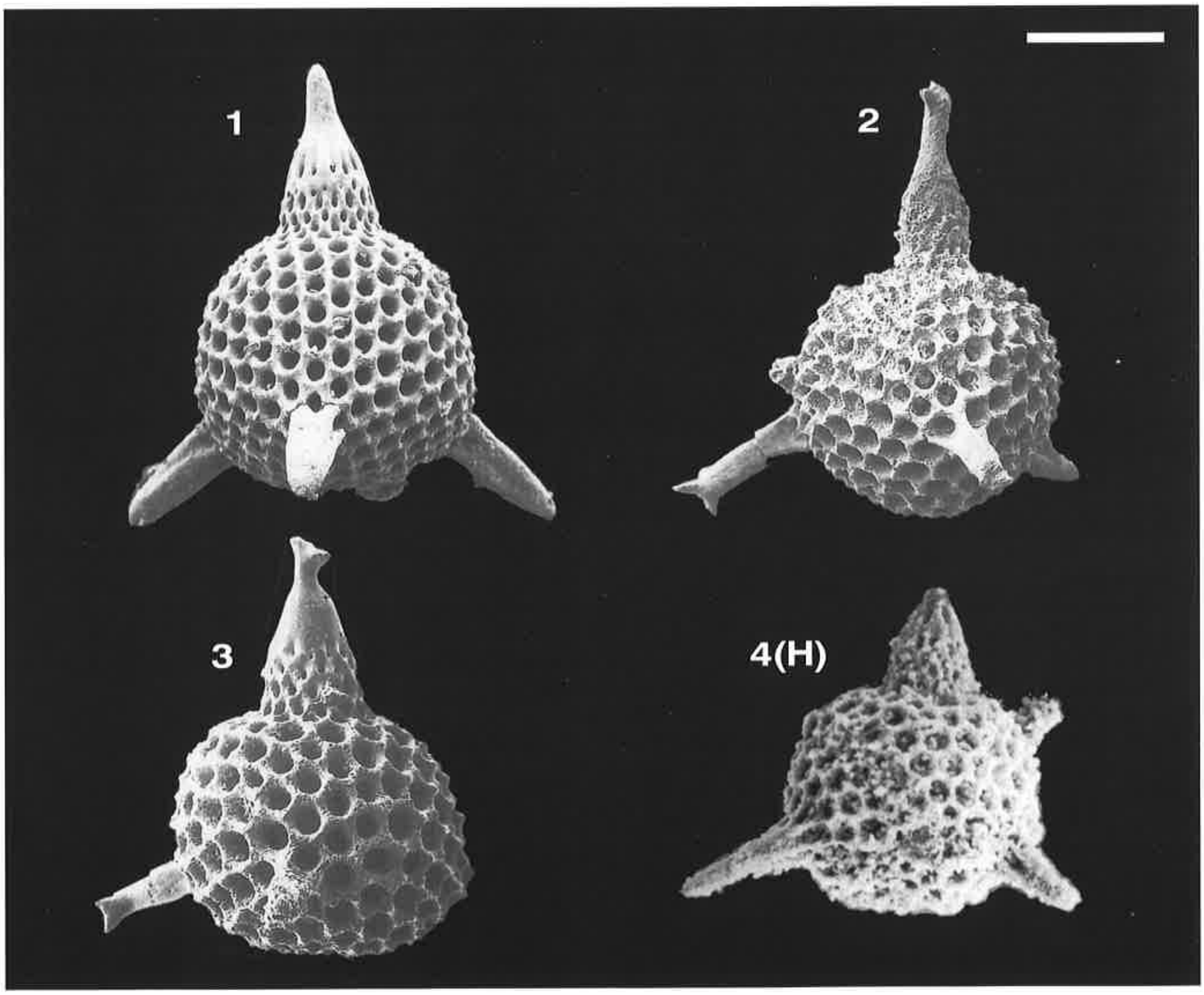


Plate 3168. *Sethocapsa* (?) *sphaerica* (OZVOLDOVA). Magnification x200. **Fig. 1.** POB78/8193, POB986.51. **Fig. 2.** POB79/1660, POB79.5 J.86. **Fig. 3.** POB81/9013, 76.534A.106.1.29. **Fig. 4(H).** OZVOLDOVA 1988, pl. 5, fig. 1.

SETHOCAPSA TRACHYOSTRACA 3063

Sethocapsa trachyostraca FOREMAN

Synonymy.-
Sethocapsa trachyostraca FOREMAN
FOREMAN 1973b, p. 268, pl. 12, fig. 4.
FOREMAN 1975, p. 617, pl. 2J, figs. 3-4.
MUZAVOR 1977, p. 119, pl. 6, fig. 5.
FOREMAN 1978, p. 749, pl. 1, fig. 18.
not BAUMGARTNER et al. 1980, pl. 6, fig. 2.
SCHAAF 1981, p. 437, pl. 23, figs. 1a-b.
not KOCHER 1981, pl. 16, figs. 9-10.
BAUMGARTNER 1984, p. 784, pl. 8, fig. 14.
AITA & OKADA 1986, p. 118, pl. 3, figs. 9-10.
KITO 1987, pl. 2, fig. 5.
PAVSIC & GORICAN 1987, p. 29, pl. 4, fig. 8.
IWATA & TAJIKA 1989, pl. 4, fig. 1.
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 9; pl. 4, fig. 12.
JUD 1994, p. 105, pl. 20, fig. 9.
Sethocapsa cf. *trachyostraca* FOREMAN
OZVOLDOVA & PETERCAKOVA 1987, p. 122, pl. 35, fig. 3.

Original Definition.- The shell is of four segments, a cephalis and two postcephalic segments forming a small, conical, proximal part and a large globose terminal segment without aperture. The cephalis is poreless and bears a short, slender, cylindrical apical horn. The first postcephalic segment has few or no pores and the second, numerous, closely spaced, regular, rounded pores. The large globose terminal segment has a nodose surface with a short, slender, cylindrical spine, similar to the apical horn, extending from the apex of many of the nodes. Pores are moderate in size, rounded, slightly irregular, and tend to be scalloped or subdivided on their lower margin.

Original Remarks.- This species differs from *S. leiostraca* as described under that species.

Remarks.- In our samples *Sethocapsa trachyostraca* FOREMAN shows considerable variations in the size and shape of the proximal and distal portions of test, in the size and number of tubercles and spines on the last globose segment.

Etymology.- Greek *trachys* rough plus *ostrakon* (n.) shell = *trachyostracus, -a, -um* with a rough shell.

Measurements (in μm).-
Based on 10 specimens. Length overall exclusive of apical horn, 170-300, (majority 200-300); of globose terminal segment, 150-210; width of globose terminal segment, 140-245 (majority 185-245); diameter of pores, 10-15.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 7-22, late Bath.-early Call. to late Barr.-early Apt.

SETHOCAPSA TRICORNIS 5510

Sethocapsa tricornis JUD

Synonymy.-
Sethocapsa tricornis JUD
JUD 1994, p. 105, pl. 20, figs. 10-11.

Original Definition.- Test of probably 4 segments increasing in size in distal direction, the last segment being large and globose. Cephalis conical, poreless, with a sturdy, conical apical horn. Thorax and abdomen slowly increasing in width; their surface nodose to slightly spiny, with small irregularly placed pores. Boundary to postabdominal segment constricted. The latter segment globular, with nodose to tuberculate surface and pores arranged more or less irregularly or in transverse rows. Lower part with 3, rarely 4 radially directed, long, conical spines. Base of spines expanded, with wide pores. No aperture observed.

Original Remarks.- *Sethocapsa tricornis* n.sp. differs from *Sethocapsa* (?) *sphaerica* OZVOLDOVA and *Sethocapsa* (?) *concentrica* STEIGER, both of them characterized by having three spines on the inflated segment, by having a nodose to tuberculate surface. *S. tricornis* n.sp. differs from *Sethocapsa trachyostraca* FOREMAN, which has also a tuberculate surface, by possessing only 3 or rarely 4 strong spines developed on the distal portion of the last segment, and by its longer proximal portion. Base of spines is however similar in both species.

Etymology.- Latin *tri*, three and *cornu*, horn.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
Height of test:	278	266	246	320
Width of test:	178	178	151	216
Length dist. spines:	73	63	49	80
Length apical horn:	67	60	43	72

Type Locality.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

UAZones.- 13-16, latest Tith. to early Val.

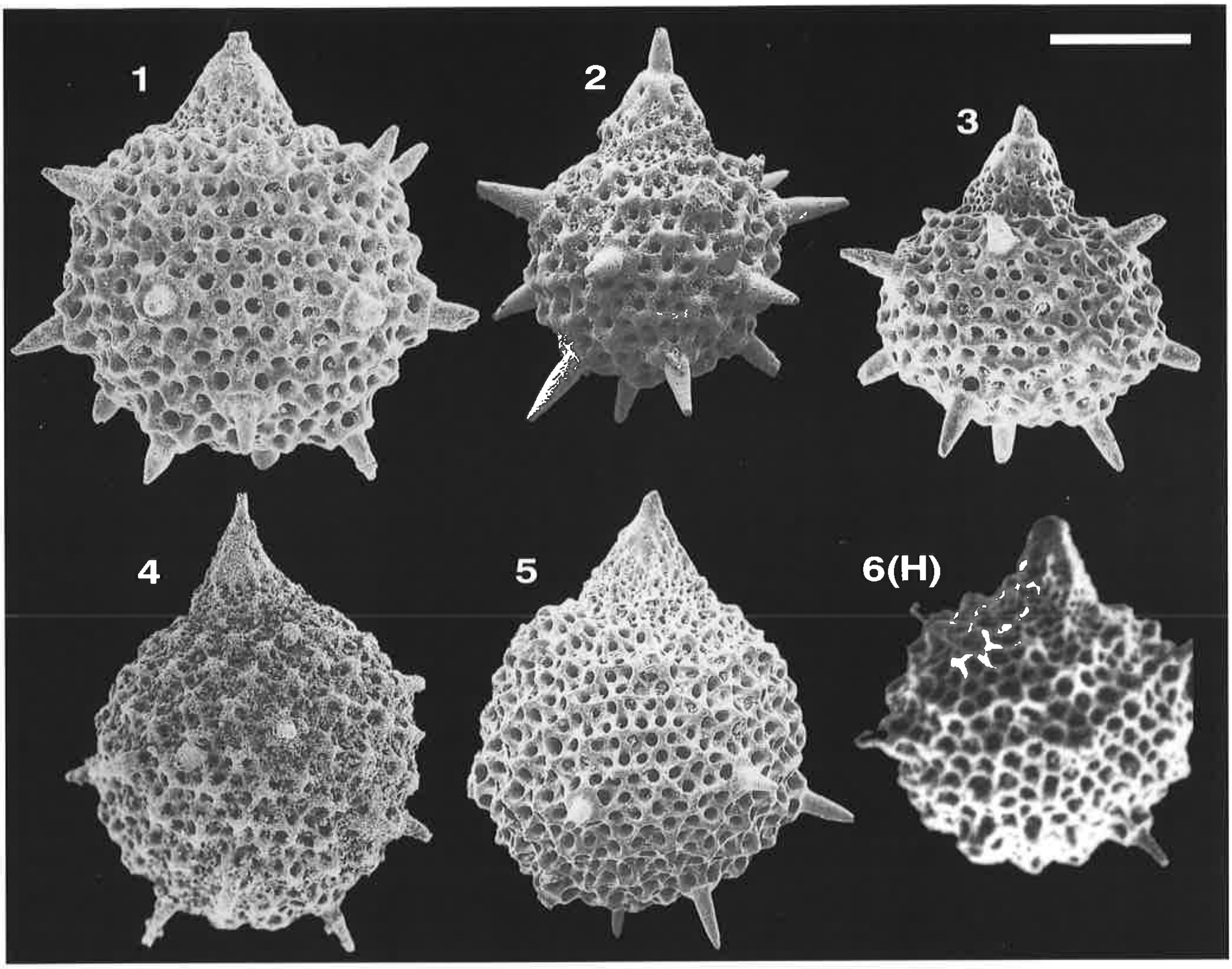


Plate 3063. *Sethocapsa trachyostraca* FOREMAN. Magnification x200. **Fig. 1.** DU1333, V40. **Fig. 2.** POB79/4143, MO2 46. **Fig. 3.** DU1331, V40. **Fig. 4.** RJ136, Br141.55. **Fig. 5.** POB80/2781, V-37. **Fig. 6(H).** FOREMAN 1973b, pl. 12, fig. 4.

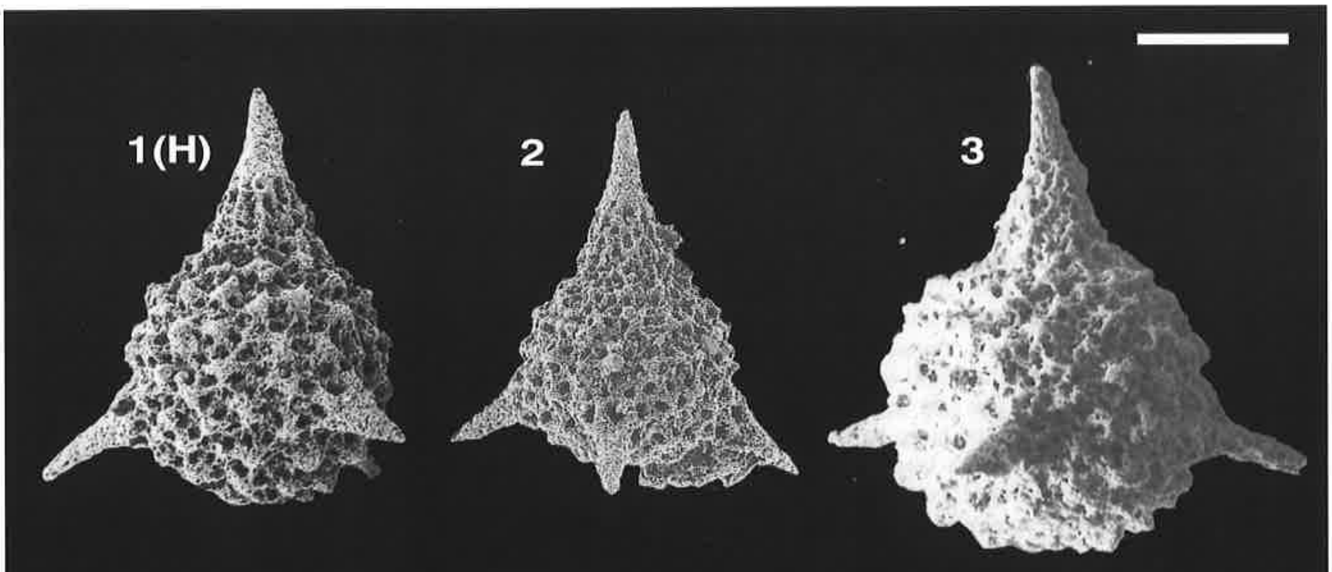


Plate 5510. *Sethocapsa tricornis* JUD. Magnification x200. **Fig. 1(H).** RJ433, Br1330. **Fig. 2.** RJ423, Br1330. **Fig. 3.** RJ830, Pi57.50.

SETHOCAPSA UTERCULUS 5462

Sethocapsa uterculus (PARONA) sensu FOREMAN

Synonymy.-
? *Theocapsa uterculus* PARONA
PARONA 1890, p. 168, pl. 5, fig. 17.
? *Sethocapsa crucigera* RÜST
RÜST 1898, p. 46, pl. 14, fig. 10.
? *Theocapsa tricornis* VINASSA
VINASSA, 1901, p. 507, pl. 1, fig. 56.
Sethocapsa sp. cf. *Theocapsa uterculus* PARONA
FOREMAN 1975, p. 617, pl. 2I, figs. 21-22.
FOREMAN 1978, p. 749, pl. 2, fig. 8.
KANIE et al. 1981, pl. 1, fig. 12.
Sethocapsa uterculus (PARONA)
SCHAAF 1981, p. 437, pl. 5, figs. 8 a-b; pl. 26, figs. 5a-b.
OKAMURA & UTO 1982, pl. 3, fig. 15.
BAUMGARTNER 1984, p. 784, pl. 8, fig. 15.
SCHAAF 1984, p. 151, figs. 1a-b, 3a-b, 4, not 2a-c.
YAO 1984, pl. 4, fig. 1.
KIMINAMI et al. 1985, pl. 2, fig. 12.
SUYARI 1986b, pl. 4, figs. 1-2.
KITO 1987, pl. 2, fig. 1.
IGO et al. 1987, text-fig. 2.19.
TUMANDA 1989, p. 39, pl. 5, fig. 7.
AGUADO et al. 1991, fig. 7.12.
MATSUOKA 1992, pl. 2, fig. 4; not pl. 2, fig. 9.
not STEIGER 1992, p. 63, pl. 17, fig. 14.
TAKETANI & KANIE 1992, fig. 5.4.
JUD 1994, p. 106, pl. 20, figs. 15-16.
Sethocapsa cf. *uterculus* (PARONA)
IGO et al. 1987, fig. 2.8.
TAKETANI & KANIE 1992, fig. 5.5.

Original Definition.- "The first segment conical, the second subrectangular and the width larger in size than the height, the 3rd. circular and much bigger. The first and the second with small points, on the 3rd. round pores were observed only in one place".

Actualized Definition.- (FOREMAN, 1975) These forms are characterized by their last two segments which have distinctly flattened proximal margins. The illustrated forms have the last segment with uniform rounded pores, set in angular pore frames. Other forms in which the last segment has a nodose surface are also known.

Original Remarks.- This species differs from *Theocapsa obesa* RÜST especially by the presence of pores and the form of the second segment.

Remarks.- There is a remarkable number of different morphotypes. A common characteristic is the flattened proximal part of the last globose segment.

Measurements (in μm).-
Total length 183, height the 1st. segment 30, width 41, height of the 2nd segment 24, width 61, diameter of the 3rd 128.

Type Locality.- Cittiglio, Prov. Varese, North Italy.

UAZones.- 11-22, late Kimm.-early Tith. to late Barr.-early Apt.

SETHOCAPSA (?) ZWEILII 5464

Sethocapsa (?) *zweilii* JUD

Synonymy.-
Sethocapsa lagenaria WU & LI
AITA & OKADA 1986, p. 116, pl. 3, fig. 11.
Sethocapsa (?) *zweilii* JUD
JUD 1994, p. 106, pl. 20, figs. 12-14.

Original Definition.- Test of 4 segments, the first 3 segments forming a wide conical portion, the last one being large and subspherical. Cephalis conical, proximally rounded or slightly acute, smooth, poreless, separated from thorax by one row of small pores. Thorax slightly inflated, poreless, smooth, separated from abdomen by a row of pores. Abdomen slightly inflated, rounded in outline, with irregularly polygonal pore frames and very small circular pores; it is separated from the last segment by a deep constriction marked by a row of large subcircular pores. Last segment subspherical, with large hexagonal pore frames the size of which decreases distally. Pores are circular, very small in the center of each depression.

Original Remarks.- The specimen illustrated by Wu & Li (1982) as *Sethocapsa lagenaria* seems to be in fact *Sethocapsa uterculus* sensu FOREMAN and is not assignable to a new species. On the contrary, the specimens illustrated by Aita & Okada 1986 as *Sethocapsa lagenaria* do not correspond to *S. lagenaria* WU & LI, but represent the new species herein described. *Sethocapsa zweilii* n.sp. differs from *Sethocapsa simplex* TAKETANI by having a wider conical upper portion of test, larger and less pores on the last segment and by having a row of large openings on the constriction between abdomen and the last segment. By the latter character, by the abdomen being broader and slightly inflated with irregular pore-frames, and by lacking the first row of large pores on the proximal part of the last segment *Sethocapsa zweilii* n.sp. differs clearly from *Sethocapsa uterculus* (PARONA) sensu FOREMAN.

Etymology.- This species is dedicated to Fred Zweili, technician on the SEM at the Institute of Geology at University of Bern.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Total height:	151	180	151	209
Maximum width:	113	130	113	142

Type Locality.- Fiume Bosso, Umbria Marche, Italy.

UAZones.- 14-19, early-early late Berr. to early Haut.

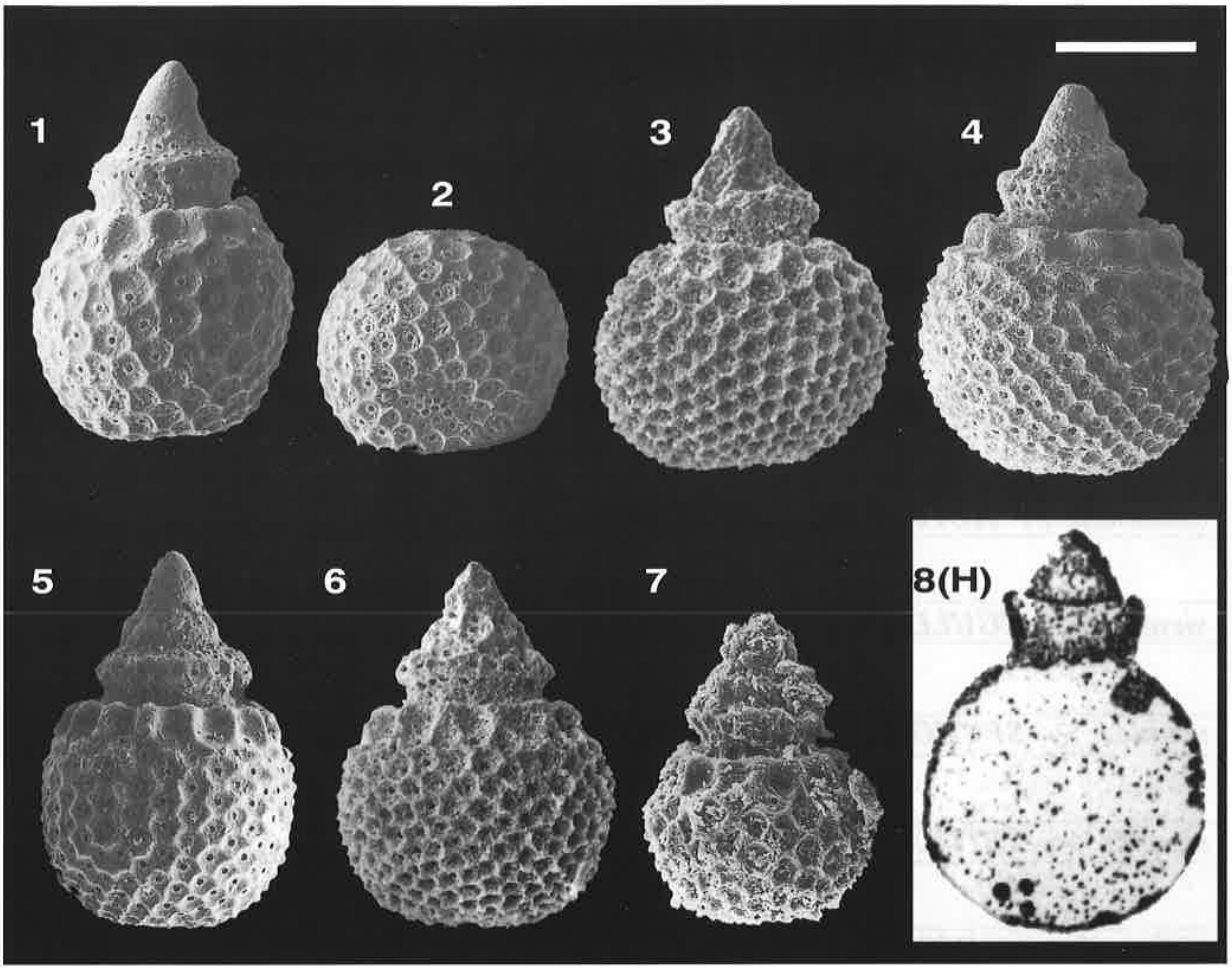


Plate 5462. *Sethocapsa uterculus* (PARONA) sensu FOREMAN. Magnification x300. **Fig. 1.** DU1320, V47. **Fig. 2.** DU1322, V47. **Fig. 3.** RJ183, Pr225.3. **Fig. 4.** DU2347, Mo22. **Fig. 5.** DU9, V37. **Fig. 6.** RJ182, Pr225.3. **Fig. 7.** RJ82, Bo619.9. **Fig. 8(H).** PARONA 1890, pl. 5, fig. 17.

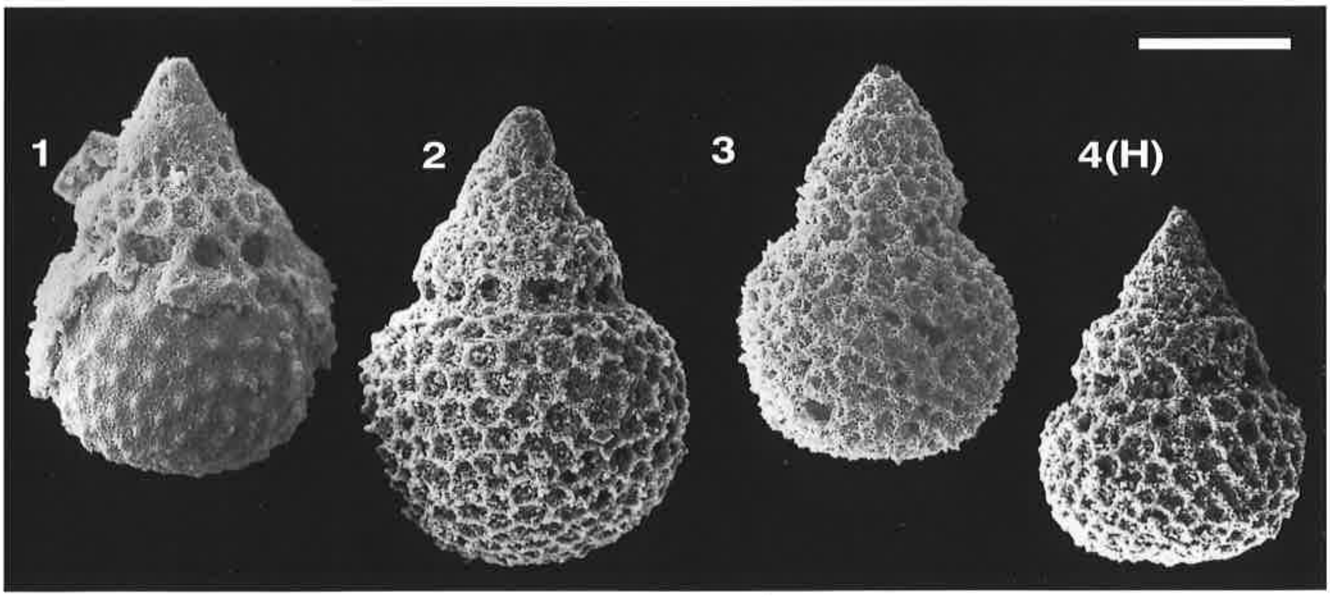


Plate 5464. *Sethocapsa* (?) *zweilii* JUD. Magnification x300. **Fig. 1.** RJ31, Oman1. **Fig. 2.** RJ212, Bo449.5. **Fig. 3.** RJ10, Bo323.2. **Fig. 4(H).** RJ200, Bo449.5.

SETHOCAPSA | *A* 3167

Sethocapsa sp. A

Synonymy.-
Sethocapsa globosa PARONA
MUZAVOR 1977, p. 117, pl. 5, fig. 8.

Remarks.- *Sethocapsa dorysphaeroides* differs from this species by a well developed apical horn, and by having a slightly elongated, instead of sphaerical terminal segment. Early forms tend to have a shorter conical proximal portion, late forms may be more elongated and transitional to *S. dorysphaeroides.*

AUZones.- 3-13, early-mid Baj. to latest Tith.

sexaspina >> *CECROPS (?) SEXASPINA* 5068

siciliensis >> *ACTINOMA SICILIENSIS* 2008

sicula >> *ANGULOBRACCHIA SICULA* 3301

simplex >> *SETHOCAPSA SIMPLEX* 5469

simplex >> *TRITRABS SIMPLEX* 3303

siphonofer >> *GONGYLOTHORAX SIPHONOFER AFF.* 4024

skowkonaensis >> *PARONAELLA SKOWKONAENSIS* 2005

sognoensis >> *PALINANDROMEDA SOGNOENSIS* 3010

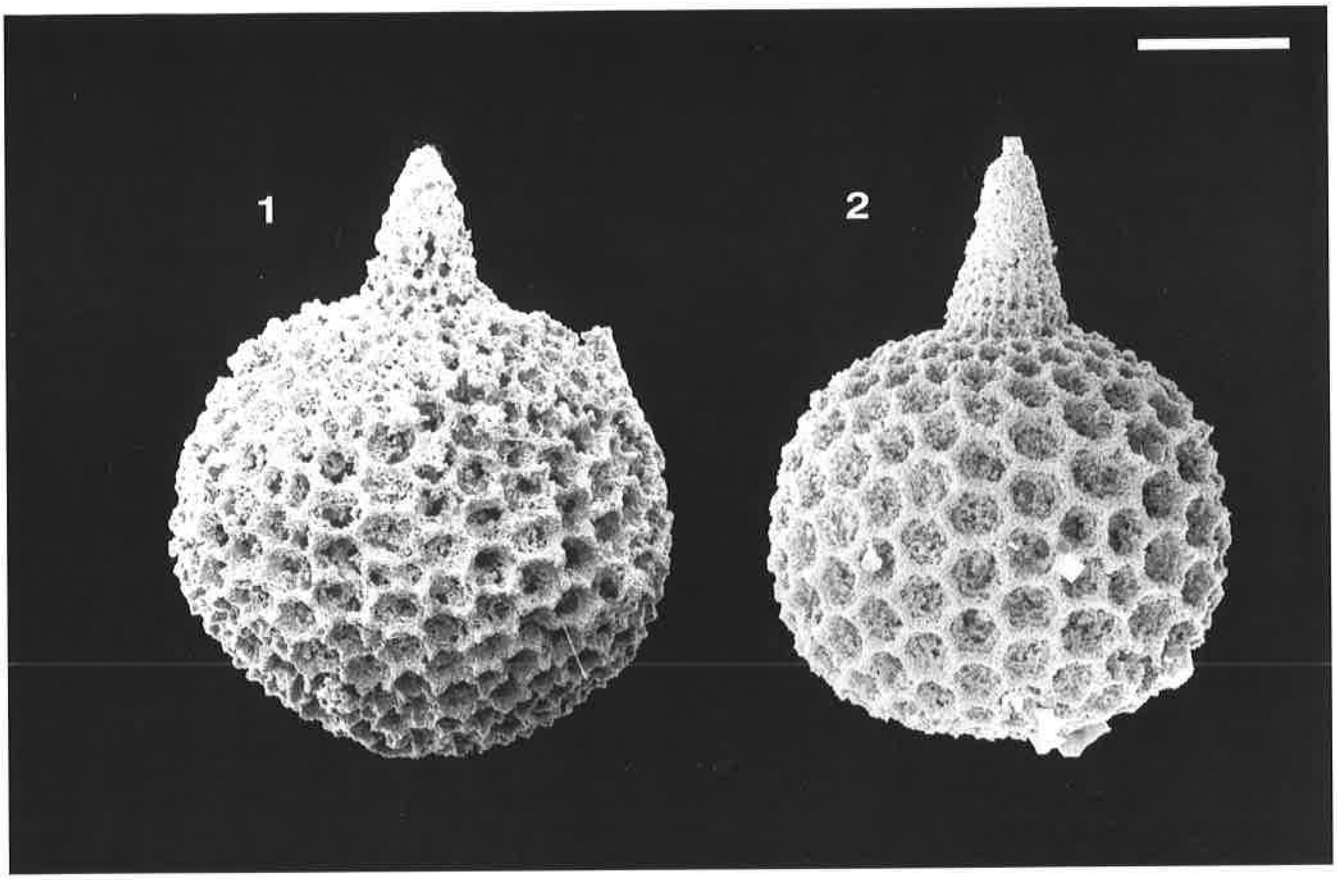


Plate 3167. *Sethocapsa* sp. A. Magnification x200. **Fig. 1.** AB1563, TM109.25f13. **Fig. 2.** AB2761 TM164.66c.7.

SOLENOTRYMA 3690

Genus: *Solenotryma* FOREMAN

Synonymy.-
Solenotryma FOREMAN
FOREMAN 1968, p. 33.

Type Species.- *Solenotryma dacryodes* FOREMAN 1968.

Original Definition.- Eradiate tricyrtid forms with small, simple cephalis, relatively large thorax with constricted aperture, and abdomen with constricted (sometimes tubular) aperture.

Etymology.- From the Greek *solen*, tube and *tryma*, pore (neuter).

Included Taxa.-
4037 *Solenotryma ichikawai* MATSUOKA & YAO

SOLENOTRYMA ICHIKAWAI 4037

Solenotryma ichikawai MATSUOKA & YAO

Synonymy.-
cf. *Solenotryma* sp.
RIEDEL & SANFILIPPO 1974, pl. 9, figs. 9-10; pl. 13, fig. 11.
Solenotryma sp. B
YAO et al. 1982, pl. 4, fig. 23.
YAO 1984, pl. 3, figs. 15-16.
Solenotryma (?) *ichikawai* MATSUOKA & YAO
MATSUOKA & YAO 1985, p. 133, pl. 1, figs. 7-10; pl. 3, figs. 5, 10-13.
MATSUOKA & YAO 1986, pl. 3, fig. 21.
Solenotryma ichikawai MATSUOKA & YAO
JUD 1994, p. 107, pl. 20, fig. 17.

Original Definition.- Shell ovate to elongate, consisting of 5 to 12 segments. cephalis spherical without apical horn, partly encased in thoracic cavity. Thorax truncated cone-shaped with a large, circular aperture. Abdomen relatively large, with constricted aperture and hidden partly or completely in the fourth segmental cavity. Cephalis, thorax and abdomen form together a fundamental part of the shell. Postabdominal segments expanding rapidly in width in proximal part where weak strictures are present. Individual postabdominal segment truncated oval in shape with a constricted aperture. Distal part of all postabdominal segments but final one hidden in subsequent postabdominal cavity. Shell generally smooth, perforate but provided with small numerous projections. Pores small, circular, irregularly arranged, varying slightly in size, closely or widely spaced.

Original Remarks.- Although *Solenotryma* (?) *ichikawai* n.sp. is a species of multicyrtoids consisting of more than four segments and does not conform to the generic definition of *Solenotryma* as given by Foreman (1968), this species is apparently related to *Solenotryma* which consists of both a fundamental part and an appendage of the shell. *S.* (?) *ichikawai* differs from *Solenotryma dacryodes* FOREMAN by having a greater number of segments. The degree of encasement of segments into subsequent segments varies among specimens.

Etymology.- This species is named for Dr. K. Ichikawa in honor of his contributions to the study of Mesozoic radiolarians.

Measurements (in μm).-
Based on 17 specimens. Height overall 158-255 (av. 191); of fundamental part of shell (cephalis, thorax and abdomen) 45-66 (av. 52); maximum width of shell 72-120 (av. 99).

Type Locality.- Locality Y-VI906-14; Torinosu Group, southwest Japan.

UAZones.- 7-21, late Bath.-early Call. to early Barr.

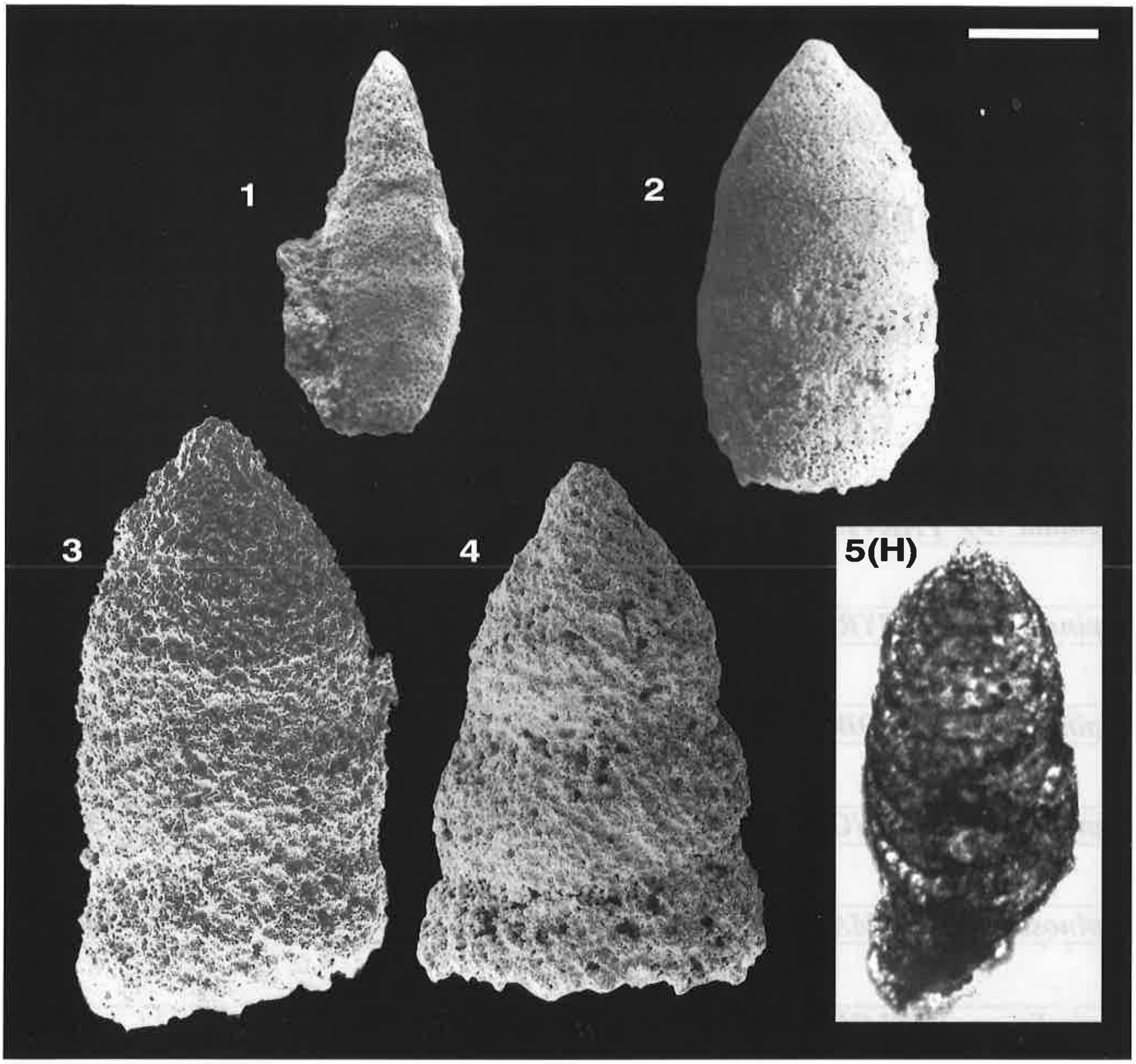


Plate 4037. *Solenotryma ichikawai* MATSUOKA & YAO. Magnification x300. **Fig. 1.** MA1416, 6-2801. **Fig. 2.** MA1471, 6-2801. **Fig. 3.** RJ69, Bo569.6. **Fig. 4.** RJ47, Bo569.5. **Fig. 5(H).** MATSUOKA & YAO 1985, pl. 3, fig. 5.

speciosa >> *HOMOEOPARONAELLA SPECIOSA*		*5163*

spelae >> *BERNOULLIUS SPELAE*		*5369*

sphaerica >> *PARVICINGULA SPHAERICA*		*3717*

sphaerica >> *SETHOCAPSA SPHAERICA*		*3168*

spicularius >> *XITUS SPICULARIUS AFF.*		*3295*

spinata >> *PARVICINGULA (?) SPINATA*		*3187*

spinellifera >> *SYRINGOCAPSA SPINELLIFERA*		*3170*

spinosa >> *PODOBURSA SPINOSA*		*3230*

spinosa >> *SYRINGOCAPSA SPINOSA AFF.*		*5711*

spinosum >> *YAMATOUM SPINOSUM*		*4077*

spiralis >> *STYLOCAPSA (?) SPIRALIS GR.*		*3046*

splendida >> *EMILUVIA SPLENDIDA*		*2002*

SPONGOCAPSULA 3691

Genus: *Spongocapsula* PESSAGNO

Synonymy.-
Spongocapsula PESSAGNO
PESSAGNO 1977a, p. 88.

Type Species.- *Spongocapsula palmerae* PESSAGNO 1977a.

Original Definition.- Test elongate, slightly lobulate with six or more postabdominal chambers which increase slowly in height and moderately rapidly in width proximally, gradually decreasing in width distally.

Original Remarks.- *Spongocapsula* n.gen. differs from *Obesacapsula* n.gen. by having more numerous chambers that increase more slowly in height and width. The final chamber of *Obesacapsula* may be 3 to 5 times as high and twice as wide as the preceding chamber.

Etymology.- This genus is named from the Latin noun *spongia*, meaning sponge, plus *capsula*, meaning little case.

Included Taxa.-
5773 *Spongocapsula* sp. aff. *S. coronata* (SQUINABOL)
5771 *Spongocapsula obesa* JUD
3199 *Spongocapsula palmerae* PESSAGNO
3267 *Spongocapsula perampla* (RÜST)
5526 *Spongocapsula* (?) *tripes* JUD

SPONGOCAPSULA CORONATA AFF. 5773

Spongocapsula sp. aff. *S. coronata* (SQUINABOL)

Synonymy.-
Spongocapsula coronata (SQUINABOL)
JUD 1994, p. 107, pl. 20, fig. 18.

Remarks.- It is possible that *Dictyomitra nardaranensis* ALIEV (1961, p. 31, pl. 1, fig. 9), described from the Valanginian deposits from Azerbaidzhan, could corresponds to *Spongocapsula* aff. *S. coronata* (SQUINABOL). Unfortunately the original illustration it not clear enough to prove this.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

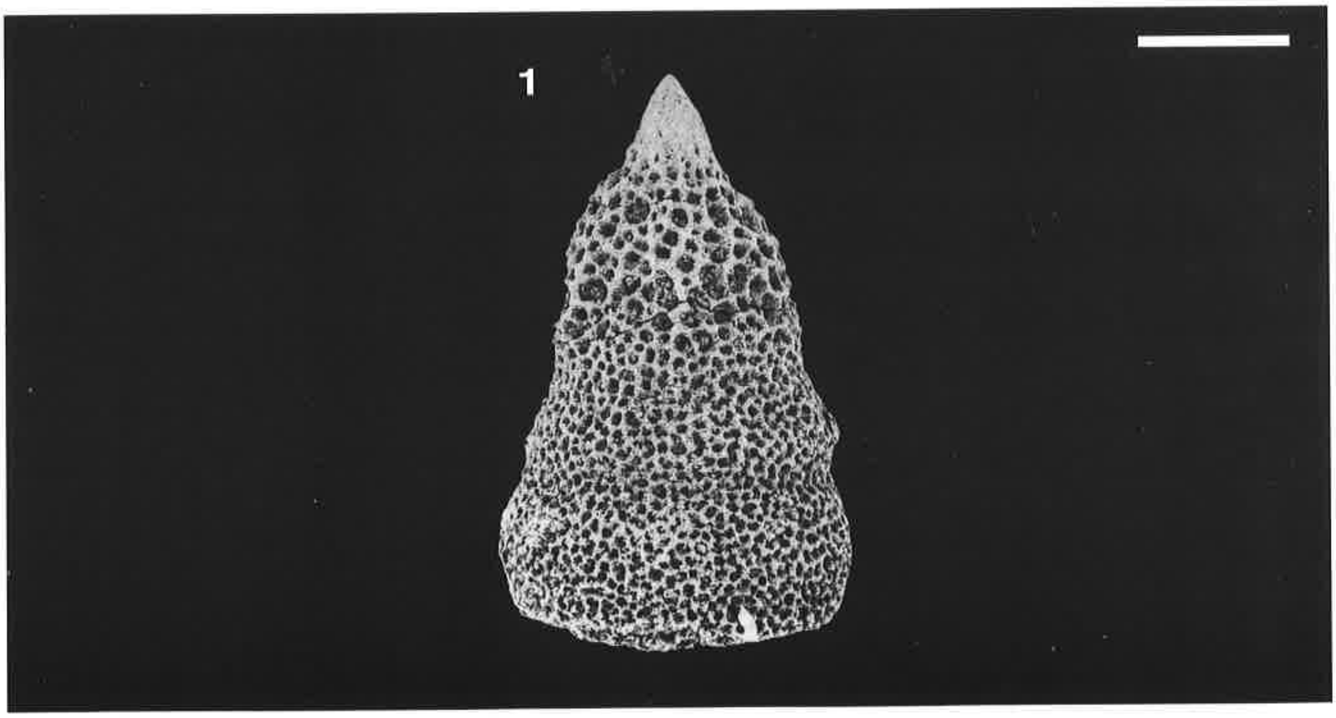


Plate 5773. *Spongocapsula* sp. aff. *S. coronata* (SQUINABOL). Magnification x200. **Fig. 1.** RJ171, Bo566.5.

SPONGOCAPSULA OBESA 5771

Spongocapsula obesa JUD

Synonymy.-
Spongocapsula obesa JUD
JUD 1994, p. 107, pl. 20, fig. 19; pl. 21, fig. 1.

Original Definition.- Broad, approximately cylindrical spongy test with indeterminable number of segments, due to the absence of external constrictions. Apical part small, wide conical, with the upper portion apparently poreless, the lower portion expanded, with a network of fine meshes. Remaining part of test broad, subcylindrical, with convex outline and wide distal aperture. Upper portion of this part consisting of a coarse, thick network, with large, irregular meshes and rough surface. Middle and distal portions with a fine network and smooth surface.

Original Remarks.- *S. obesa* n.sp. is similar to *S. coronata* (SQUINABOL) and to *S.* (?) *tripes* n.sp. It differs from both species by its less conical or sometimes even slightly inflated median portion of test, by lacking distinct external constrictions and the very coarse meshwork on the upper portion of test characteristic of *S. coronata* (SQUINABOL). From S. *tripes* it differs also by lacking the triangular terminal part.

Etymology.- From the Latin *obesus*, obese, very fat.

Measurements (in μm).-
Based on 3 specimens.

	HT	av	min	max
Total height:	240	246	225	273
Maximum width:	140	164	140	180

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 10-22, late Oxf.-early Kimm. to late Barr.-early Apt.

SPONGOCAPSULA PALMERAE 3199

Spongocapsula palmerae PESSAGNO

Synonymy.-
Spongocapsula palmerae PESSAGNO
PESSAGNO 1977a, p. 88, pl. 11, figs. 12-14.
KOCHER 1981, p. 93, pl. 16, fig. 17.
BAUMGARTNER 1984, p. 785, pl. 8, fig. 16.
WIDZ 1991, p. 254, pl. 4, fig. 1.
STEIGER 1992, p. 66, pl. 18, fig. 8.
PESSAGNO et al. 1993, p. 157, pl. 7, fig. 18.
Spongocapsula cf. *perampla* (RÜST)
OZVOLDOVA 1988, p. 387, pl. 8, fig. 3.
Spongocapsa palmerae PESSAGNO
YANG & WANG 1990, p. 209, pl. 4, figs. 8, 14.

Original Definition.- Test elongate, conical; decreasing slightly in width distally. Spongy meshwork very fine with irregular polygonal pore frames.

Original Remarks.- This species differs from *S. perampla* (RÜST) in being considerably slenderer.

Etymology.- This species is named for Dr. K.V.W. Palmer, Director of the Paleontological research In. Ithaca, N.Y., to honor her many contributions to paleontology.

Measurements (in μm).-
Based on 7 specimens. Height cephalis plus thorax: 15 to 25; H. abdomen: 15 to 20.

Type Locality.- Sample NSF 907, Point Sal, Santa Barbara County, California.

UAZones.- 6-13, mid Bath. to latest Tith.

SPONGOCAPSULA PERAMPLA 3267

Spongocapsula perampla (RÜST)

Synonymy.-
Lithocampe perampla RÜST
RÜST 1885, p. 315, pl. 39, fig. 11.
RIEDEL & SANFILIPPO 1974, p. 779, pl. 8, figs. 1-4.
Spongocapsula sp. aff. *S. perampla* (RÜST)
PESSAGNO 1977a, p. 90, pl. 11, fig. 15.
Spongocapsula perampla (RÜST)
? KOCHER 1981, p. 94, pl. 16, fig. 18.
BAUMGARTNER 1984, p. 785, pl. 8, fig. 17.
DE WEVER et al. 1986, pl. 10, figs. 16, 20.
OZVOLDOVA 1988, pl. 2, fig. 7.
STEIGER 1992, p. 66, pl. 18, fig. 9.
Spongocapsula sp. A
YAO 1984, pl. 3, fig. 20.
MATSUOKA & YAO 1985, pl. 2, fig. 3.

Original Definition.- "With five to six segments which increase rapidly in width towards a very large opening."

Actualized Remarks.- (RIEDEL & SANFILIPPO, 1974) We apply this name to a large form with usually approximately seven segments, which are inflated-anular, markedly but gradually increasing in size downward, and with a thick spongy wall showing little if any superficial indentation between segments.

Measurements (in μm).-
Length: 254, width of the opening: 200.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 6-11, mid Bath. to late Kimm.-early Tith.

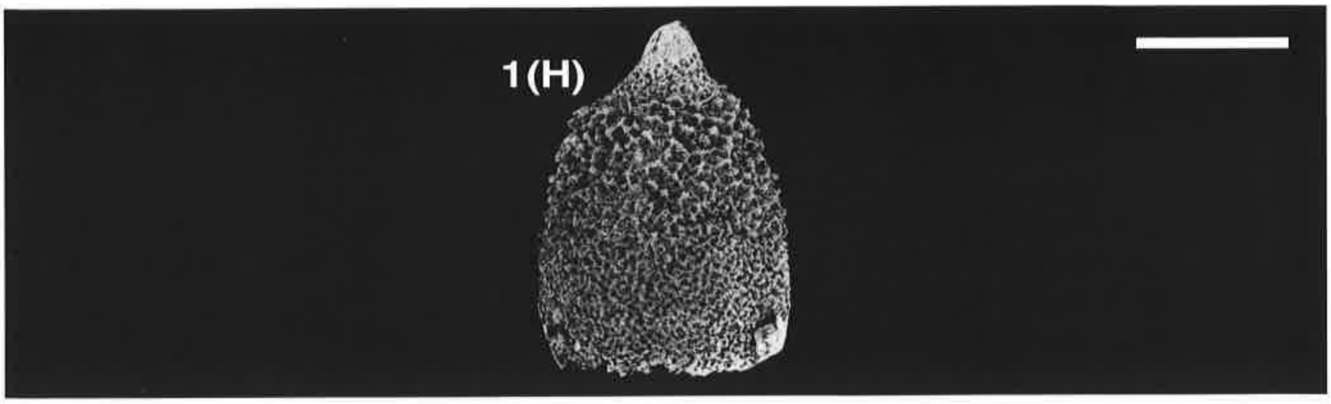


Plate 5771. *Spongocapsula obesa* JUD. Magnification x200. **Fig. 1(H).** RJ163, Bo566.5.

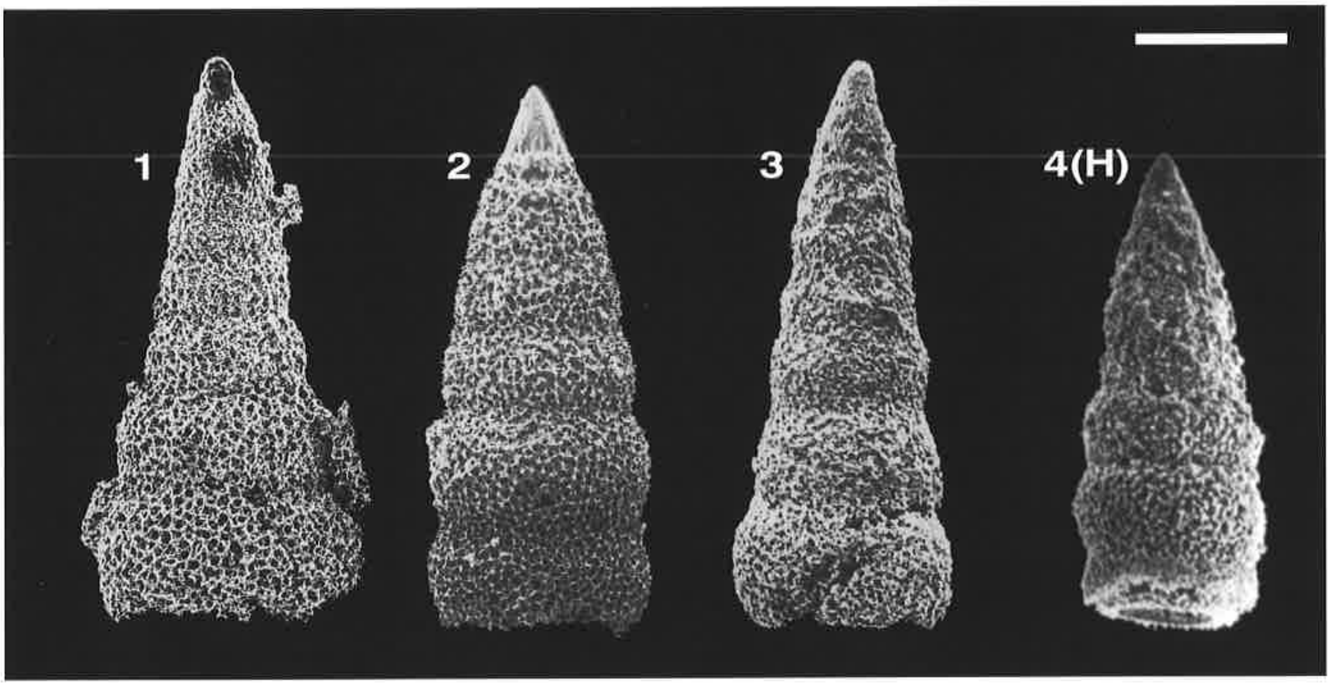


Plate 3199. *Spongocapsula palmerae* PESSAGNO. Magnification x150. **Fig. 1.** POB78/6528, POB899.54. **Fig. 2.** POB81/9204, 76. 534a, 125.5.72, **Fig.3.** POB78/6568, POB 899.54. **Fig. 4(H).** PESSAGNO 1977a, pl. 11, fig. 12.

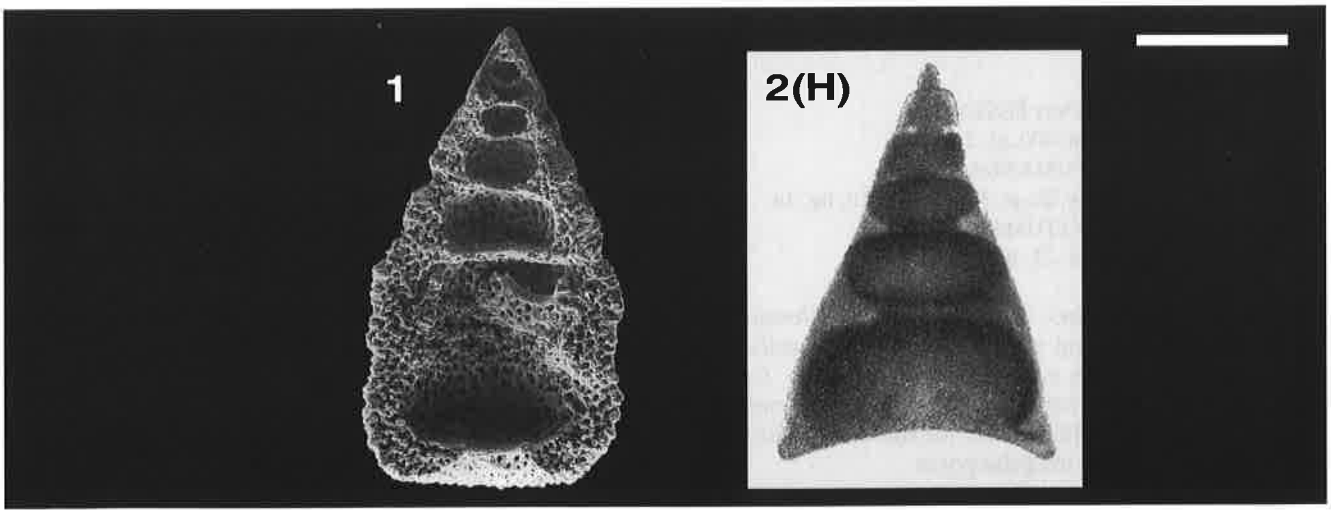


Plate 3267. *Spongocapsula perampla* (RÜST). Magnification x150. **Fig. 1.** DU1841, R102. **Fig. 2(H).** RÜST 1885, pl. 39, fig. 11.

SPONGOCAPSULA (?) TRIPES 5526

Spongocapsula (?) *tripes* JUD

Synonymy.-
Spongocapsula sp. A
MIZUTANI 1981, pl. 60, fig. 2.
Spongocapsula (?) *tripes* JUD
JUD1 1994, p. 107, pl. 21, fig. 2.

Original Definition.- Test large, subcylindrical to conical, consisting of three portions: a short wide conical apical part, a middle subcylindrical and a triangular terminal part. Upper portion of apical part (corresponding probably to cephalis) wide conical, apparently poreless, with a very small apical spine. Lower part with fine, spongy network. Upper part of subcylindrical middle portion thick-walled, forming a kind of shoulder and consisting of a superficial coarse spongy network whereas lower part of this portion has fine, spongy meshwork. Distal portion of test gradually increasing in width and tending to become triangular in cross-section. Termination flat with a small circular aperture in the center. On the corners, short protrusions could be developed.

Original Remarks.- *Spongocapsula* (?) *tripes* differs from *Spongocapsula coronata* (SQUINABOL) in lacking the very coarse meshwork on the proximal part of test, in being subcylindrical rather than conical, and in having triangular base. It differs also from *Spongocapsula obesa* n.sp. by having a triangular terminal part.

Etymology.- Latin *tres*, *tria* = three and *pes* = foot.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total height:	333	312	289	333
Maximum width:	223	230	200	267
Length apical horn:	21	12	8	21

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 19-21, early Haut. to early Barr.

SPONGOTRIPUS 3692

Genus: *Spongotripus* HAECKEL

Synonymy.-
Spongotripus HAECKEL
HAECKEL 1887, p. 580.

Type Species.- *Spongotripus regularis* HAECKEL 1887.

Original Definition.- Spiny Spongodiscida (but not armed) with marginal spines situated in the plane of the disc. With three equidistant spines.

Original Remarks.- Spongodiscida with three solid radial spines on the margin of circular or triangular disc.

Etymology.- *Spongotripus* = Spongy disc with tripod.

Included Taxa.-
5262 *Spongotripus* (?) *satoi* (TUMANDA)

SPONGOTRIPUS (?) SATOI 5262

Spongotripus (?) *satoi* (TUMANDA)

Synonymy.-
Dumitricaia maxwellensis PESSAGNO
? THUROW 1988, p. 400, pl. 2, fig. 22.
Orbiculiforma satoi TUMANDA
TUMANDA 1989, p. 29, pl. 5, fig. 9; pl. 10, fig. 14.
Spongotripus (?) *satoi* (TUMANDA)
JUD 1994, p. 108, pl. 21, fig. 3.

Original Definition.- Triangular *Orbiculiforma* with spines from vertices and with shallow central cavity. Test triangular with spines radiating from vertices. Central cavity shallow, with dense slightly raised axes radiating from center in line with spines. Meshwork of polygonal pore frames with some irregular pores.

Original Remarks.- This species differs from *O. igoi* n.sp. in lacking the crown-like central structure and in having a thin central portion. Sometimes only the axes radiating from the center are preserved in the central portion.

Remarks.- Based on our material and on the illustrations of other authors one can conclude that the central depression is not a character of this species but a result of dissolution of test. No axes, radiating from central area have so far been observed. Some of our specimens are armed with one or more spines on the vertices of test.

Etymology.- Named after Prof. T. Sato (Univ. Tsukuba) for his contributions to the study of Mesozoic ammonites.

Measurements (in μm).-
Holotype diameter 380, diameter of central cavity 200.

Type Locality.- Eashi Mountain area, northern Hokkaido, Japan.

UAZones.- 19-22, early Haut. to late Barr.-early Apt.

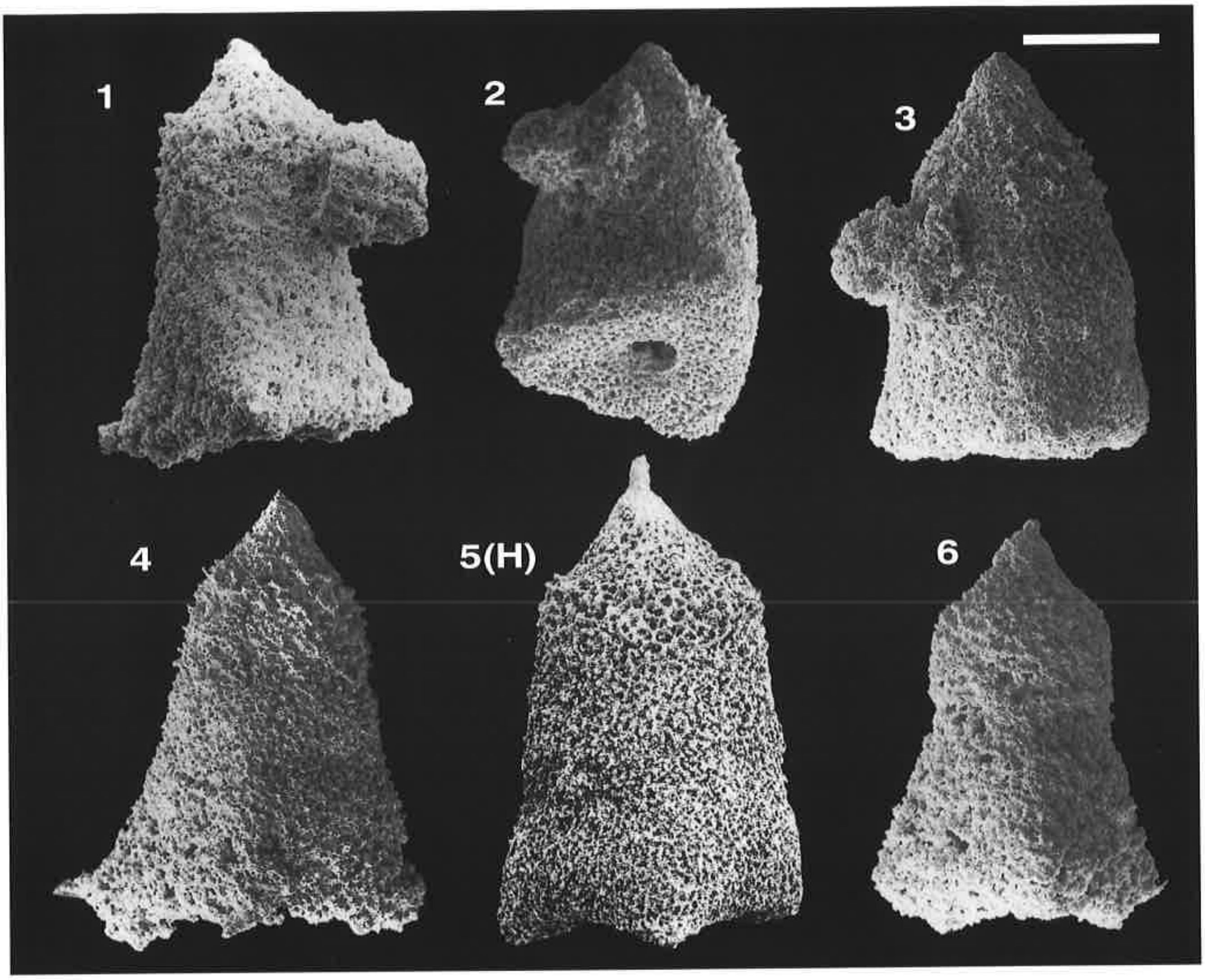


Plate 5526. *Spongocapsula* (?) *tripes* JUD. Magnification x200. **Fig. 1.** RJ78, Bo552.1. **Fig. 2.** RJ25, Bo581.65. **Fig. 3.** RJ24, Bo581.65. **Fig. 4.** RJ43, Bo569.6. **Fig. 5(H).** RJ106, Bo566.5. **Fig. 6.** RJ14, MN47.7.

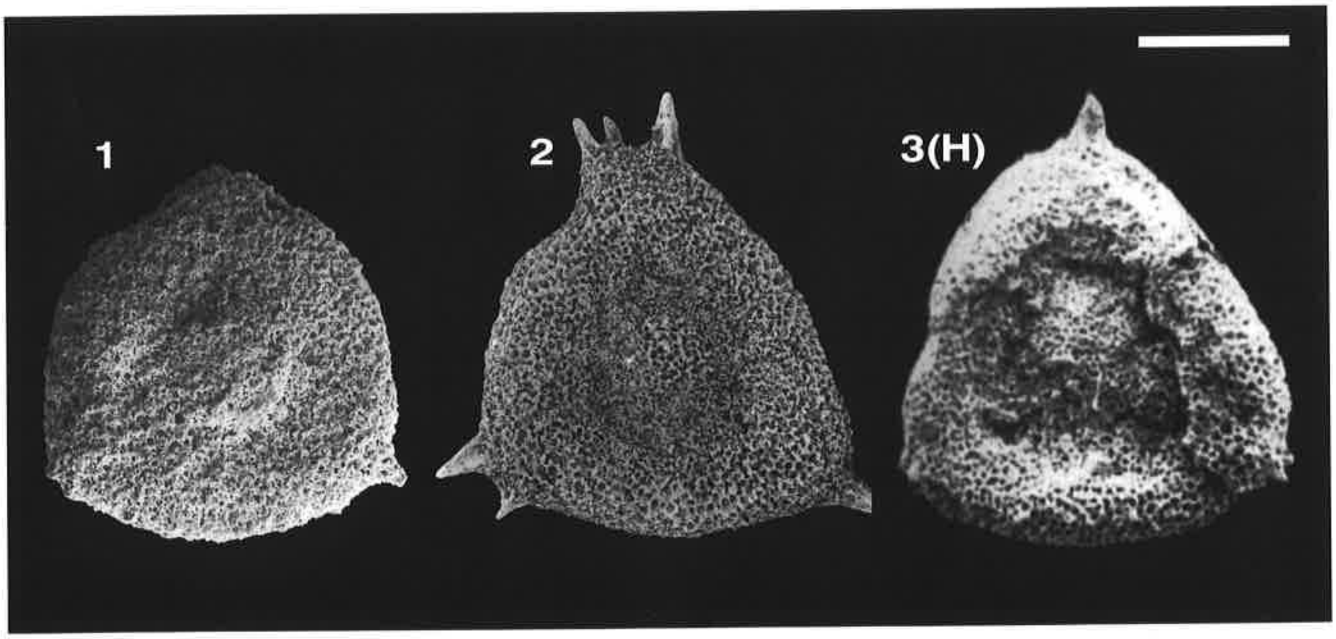


Plate 5262. *Spongotripus* (?) *satoi* (TUMANDA). Magnification x150. **Fig. 1.** RJ113, Pr225.3. **Fig. 2.** RJ106. Bo566.50. **Fig. 3(H).** TUMANDA 1989, pl. 5, fig. 9.

squinaboli >> *PANTANELLIUM SQUINABOLI* 5607

stanleyensis >> *PARAHSUUM STANLEYENSIS* 2023

STAUROLONCHE 3693

Genus: *Staurolonche* HAECKEL, emend. PESSAGNO

Synonymy.-
Staurolonche HAECKEL
HAECKEL 1881, p. 466.
PESSAGNO 1977a, p. 75.

Type Species.- *Staurolonche robusta* RÜST 1885, subsequent designation by Campbell (1954).

Original Definition.- "Staurolonchida. Aculeis separatis, in centro corporis invicem innisis et contiguis, sed non coalitis. Aculeis processibus transversis quatuor cruciatis. Processibus simplicibus."

Actualized Definition.- (PESSAGNO 1977a) Cortical shell lacking secondary layering; consisting of massive polygonal pore frames. Sides of test convex outward; top and bottom surfaces of test slightly convex outward. Primary spines with alternating longitudinal grooves and ridges.

Remarks.- Haeckel (1881) includes this in the order Acantharia which Riedel has not translated from the Latin. Subsequent designation of the type species by Campbell is questionable.

Staurolonche HAECKEL differs from *Emiluvia* FOREMAN by (1) lacking a secondary layer on its cortical shell, (2) having a test with convex rather than concave or vertical sides, (3) lacking secondary radial beams between the cortical and first medullary shell. It is probable that *Emiluvia* arose from a *Staurolonche* stock through the development of a secondary meshwork on its cortical shell and secondary radial beams.

The type species of *Staurolonche*, *S. robusta* RÜST, was originally figured in thin-section. No evidence of nodes, secondary meshwork, or secondary radial beams between the cortical and first medullary shell can be seen in Rüst's illustration.

Staurolonche HAECKEL 1881, is grossly similar to *Staurosphaera* HAECKEL 1881. The illustration of *Staurosphaera crassa* DUNIKOWSKI 1882, the type species of *Staurosphaera* is at best poor. It is difficult to determine whether the figured type specimen represents a form with a spongy or a latticed test. It is also likely that Dunikowski's type specimen has long since disappeared. As a result, the perpetuation of the name *Staurosphaera* in the literature can serve no useful purpose. It is suggested that this name be treated as a nomen dubium (cf. Pessagno, 1977a).

Etymology.- *Staurolonche*, crossed spear.

Included Taxa.-
3220 *Staurolonche robusta* RÜST sensu PESSAGNO

STAUROLONCHE ROBUSTA 3220

Staurolonche robusta RÜST sensu PESSAGNO

Synonymy.-
Staurolonche robusta RÜST
? RÜST 1885, p. 291, pl. 29 (4), fig. 2.
Staurolonche sp. aff. *S. robusta* RÜST
PESSAGNO 1977a, p. 75, pl. 4, fig. 8.
Emiluvia orea BAUMGARTNER
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, figs. 1-2.

Original Definition.- "Rounded shell with four very strong spines. Medullary shell small, lattice of pores never clearly visible."

Definition.- Robust form with four stout spines at right angles. Central area circular to rounded square in vertical view, elliptical in lateral view, regular pentagonal to hexagonal pore frames without prominent nodes on vertices. Four primary spines with three broad primary grooves and three narrow and shallow secondary grooves that extend almost to the spine tip. The four primary spines extend inward to primary bars and connect cortical with medullary shell.

Remarks.- This species differs from *Emiluvia* spp. by an almost spherical central shell without differentiation of upper/lower and lateral surfaces.

Measurements (in μm).-
Width of central area, 147; lenght of longest spines, 165.

Type Locality.- Aptychus Beds from Urshau, Germany

UAZones.- 4-10, late Baj. to late Oxf.-early Kimm.

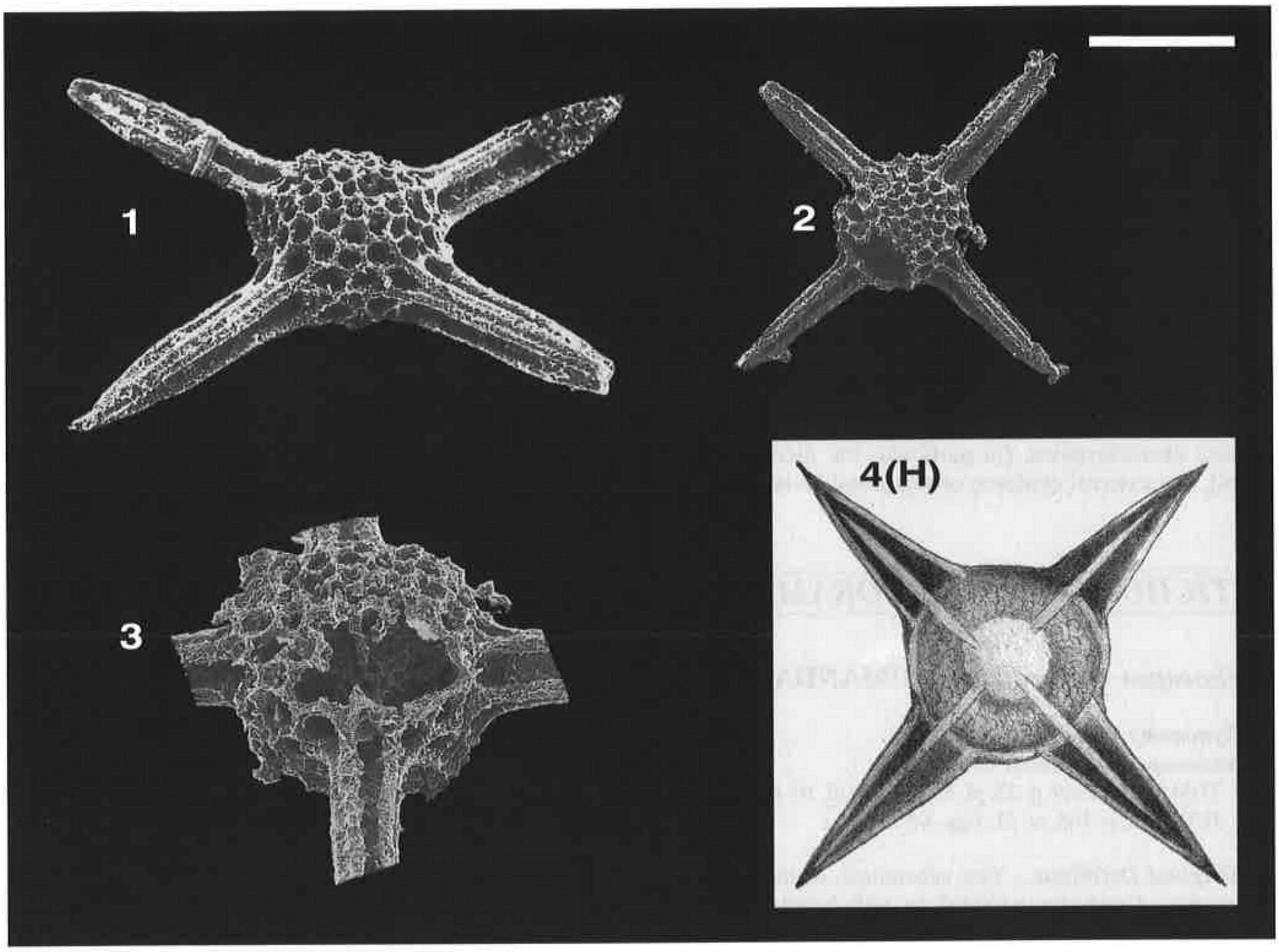


Plate 3220. *Staurolonche robusta* RÜST sensu PESSAGNO. Magnification x200, except Fig. 3 x400. **Fig. 1.** POB78/6544, POB899.54. **Fig. 2.** POB78/6134, POB899.51. **Fig. 3.** POB78/6135, POB899.51. **Fig. 4(H).** RÜST pl. 29, fig. 2.

STICHOCAPSA 3696

Genus: *Stichocapsa* HAECKEL

Synonymy.-
Stichocapsa HAECKEL
HAECKEL 1881, p. 439.

Type Species.- *Stichocapsa jaspidea* RÜST 1885.

Original Definition.- Closed spinelessStichocyrtida. Obtuse (with cephalis smooth, not spiny).

Remarks.- Species are differentiated by overall shape, surface characteristics, (in particular the distribution of pores), and external evidence of segmental divisions on the inflated, distal portion of the test.

Etymology.- Greek *Stichocapsa*, jointed capsule.

Included Taxa.-
5761 *Stichocapsa altiforamina* TUMANDA
3055 *Stichocapsa convexa* YAO
3269 *Stichocapsa decora* RÜST
4038 *Stichocapsa himedaruma* AITA
3049 *Stichocapsa japonica* YAO
3045 *Stichocapsa naradaniensis* MATSUOKA
5744 *Stichocapsa pulchella* (RÜST)
3298 *Stichocapsa robusta* MATSUOKA
4042 *Stichocapsa* sp. E

STICHOCAPSA ALTIFORAMINA 5761

Stichocapsa altiforamina TUMANDA

Synonymy.-
Stichocapsa altiforamina TUMANDA
TUMANDA 1989, p. 33, pl. 5, figs. 1-2; pl. 10, figs. 4a-b, 6.
JUD 1994, p. 108, pl. 21, figs. 4-5.

Original Definition.- Test subconical, of three to four segments. Cephalis conical to sub-hemispherical; imperforate. Last globose segment terminates in a circular inwardly set peristome. Test coarsely perforate consisting of outer layer of large subcircular pore frames and interconnected inner layer of small pores.

Original Remarks.- Diagnostic characteristic of this species is its two-layered chamber wall, composed of an outer layer of large pores and an inner layer of small pores.

Etymology.- The species name is from the Latin noun *altus*, meaning deep and *foramen*, pore or hole.

Measurements (in μm).-
Based on 3 specimens. Holotype overall height, 160; max. width, 145. Average overall height, 193; max. width, 155.

Type Locality.- Eashi Mt. area, N. Hokkaido, Japan.

UAZones.- 18-21, latest Val.-earliest Haut. to early Barr.

STICHOCAPSA CONVEXA 3055

Stichocapsa convexa YAO

Synonymy.-
Stichocapsa convexa YAO
YAO 1979, p. 35, pl. 5, figs. 14-16; pl. 6, figs. 1-7.
KOCHER 1981, p. 95, pl. 16, figs. 21-22.
not AITA 1982, pl. 1, figs. 6-7b.
WAKITA 1982, pl. 3, fig. 7.
BAUMGARTNER 1984, p. 785, pl. 8, fig. 19.
MATSUOKA 1985, pl. 1, fig. 8.
YAMAMOTO et al. 1985, p. 38, pl. 7, fig. 4.
TAKEMURA 1986, p. 55, pl. 7, figs. 9-10.
YOKOTA & SANO 1986, pl. 1, fig. 4.
AITA 1987, p. 67, pl. 11, fig. 10.
DANELIAN 1989, p. 192, pl. 8, figs. 4-5.
KITO 1989, p. 206, pl. 24, figs. 2-4.
Stichocapsa sp. J
AITA 1982, pl. 1, figs. 8-9b.

Original Definition.- Shell of four segments, conical at upper half. Cephalis spherical, poreless, partly depressed in thoracic cavity. Thorax and abdomen together truncate-conical with flat base and externally indistinct strictures. Fourth segment truncate-spherical with small aperture. Pores small, circular, arranged sparsely on post-cephalic segments, and densely in one transverse row at proximal part of thorax.

Original Remarks.- This species is similar to *Cyrtocapsa asseni* TAN 1927 (p. 67, pl. 14, fig. 118), but differs from it in having four segments and smaller pores. This species also differs from *Stichocapsa japonica* YAO as indicated under the latter species.

Etymology.- Latin adj. *convexus*, meaning convex.

Measurements (in μm).-
Based on 10 specimens. Height overall, 105-185 (153); cephalis, 15-24 (20); thorax, 20-30 (24); abdomen, 18-27 (22); fourth segment, 50-117 (91); maximum width of shell, 75-145 (114).

Type Locality.- IN 1, Inuyama area, Gifu Prefecture, cental Japan.

UAZones.- 1-11, early-mid Aal. to late Kimm.-early Tith.

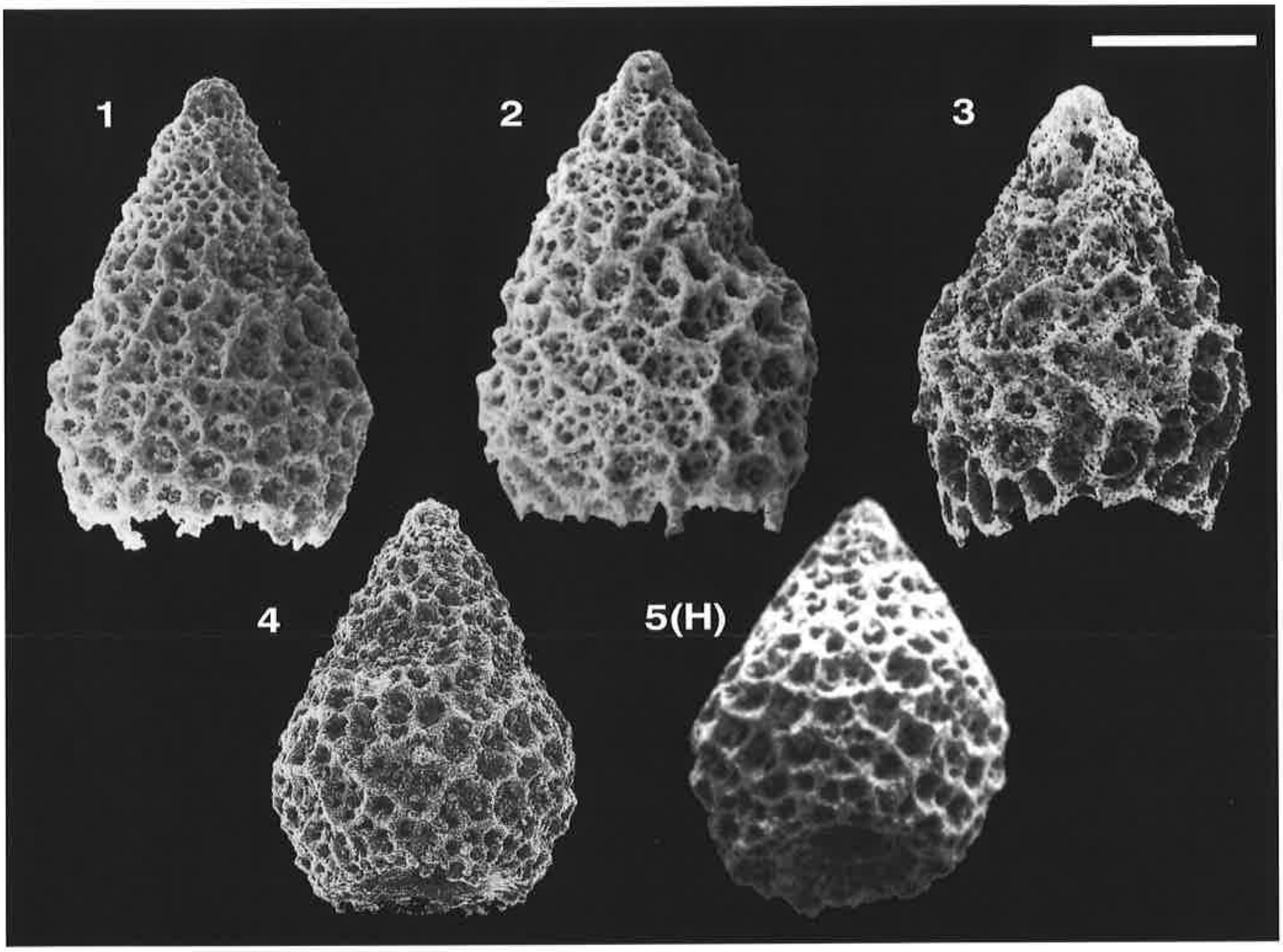


Plate 5761. *Stichocapsa altiforamina* TUMANDA. Magnification x300. **Fig. 1.** RJ7, Pr225.3. **Fig. 2.** RJ16, Pr225.3. **Fig. 3.** RJ99, Bo566.5. **Fig. 4.** RJ61, Br141.55. **Fig. 5(H).** TUMANDA 1989, pl. 5, fig. 2.

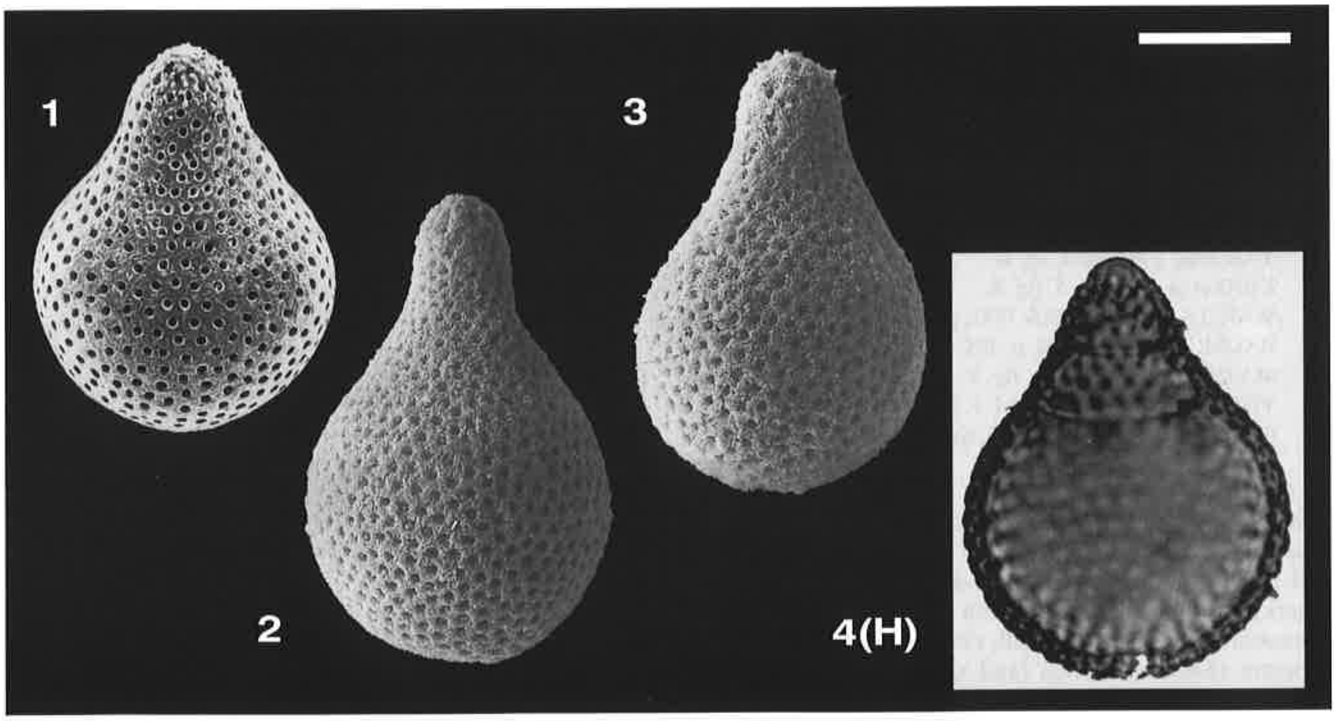


Plate 3055. *Stichocapsa convexa* YAO. Magnification x300. **Fig. 1.** POB81/2440, 534.125.3.29. **Fig. 2.** DU3043, PJ9. **Fig. 3.** DU3123, PJ9. **Fig. 4(H).** YAO 1979, pl. 6, fig. 1.

STICHOCAPSA DECORA 3269

Stichocapsa decora RÜST

Synonymy.-
Stichocapsa decora RÜST
RÜST 1885, p. 319, pl. 42(17), fig. 3.
not SCHAAF 1981, p. 439, pl. 27, figs. 13a-b.
AITA 1987, p. 67, pl. 6, fig. 2; pl. 11, figs. 6-7.

Original Definition.- "With five segments. The first four segments increase regularly in width, the fifth segment spherical. Large pores arranged in eight longitudinal rows."

Measurements (in μm).- Length: 214, width: 120.

Type Locality.- Jaspers from Western Switrzerland

UAZones.- 4-7, late Baj. to late Bath.-early Call.

STICHOCAPSA HIMEDARUMA 4038

Stichocapsa himedaruma AITA

Synonymy.-
Stichocapsa sp. D
AITA 1982, pl. 2, figs. 1-3b.
Stichocapsa himedaruma AITA
AITA 1987, p. 74, pl. 3, figs. 1a-3; pl. 10, figs. 1-2.

Original Definition.- Ovoidal shell of four segments with strongly constricted aperture. Cephalis spherical, poreless or with a few small pores. Collar stricture indistinct in contour. Thorax small, conical, perforated. Pronounced change in contour between thorax and third segment. Third segment inflated-cylindrical; pores of third and fourth segment small, circular set in hexagonal pore frames in transverse rows. Fourth segment hemi-ellipsoidal, porous with an aperture about twice as wide as a pore. External stricture between third and fourth segments distinct; fourth segment is same to or somewhat broader than third in maximum width.

Etymology.- This specific name is derived from the Japanese traditional toy, Himedaruma, a kind of tumbler.

Measurements (in μm).-
Based on 20 specimens.

	HT	max.	min.	av.
Overall height:	138	145	105	132
Height of cephalo-thorax:	38	35	25	34
Height of abdomen:	35	20	20	28
Height of 4th segment:	65	90	50	69
Width of abdomen:	78	88	65	66
Width of 4th segment:	90	108	73	74

Type Locality.- Sample TKN-04, Takano section, Irazuyama Formation, Kochi Prefecture, southwest Japan.

UAZones.- (Not zoned: late Middle-early Late Jurassic)

STICHOCAPSA JAPONICA 3049

Stichocapsa japonica YAO

Synonymy.-
Stichocapsa japonica YAO
YAO 1979, p. 36, pl. 6, figs. 8-12; pl. 7, figs. 1-15.
KOCHER 1981, p. 96, pl. 16, fig. 23.
YAO et al. 1982, pl. 3, fig. 6.
KIDO et al. 1982, pl. 5, fig. 8.
WAKITA & OKAMURA 1982, pl. 8, fig. 4.
BAUMGARTNER 1984, p. 785.
MATSUOKA 1985, pl. 1, fig. 7.
YOKOTA & SANO 1986, pl. 1, fig. 3.
GORICAN 1987, p. 186, pl. 3, figs. 11-12.

Original Definition.- Shell of 4-6 segments. Cephalis spherical, poreless, partly depressed in thoracic cavity. Thorax and abdomen together truncate-conical with indistinct stricture externally. Fourth segment flattened-spherical with basal flat, and with relatively large aperture or central opening. Pores small, circular, arranged sparsely. In some specimens, fifth (and sixth) segment present, which are flattened-spherical with slightly larger pores arranged randomly; those height and width nearly same as fourth segment. Strictures among 4-6 th segments distinct.

Original Remarks.- Specimens with fifth and sixth segments are rare. More common are four-segmented specimens. In this study, they are treated as one species. Simple four-segmented specimens of this species are distinguished from *Stichocapsa convexa* YAO described above by having a flattened fourth segment with flat base.

Etymology.- Latin adj. *japonicus*, meaning Japanese.

Measurements (in μm).-
Based on 18 specimens.

	av.	HT
Height overall	85-155	113
Height of cephalis:	15-25	20
Height of thorax:	15-30	22
Height of abdomen:	15-28	21
Height of fourth segment:	37-85	57
Height of fifth segernt:	25-70	54
Height of sixth segment:	47-65	53
Maximum width of shell:	75-135	106

Type Locality.- Sample IN 6, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

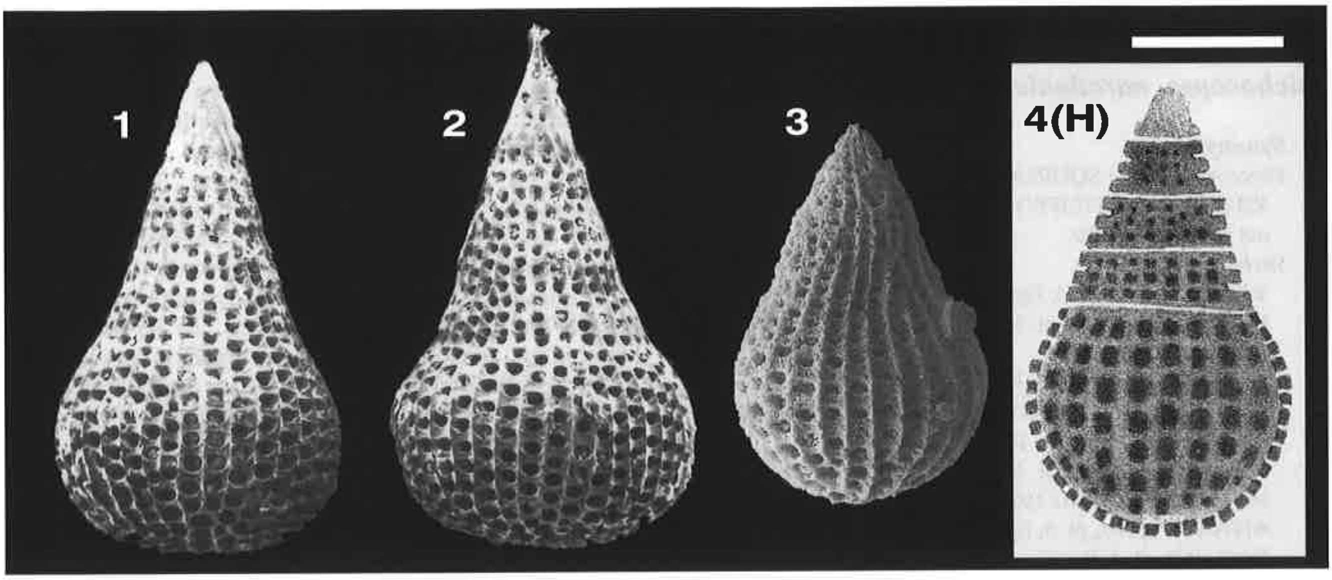


Plate 3269. *Stichocapsa decora* RÜST. Magnification x250. **Fig. 1.** POB81/9159, 76.534A.126.2.125. **Fig. 2.** POB81/9159, 76.534A.126.2.125. **Fig. 3.** DU2690, PJ14. **Fig. 4(H).** RÜST 1885, pl. 42(17), fig. 3.

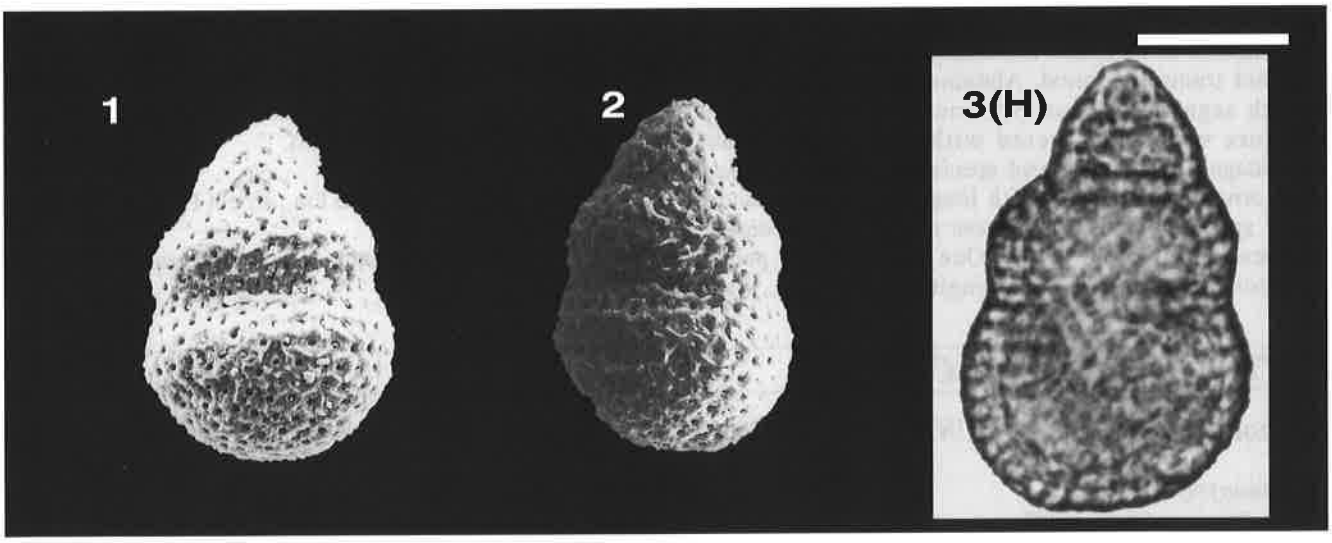


Plate 4038. *Stichocapsa himedaruma* AITA. Magnification x500. **Fig. 1.** MA310, S-03. **Fig. 2.** MA743, S-03. **Fig. 3(H).** AITA 1987, pl. 3, fig. 1a.

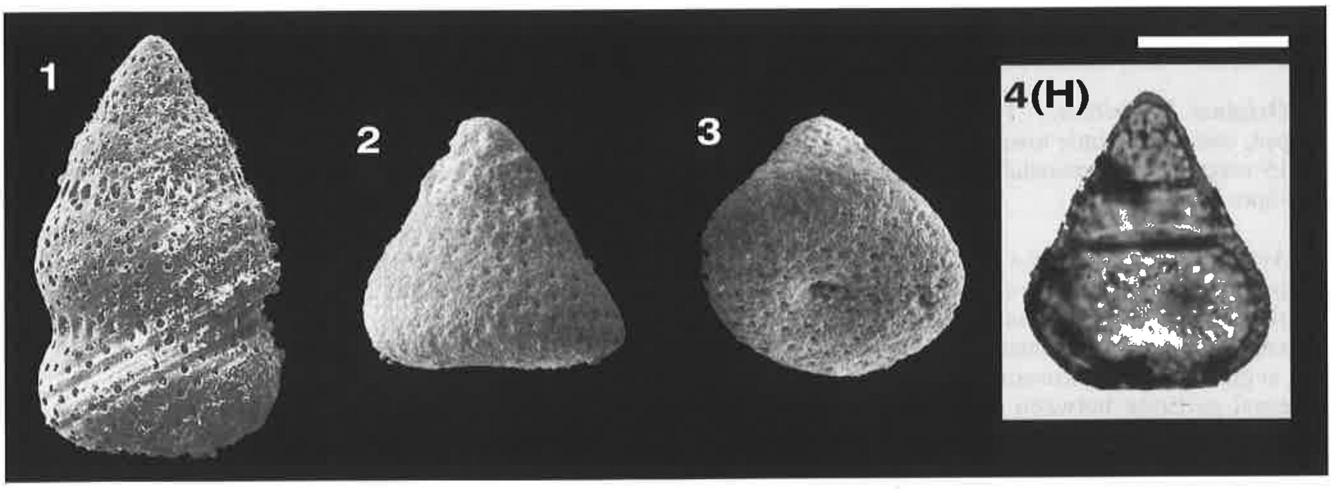


Plate 3049. *Stichocapsa japonica* YAO. Magnification x300. **Fig. 1.** POB81/3026, IN7. **Fig. 2.** GO903405, ZB28. **Fig. 3.** GO903406, ZB28. **Fig. 4(H).** YAO 1979, pl. 6, fig. 10a.

STICHOCAPSA NARADANIENSIS 3045

Stichocapsa naradaniensis MATSUOKA

Synonymy.-
Theocorys antiqua SQUINABOL
RIEDEL & SANFILIPPO 1974, p. 781, pl. 10, fig. 11; not pl. 10, figs. 9-10.
Stichocapsa sp. C
YAO et al. 1982, pl. 4, figs. 15-16.
MATSUOKA 1982a, pl. 3, fig. 6.
YAO 1983, fig. 3 (12).
Stichocapsa naradaniensis MATSUOKA
MATSUOKA 1984, p. 145, pl. 1, figs. 1-5; pl. 2, figs. 1-6.
ISHIDA 1985, pl. 3, fig. 10.
MATSUOKA 1986a, pl. 3, fig. 18.
MATSUOKA & YAO 1986, pl. 2, fig. 12; pl. 3, fig. 19.
AITA 1987, p. 67, pl. 6, figs. 9a-10b.
YAO 1991, pl. 4, fig. 13.
Stichocapsa cf. *naradaniensis* MATSUOKA
WAKITA 1988, pl. 4, fig. 18.

Original Definition.- Shell of four segments, oval, thin walled. Cephalis small, spherical internally and partly encased in thoracic cavity. Collar stricture slightly recognizable or indistinct externally. Thorax and abdomen together truncate conical. Abdomen higher than thorax. Fourth segment truncate spherical with a constricted aperture which is covered with a very small basal appendage in well preserved specimens. Outer surface of shell ornamented mainly with longitudinal plicae and in many specimens with transverse ridges connecting two adjacent longitudinal plicae. One row of pores present between neighbouring two longitudinal plicae; where transverse ridges are present, pores are recessed in tetragonal frames formed by longitudinal plicae and transverse ridges. Pores small, circular and uniform in size.

Original Remarks.- Ornament of outer shell surface varies among specimens. Most specimens possess longitudinal plicae and weaker transverse ridges which form tetragonal frames. Some possess only longitudinal plicae, lacking transverse ridges. In some others, longitudinal plicae are somewhat irregularly arranged (pl. 1, fig. 1). Size of basal appendage varies among specimens. Most specimens have a small vestigial appendage, while some specimens possess a larger dish-like one (pl. 2, figs. 5a-b). This species is similar to *Tricolocapsa conexa* MATSUOKA (1983a, p. 20-22, pl. 3, figs. 3-7; pl. 7, figs. 11-14) in ornamentation of outer shell surface, but differs from the latter in consisting of 4 segments. Also it differs from *Cyrtocapsa mastoidea* YAO (1979, p. 36-37, pl. 8, figs. 1-8) in lacking apical horn and tube-like 5th segment, and in possessing ornamentation of outer shell surface.

Etymology.- This species is named for its type locality.

Measurements (in μm).-
Based on 11 specimens. Total height, 115-132 (124); width 70-85 (79); W. cephalis, 13-17 (14); H. thorax, 15-25 (20); H. abdomen, 27-35 (29); H. 4th segm., 45-64 (55).

Type Locality.- Naradani Fm., Kochi Pref., SW Japan.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

STICHOCAPSA PULCHELLA 5744

Stichocapsa pulchella (RÜST)

Synonymy.-
Archicorys pulchella RÜST
RÜST 1898, p. 40, pl. 13, fig. 6.
Stichocapsa cribata HINDE
MOORE 1973, p. 827, pl. 4, figs. 1-2.
SCHAAF 1981, p. 439, pl. 6, fig. 4; pl. 25, fig. 6.
SCHAAF 1984, p. 157, fig. 6.
Stichocapsa pulchella (RÜST)
JUD 1994, p. 108, pl. 21, figs. 6-7.

Original Definition.- "Test of middle-size, pitcher-shaped, constricting little towards the wide aperture, having 14-15 very regular horizontal rows of middle-sized pores. The horn is very short".

Actualized Definition.- (JUD, 1994) Test spindle-shaped, smooth-surfaced, consisting of 8-9 segments. Cephalis small and poreless. Postcephalic segments increasing gradually in diameter and height up to the 6th or 7th segment, then decreasing to the last segment. No external partition between segments expressed on the surface of test. Pores circular, quincuncially disposed in transverse rows, increasing in size to the middle part, then decreasing to the distal one. The number of transverse rows increases from 2 in the first segments to 3 and 4 in the middle part of test. Wall thick, especially towards the middle part of test. The terminal part has a thinner wall and an irregular border, as if unfinished. A small depression almost always developed in the middle part of test, resulting from the absence of the external layer of the wall. Mature specimens show a trend to close the lumen of pores on the surface of the test, which becomes very smooth.

Actualized Remarks.- (JUD, 1994) In *S. pulchella* we included all forms considered by previous authors as *S. cribata* HINDE. It is to mention that Hinde‘s illustration represents quite another species, which has both ends closed. This species, as most species described from thin sections, is impossible to recognize at present in our samples. In *S. pulchella* (RÜST) are herein included only morphotypes having a slender apical part, with slightly concave outline. Together with these specimens there is another morphotype characterized by an apical part shorter, more robust and with slightly convex outline. This morphotype was not included in *S. pulchella*. Our specimens (8 specimens) have a length of 233-300 μm, av 262 μm and a width of test of 143-180 μm, av. 156 μm. They are larger than those described by Rüst.

Measurements (in μm).- Height/width: 215/155.

Type Locality.- Cittiglio, Prov. Varese, North Italy.

UAZones.- 17-22, late Val. to late Barr.-early Apt.

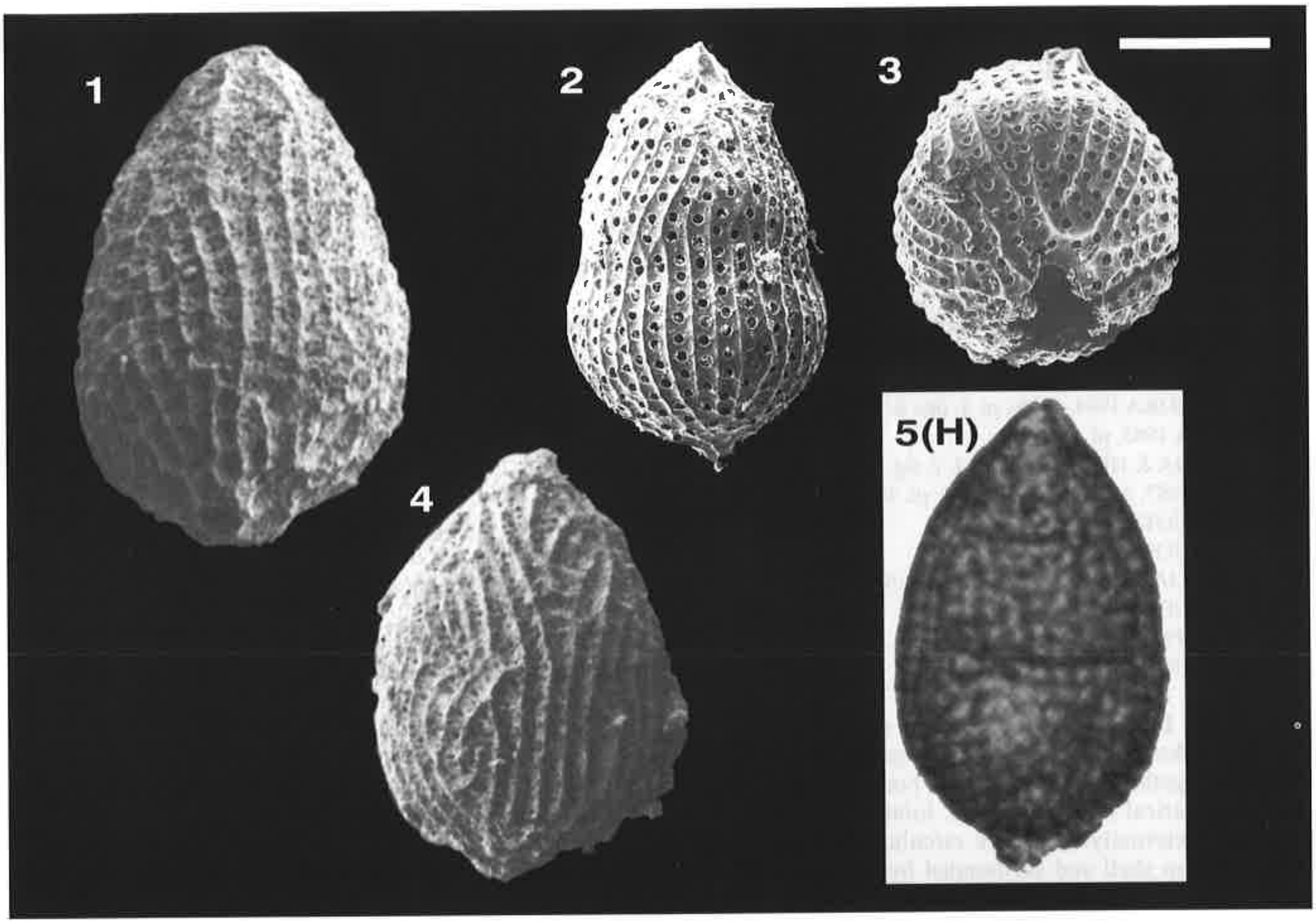


Plate 3045. *Stichocapsa naradaniensis* MATSUOKA. Magnification x500. **Fig. 1.** MAOCUMR2910, D-32. **Fig. 2.** POB81/2659, 534.124.1.52. **Fig. 3.** POB81/2434, 534.124.1.52. **Fig. 4.** MAOCUMR2707, D-32. **Fig. 5(H).** MATSUOKA 1984, pl. 2, fig. 1a.

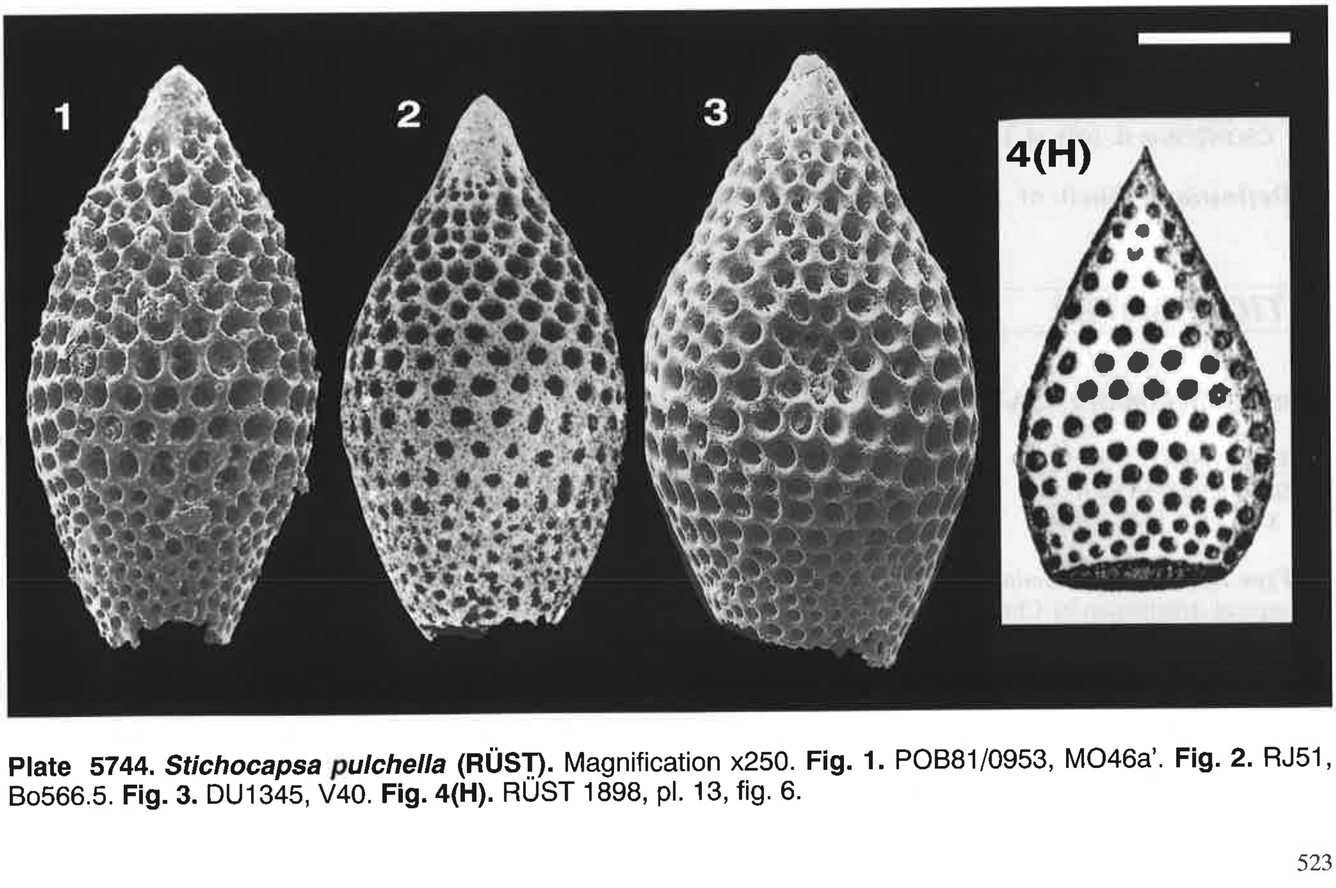


Plate 5744. *Stichocapsa pulchella* (RÜST). Magnification x250. **Fig. 1.** POB81/0953, MO46a'. **Fig. 2.** RJ51, Bo566.5. **Fig. 3.** DU1345, V40. **Fig. 4(H).** RÜST 1898, pl. 13, fig. 6.

STICHOCAPSA ROBUSTA 3298

Stichocapsa robusta MATSUOKA

Synonymy.-
Stichocapsa convexa YAO
AITA 1982, pl. 1, figs. 6-7b.
Stichocapsa sp.
SATO et al. 1982, pl. 4, fig. 1.
Stichocapsa sp. aff. *S. convexa* YAO
EL KADIRI 1984, p. 225, pl. 19, fig.4; pl. 25, fig. 6.
Stichocapsa robusta MATSUOKA
MATSUOKA 1984, p. 146, pl. 1, figs. 6-13; pl. 2, figs. 7-12.
ISHIDA 1985, pl. 3, fig. 11.
KISHIDA & HISADA 1986, pl. 2, fig. 16.
AITA 1987, p. 67, pl. 7, fig. 1a-b; pl. 11, figs. 11-12.
MATSUOKA 1986a, pl. 1, fig. 12.
MATSUOKA 1988, pl. 1, fig. 8.
DANELIAN 1989, p. 193, pl. 8, figs. 6-7.
MATSUOKA 1990, pl. 1, fig. 10.
YAO 1991, pl. 4, fig. 8.
MATSUOKA 1992, pl. 5, fig. 3.

Original Definition.- Shell of four segments, drop-like shaped. Cephalis spherical internally, poreless. Thorax and abdomen together truncate conical. Fourth segment large, truncate spherical to truncate oval. Joint between segments indistinct externally. Aperture circular, small but larger than pores on shell and surrounded by flat poreless area. Shell thick porous. Pores diagonally arranged, densely spaced and tapering internally. One circular depression present near the junction between thorax and abdomen.

Original Remarks.- One depression near the junction between thorax and abdomen may be a sutural pore. It is not clear whether other forms assigned to *Stichocapsa* possess such a depression or not. This species is very similar to *Stichocapsa convexa* YAO 1979 (p. 35-36, pl. 5, figs. 14-16; pl. 6, figs. 1-7) in external shape and proportion of the segments, but differs from the latter in its thick wall and internally tapering pores. It is distinguished from *Theocorys renzae* SCHAAF 1981 (p. 440, pl. 5, figs. 13a-c; pl. 27, figs. 1a-b) by lacking protruding rim around aperture.

Etymology.- This species is named for the Latin adjective *robustus*, meaning robust.

Measurements (in μm).-
Based on 14 specimens. Total height, 183-230 (195); width 112-160 (132); diameter of cephalis, 18-22 (19); height of thorax, 20-25 (23); of abdomen, 25-30 (27); of 4th segment, 125-160 (136).

Type Locality.- Sample D-32, Naradani Formation, Kochi Prefecture, southwest Japan.

UAZones.- 5-7, latest Baj.-early Bath. to late Bath.-early Call.

STICHOCAPSA | *E* 4042

Stichocapsa sp. E

Synonymy.-
Stichocapsa sp. B
KIDO et al. 1982, pl. 5, fig. 10.
Yaocapsa aff. *macroporata* KOZUR
CSONTOS et al. 1991, pl. 1, fig. 1.

Definition.- Shell of four segments with two prominences; upper one represented by proximal three segments and lower one by a basal appendage. Cephalis spherical without apical horn. Thorax and abdomen truncate-conical. Collar stricture slightly recognizable. Fourth segment large, globose with a basal appendage. Pores medium, circular and uniform in size except on basal appendage where pores are larger.

UAZones.- 5-5, latest Baj.-early Bath. to latest Baj.-early Bath.

STICHOMITRA 3697

Genus: *Stichomitra* CAYEUX

Synonymy.-
Stichomitra CAYEUX
CAYEUX 1897, p. 204.

Type Species.- *Stichomitra costata* CAYEUX 1897, subsequent designation by Chediya (1959).

Original Definition.- "Test consisting of two parts, an upper conical one and a lower cylindrical one: segments almost equal. Without apical spine."

Original Remarks.- "Haeckel created the genus *Stichocorys* for the Stichocyrtida conformable to the type of this genus, but having an apical spine. This new genus is for the *Stichocorys* what the *Dictyomitra* are in comparison to *Lithostrobus*."

Remarks.- Species are differentiated primarily on overall test shape and external character and distribution of pores.

Included Taxa.-
5672 *Stichomitra* sp. aff. *S. asymbatos* FOREMAN
5550 *Stichomitra* sp. (?) aff. *S. euganea* (SQUINABOL)
4044 *Stichomitra* (?) *takanoensis* gr. AITA
3192 *Stichomitra* (?) sp. A

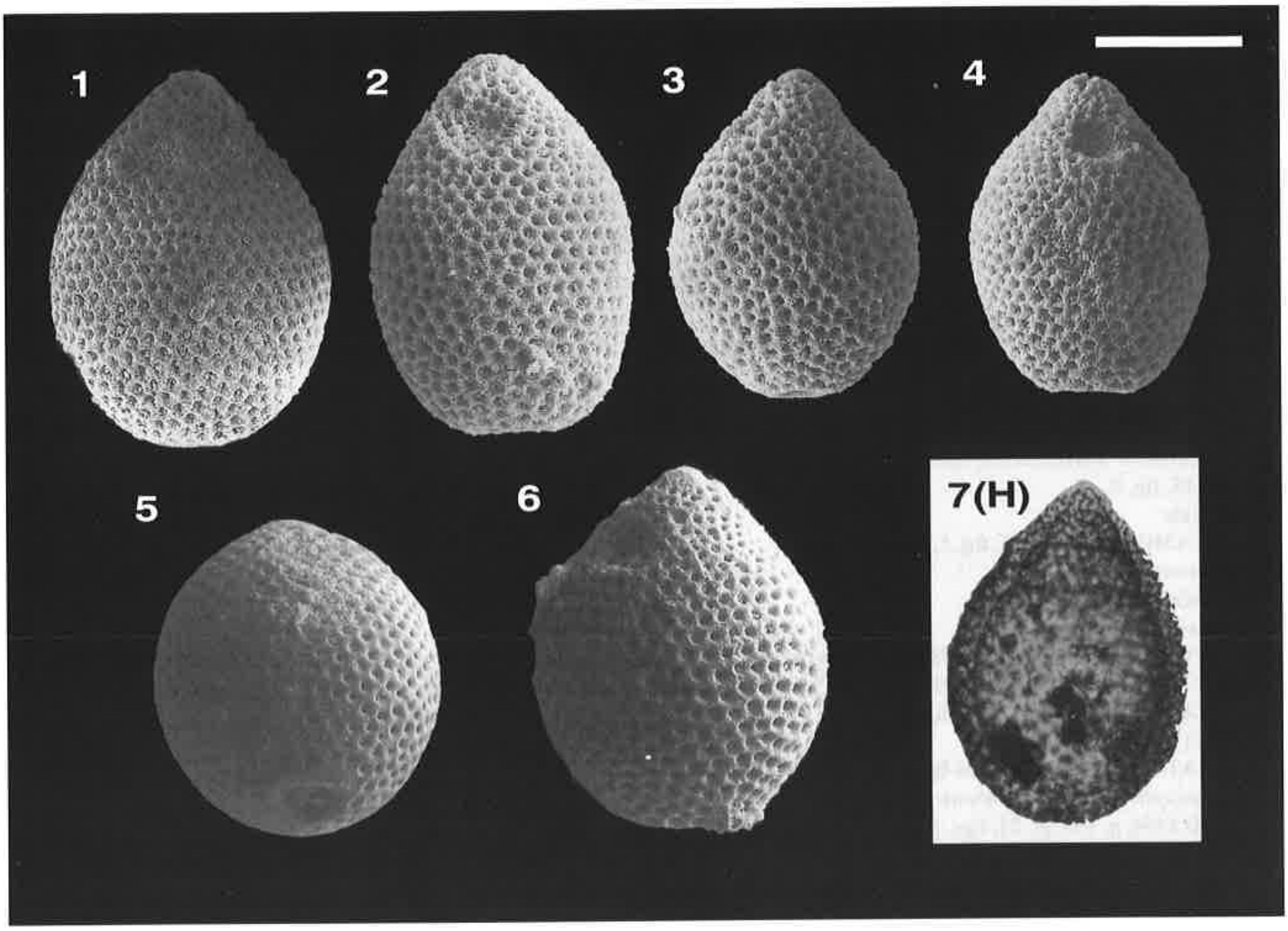


Plate 3298. *Stichocapsa robusta* MATSUOKA. Magnification x250. **Fig. 1.** GOB3/1106, KRS6. **Fig. 2.** DU3039, PJ10. **Fig. 3.** DU2700, PJ14. **Fig. 4.** DU2697, PJ14. **Fig. 5**. GO900437, UPC18. **Fig. 6.** GO900438, UPC18. **Fig. 7(H).** MATSUOKA 1984, pl. 2, fig. 7a.

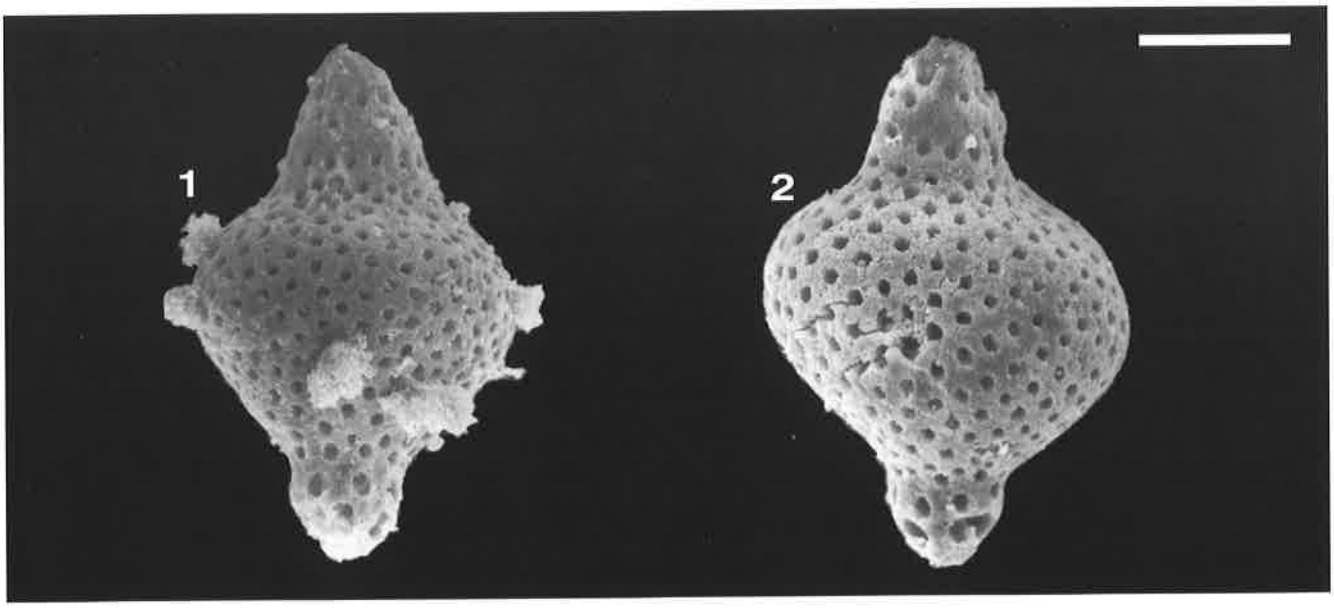


Plate 4042. *Stichocapsa* sp. E. Magnification x500. **Fig. 1.** MA10581, MKS-7.5A. **Fig. 2.** MA10588, MKS-7.5A.

STICHOMITRA ASYMBATOS AFF. 5672

Stichomitra sp. aff. *S. asymbatos* FOREMAN

Synonymy.-
? *Stichomitra asymbatos* FOREMAN
FOREMAN 1968, p. 73, pl. 8, figs. 10 a-c.
DUMITRICA 1975, p. 87-89, text-fig. 2.13.
FOREMAN 1978, p. 748, pl. 4, fig. 15.
SCHAAF 1981, p. 439, pl. 22, figs. 6a-b.
TAKETANI 1982a, p. 54, pl. 4, fig. 13; pl. 11, figs. 3-4.
SUYARI & HASHIMOTO 1985, pl. 6, figs. 1, 3, ? 2.
SUYARI 1986a, pl. 17, fig. 8.
Stichomitra asymbatos group FOREMAN
RIEDEL & SANFILIPPO, 1974, p. 780, pl. 10, figs. 1-7; pl. 15, fig. 5.
Xitus sp.
OKAMURA 1982, pl. 5, fig. 5, not 4.
Stichomitra (?) sp.
YAO 1984, pl. 5, fig. 15.
Stichomitra sp. C
SUYARI & HASHIMOTO 1985, pl. 6, fig. 13.
Xitus (?) *asymbatos* (FOREMAN)
IWATA & KATO 1986, text-fig. 4.1.
Xitus (?) sp. A
IWATA & KATO 1986, text-fig. 4.2.
Stichocapsa sp. aff. *S. asymbatos* FOREMAN
JUD 1994, p. 109, pl. 21, figs. 8-9.

Definition.- (JUD, 1994) Test conical to subcylindrical, consisting of 6 or more segments. Cephalis bearing a short pointed apical horn, which in most cases is slightly inclined. Apical part formed by cephalis and thorax wide conical, inflated distally. Post-thoracic segments slowly and uniformly increasing in width, forming a cone the angle of which is smaller than that formed by the first two segments. Segments relatively high, convex in outline, separated by visible constrictions. Surface rough with relatively small tubercles disposed either in several transverse rows or irregularly, interconnected by a dense irregular network of ridges. Pores very small, densely and irregularly disposed. Last segment may terminate with a funnel-shaped tube.

Remarks.- (JUD, 1994) Two extreme morphotypes have been distinguished: a) with slightly visible spiny tubercles interconnected by an irregular network of ridges and b) with tubercles disposed in several rows per segment (not illustrated herein). Both morphotypes together with all transitional forms have been taken into account for biostratigraphy. Our specimens differ from *S. asymbatos* FOREMAN in that the cephalis with the apical horn and the thorax form a well defined wide cone the angle of which is much larger (57-66°) than the angle made by the post-thoracic segments (26-30°), and by generally having higher segments.

Measurements (in μm).-
Measured from the base of the apical horn to base of fifth segment: maximum length 228-290, maximum width (measured on 5th segment) 142-154.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

STICHOMITRA (?) EUGANEA AFF. 5550

Stichomitra (?) sp. aff. *S. euganea* (SQUINABOL)

Synonymy.-
Stichomitra euganea SQUINABOL
? SQUINABOL 1903, p. 142, pl. 8, fig. 30.
Stichomitra (?) *euganea* SQUINABOL
? PESSAGNO 1976, p. 54, pl. 3, fig. 11.
Stichomitra (?) *euganea* (SQUINABOL)
TAKETANI 1982, pl. 1, fig. 4.
Stichocapsa perspicua (SQUINABOL)
BAUMGARTNER 1992, p. 326, pl. 13, figs. 4-5.
Stichomitra (?) sp. aff. *S. euganea* (SQUINABOL)
JUD 1994, p. 109, pl. 21, figs. 10-13.

Definition.- (JUD, 1994) Test long, conical, closed distally, consisting of 9-10 segments. Cephalis smooth bearing a short apical horn. Segments of upper part slightly convex, separated from each other by a slightly to well marked constriction. In the lower part the segmental partition becomes less and less visible. Height of segments in the upper part almost constant but increases distally. Last segment widest and highest. Its terminal part flattened, rounded or acute. Upper part rough-surfaced with pores disposed irregularly; lower part with pores disposed quincuncially in longitudinal rows and hexagonally framed. Size of pores increases distally. Outline of whole test straight or slightly concave.

Remarks.- (JUD, 1994) Specimens having affinities with *Stichomitra euganea* SQUINABOL are not frequent in the Lower Cretaceous sections. Some authors assigned such forms to *S. perspicua* SQUINABOL due to its general shape. It is however clear that they cannot be assigned to this species because it has the pores always disposed in longitudinal rows on the last segments whereas *S. perspicua* does not show such a character. By this longitudinal disposition of pores they are much closer to *S. euganea* SQUINABOL where this disposition is well emphasized on the holotype and probably represent its ancestor.

Measurements (in μm).-
Total length 530-700, maximum width 200-270.

UAZones.- 21-22, early Barr. to late Barr.-early Apt.

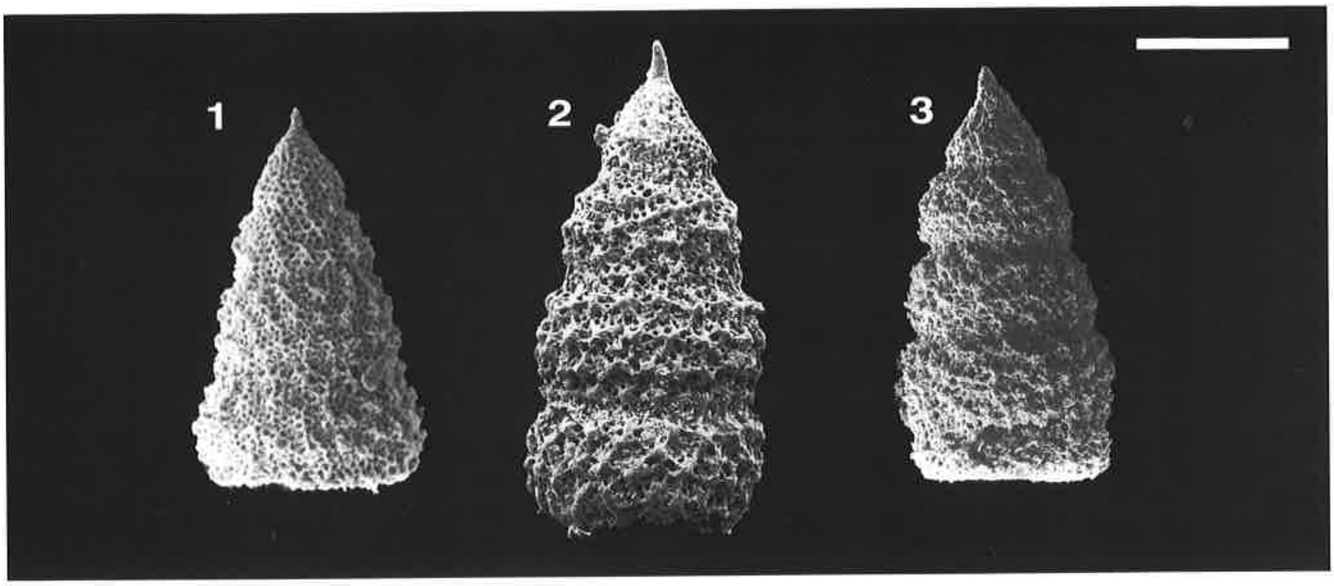


Plate 5672. *Stichomitra* sp. aff. *S. asymbatos* FOREMAN. Magnification x200. **Fig. 1.** RJ613, Bo566.5. **Fig. 2.** POB79/0139, MO41. **Fig. 3.** RJ4, GC887.0.

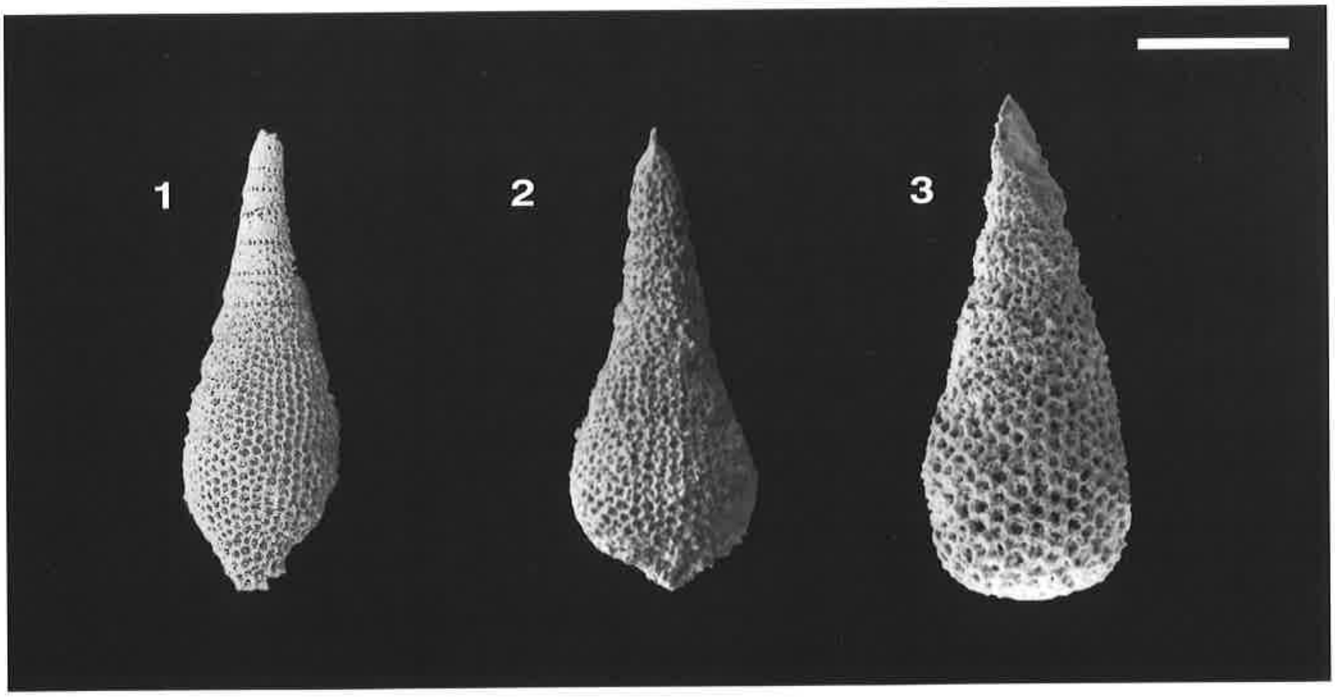


Plate 5550. *Stichomitra* (?) sp. aff. *S. euganea* (SQUINABOL). Magnification x100. **Fig. 1.** RJ103, Bo619.9. **Fig. 2.** RJ 894, GC 887.00. **Fig. 3.** RJ 745, GC 882. 40.

STICHOMITRA (?) TAKANOENSIS GR. 4044

Stichomitra (?) *takanoensis* gr. AITA

Synonymy.-
Macrocephalic multicyrtid theoperid gen et sp. indet.
BAUMGARTNER 1985, figs. 43.l-m.
Nassellaria gen. et sp. ind.
CONTI 1986, pl. 1, figs. 2-3.
Stichomitra (?) *takanoensis* AITA
AITA 1987, p. 73, pl. 3, figs. 10a-12; pl. 10, figs. 6-7.
Macrocephalic multicyrtid nassellarian
GORICAN 1987, p. 184, pl. 2, figs. 16-17.

Original Definition.- Shell of four to eight segments; cephalis large, mostly spherical, poreless with apical horn; post-cephalic segments cylindrical, with numerous small irregularly arranged pores and spongy surface; strictures between postcephalic segments well-defined externally.

Original Remarks.- This species has a feature on cephalis similar to that of *Stichomitra* (?) *tairai* n.sp., but differs from the latter by its spongy feature on the postcephalic segments.

Remarks.- We include also forms without apical horn.

Etymology.- This species is named for the hamlet of Takano, Higashitsuno Village, Kochi Prefecture, southwest Japan.

Measurements (in μm).-
Based on 2 specimens.

	HT	PT
Overall height:	170	-
Height of cephalis:	50	65
Width of cephalis:	60	63
Maximum width:	108	100

Type Locality.- Sample FNT-03, Funato section, Irazuyama Formation (Togano Group), Kochi Prefecture, southwest Japan.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

STICHOMITRA (?) | A 3192

Stichomitra (?) sp. A

Synonymy.-
unidentified cyrtoid
BAUMGARTNER 1985, fig. 37.o.
? g. et sp. indet.
DE WEVER & MICONNET 1985, pl. 4, fig. 13.
macrothoracic multicyrtid nassellarian
GORICAN 1987, p. 184, pl. 2, figs. 18-19.

Remarks.- The general shape of this morphotype, especially the shape of the cephalis resembles *Stichomitra* (?) *tairai* AITA (1987, p. 72, pl. 3, figs. 7a-9; pl. 10, figs. 3-4). It differs from the latter by the wall-structure which is more reminiscent of *Stichomitra* (?) *takanoensis* gr.

UAZones.- 3-7 , early-mid Baj. to late Bath.-early Call.

STYLOCAPSA 3698

Genus: *Stylocapsa* PRINCIPI, emend. TAN

Synonymy.-
Stylocapsa PRINCIPI
PRINCIPI 1909, p. 20.
emend. TAN 1927, p. 32.

Type Species.- *Stylocapsa exagonata* PRINCIPI 1909.

Original Definition.- "I propose this new genus for some forms similar to *Cryptocapsa* but differing from it by having a horn. The new genus can be defined as: Two rayed cyrtoid with thorax without appendix and cephalis armed with a horn".

Actualized Remarks.- (TAN, 1927) Principi erroneously uses the term "radiato" for segment, therefore the definition should be: "Dicyrtoid without rays, with cephalis armed with a horn".

Remarks.- In this catalogue species have been distinguished by overall shape, relative size and configuration of plicae.

Included Taxa.-
3044 *Stylocapsa catenarum* MATSUOKA
4045 *Stylocapsa* (?) *hemicostata* MATSUOKA
4046 Stylocapsa *lacrimalis* MATSUOKA
3059 *Stylocapsa oblongula* KOCHER
3046 *Stylocapsa* (?) *spiralis* gr. MATSUOKA
4047 *Stylocapsa tecta* MATSUOKA

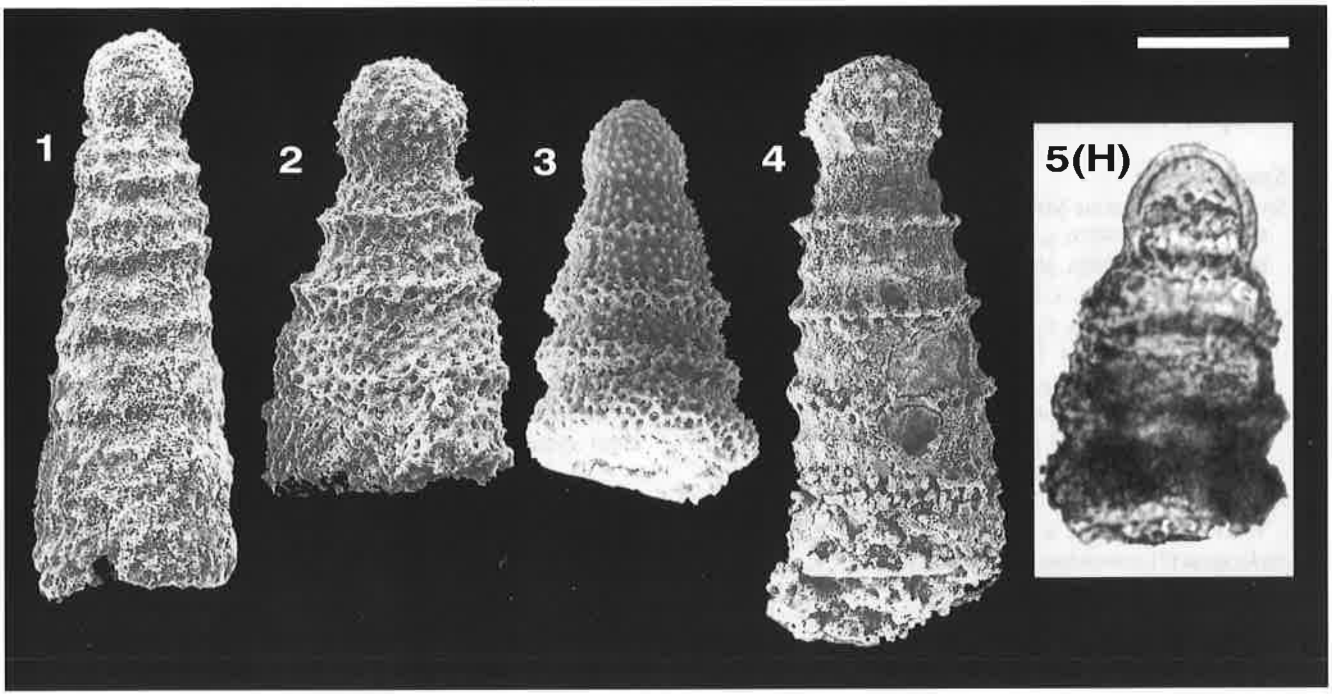


Plate 4044. *Stichomitra* (?) *takanoensis* gr. AITA. Magnification x300. **Fig. 1.** POB80/3808, POB796. **Fig. 2.** POB80/3931, POB926. **Fig. 3.** MA1119, S-02. **Fig. 4.** GOB14/1101, 5398/1. **Fig. 5(H).** AITA 1987, pl. 3, fig. 10a.

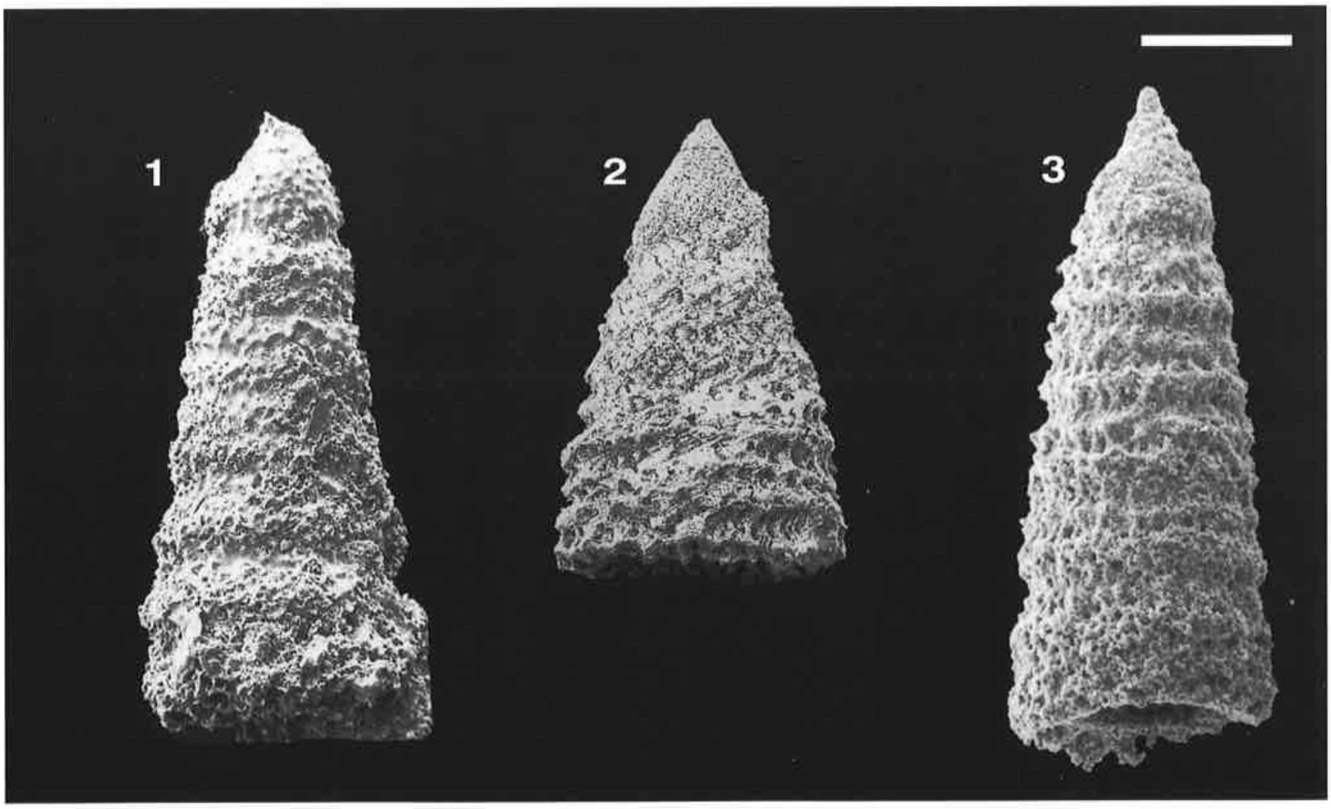


Plate 3192. *Stichomitra* (?) sp. A. Magnification x300. **Fig. 1.** POB81/2279, 534.122.1.43. **Fig. 2.** POB80/2145, POB1262. **Fig. 3.** GO890525, ZB28.

STYLOCAPSA CATENARUM 3044

Stylocapsa catenarum MATSUOKA

Synonymy.-
Stylocapsa catenarum MATSUOKA
MATSUOKA 1982b, p. 75, pl. 2, figs. 1-11.
MATSUOKA 1982a, pl. 3, figs. 3-4.
YAO et al. 1982, pl. 4, fig. 10.
MATSUOKA 1983a, p. 18, pl. 2, fig. 10; pl. 7, figs. 1-2.
YAO 1984, pl. 2, figs. 17-18.
ISHIDA 1985, pl. 3, fig. 9.
MATSUOKA 1986a, pl. 3, fig. 17.
MATSUOKA & YAO 1986, pl. 2, fig. 11.
WAKITA 1988, pl. 4, fig. 20.
MATSUOKA 1990, pl. 2, fig. 4.
YAO 1991, pl. 4, fig. 6.
Stylocapsa (?) *catenarum* MATSUOKA
AITA 1987, p. 67, pl. 7, figs. 4a-5b.

Original Definition.- Shell of two segments, ellipsoidal with a short, stout apical horn. Cephalis small, spherical internally, partly encased in thoracic cavity. Thorax ellipsoidal with thin wall. Outer surface of shell with longitudinal chain-like plicae in which one row of pores present. Pores small, circular, uniform in size. Seven to eight plicae observed in lateral view. Numerous, short transverse ridges between neighbouring two longitudinal plicae distinct in some specimens, obscure in others. Arrangement of longitudinal plicae and transverse ridges becoming irregular toward proximal and distal parts where shell surface is ornamented with meshwork ridges. Aperture small, constricted with protruding rim.

Original Remarks.- There is a correlation between total length and height of apical horn; larger specimens tend to become more elongate. Difference of development of transverse ridges between neighbouring longitudinal plicae may represent various stage of growth due to occlusion.

This species differs from *Stylocapsa oblongula* KOCHER (Baumgartner et al., 1980, p. 62, pl. 6, fig. 1) by having longitudinal chain-like plicae. This species differs from Theoperid gen. et sp. indet. in FOREMAN (1971, p. 1676, pl. 3, fig. 1; 1973, pl. 15, fig. 17), *Dicolocapsa* sp. A in MOORE 1973, p. 826, pl. 11, fig. 10) in possessing a stout apical horn.

Actualized Remarks.- (MATSUOKA, 1983a) Some specimens entirely lack apical horn (pl. 7, figs. 2a-b), but are otherwise similar to the specimens with apical horn. Whether apical horn is present or not, is not a diagnostic criterion for identification of this species.

Etymology.- This species is named for the Latin noun *catenae*, meaning chain.

Measurements (in μm).-
Based on 17 specimens. Total length, 105-150; width of widest portion, 53-67; diameter of cephalis, 12-17; height of horn, 4-15; diameter of aperture, 3-6; thickness of wall, 4-7.

Type Locality.- Sample 7-0503, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

STYLOCAPSA (?) HEMICOSTATA 4045

Stylocapsa (?) *hemicostata* MATSUOKA

Synonymy.-
Stylocapsa (?) *hemicostata* MATSUOKA
MATSUOKA 1983a, p. 17, pl. 2, figs. 1-4; pl. 6, figs. 8-13.
MATSUOKA 1986a, pl. 1, fig. 5.
MATSUOKA & YAO 1986, pl. 2, fig. 5.

Original Definition.- Shell of two segments, oval. Cephalis small, spherical internally, partly encased in thoracic wall and cavity. Collar stricture indistinct externally. Thorax oval with a small, constricted aperture. Small projection(s) at proximal end of some specimens. Ornament on outer surface of shell differentiated between proximal and distal parts. Proximal part with 17 to 20 longitudinal plicae in lateral view; one row of pores between neighbouring two longitudinal plicae. Distal part with polygonal frames. One pore present in the center of each depression surrounded by the polygonal frames. Longitudinal plicae changing distally to polygonal frames by adding perpendicular or oblique ridges to the longitudinal plicae. Pores on outer surface of shell small, circular and uniform in size.

Original Remarks.- This species does not bear a prominent apical horn, but small projection(s) are present in some specimens (pl. 2, fig. 1). Therefore this species is doubtfully assigned to *Stylocapsa*. On outer surface, proportion of the area with longitudinal plicae to that with polygonal frames varies among specimens. *Stylocapsa* (?) *hemicostata* n.sp. differs from *Stylocapsa* (?) *spiralis* MATSUOKA by possessing longitudinal plicae.

Etymology.- This species is named for the Latin adjective *hemicostatus*, meaning half-costated.

Measurements (in μm).-
Based on 14 specimens. Total height, 125-148 (135); maximum width of shell, 95-114 (105); diameter of cephalis, 18-19 (18); of aperture, 5-8 (6).

Type Locality.- Sample S-15, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 5-6, latest Baj.-early Bath. to mid Bath.

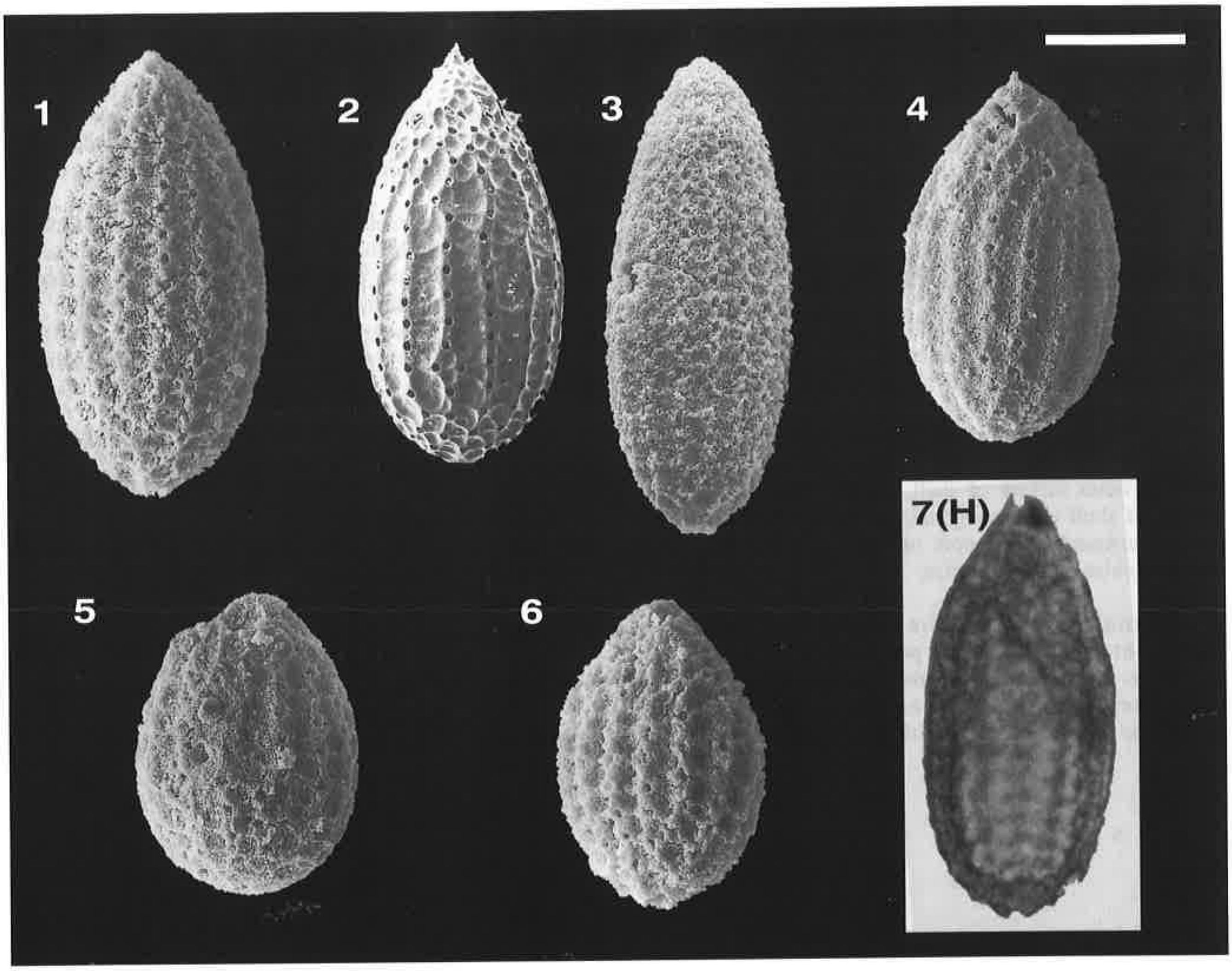


Plate 3044. *Stylocapsa catenarum* MATSUOKA. Magnification x500. **Fig. 1.** DU3071, PJ9. **Fig. 2.** POB81/2692, 534.124.1.52. **Fig. 3.** DU2726, PJ14. **Fig. 4.** DU3176, PJ7. **Fig. 5.** DU3160, PJ7. **Fig. 6.** DU3122, PJ9. **Fig. 7(H).** MATSUOKA 1982b, pl. 2, fig. 1a.

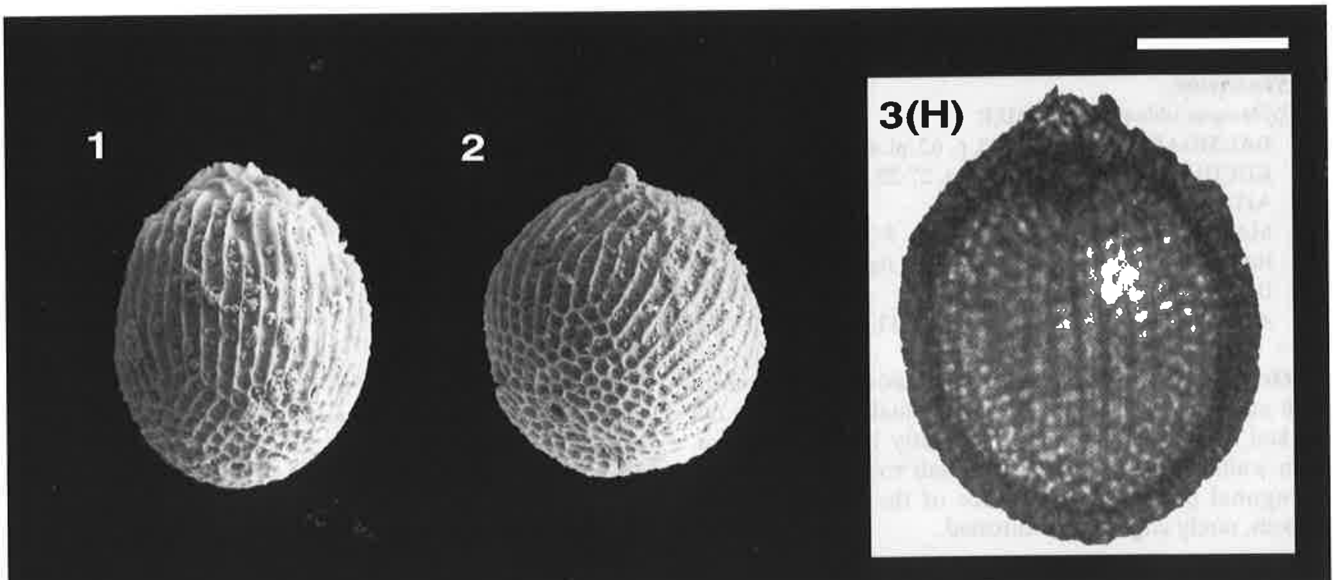


Plate 4045. *Stylocapsa* (?) *hemicostata* MATSUOKA. Magnification x400. **Fig. 1.** MA1037, OCUMR2611, S-15. **Fig. 2.** MA1029, OCUMR2613. **Fig. 3(H).** MATSUOKA 1983a, pl. 6, fig. 8a.

STYLOCAPSA LACRIMALIS — 4046

Stylocapsa lacrimalis MATSUOKA

Synonymy.-
Stylocapsa lacrimalis MATSUOKA
MATSUOKA 1983a, p. 16, pl. 1, figs. 12-13; pl. 7, figs. 3-10.
MATSUOKA 1986a, pl. 1, fig. 4.

Original Definition.- Shell of two segments, inflated drop-like shaped. Cephalis small, spherical internally, encased in wall, with small pointed apical end externally. Thorax subspherical with thick wall. Aperture small, circular, constricted. A well-defined circular depression situated near aperture. Pores in the depression larger than those on outer surface of shell, densely distributed. Outer surface of shell with tetragonal, pentagonal and hexagonal frames surrounding one pore or rarely a few pores. Pores small, circular, uniform in size.

Original Remarks.- This species does not bear a prominent apical horn but pointed apical end. Some specimens possess rather rounded apical end. Ornament on outer shell surface varies among specimens. Some specimens are ornamented with tetragonal frames which are arranged longitudinally. Some others are covered with hexagonal and pentagonal frames. More specimens have ornament in combination of the above-mentioned two types.

Stylocapsa lacrimalis n.sp. is similar to *Tricolocapsa conexa* n.sp. described below, in outline of shape, ornament of outer shell surface and presence of circular depression near aperture, but differs from the latter in its smaller size and in number of segments. Judging from morphological similarity, *S. lacrimalis* n.sp. seems to be related phylogenetically to *T. conexa* n.sp.

Etymology.- This species is named for the Latin adjective *lacrimalis*, meaning lacrimal.

Measurements (in μm).-
Based on 13 specimens. Total height, 98-119 (107); maximum width of shell, 76-100 (88), diameter of cephalis, 11-15 (13), of aperture, 6-9 (7).

Type Locality.- Sample S-17, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

STYLOCAPSA OBLONGULA — 3059

Stylocapsa oblongula KOCHER

Synonymy.-
Stylocapsa oblongula KOCHER
BAUMGARTNER et al. 1980, p. 62, pl. 6, fig. 1.
KOCHER 1981, p. 97, pl. 16, figs. 27-29.
AITA 1982, pl. 1, figs. 18a-b.
MATSUOKA 1983a, p. 19, pl. 6, figs. 5-7.
BAUMGARTNER 1984, p. 786, pl. 9, figs. 1-2.
BAUMGARTNER 1985, fig. 38.n.
AITA 1987, p. 67, pl. 7, figs. 6a-b; pl. 11, figs. 14-15.

Original Definition.- Ellipsoidal two-segmented form with slender apical horn. Cephalis small, spherical, not marked in external outline, since partly included in horn. Thin walled thorax covered by small rounded pores in a hexagonal pattern. The surface of the horn is mostly smooth, rarely edged and bifurcated.

Original Remarks.- This species is very closely related to *Stylocapsa* (?) sp. in DE WEVER et al. (1979); it differs only by its more elongate form, thinner wall and narrower horn.

Etymology.- This species is named for the Latin adjective, *oblongus*, meaning elongated.

Measurements (in μm).-
Based on 36 specimens.

	HT	av.	min.	max.
Height (cephalis and thorax):	86	88	84	97
Maximum width:	61	62	56	70
Maximum length of horn:	64	-	-	-
Maximum width of horn:	14	-	-	-
Distance between centres of pores:	6	9	-	-
Diameter of pores:	2	3	-	-
Thickness of thoracic wall:	2	3	-	-

Type Locality.- Sample B3, Breggia Gorge, southern Switzerland.

UAZones.- 6-8, mid Bath. to mid Call.-early Oxf.

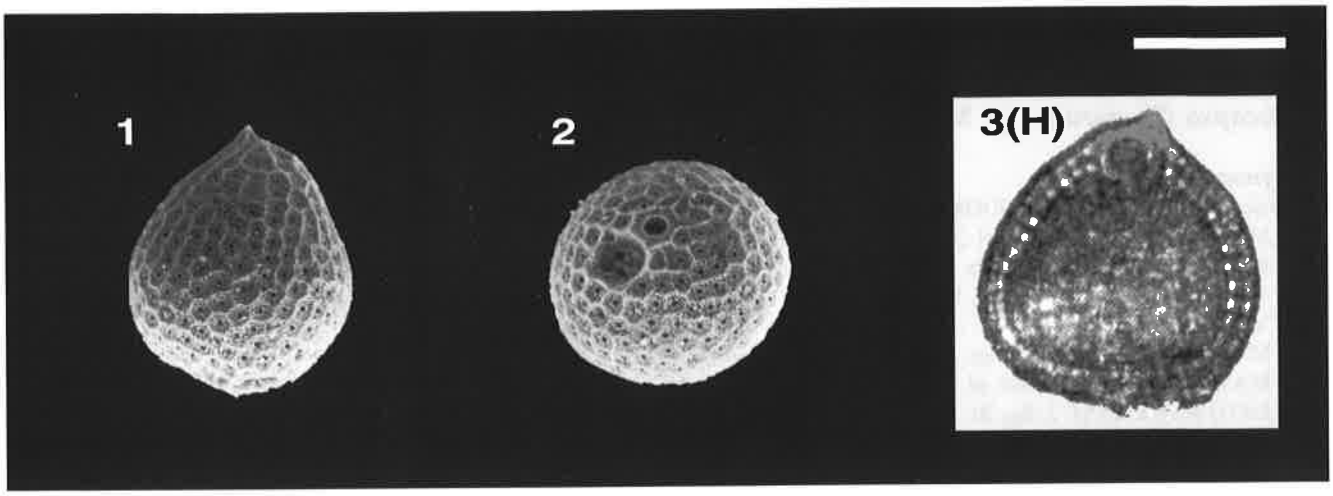


Plate 4046. ***Stylocapsa lacrimalis*** **MATSUOKA.** Magnification x400 **Fig. 1.** MA1072, OCUMR2599, S-17. **Fig. 2.** MA1073, OCUMR2599, S-17. **Fig. 3(H).** MATSUOKA 1983a, pl. 7, fig. 9a.

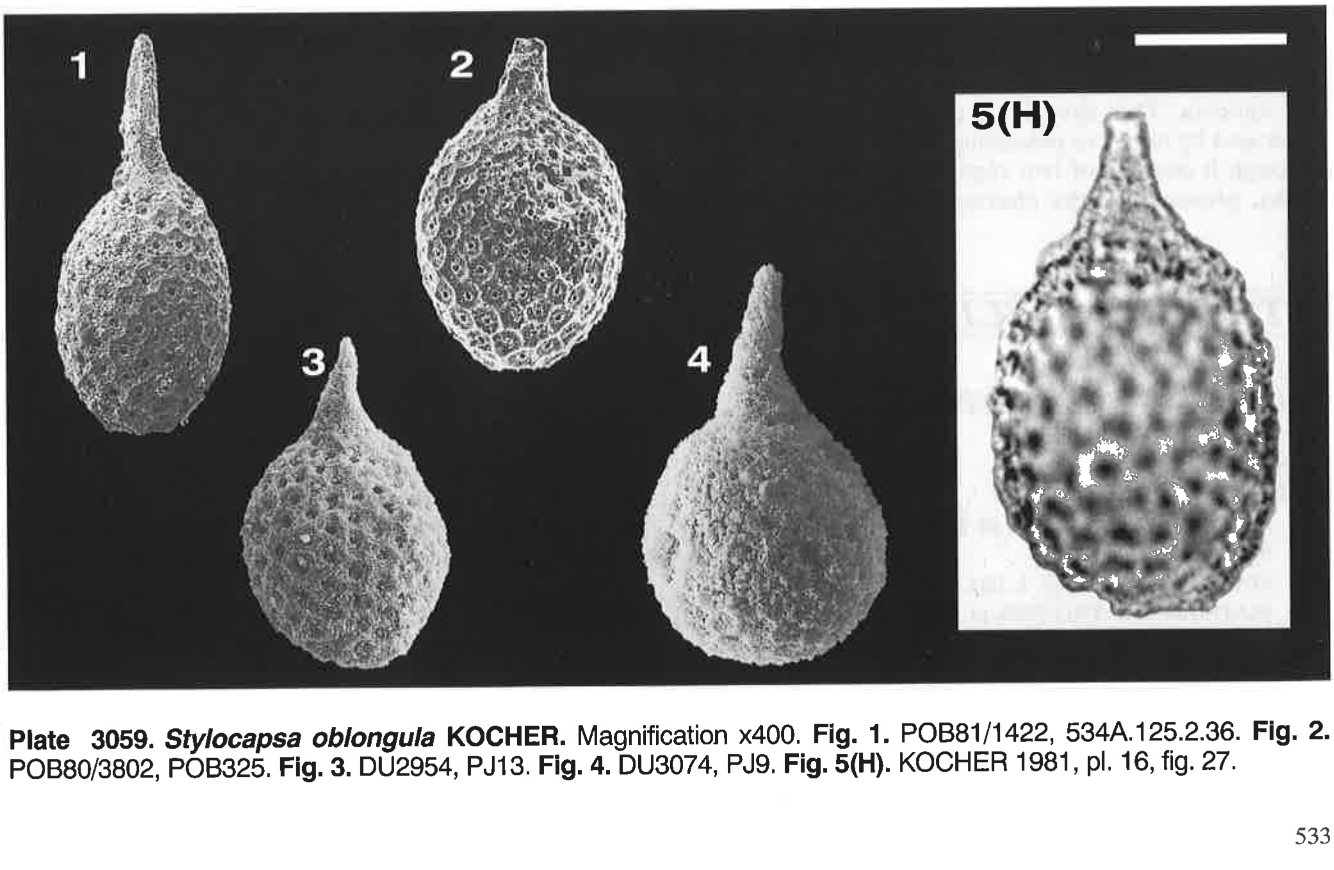


Plate 3059. ***Stylocapsa oblongula*** **KOCHER.** Magnification x400. **Fig. 1.** POB81/1422, 534A.125.2.36. **Fig. 2.** POB80/3802, POB325. **Fig. 3.** DU2954, PJ13. **Fig. 4.** DU3074, PJ9. **Fig. 5(H).** KOCHER 1981, pl. 16, fig. 27.

STYLOCAPSA (?) SPIRALIS GR. 3046

Stylocapsa (?) *spiralis* gr. MATSUOKA

***Synonymy*.-**
Stylocapsa (?) *spiralis* MATSUOKA
MATSUOKA 1982b, p. 77, pl. 3, figs. 1-8.
MATSUOKA 1982a, pl. 3, figs. 8-9.
YAO et al. 1982, pl. 4, figs. 11-12.
YAO 1984, pl. 2, figs. 15-16.
MATSUOKA 1986a, pl. 1, figs. 6-7.
MATSUOKA & YAO 1986, pl. 2, fig. 6; pl. 3, fig. 20.
SATO et al. 1986, pl. 2, fig. 20.
AITA 1987, p. 67, pl. 7, figs. 7a-b.
WAKITA 1988, pl. 4, fig. 19.
IWATA & TAJIKA 1989, pl. 5, figs. 4-5.
YAO 1991, pl. 4, fig. 5.
MATSUOKA 1992, pl. 5, fig. 1.
Stylocapsa (?) *spiralis* MATSUOKA group
MATSUOKA 1983a, p. 18, pl. 2, figs. 5-9; pl. 6, figs. 14-15.

***Original Definition*.-** Shell of two segments, oval with two horns at apical part in well preserved specimens. Apical horns straight with longitudinal grooves. The maximum length of horns approximately equal to total length of shell excluding horns. Cephalis small, spherical internally, partly encased in thoracic cavity. Thorax oval with thick wall. Ornament on outer surface of shell differentiated between proximal and distal parts. Proximal part with oblique plicae which are spirally arranged, dominantly sinistrally, partly dextrally. The plicae mainly continuous, partly discontinuous and partly branching out. One row (rarely two rows) of pores present between neighbouring two plicae. Distal part covered by polygonal frames. One pore present in the center of each depression surrounded the polygonal frames. Oblique plicae changing distally to polygonal frames by adding mainly dextrally arranged ridges. Pores on outer surface of shell small, circular, uniform in size. Aperture circular, constricted.

***Original Remarks*.-** *Stylocapsa* PRINCIPI possesses one apical horn, while there are two horns at apical part in this species. This species is doubtfully assigned to *Stylocapsa* by reason of possessing two horns at apical part, although it consists of two segments. In addition to the horns, presence of the characteristic oblique plicae distinguishes this species from the species hitherto referred to *Stylocapsa*. Inner structure of cephalis and the relationship between the two horns and cephalic structure were not observed. On outer surface, the rate of area between two types of ornament, one with oblique plicae, the other with polygonal frames, varies among specimens, and the boundary of two types tends to be wavy in one specimen.

***Actualized Remarks*.-** (MATSUOKA, 1983a) Various forms are included under this name. There are several varieties in ornamentation of outer surface of shell. Some have regular spiral arrangement of plicae (*S.* (?) *spiralis* s.s., pl. 2, figs. 8-9; pl. 6, figs. 14-15). Some others have chevron-like arrangement of plicae (pl. 2, fig. 7). The remaining ones have ornament with combination of longitudinal, spiral and chevron-like plicae (pl. 2, fig. 7). The remaining ones have ornament with combination of longitudinal, spiral and chevron-like plicae (pl. 2, figs. 5-6). *Stylocapsa* (?) *spiralis* group include all intermediate forms between *Stylocapsa* (?) *hemicostata* n.sp. and *Stylocapsa* (?) *spiralis* s.s. in addition to *S.* (?) *spiralis* s.s. These intermediate forms occur abundantly at the horizon of the first occurrence of *S.* (?) *spiralis* group. *Stylocapsa* (?) *spiralis* group seems to be derived from *Stylocapsa* (?) *hemicostata* through change in plicae arrangement from longitudinal pattern to spiral pattern. Judging from stratigraphic distribution of *S.* (?) *hemicostata* and *S.* (?) *spiralis* group, it seems that the morphologic change took place rapidly and *S.* (?) *spiralis* s.s. survived without remarkable morphologic change.

***Etymology*.-** Latin adjective *spiralis*, meaning spiral.

Measurements (in μm).-
Based on 20 specimens. Total length, 105-155; Width of widest portion, 80-120; Diameter of cephalis, 9-17; Max. length of horn, 110; Diameter of aperture, 3-8; Thickness of wall, 7-14.

***Type Locality*.-** Sample 7-0503, Togano Group, Kochi Prefecture, southwest Japan.

***UAZones*.-** 6-7, mid Bath. to late Bath.-early Call.

STYLOCAPSA TECTA 4047

Stylocapsa tecta MATSUOKA

***Synonymy*.-**
Stylocapsa tecta MATSUOKA
MATSUOKA 1983a, p. 14, pl. 1, figs. 5-11; pl. 5, figs. 8-14.
MATSUOKA 1986a, pl. 1, figs. 1-2.
MATSUOKA & YAO 1986, pl. 2, fig. 8.
AITA 1987, p. 68, pl. 7, figs. 8a-b; pl. 11, figs. 16-17.
MATSUOKA 1989, pl. 1, figs. 6-7.

***Original Definition*.-** Shell of two segments, pyriform, widest at about 3/4 portion of total length from the apical end. Cephalis spherical internally, hidden in stout apical horn. Apical horn consisting of numerous blades and grooves. Thorax ovoidal with a circular, constricted aperture. Pores of thoracic shell tapering externally and arranged longitudinally. Thirteen to 15 longitudinal rows of pores visible in lateral view. Pores on upper part of thorax set in small, circular to rounded polygonal pits which become obscure distally. Outer surface of upper part of thorax rough due to longitudinally arranged pits, that of lower part smooth.

***Original Remarks*.-** Concerning the outer surface of thorax, proportion of the area with smooth surface to that

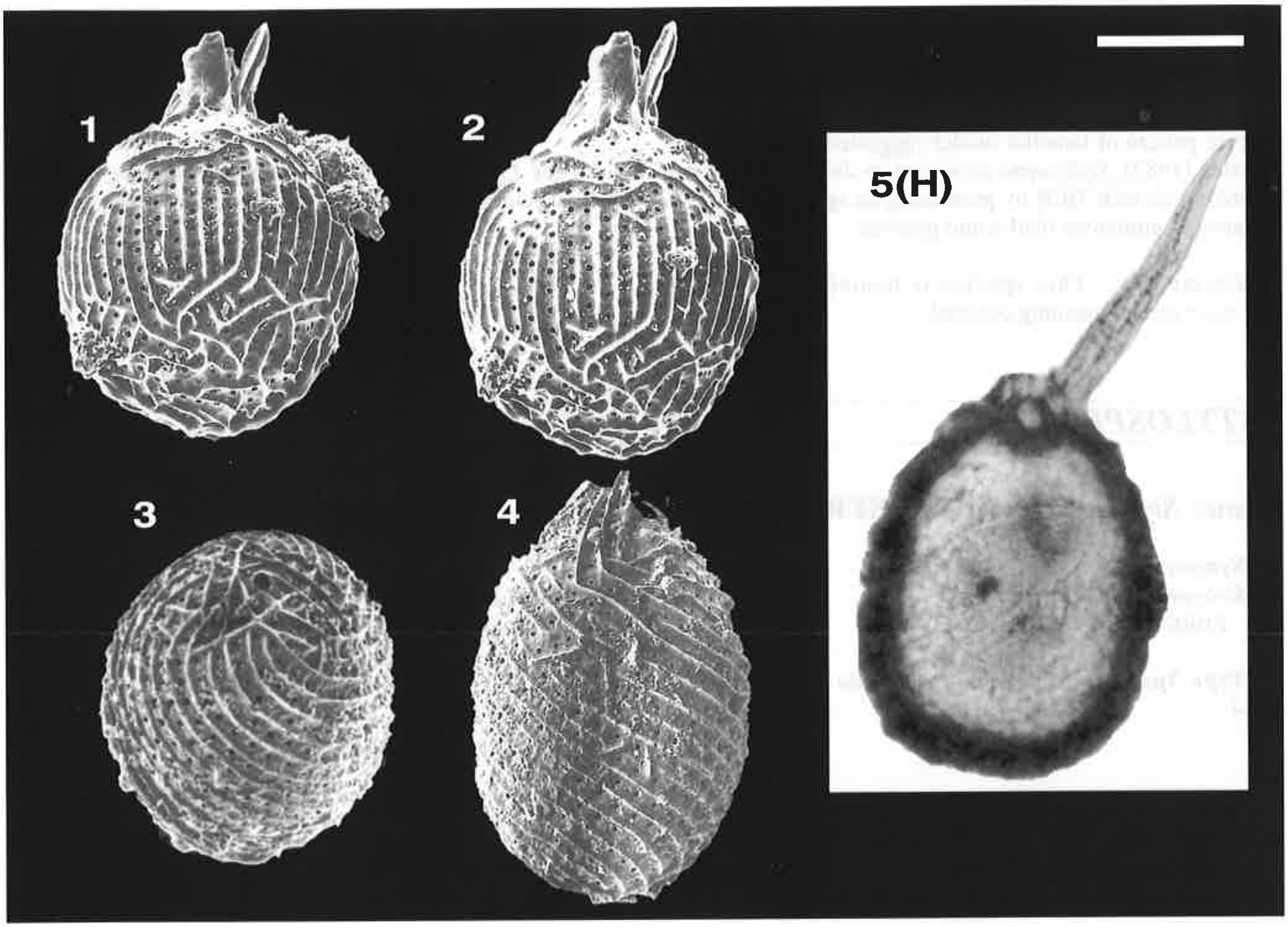


Plate 3046. *Stylocapsa* (?) *spiralis* gr. MATSUOKA. Magnification x400. **Fig. 1.** POB81/2806. **Fig. 2.** POB81/2805, 534.124.1.52. **Fig. 3.** POB81/2229, 534.122.1.43. **Fig. 4.** POB81/2228, 534.122.1.43. **Fig. 5(H).** MATSUOKA 1982b, pl. 3, fig. 1a.

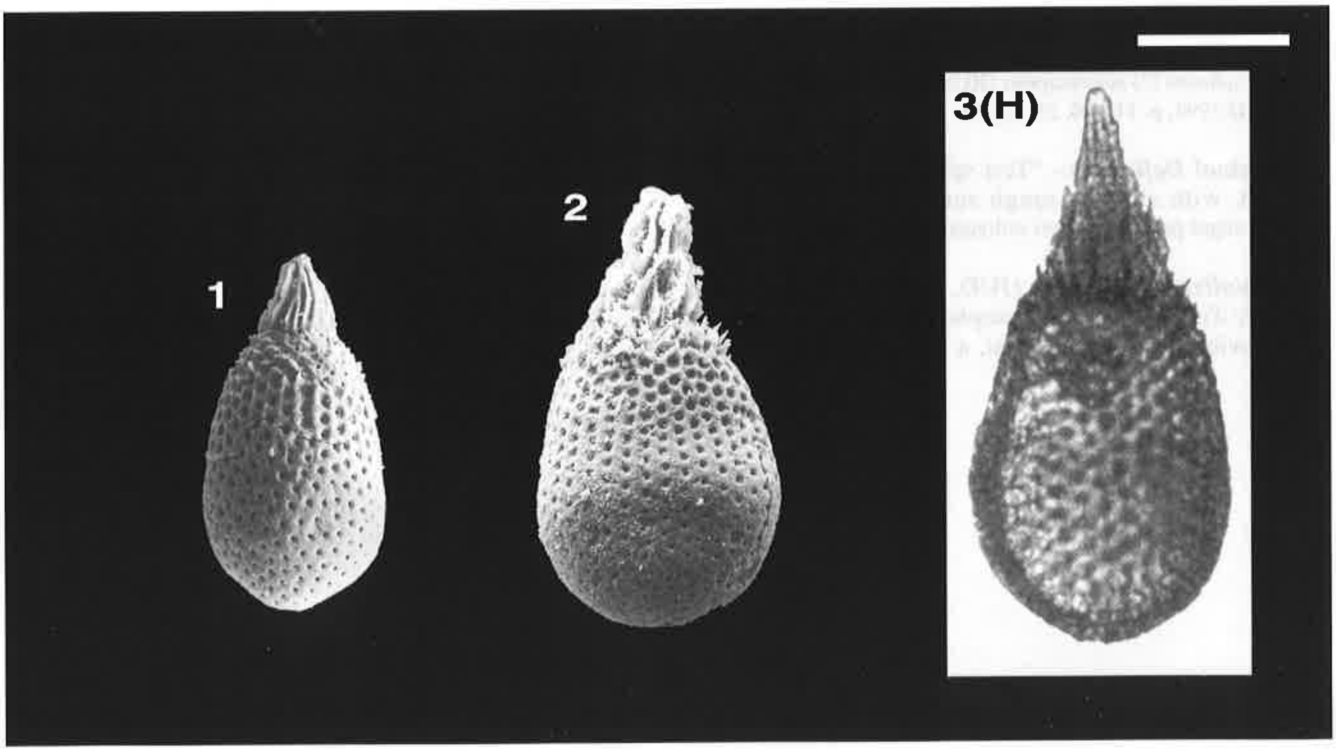


Plate 4047. *Stylocapsa tecta* MATSUOKA. Magnification x400. **Fig. 1.** MA960, OCUMR2574, S-17. **Fig. 2.** MA867, OCUMR2580, S-17. **Fig. 3(H).** MATSUOKA 1983a, pl. 5, fig. 8a.

with rough surface varies among specimens. Smooth surface changes gradually to rough surface proximally. This indicates that coating of shell surface decreases in apical direction during ontogeny in this species. This is a inverse pattern of lamellar model suggested by Pessagno & Whalen (1982). *Stylocapsa tecta* n.sp. is distinguished from *S. oblongula* KOCHER by possessing an apical horn which consists of numerous blades and grooves.

Etymology.- This species is named for the Latin adjective *tectus*, meaning covered.

Measurements (in μm).-
Based on 30 specimens. Total height, 128-192 (152); maximum width of shell, 72-102 (86); diameter of cephalis, 11-19 (15); of aperture, 6-10 (8).

Type Locality.- Sample S-17, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 5-6, latest Baj.-early Bath. to mid Bath.

STYLOSPHAERA — *3699*

Genus: *Stylosphaera* EHRENBERG

Synonymy.-
Stylosphaera EHRENBERG
EHRENBERG 1847b, p. 46.

Type Species.- *Stylosphaera hispida* EHRENBERG 1854.

Original Definition.- "Nuclei radiate with two opposite spiny radii from the center."

Included Taxa.-
5044 *Stylosphaera* (?) *macroxiphus* (RÜST)

STYLOSPHAERA (?) MACROXIPHUS — *5044*

Stylosphaera (?) *macroxiphus* (RÜST)

Synonymy.-
Xiphosphaera macroxiphus RÜST
RÜST 1898, p. 7, pl. 1, fig. 8.
? *Stylosphaera macrostyla* RÜST
SCHAAF 1981, p. 439, pl. 14, fig. 2.
? *Archaeospongoprunum macrostylum* (RÜST)
ORIGLIA-DEVOS 1983, p. 127, pl. 14, fig. 31.
Stylosphaera (?) *macroxiphus* (RÜST)
JUD 1994, p. 110, pl. 21, fig. 14.

Original Definition.- "Test spherical, of middle size, latticed, with slightly rough surface and 6-7 rows of middle-sized pores and two colossal polar spines."

Actualized Remarks.- (JUD, 1994) Our specimens resemble *Xiphosphaera macroxiphus* RÜST but differ from it by having an ellipsoidal test, a larger number of pores and generally less massive spines. On the other side *Stylosphaera macrostylus* RÜST, with which they could also be compared, has thinner spines and a larger number of pores. Measurements of specimens found in our material vary as follows: total length 558-591 μm, width of the central part 100-120 μm, maximum length of spines 220-255 μm and minimum length of spines 208-224 μm. They are thus a little smaller than *Xiphosphaera macroxiphus* RÜST.

Measurements (in μm).-
Diameter of spherical test 124, length of entire spine 326, of the broken one 204, width of spine 45.

Type Locality.- Maiolica Formation, Cittiglio, Prov. Varese (northern Venetian Alps, North Italy).

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

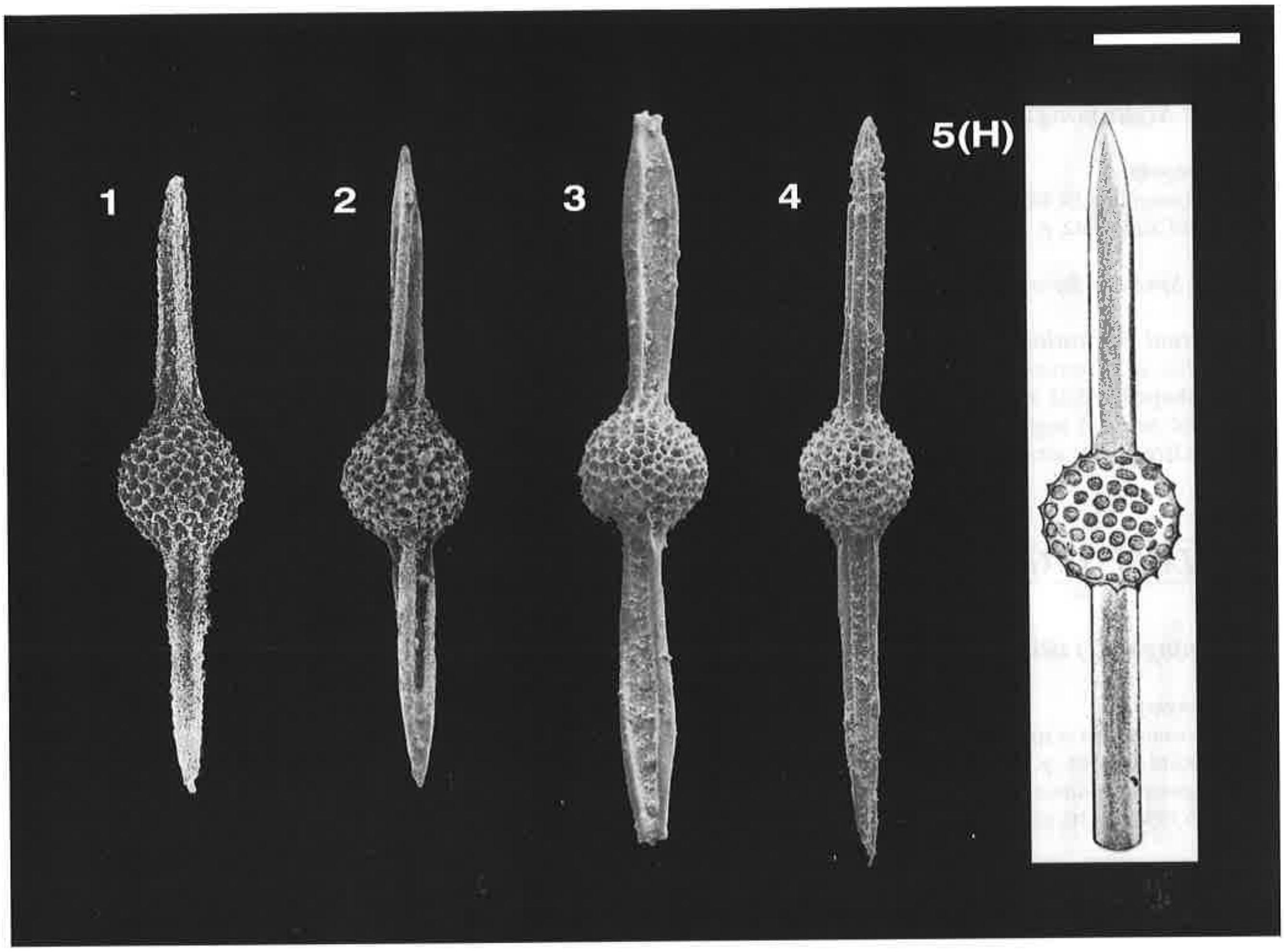


Plate 5044. *Stylosphaera* (?) *macroxiphus* (RÜST). Magnification x150. **Fig. 1.** RJ549, Bo566.5. **Fig. 2.** RJ63, Br141.55. **Fig. 3.** DU871, Mo46a. **Fig. 4.** DU858, Mo46a. **Fig. 5(H).** RÜST 1898, pl. 1, fig. 8.

STYLOSPONGIA 3802

Genus: *Stylospongia* HAECKEL

Synonymy.-
Stylospongia HAECKEL
HAECKEL 1862, p. 473.

Type Species.- *Stylospongia huxleyi* HAECKEL 1862.

Original Definition.- "Spongy, circular or variable shaped flat or biconvex disc, with simple, cylindrical or needle-shaped radial spines. Central part with circular, concentric rings of regularly arranged chambers, external part with irregularly arranged chambers."

Original Remarks.- "This new genus differs from the latter ones by the radial appendices and from the following ones in that these appendices are not spongy but simple, solid spines. This genus corresponds therefore exactly *Spongotrochus* in the tribus Spongodiscides and *Spongosphaera* in the tribus Spongosphaerides. The 3 Subfamilies of the discides contain the corresponding genera: *Stylocyclia, Stylodictya* and *Stylospira*."

Included Taxa.-
5090 *Stylospongia* (?) *titirez* JUD

STYLOSPONGIA (?) TITIREZ 5090

Stylospongia (?) *titirez* JUD

Synonymy.-
Actinommids gen et sp. indet.
FOREMAN 1975, p. 610, pl. 2F, figs. 12, ? 13-14.
Stylospongia (?) *titirez* JUD
JUD 1994, p. 110, pl. 21, figs. 15-17.

Original Definition.- Square lenticular test with 6 equal, conical, slender spines, of which 2 are in polar and 4 in equatorial position. Test probably spongy. Each side of the test may bear one or more shorter, thinner spines.

Original Remarks.- *Stylospongia* (?) *titirez* n.sp. is well characterized by its morphology, but the structure of test is difficult to establish because of poor preservation. It seems that Foreman (1975) illustrated and described rather similar forms with lenticular or discoidal, spongy test and 4-6 conical, smooth spines.

Etymology.- From the Rumanian *titirez,* spinning top.

Measurements (in μm).-
Based on 4 specimens.

	HT	av.	min.	max.
Total width:	325	284	263	278
Total height:	200	215	200	225
Diameter centr. part:	143	150	142	165
Height centr. part:	75	89	75	103

Type Locality.- Gorgo a Cerbara, Umbria-Marche, Italy.

UAZones.- 20-22, late Haut. to late Barr.-early Apt.

suboblongus >> *ACANTHOCIRCUS SUBOBLONGUS MINOR* 3085

suboblongus >> *ACANTHOCIRCUS SUBOBLONGUS S.L.* 3064

suboblongus >> *ACANTHOCIRCUS S. SUBOBLONGUS* 3088

SUNA 3810

Genus: *Suna* WU

Synonymy.-
Suna WU
WU 1986, p. 357.

Type Species.- *Suna geometrica* WU 1986.

Original Definition.- Test cylindrical, with 3 symmetrically arranged massive spines. Three spines with alternating longitudinal grooves and ridges.

Included Taxa.-
3094 *Suna echiodes* (FOREMAN)
5049 *Suna hybum* (FOREMAN)

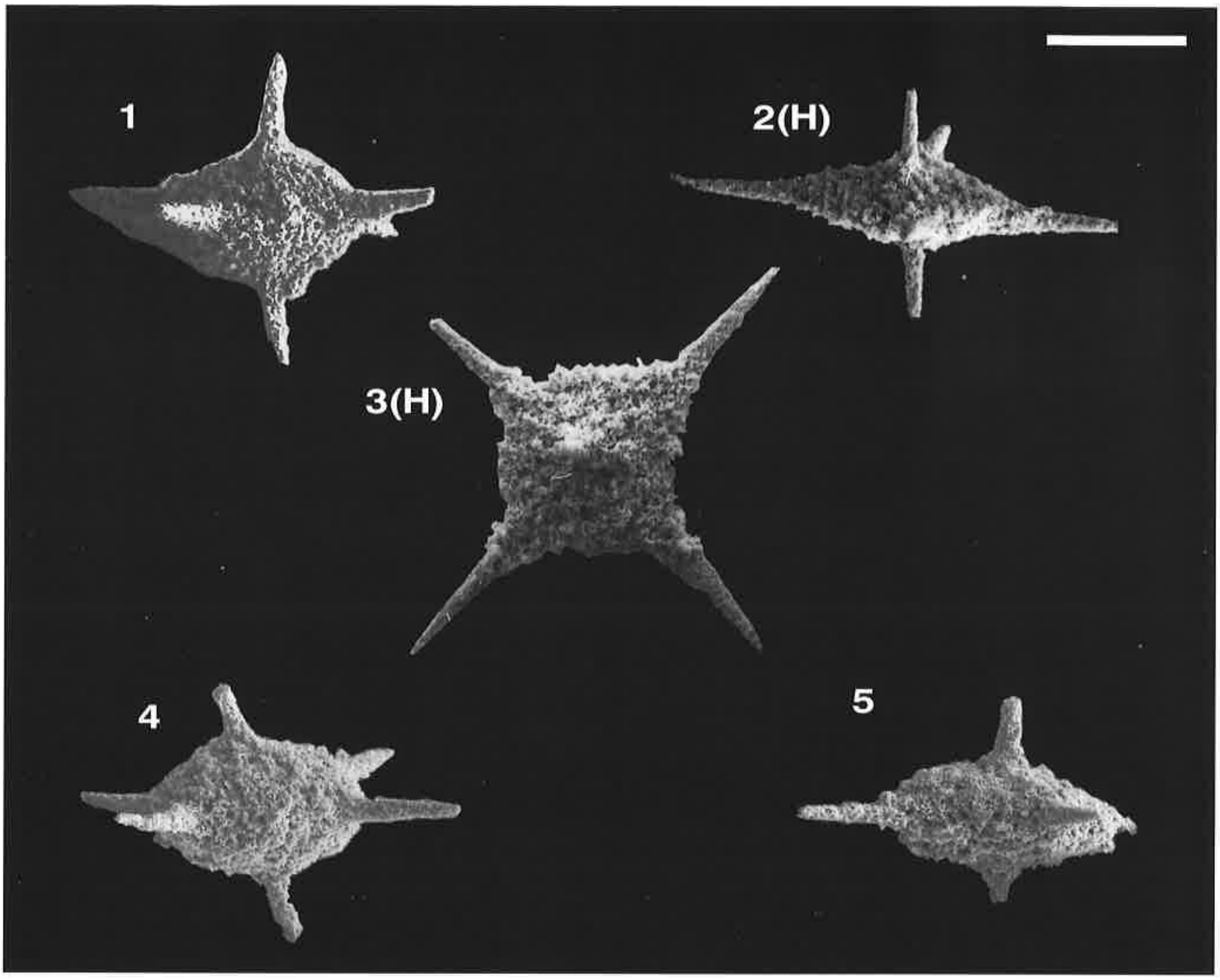


Plate 5090. *Stylospongia* (?) *titirez* JUD. Magnification x200. **Fig. 1.** RJ781, GC887.0. **Fig. 2(H).** RJ1791, GC821.45. **Fig. 3(H).** RJ1790, GC821.45. **Fig. 4.** RJ1025, GC824,8. **Fig. 5.** RJ1029, GC824,8.

SUNA ECHIODES 3094

Suna echiodes (FOREMAN)

Synonymy.-

Triactoma echiodes FOREMAN
FOREMAN 1973b, p. 260, pl. 3, fig. 1; pl. 16, fig. 21.
FOREMAN 1975, p. 609, pl. 2F, figs. 9-10; pl. 3, fig. 10.
BAUMGARTNER et al. 1980, p. 64, pl. 2, fig. 10.
KOCHER 1981, p. 101, pl. 17, figs. 8-9.
KANIE et al. 1981, pl. 1, fig. 7.
ORIGLIA-DEVOS 1983, p. 43, pl. 2, figs. 12-13, ? 1.
BAUMGARTNER 1984, p. 789, pl. 10, fig. 2.
SCHAAF 1984, p. 108-109, figs. 1, 4, ? 2-3.
STEIGER 1992, p. 30, pl. 3, figs. 7, ? 6.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 14; pl. 2, figs. 1-5.
Triactoma sp. cf. *T. echiodes* FOREMAN
FOREMAN 1973b, pl. 3, figs. 2-3.
OZVOLDOVA & SYKORA 1984, p. 272, pl. 13, fig. 3.
AITA 1987, p. 64, pl. 12, fig. 9.
Suna echiodes (FOREMAN)
JUD 1994, p. 111, pl. 22, fig. 1.

Original Definition.- The shell is in the shape of a truncate cylinder or drum with the upper and lower surfaces very slightly convex. It bears three sturdy three-bladed spines which extend medially from the sides. Two of the spines are equal in length and one is generally longer. Angles between adjacent spines are approximately 80°, 90°, and 170°. Pores are moderate in size, irregular, circular to subangular, frequently scalloped, and subdivided on their lower margin.

Original Remarks.- The drum-like shape of the shell, together with the three sturdy three-bladed spines arranged as for a staurosphaerid with one spine broken off, distinguish this species from *Triactoma cellulosa*. A related undescribed form (pl. 3, figs. 2-3) has the same drum-like shape but is smaller with smaller pores, and has its three spines arranged more symmetrically.

Etymology.- Greek *echion* (n.) drum and *-odes*, like, *echiodes*, *-es* drum like.

Measurements (in μm).-
Based on 10 specimens. Diameter 100-130 (125); height, 120-125; length of spines, 125-200.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 9-22, mid-late Oxf. to late Barr.-early Apt.

SUNA HYBUM 5049

Suna hybum (FOREMAN)

Synonymy.-

Triactoma hybum FOREMAN
FOREMAN 1975, p. 609, pl. 2F, figs. 6-7; pl. 3, figs. 7, 9.
SCHAAF 1981, p. 440, pl. 12, fig. 7.
ORIGLIA-DEVOS 1983, p. 44, pl. 2, figs. 2-5.
THUROW 1988, p. 408, pl. 9, fig. 11.
TUMANDA 1989, p. 35, pl. 1, fig. 6.
TAKETANI & KANIE 1992, fig. 3.8.
Triactoma sp. cf. *T. echiodes* FOREMAN
FOREMAN 1973b, pl. 3, fig. 2, not fig. 3.
Suna geometrica WU
WU 1986, p. 357, pl. 2, figs. 12-13.
Triactoma cfr. *echiodes* FOREMAN
IGO et al. 1987, text-fig. 2.10.
Suna hybum (FOREMAN)
JUD 1994, p. 111, pl. 22, figs. 2-3.

Original Definition.- Shell as for *T. echiodes* with the exception that it is generally smaller, with smaller pores, has a distinct hump-like raised area at the center of the upper and lower surfaces, and the spines are somewhat more regularly disposed.

Original Remarks.- This species is apparently closely related and probably descended from a form *Triactoma* sp. cf. *T. echiodes* FOREMAN with which it co-occurs in the early part of its range and from which it differs in having a distinct raised area as described above. Both differ from *T. echiodes* in their size and more regularly disposed spines.

Etymology.- The specific name is derived from the Greek adjective *hybos*, humped.

Measurements (in μm).-
Based on 10 specimens. width 85-115, length of spines 115-195.

Type Locality.- DSDP Leg 32, Site 306, north Pacific.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

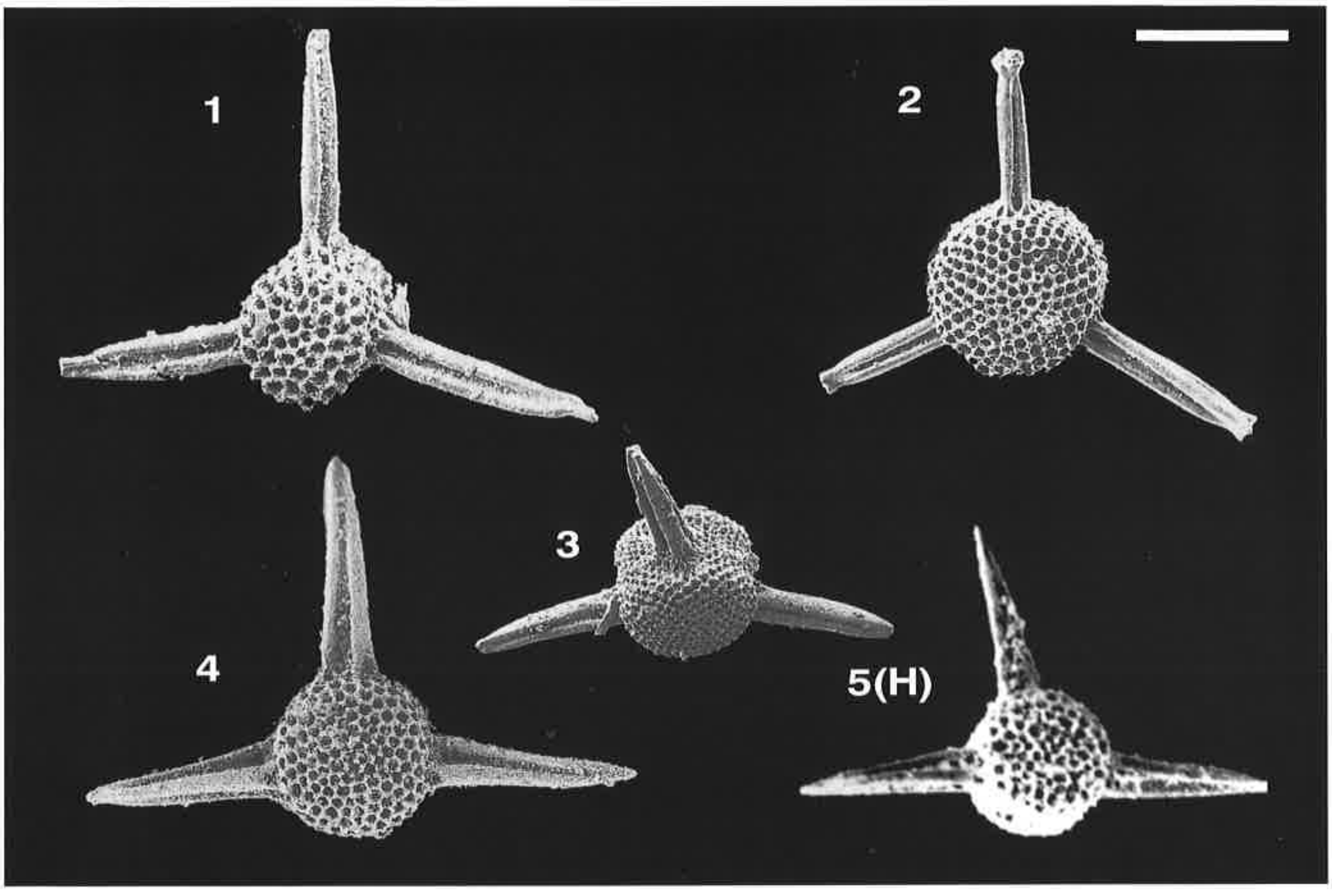


Plate 3094. ***Suna echiodes*** **(FOREMAN).** Magnification x150. **Fig. 1.** POB81/0986, MO46a'. **Fig. 2.** POB80/2712, V-37. **Fig. 3.** POB79/4268, MO2 46. **Fig. 4.** RJ125, Br141.55. **Fig. 5(H).** FOREMAN 1973b, pl. 3, fig. 1.

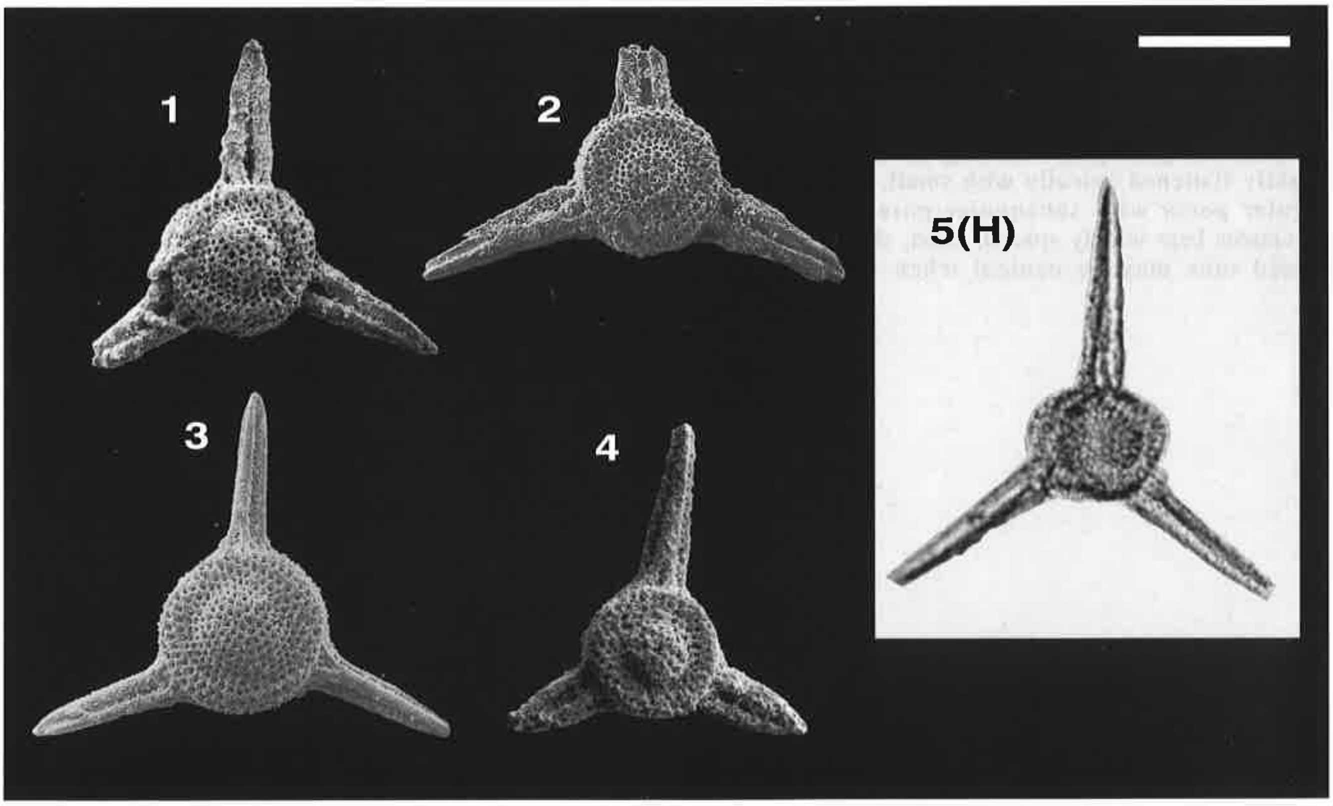


Plate 5049. ***Suna hybum*** **(FOREMAN).** Magnification x150. **Fig. 1.** RJ138, Bo619.9. **Fig. 2.** RJ137, Bo619.9. **Fig. 3.** DU901, Mo46. **Fig. 4.** RJ93, GC887.0. **Fig. 5(H).** FOREMAN 1975, pl. 3, fig. 7.

SYRINGOCAPSA 3630

Genus: *Syringocapsa* NEVIANI

Synonymy.-
Syringocapsa NEVIANI
NEVIANI 1900, p. 662.

Type Species.- *Theosyringium robustum* VINASSA 1901.

Original Definition.- "Tricyrtid, consisting of 3 segments, with apical horn and the abdominal segment closed. Thoracic segment much larger than the other two ones".

Remarks.- Species are determined on size, shape and surface ornamentation.

Included Taxa.-
3291 *Syringocapsa agolarium* FOREMAN
5417 *Syringocapsa coronata* STEIGER
5416 *Syringocapsa* sp. aff. *S. coronata* STEIGER
5426 *Syringocapsa limatum* FOREMAN
5410 *Syringocapsa longitubus* JUD
3170 *Syringocapsa spinellifera* n.sp. BAUMGARTNER
5711 *Syringocapsa* sp. aff. *S. spinosa* (SQUINABOL)
5409 *Syringocapsa vicetina* (SQUINABOL)
3268 *Syringocapsa* (?) sp. A

SYRINGOCAPSA AGOLARIUM 3291

Syringocapsa agolarium FOREMAN

Synonymy.-
Syringocapsa agolarium FOREMAN
FOREMAN 1973b, p. 268, pl. 11, fig. 5; pl. 16, fig. 17.
BAUMGARTNER 1984, p. 786, pl. 9, figs. 3-4.
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 4.
JUD 1994, p. 111, pl. 22, fig. 4.

Original Definition.- The shell is of three segments, a proximal small hemispherical portion made up of cephalis and thorax, and the major distal part consisting of a globose abdomen with a very variably developed terminal tube. The cephalis and thorax cannot always be distinguished by an external change in contour, and only rarely can any internal segmental division be discerned. The cephalis is apparently poreless and bears a slender, relatively moderate to long, smooth, oblique apical horn. The thorax may be poreless or have small irregular pores. The large abdomen is generally slightly flattened apically with small, closely spaced, regular pores with subangular pore frames. Some specimens bear widely spaced, short, sharp thorns. The closed tube may be conical when long to almost hemispherical when short, and terminates in a spine. Its pores are angular, regular, and markedly larger than those of the abdomen.

Original Remarks.- This species differs from *Trisyringium capellini* VINASSA 1901 in its larger size and in having relatively smaller, more closely spaced pores. *T. capellini* VINASSA is reported from the probable Upper Cretaceous of the island of Karpathos, Greece.

Etymology.- Latin *agolum* (n.) shepherds's staff plus *arius* having = *agolarius, -a, -um,* having a shepherd's staff.

Measurements (in μm).-
Based on 10 specimens. Length overall, 225-350; of cephalis and thorax, 45-50; of abdomen without terminal tube, 125-165; of tube, 50-110; width of abdomen, 130-170.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 13-20, latest Tith. to late Haut.

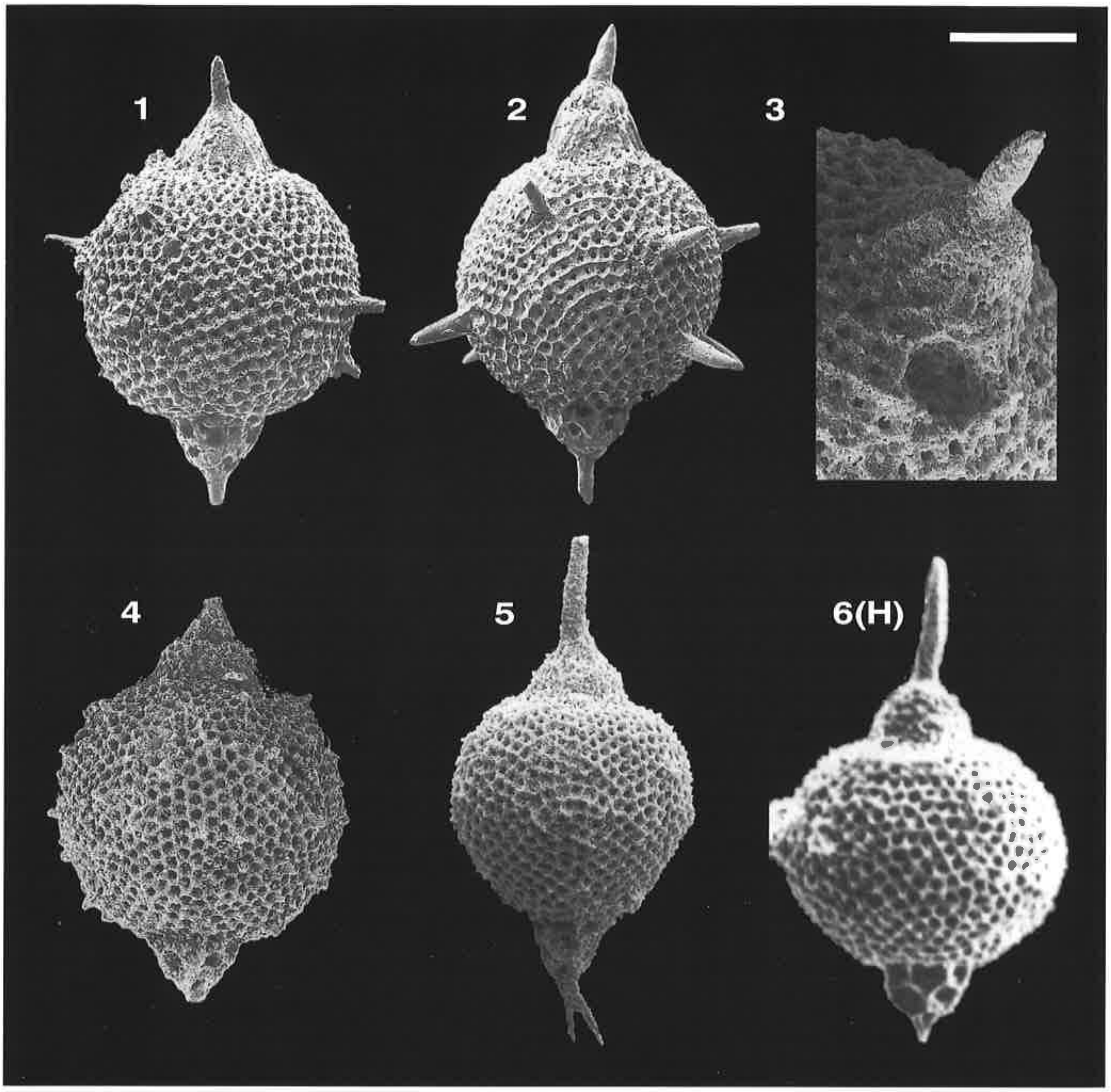


Plate 3291. ***Syringocapsa agolarium*** **FOREMAN.** Magnification x250, except Fig. 3 x600. **Fig. 1.** POB80/1881, POBMO26. **Fig. 2.** POB79/3706, MO1 22. **Fig. 3.** DU2232, Mo22. **Fig. 4.** RJ200, Bo566.5 1. **Fig. 5.** RJ631, Bo566.5. **Fig. 6(H).** FOREMAN 1973b, pl. 11, fig. 5.

SYRINGOCAPSA CORONATA 5417

Syringocapsa coronata STEIGER

Synonymy.-
Syringocapsa coronata STEIGER
STEIGER 1992, p. 60, pl. 16, figs. 6-7.
JUD 1994, p. 111, pl. 22, fig. 5.

Original Definition.- "Big test with 3 segments, concentrically arranged pore rows, a ring of spines and a short postabdominal tube. The cephalis bears a short apical horn. The thorax is ring-like and has two pore rows. The abdomen is twice as broad and high as cephalis and thorax together. Above the equator 10 rounded spines of medium length are located in one plane. The pore pattern consists of hexagonal pore frames which are arranged concentrically in axial view. Largest pores occur equatorially. The pore tube is short, slightly narrower as the thorax showing hexagonal pore frames."

Original Remarks.- "The species differs from all other species of *Syringocapsa* by having concentrically arranged pore rows on the abdomen and by having a ring of spines which occurs in a plane above the equator."

Etymology.- *Corona* = crown, according to the crown-like ring of spines on the abdomen.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Length of test:	550	391	220	550
Eighth of abdomen:	275	176	110	275
Width of abdomen :	450	287	140	475
Diameter of eq. pores:	25	22	-	-

Type Locality.- Gartenau, quarry near St. Leonhard, Salzburg.

UAZones.- 13-16, latest Tith. to early Val.

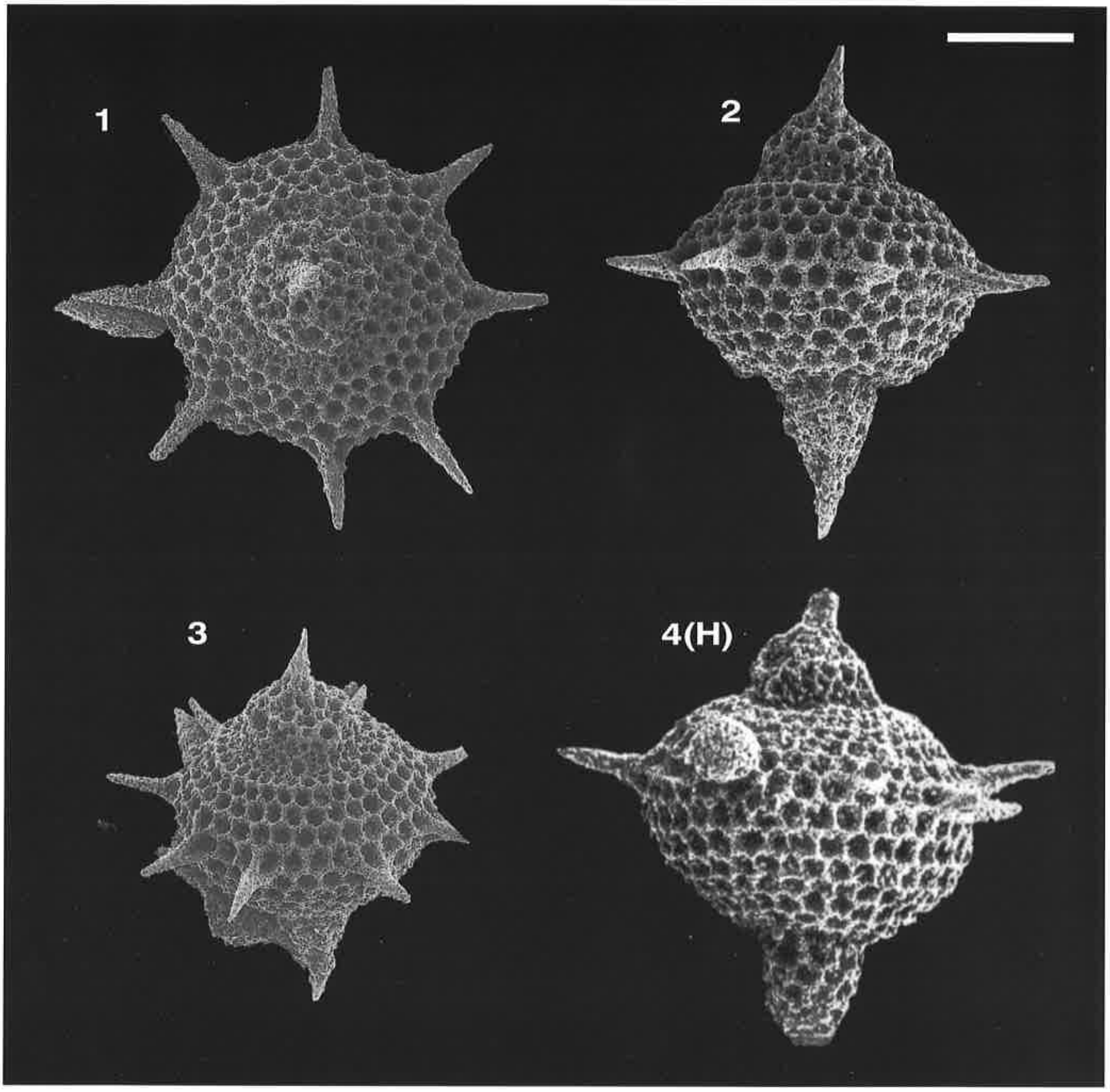


Plate 5417. ***Syringocapsa coronata*** **STEIGER.** Magnification x150. **Fig. 1.** RJ21, Br1330. **Fig. 2.** RJ20, Br1330. **Fig. 3.** RJ19, Br1330. **Fig. 4(H).** STEIGER 1992, pl. 16, fig. 6.

SYRINGOCAPSA CORONATA AFF. 5416

Syringocapsa sp. aff. *S. coronata* STEIGER

***Synonymy*.-**
Syringocapsa sp. A
AITA 1987, p. 68, pl. 12, fig. 5.
JUD 1994, p. 111, pl. 22, figs. 6-8.

***Remarks*.-** Included are herein two morphotypes, both of them with an antapical spine rather than a closed postabdominal tube. One morphotype has all morphological characters of *S. coronata* except for the terminal tube which is replaced by a spine. Because of this the base of the last inflated segment is not flat but rounded. The second morphotype, is pear shaped or spherical, has no evident constriction between the thorax and the inflated abdomen, has a smaller number of equatorial spines and an antapical spine. The former morphotype could be considered as a tubeless *S. coronata*. The second morphotype represents certainly a different species.

Measurements (in μm).-
Height of test without apical horn and terminal spine 285-400, maximum width of inflated segment 265-370.

***UAZones*.-** 11-20, late Kimm.-early Tith. to late Haut.

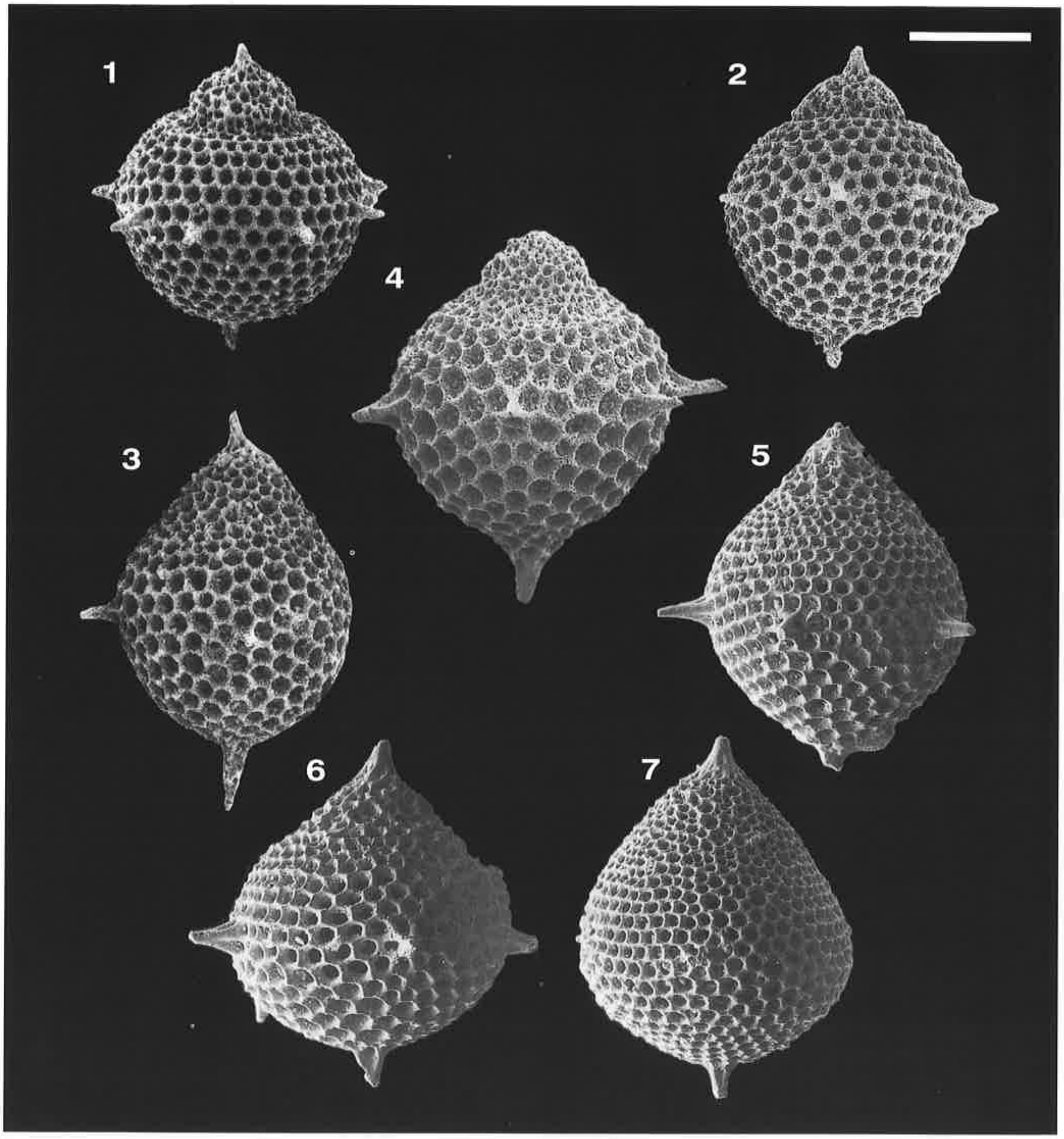


Plate 5416. ***Syringocapsa* sp. aff. *S. coronata* STEIGER.** Magnification x150. **Fig. 1.** RJ33, Br28.85. **Fig. 2.** RJ106, Br28.85. **Fig. 3.** RJ385, Br28.85. **Fig. 4.** POB80/2995, POB1205. **Fig. 5.** DU3338, Mo46. **Fig. 6.** DU3344, Mo46. **Fig. 7.** DU3345, Mo46.

SYRINGOCAPSA LIMATUM 5426

Syringocapsa limatum FOREMAN

***Synonymy*.-**
Syringocapsa limatum FOREMAN
FOREMAN 1973b, p. 268, pl. 11, figs. 6-7; pl. 16, fig. 8.
FOREMAN 1975, p. 617, pl. 2K, fig. 7.
not AITA 1987, p. 68, pl. 12, fig. 1.
not KITO 1989, p. 202, pl. 23, fig. 5.
JUD 1994, p. 111, pl. 22, figs. 9-10.
Syringocapsa limata FOREMAN
TUMANDA 1989, p. 40, pl. 2, fig. 2.
Morosyringium limatum (FOREMAN)
? STEIGER 1992, p. 85, pl. 22, fig. 12.

***Original Definition*.-** The shell is large with a sturdy, long, smooth apical horn, a slender proximal portion, and a large, globose, nodose abdomen without spines and with a closed terminal tube. It is not possible to determine the number of segments since the proximal part shows no external segmental division and preservation does not allow the interior to be observed. It is probable that the older forms with a longer proximal part may have more than two. Pores of the proximal part are small, rounded, and irregular in size and arrangement. Those of the large globose segment are moderate in size with rounded to subangular pore frames, very closely spaced. On older specimens they are irregularly arranged and on the younger ones tend to be aligned in rows between nodes. The tube is long, slender, conical, with large regular pores, and terminates in a smooth pointed spine.

***Original Remarks*.-** *Sethocapsa polymasta* RÜST (1898) from the Upper Jurassic of Cittiglio in northern Italy appears to be a related form. However, it differs in having a longer proximal part with only a small apical horn and in lacking a tube.

***Etymology*.-** Latin *limatus, -a, -um,* elegant.

***Measurements* (in μm).-**
Based on 10 specimens. Length overall of six complete specimens, 495-560; estimated length of largest broken specimen, 650; length of horn and proximal segments, 160-225 (160-185); length of abdomen exclusive of tube, 155-195; greatest width of abdomen, 185-240 (185-215).

***Type Locality*.-** DSDP Leg 20, Site 196, northwest Pacific basin.

***UAZones*.-** 11-21, late Kimm.-early Tith. to early Barr.

SYRINGOCAPSA LONGITUBUS 5410

Syringocapsa longitubus JUD

***Synonymy*.-**
Syringocapsa longitubus JUD
JUD 1994, p. 112, pl. 22, figs. 11-12.

***Original Definition*.-** Test long with a globose segment and a very long distal tube. Cephalis, thorax and abdomen conical, small, with irregularly arranged pores. Cephalis with a three-bladed pointed horn. Last segment greatly inflated, subspherical or oval with rough, spiny surface, formed by an irregular meshwork of ridges. Pores small, irregularly disposed. Inflated segment prolonged into a very long, slender, subcylindrical tube, which is open on the distal part. Pores of the tube very small, irregularly arranged.

***Original Remarks*.-** *Syringocapsa longitubus* n.sp. differs from *Syringocapsa vicetina* (SQUINABOL) by having a much shorter apical portion, a more spherical inflated last segment and a distal tube with a blunt end. From *S. bulbosa* STEIGER it differs in having the inflated segment oval, surface rough, without polygonally framed pores and a much longer conical apical portion.

***Etymology*.-** From the Latin *longus* = long and *tubus* = tube.

***Measurements* (in μm).-**
Based on 3 specimens.

	HT	av.	min.	max.
Length of test:	505	207	505	746
Max. width test:	145	169	145	207
Length of tube:	245	322	245	420
Max. width tube:	45	52	44	73
Height ap. part:	82	94	82	100

***Type Locality*.-** Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

***UAZones*.-** 13-16, latest Tith. to early Val.

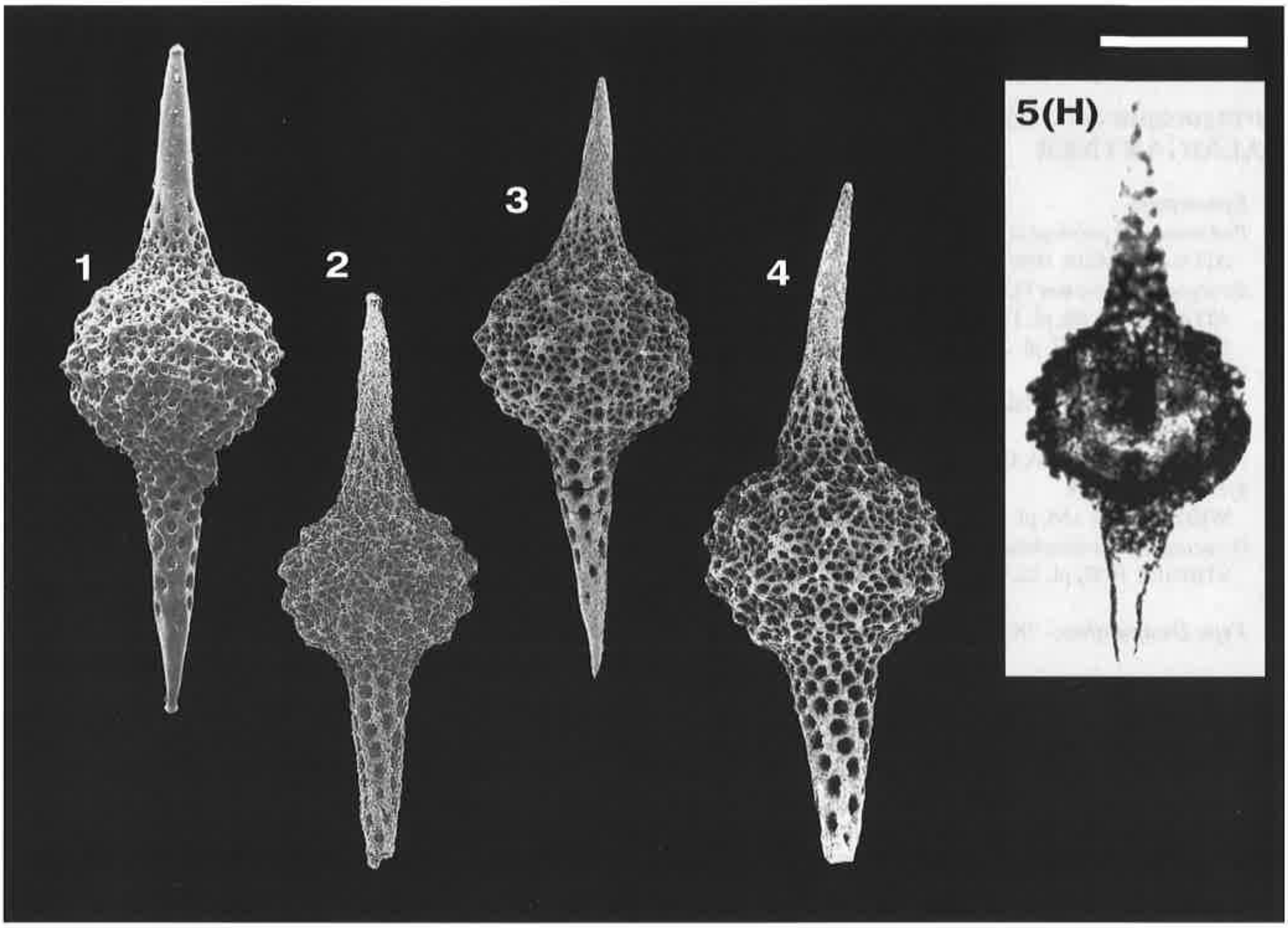


Plate 5426. *Syringocapsa limatum* FOREMAN. Magnification x150. **Fig. 1.** POB79/4163, MO2 46. **Fig. 2.** RJ524, Bo566.5. **Fig. 3.** RJ483, Bo566.5. **Fig. 4.** RJ234, Bo566.5. **Fig. 5(H).** FOREMAN 1973b, pl. 16, fig. 8.

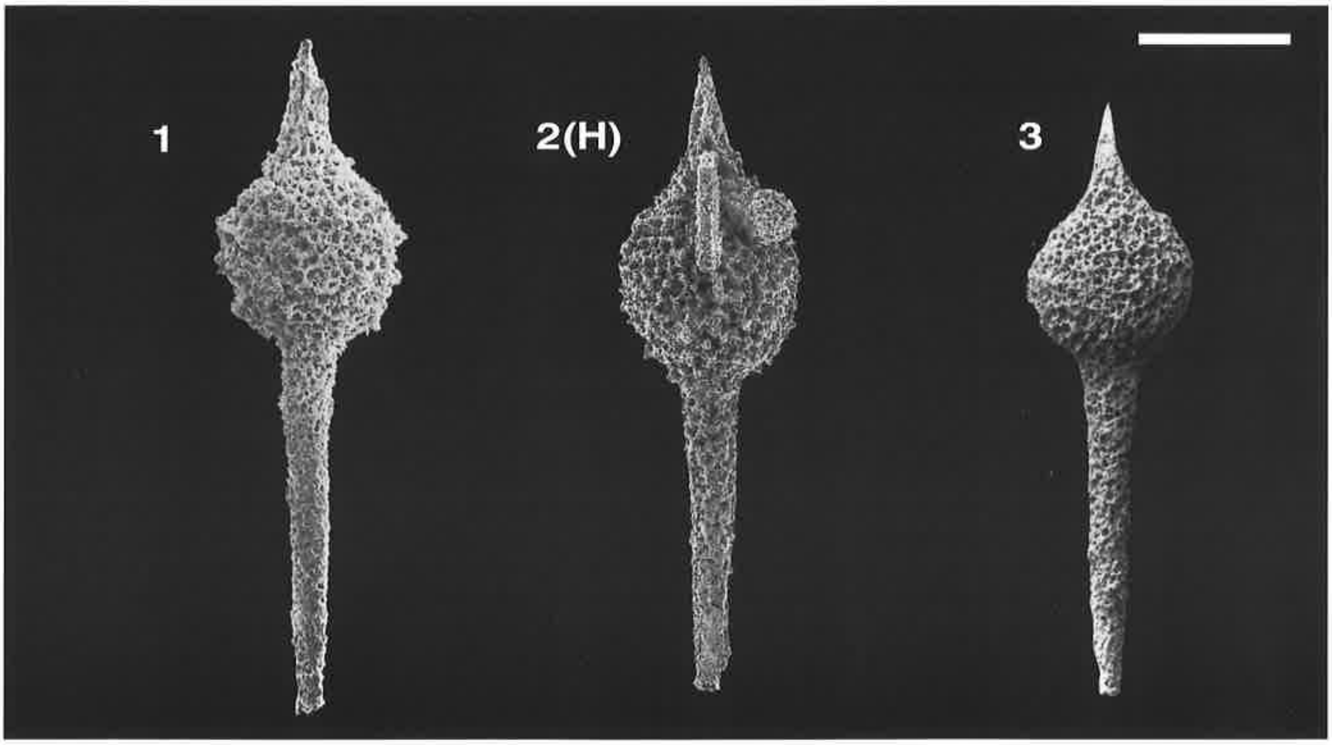


Plate 5410. *Syringocapsa longitubus* JUD. Magnification x150. **Fig. 1.** RJ50, Bo311.2. **Fig. 2(H).** RJ41, Br1330. **Fig. 3.** RJ1195, Bo311.20.

SYRINGOCAPSA SPINELLIFERA 3170

Syringocapsa spinellifera n.sp. BAUMGARTNER

***Synonymy*.-**
Podobursa (?) *polylophia*
AITA & OKADA 1986, pl. 3, figs. 4-5.
Syringocapsa limatum FOREMAN
AITA 1987, p. 68, pl. 12, fig. 1.
KITO 1989, p. 202, pl. 23, fig. 5.
Syringocapsa sp.
DE WEVER et al. 1986, pl. 10, fig. 1.
Podobursa sp.
? IWATA & TAJIKA 1989, pl. 4, fig. 6.
Syringocapsa sp. A
WIDZ 1991, p. 156, pl. 4, fig. 6.
Helocingulum polylophium (FOREMAN)
STEIGER 1992, pl. 22, figs. 10-11.

***Type Designation*.-** 78/7608, POB 986.51.

***Original Definition*.-** Podobursid with a spinose inflated part. Proximal conical portion comprising cephalis thorax abdomen and (1-2?) postabdominal chambers, externally smooth bearing a stout horn with several elongated pores or grooves at its base. Remaining proximal portion with circular pores in loose vertical rows. Inflated median portion ellipsoidal with short axis vertical. Covered with irregular ridges leaving polygonal, curved surfaces comprising 4-8 small circular pores each. Thin, sharp, radially outwards-directed spines are placed at intersection of ridges. Terminal tube long, conical, smooth with circular to polygonal pores placed in vertical or slightly transverse rows. Some specimens show a glove-like termination with several downwards directed spines.

***Original Remarks*.-** This species differs form other similar species like *Podobursa polylophia* or *Syringocapsa limatum* by its spinose inflated median portion.

***Etymology*.-** *Spinelliferus*, *-a*, *-um*, Latin for wearing small spines.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Length of horn:	-	41	38	44
H/W conical proximal part:	65/60	65/63	65/60	66/75
H/W inflated median part:	190/250	179/236	138/222	211/238
H/W terminal tube:	275/65	226/60	177/50	275/65

***Type Locality*.-** Sample POB 986, Theokafta, Central Argolis Peninsula, Greece.

***UAZones*.-** 9-12, mid-late Oxf. to early-early late Tith.

SYRINGOCAPSA SPINOSA AFF. 5711

Syringocapsa sp. aff. *S. spinosa* (SQUINABOL)

***Synonymy*.-**
Eucyrtis bulbosus RENZ
RIEDEL & SANFILIPPO 1974, p. 778, pl. 5, fig. 8.
Syringocapsa spinosa (SQUINABOL)
JUD 1994, p. 112, pl. 22, figs. 13-14.

***Definition*.-** Spindle-shaped test of 4-6 segments with terminal tube. Test without visible constrictions. Cephalis conical, smooth and poreless. Next 1-3 postcephalic segments slowly increasing in width, with irregularly arranged small pores and a few spiny tubercles. Last postabdominal segment inflated, elongate, subglobular, with irregularly placed relatively spiny tubercles. Pores small, arranged irregularly or in transverse rows. Terminal part of test open, slender, cylindrical, without tubercles, with more or less irregularly disposed small pores.

***Remarks*.-** Our specimens have generally strong tubercles. Younger forms (Upper Cretaceous) seem to have a smoother surface.

***UAZones*.-** 19-22, early Haut. to late Barr.-early Apt.

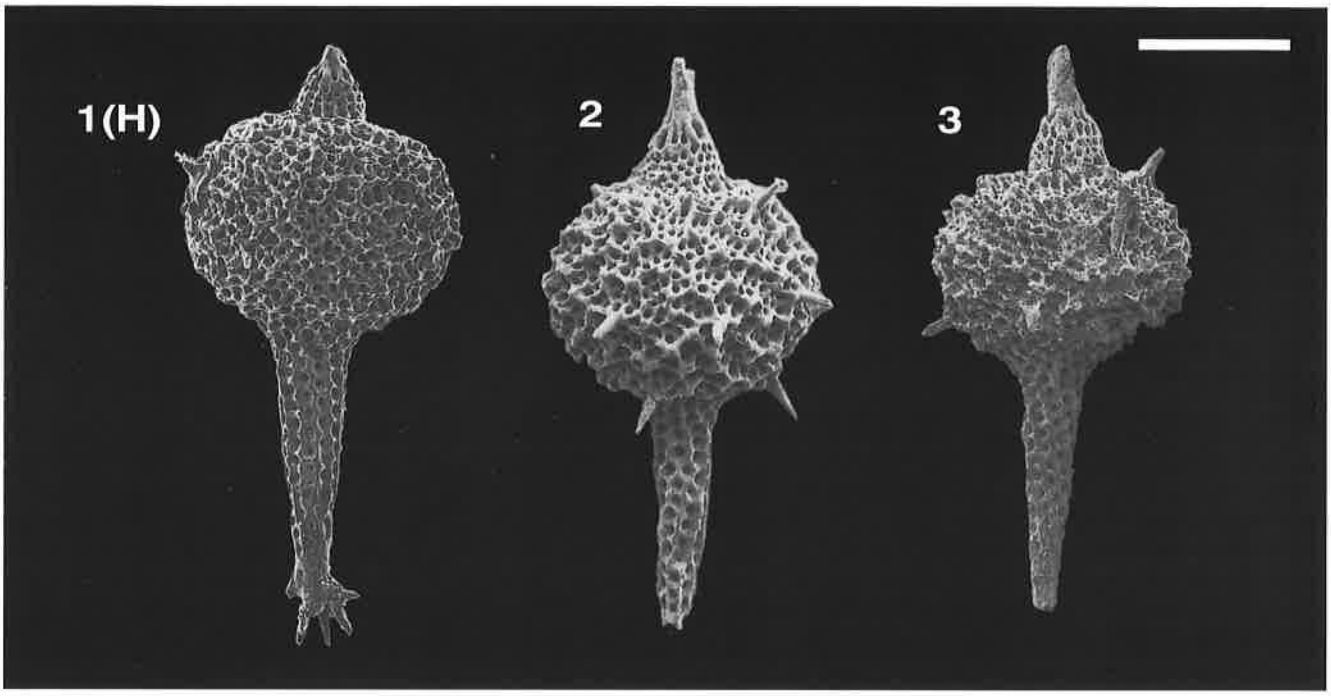


Plate 3170. ***Syringocapsa spinellifera*** **n.sp. BAUMGARTNER.** Magnification x150. **Fig. 1(H).** POB78/7608, POB986.51. **Fig. 2.** POB79/1677, POB79.5 J.86. **Fig. 3.** POB79/1658, POB79.5 J.86.

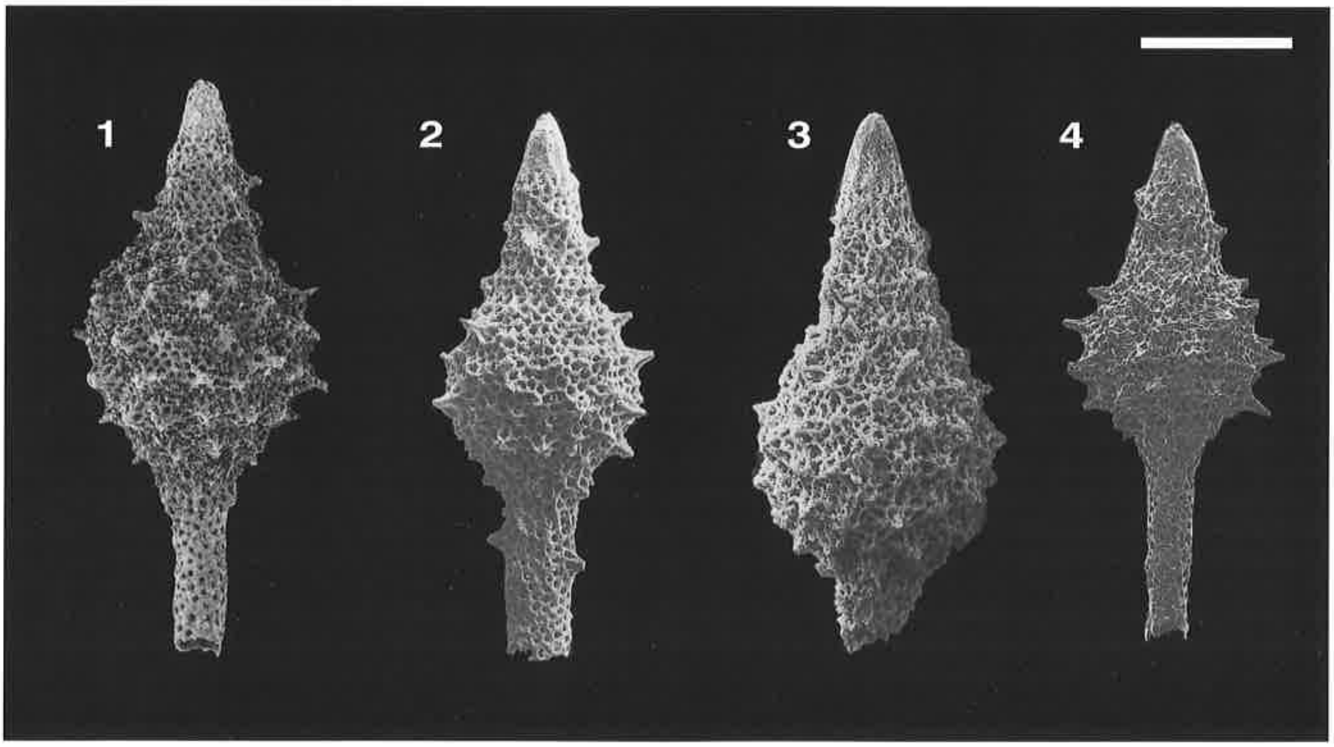


Plate 5711. ***Syringocapsa*** **sp. aff.** ***S. spinosa*** **(SQUINABOL).** Magnification x200. **Fig. 1.** RJ533, B0566.5. **Fig. 2.** PD3390, Mo41. **Fig. 3.** RJ96, Bo619.9. **Fig. 4.** POB79/4287, MO2 46.

SYRINGOCAPSA VICETINA 5409

Syringocapsa vicetina (SQUINABOL)

Synonymy.-
Theosyringium vicetinum SQUINABOL
SQUINABOL 1914, p. 281, pl. 20, fig. 10.
Syringocapsa vicetina (SQUINABOL)
JUD 1994, p. 112, pl. 22, figs. 15-16.

Original Definition.- "Smooth shell with conical apical part, terminating with a rather blunt, straight, porous spine. Thorax very inflated, oval, without spines; abdomen cylindrical, rather long and smooth. Circular pores are dispersed on the thorax, on the cephalis and on the spine, rectangular pores on the abdomen."

Remarks.- For distinction from other species see under *Syringocapsa longitubus* JUD.

Measurements (in μm).-
Total height 716, height of cephalis 106, height of thorax 200, maximal width 178, length of abdomen 358, length of spine 52.

Type Locality.- Colli Euganei, soutern Venetian Alps, central Italy.

UAZones.- 13-17, latest Tith. to late Val.

SYRINGOCAPSA (?) \ A 3268

Syringocapsa (?) sp. A

Description.- Small form with 4 segments and long slender horn. Cephalis partly covered by horn. Horn, if perserved, as long as height of all segments without terminal appendage, circular in cross section, massive at base, tapering into a sharp tip. The base of cephalis is marked by an irregular transverse row of pores. Thorax forming together with cephalis a smooth, inflated cone, covered with small, circular, regularly scattered pores. Abdomen trapezoidal, a transverse row of upwards directed spinelets is placed below the the indistinct joint to the thorax. First postabdominal segment hemispherical - bowlshaped, equipped with regularly scattered outwards directed spinelets (about 6-7 visible on a transverse line per half circumference). Pores as with thorax and abdomen, small circular scattered regularly. Terminal appendage inflated conical, covered with pores that are three times larger than those on the remainder of test. Appendage narrowing distally into a stout, tapered spine with three incipient grooves facing the last pores of appendage.

Remarks.- This form has not been observed in light microscopy (all specimens are pyritized). The inner structure is, therefore, interpreted from the external features. No synonymy can be given, because this form has not been reported previously. Its small size and its delicacy must have limited its chances of preservation.

UAZones.- 7-7, late Bath.-early Call.

takanoensis >> STICHOMITRA (?) TAKANOENSIS GR. 4044

tecta >> GODIA TECTA 5274

tecta >> STYLOCAPSA TECTA 4047

testatum >> ZHAMOIDELLUM TESTATUM 5511

tetradactylus >> HEXASTYLUS (?) TETRADACTYLUS 4027

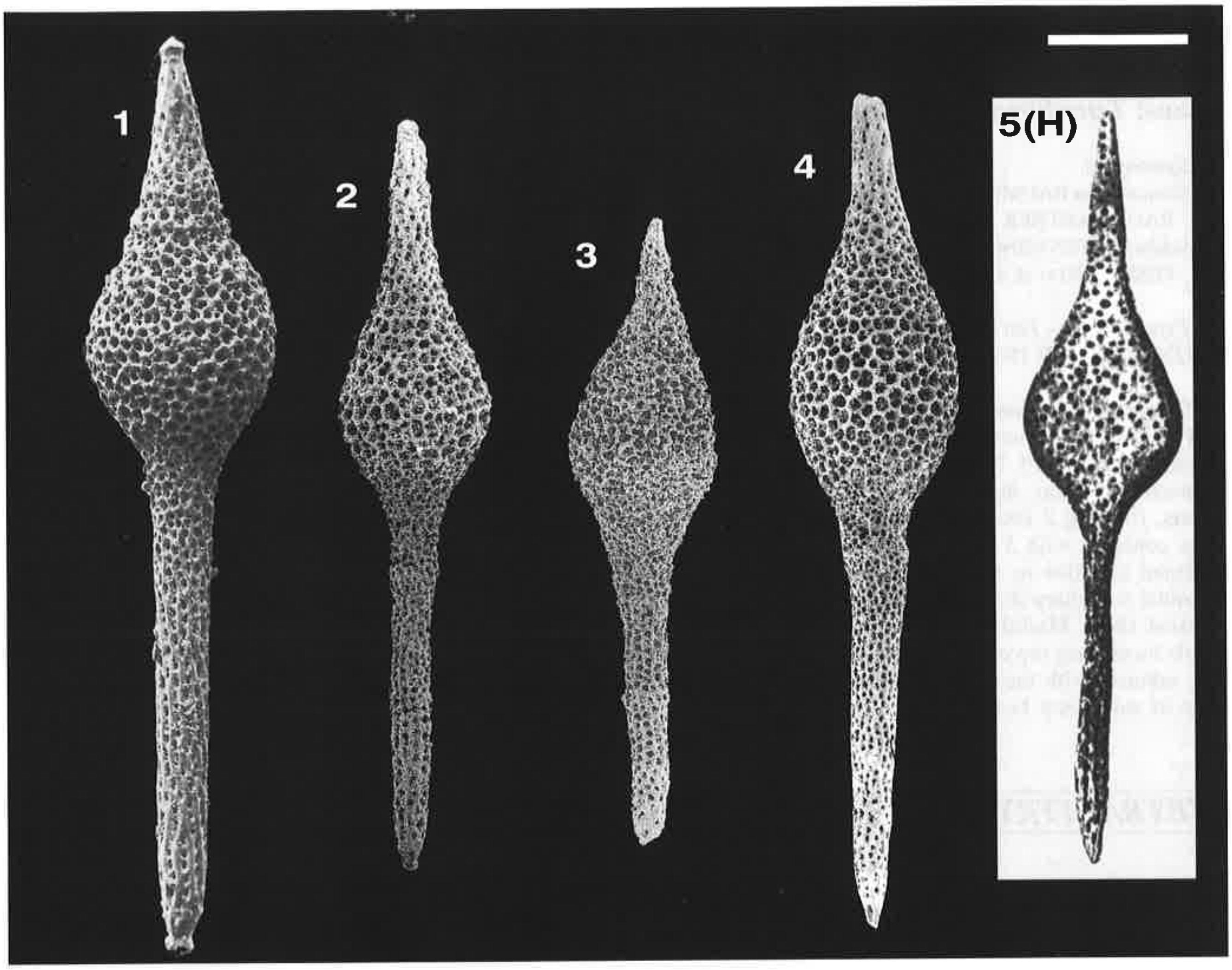


Plate 5409. *Syringocapsa vicetina* (SQUINABOL). Magnification x150. **Fig. 1.** POB79/3384, MO1 34. **Fig. 2.** RJ211, Bo449.5. **Fig. 3.** RJ203, Bo449.5. **Fig. 4.** RJ231, Br28.85. **Fig. 5(H).** SQUINABOL 1914, pl. 20, fig. 10.

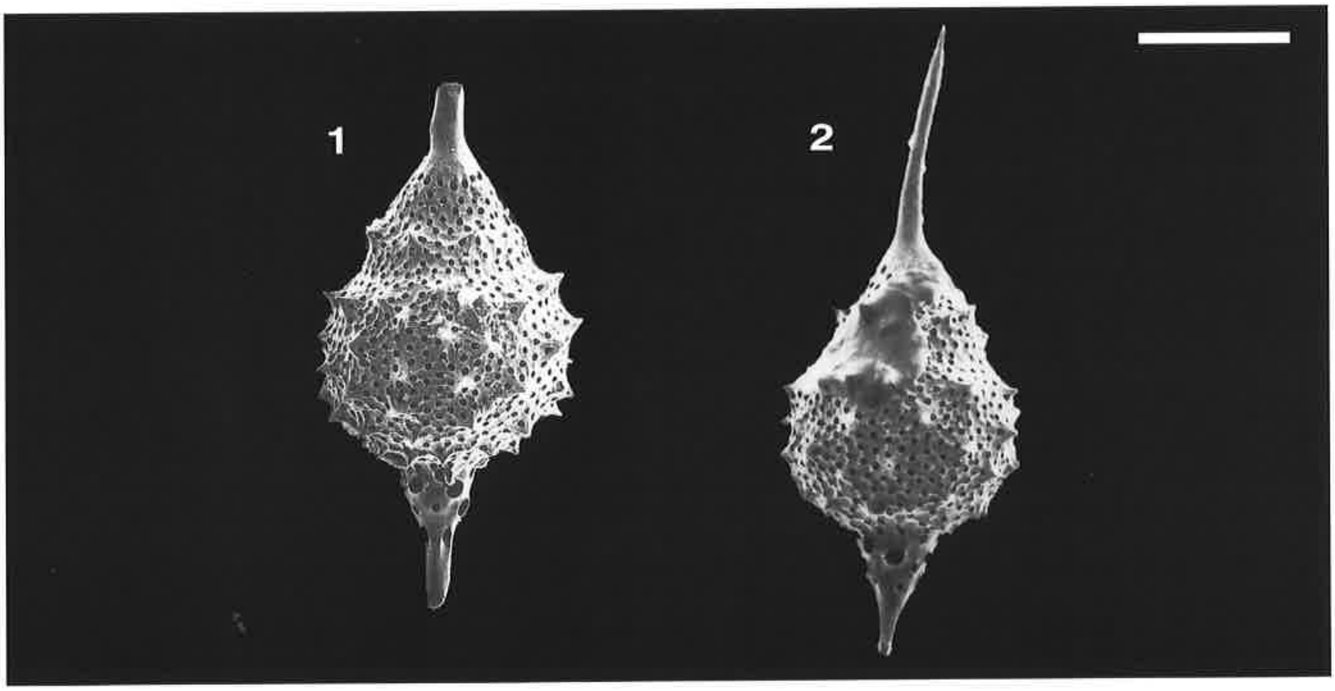


Plate 3268. *Syringocapsa* (?) sp. A. Magnification x300. **Fig. 1.** POB81/9162, 76.534A.126.2.125. **Fig. 2.** POB81/9160, 76.534A.126.2.125.

TETRADITRYMA 3638

Genus: *Tetraditryma* BAUMGARTNER

Synonymy.-
Tetraditryma BAUMGARTNER
BAUMGARTNER 1980, p. 296.
Saldorfus PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 126.

Type Species.- *Tetraditryma pseudoplena* BAUMGARTNER 1980.

Original Definition.- Test as with subfamily, composed of 4 rays of equal length. Cortical shell composed of 2 strong lateral and 1 weak median external beams, connected by short, thin bars branching at right angles to beams, forming 2 rows of paired circular pores. Lateral sides concave, with 3 to 4 alternating horizontal rows of uniform circular to rhombic pores. Centrally placed discoidal medullary shell connected by subsidiary beams to cortical shell. Medullary rays composed of 3 primary canals lie on each top or bottom side of the medullary shell; they connect with the cortical space and are confined by rows of subsidiary beams linking medullary and external beams. Ray tips inflated or tapered.

Original Remarks.- *Tetraditryma* differs from *Pseudocrucella* n. gen. and all other four-rayed hagiastrids by the paired rows of pores on top and bottom surfaces and by the horizontal symmetry axis of the arrangement of primary canals. The cortical wall of some species in this genus seems to be a relict of an additional lateral external beam on each side which can be observed on early forms of this subfamily.

Etymology.- Greek: *tetra*, four-, *di*-, two-, *tryma* (feminine), hole - 4 rays with 2 rows of pores.

Included Taxa.-
3273 *Tetraditryma corralitosensis* s.l. (PESSAGNO)
4048 *Tetraditryma corralitosensis bifida* CONTI & MARCUCCI.
3124 *Tetraditryma corralitosensis corralitosensis* (PESSAGNO)
3125 *Tetraditryma praeplena* BAUMGARTNER
3407 *Tetraditryma* sp. cf. *T. praeplena* BAUMGARTNER
3123 *Tetraditryma pseudoplena* BAUMGARTNER

TETRADITRYMA CORRALITOSENSIS S.L. 3273

Tetraditryma corralitosensis s.l. (PESSAGNO)

Synonymy.-
Crucella (?) *corralitosensis* PESSAGNO
PESSAGNO 1977a, p. 72, pl. 2, figs. 10-13.
See also subspecies.

Included Taxa.-
4048 *Tetraditryma corralitosensis bifida* CONTI & MARCUCCI
3124 *Tetraditryma corralitosensis corralitosensis* (PESSAGNO)

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

TETRADITRYMA CORRALITOSENSIS BIFIDA 4048

Tetraditryma corralitosensis bifida CONTI & MARCUCCI

Synonymy.-
Tetraditryma corralitosensis bifida CONTI & MARCUCCI
CONTI & MARCUCCI 1991, p. 804, pl. 4, figs. 4-5.

Original Remarks.- This form differ from *T. corralitosensis corralitosensis* (PESSAGNO 1977) by the shorter and less massive ray tips, terminating with two lateral short spines.

Etymology.- Latin *bifidus, a, um,* forked.

Type Locality.- Sample GR 6 Ponte di Lagoscuro (Eastern Liguria - Italy).

UAZones.- 5-7, latest Baj.-early Bath. to late Bath.-early Call.

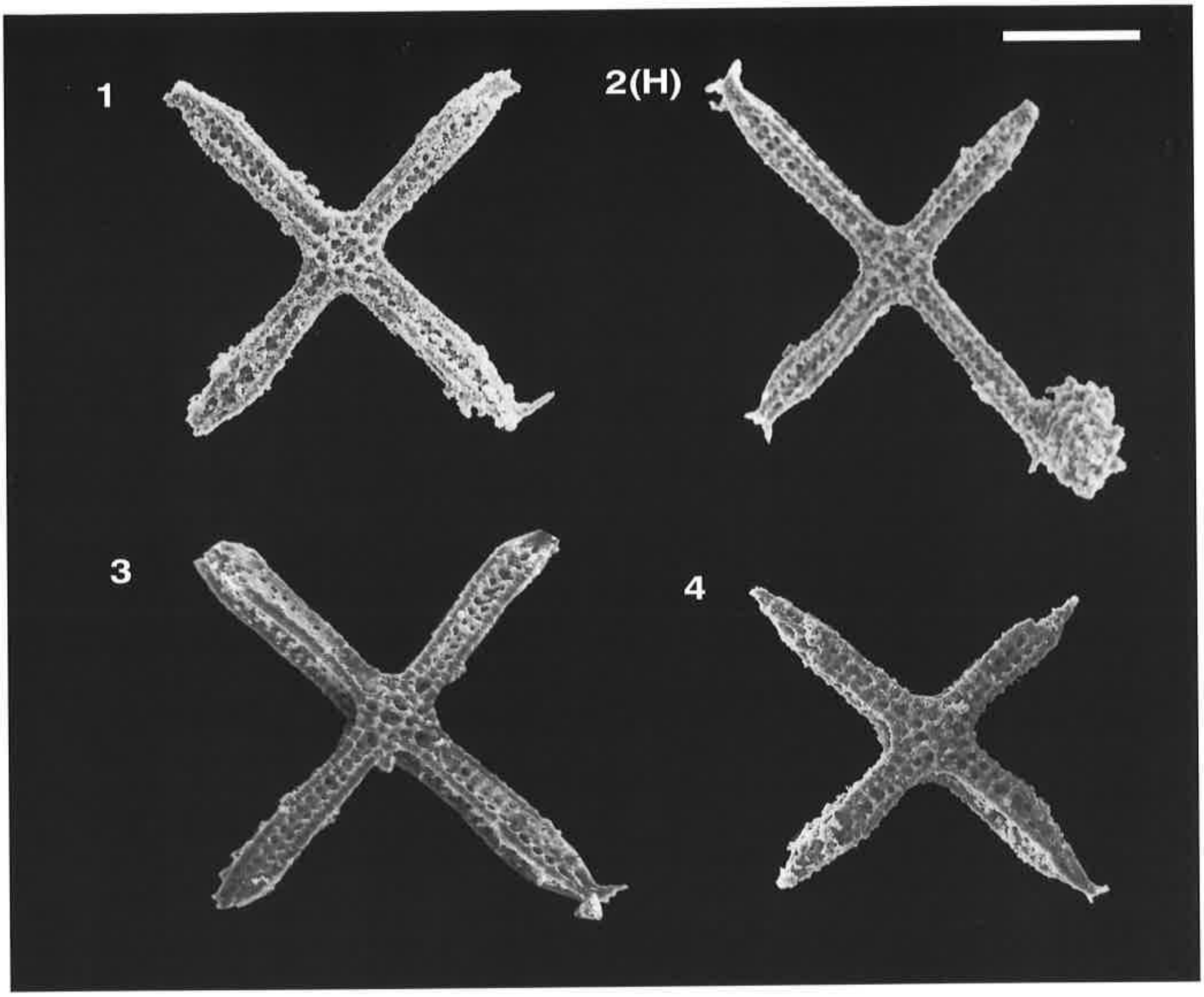


Plate 4048. ***Tetraditryma corralitosensis bifida*** **CONTI & MARCUCCI.** Magnification x150. **Fig. 1.** MC, GR6. **Fig. 2(H).** IGF 3377E, GR6. **Fig. 3.** MC42/87, GR6. **Fig. 4.** MC, GR6.

TETRADITRYMA CORRALITOSENSIS CORRALITOSENSIS 3124

Tetraditryma corralitosensis corralitosensis (PESSAGNO)

Synonymy.-
Crucella (?) *corralitosensis* PESSAGNO
PESSAGNO 1977a, p. 72, pl. 2, figs. 10-13.
Tetraditryma corralitosensis (PESSAGNO)
BAUMGARTNER 1980, p. 296, pl. 7, figs. 12-15; pl. 11, fig. 13.
KOCHER 1981, p. 98, pl. 16, fig. 31.
DE WEVER & CABY 1981, pl. 2, fig. G.
BAUMGARTNER 1984, p. 787, pl. 9, figs. 6-7.
AITA 1985, fig. 6.1.
DE WEVER & MICONNET 1985, p. 390, pl. 1, fig. 9.
ISHIDA 1985, pl. 2, fig. 4.
NAGAI 1985, pl. 3, figs. 4-4a.
AITA 1987, p. 64, pl. 9, fig. 1.
DE WEVER et al. 1987, pl. 1, fig. A4.
OZVOLDOVA 1988, pl. 6, fig. 3.
EL KADIRI 1984, p. 112, pl. 20, figs. 4-5, 8.
DANELIAN 1989, p. 194, pl. 8, fig. 8.
STEIGER 1992, p. 44, pl. 10, fig. 6.
Tetraditryma sp. cf. *T. corralitosensis* (PESSAGNO)
WAKITA 1982, pl. 5, figs. 9-10.
Saldorfus coldspringensis PESSAGNO, BLOME & HULL.
PESSAGNO et al. 1993, p. 126, pl. 3, figs. 1, 4, 7
Saldorfus corralitosensis (PESSAGNO)
PESSAGNO et al. 1993, p. 126, pl. 3, fig. 13.
Saldorfus oregonensis PESSAGNO, BLOME & HULL
PESSAGNO et al. 1993, p. 127, pl. 3, figs. 11, 12, 18.

Original Definition.- Sides and tops of ray flanked by two nodose longitudinal ridges. Tops and bottoms of rays with single row of large rectangular pore frames having massive nodes at vertices; nodes occurring along ridges. Sides of ray with three rows of smaller square to rectangular pore frames between ridges; pore frames lacking nodes. Ray tips with massive quadriradiate spines having four ridges alternating with four grooves. Central area with large polygonal pore frames (pentagonal to tetragonal) with nodes at their vertices.

Original Remarks.- This species differs from *C. sanfilippoae* in having (1) only one row of pore frames on its ray on the top and bottom surfaces; (2) a considerably thicker test; and (3) longitudinal ridges on its rays. The presence of longitudinal ridges on the ray of this species may suggest that it should be assigned to a new genus among Hagiastrinae.

Remarks.- Characterized by long and massive ray tips terminating with one spine.

Etymology.- From Corralitos Canyon near Point Sal, Santa Barbara County, California USA.

Measurements (in μm).-
Based on 10 specimens. Length of rays: 120 to 200; width of rays: 30 to 50; length of spines: 30 to 60.

Type Locality.- Corralitos Canyon, Point Sal, Santa Barbara County, California USA

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

TETRADITRYMA PRAEPLENA 3125

Tetraditryma praeplena BAUMGARTNER

Synonymy.-
Tetraditryma praeplena BAUMGARTNER
BAUMGARTNER 1984, p. 787, pl. 9, figs. 8-9, 13-13a.
DANELIAN 1989, p. 195, pl. 8, figs. 9-14.
PESSAGNO et al. 1993, p. 127 pl. 3, figs. 6, 19.
Tetraditryma pseudoplena BAUMGARTNER
? CARAYON et al. 1984, pl. 1, fig. 5.
? OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 4.

Original Definition.- General construction of test and central area very similar to *T. pseudoplena*. The four rays are of equal length, stand nearly at right angles and end in a ray tip which differs from *T. pseudoplena* in being not thickened, and having two slender, sharp, triradiate lateral spines standing at an angle of 60-70 degrees to the ray axis and several secondary lateral and small central spines. The cortical wall (arrow pl. 9, fig. 13a) is very delicate, porous, or may be totally absent.

Original Remarks.- *T. praeplena* is the immediate ancestor of *T. pseudoplena* and co-occurs with the former in Zones A0-A1. *T. praeplena* differs from *T. pseudoplena* in lacking bulbous ray tips, in having finer lateral spines which stand at an angle of 60-70, instead of 90 degrees to ray axis and in having a delicate instead of a massive imperforate cortical wall.

Etymology.- Referring to the evolutionary relationship with *T. pseudoplena*.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Length of rays AX:	246	243	198	277
Length of rays BX:	246	-	-	-
Length of rays CX:	270	-	-	-
Length of rays DX:	252	-	-	-
Width of rays :	54	44	36	54
Length of longest central spine:	42	27	12	42
Length of longest lateral spine:	69	62	69	54

Type Locality.- Locality no. 40. of locality descriptions (Baumgartner, 1984).

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

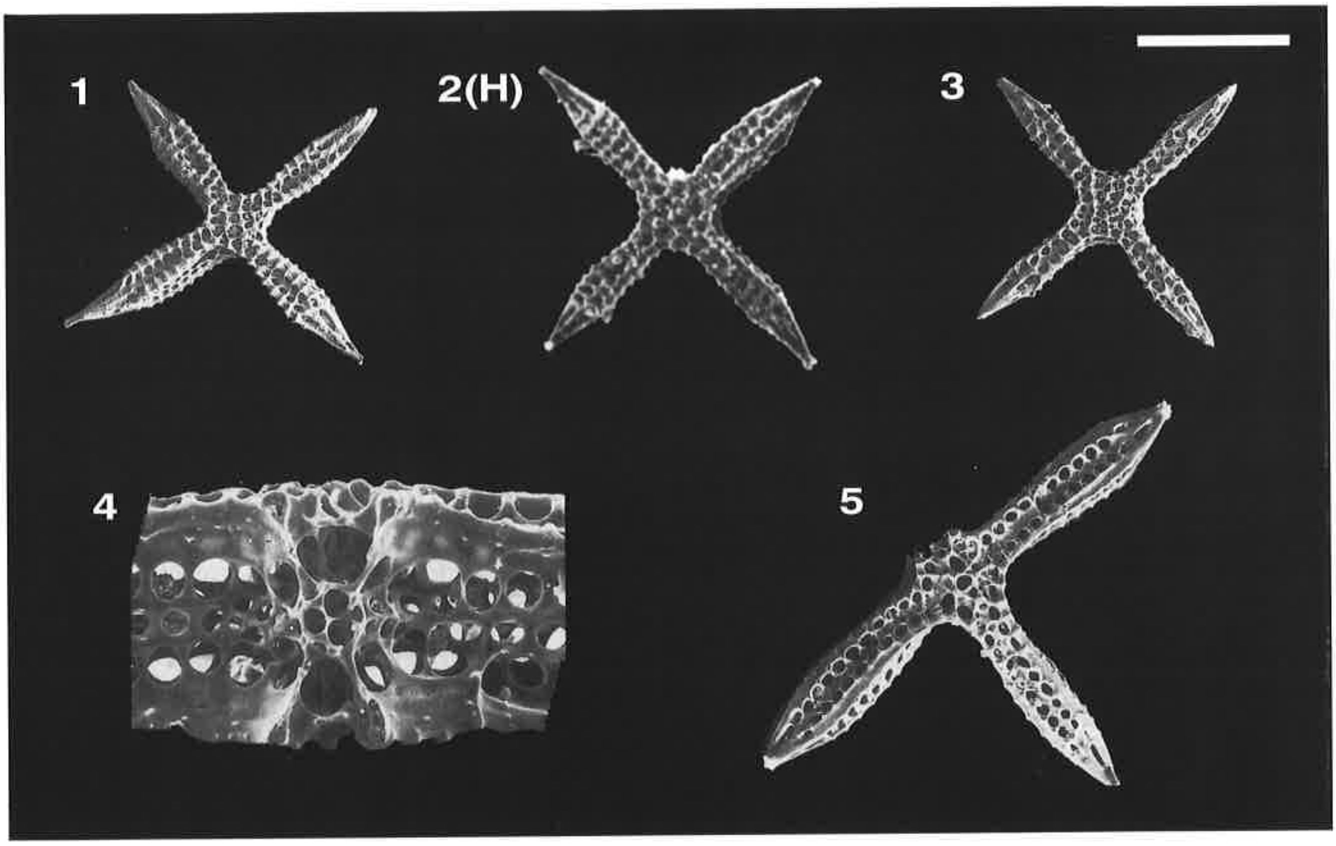


Plate 3124. *Tetraditryma corralitosensis corralitosensis* (PESSAGNO). Magnification x150, except Fig. 4 x400. **Fig. 1.** POB79/4090, OR554. **Fig. 2(H).** PESSAGNO 1977a, pl. 2, fig. 10. **Fig. 3.** POB79/4089, OR554. **Fig. 4.** POB81/9148, 76.534A.126.2.125. **Fig. 5.** POB81/9188, 76.534A.126.2.125.

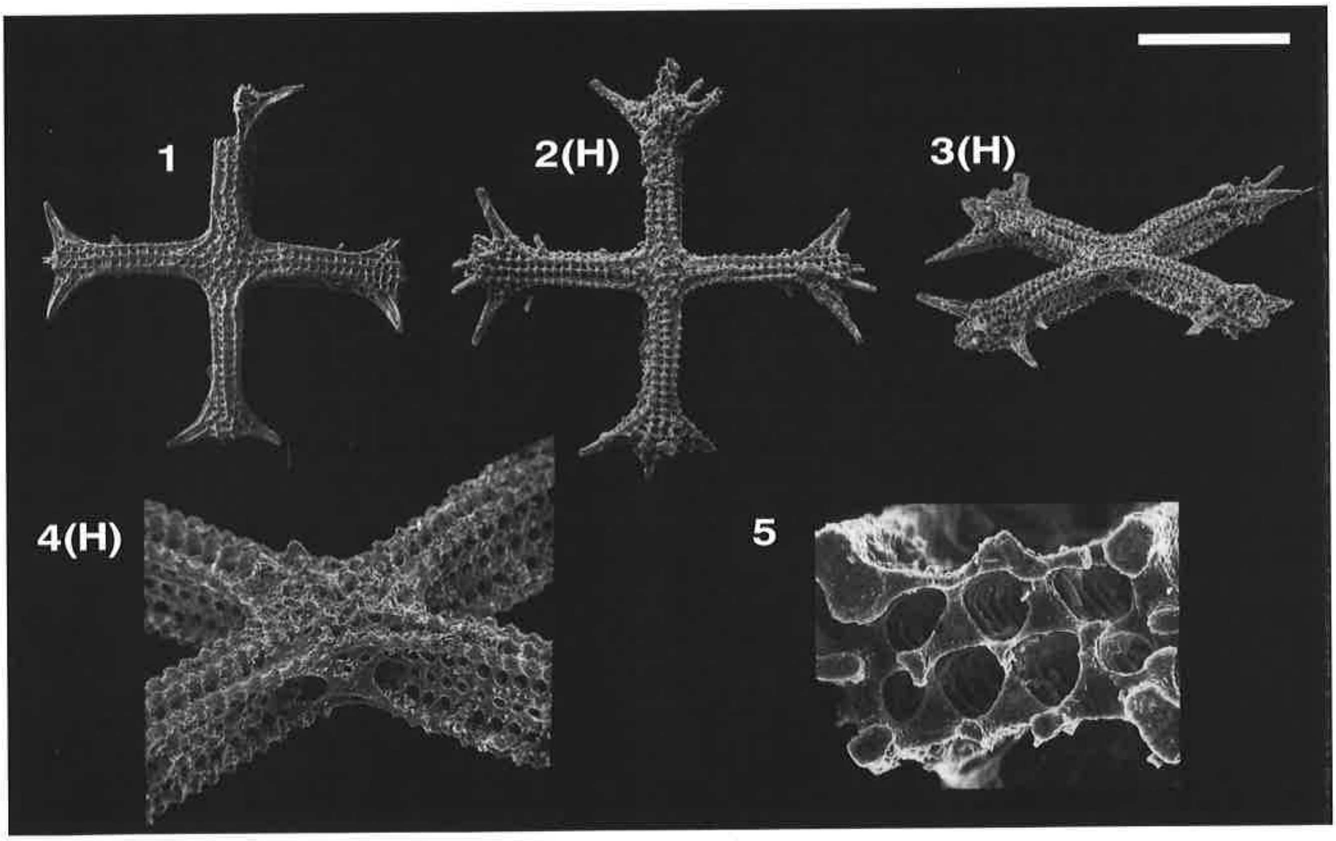


Plate 3125. *Tetraditryma praeplena* BAUMGARTNER. Magnification x150, unless otherwise indicated. **Fig. 1.** POB81/3027, IN7. **Fig. 2(H).** POB79/4426, IN7. **Fig. 3(H).** POB79/4427, IN7. **Fig. 4(H).** POB79/4428, IN7, x300. **Fig. 5.** POB79/4413, IN7, x1200.

TETRADITRYMA PRAEPLENA CF. 3407

Tetraditryma sp. cf. *T. praeplena* BAUMGARTNER

Synonymy.-
Tetraditryma sp. cf. *T. praeplena* BAUMGARTNER
CARTER & JAKOBS 1991, p. 344, pl. 2. fig. 1.

Remarks.- Lacks slender triradiate lateral spines that extend from the ray tips at a 60-70 degrees angle to the ray axis, but otherwise is very similar to *P. praeplena* and may be its immediate ancestor.

UAZones.- 1-2, early-mid Aal. to late Aal.

TETRADITRYMA PSEUDOPLENA 3123

Tetraditryma pseudoplena BAUMGARTNER

Synonymy.-
Hagiastrum plenum RÜST
PESSAGNO 1977a, p. 72, pl. 2, fig. 14.
Tetraditryma pseudoplena BAUMGARTNER
BAUMGARTNER 1980, p. 297, pl. 1, fig. 9; pl. 7, figs. 1-11.
BAUMGARTNER et al. 1980, p. 63, pl. 2, fig. 1.
KOCHER 1981, p. 98, pl. 16, figs. 32-33.
SATO et al. 1982, pl. 3, fig. 7.
ISHIDA 1983, pl. 11, fig. 7.
BAUMGARTNER 1984, p. 788, pl. 9, figs. 12, 14.
? CARAYON et al. 1984, pl. 1, fig. 5.
? BAUMGARTNER 1985, fig. 38.f.
NAGAI 1985, pl. 4, figs. 1, 1a; ? pl. 3, figs. 5-5a.
GORICAN 1987, p. 187, pl. 1, fig. 10.
? OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 4.
OZVOLDOVA 1990, pl. 3, fig. 7.
WIDZ 1991, p. 256, pl. 4, fig. 9.
Tetraditryma cf. *pseudoplena* BAUMGARTNER
DE WEVER et al. 1986, pl. 8, fig. 1.

Original Definition.- Test as with genus, with 4 rays at right angles of sometimes unequal length. Central area rectangular about twice as large as the rays. Rays with square to rectangular cross section. Median and lateral external beams in one plane. Ray tips bulbous to wedge-shaped, 2 to 3 times as wide as the rays. Two fine or sturdy three- bladed lateral spines standing at right angles to the ray axis form the proximal base of the tip. Central and lateral spines may be present. The median external beams divide at the central area to form a square area with broad nodes and small, sparse pores. The lateral external beams and 1 pore row are continuous around the central area. Lateral beams of the top and bottom sides are connected around the central area by an imperforate (or sparsely porous) wall, termed cortical wall, which confines the cortical space laterally.

Original Remarks.- This species has been identified by Pessagno (1977a) as *Hagiastrum plenum* RÜST. However, it differs considerably from Rüst's description and illustration of *H. plenum* in having 2 rows of pores instead of 3 between 4 beams, small pores in the central area instead of equally sized pores as on the rays, and sometimes strongly developed lateral spines. Furthermore, Rüst's illustration suggests a different internal structure as discussed under *Hagiastrum*. Pessagno's material (NSF 907) shows specimens with generally less strong lateral and equal central spines. However, the variable strength of spines alone seems not to justify a distinction of different species, it rather seems to be a geographic or an ecologic variation. Middle Jurassic samples from Eastern Oregon and Central Japan contain an ancestor species which is smaller than *T. pseudoplena* and has a reduced, porous cortical wall.

Etymology.- Latin, *pseudo-*, false for its wrong former identification.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.	NSF907
Length of rays AX:	290	278	224	340	283
Length of rays BX:	340	-	-	-	-
Length of rays CX:	320	-	-	-	-
Length of rays DX:	340	-	-	-	-
Width of rays:	40	40	30	50	40
Width of ray tip:	100	130	106	84	130
Length of l. cent. sp.:	25	25	29	25	34
Length of l. lat. sp.:	130	97	45	143	42

Type Locality.- 3 km east of Anngelokastron, Province Korinthos, Greece.

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

tetragona >> *TRICOLOCAPSA TETRAGONA* 4054

tetraspinus >> *HEXASATURNALIS TETRASPINUS* 3089

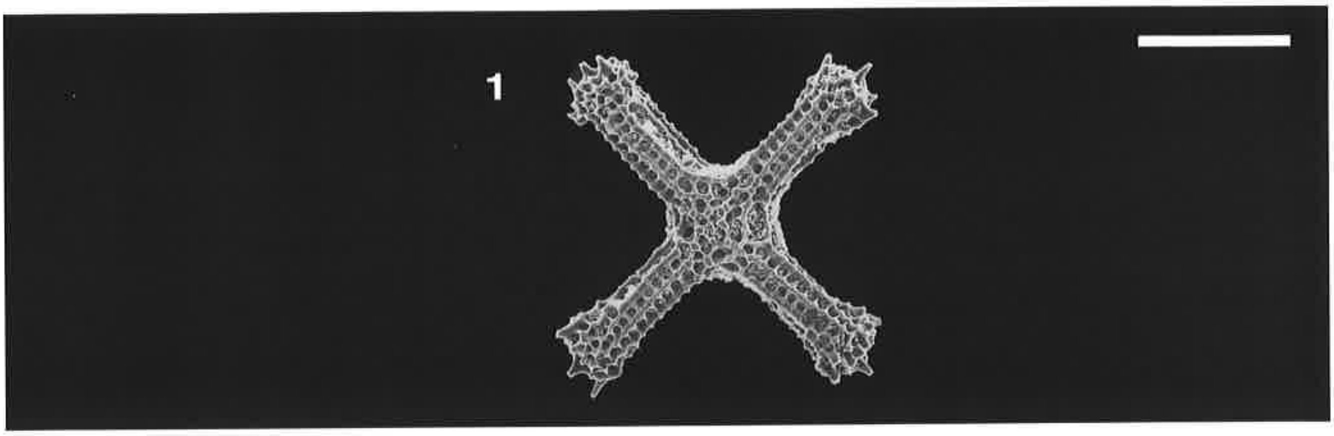


Plate 3407. *Tetraditryma* sp. cf. *T. praeplena* BAUMGARTNER. Magnification x150. **Fig. 1.** CA36, 37/4.

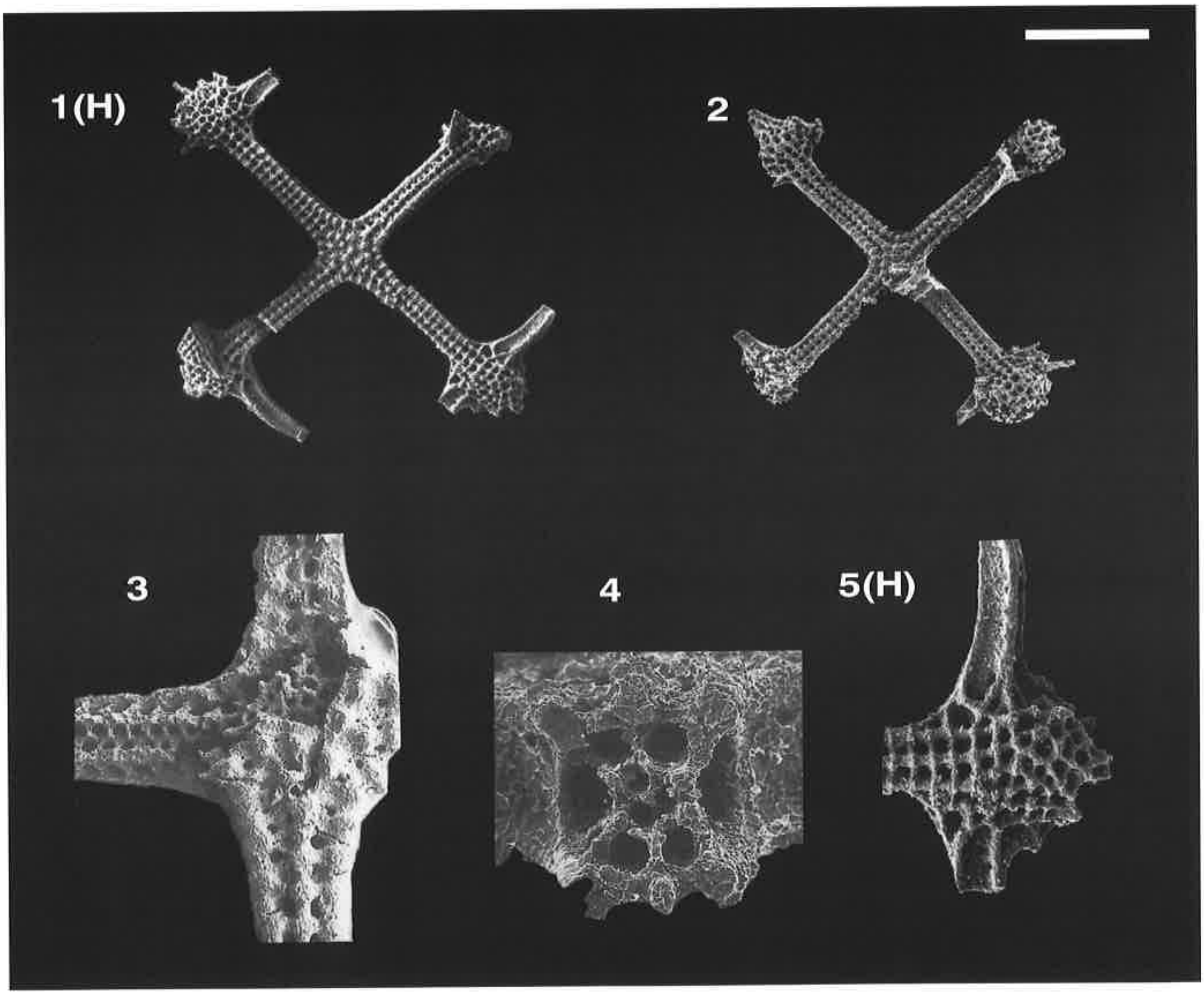


Plate 3123. *Tetraditryma pseudoplena* BAUMGARTNER. Magnification x150, unless otherwise indicated. **Fig. 1(H).** POB79/1500, POB899.61. **Fig. 2.** POB78/6205, POB899.52. **Fig. 3.** POB79/0346, POB144.52, x300. **Fig. 4.** POB79/1638, POB79.3, x600. **Fig. 5(H).** POB79/1502, POB899.61, x300.

TETRATRABS 3642

Genus: *Tetratrabs* BAUMGARTNER

Synonymy.-
Tetratrabs BAUMGARTNER
BAUMGARTNER 1980, p. 294.

Type Species.- *Tetratrabs gratiosa* BAUMGARTNER 1984.

Original Definition.- Test as with subfamily, composed of 4 rays of equal length at nearly right angles. Central area of cortical shell small, strongly nodose; rays composed of nodose beams connected by thin diagonal bars. The double pore rows on lateral sides always more widely spaced than those on upper and lower sides. Cross section of rays hexagonal to subrectangular. Rays often slightly twisted, terminating in a long, stout, proximally grooved central spine. Medullary shell large, joining cortical shell in central area. A second medullary shell seems to be present. Inner structure of rays always composed of 3 large primary canals and 3 small secondary canals.

Etymology.- Latin: *tetra-*, four; plus *trabs*, *trabis* (feminine), beam, rafter - composed of 4 rafters.

Included Taxa.-
3122 *Tetratrabs bulbosa* BAUMGARTNER
3302 *Tetratrabs izeensis* YEH
5209 *Tetratrabs radix* JUD
3121 *Tetratrabs zealis* (OZVOLDOVA)

TETRATRABS BULBOSA 3122

Tetratrabs bulbosa BAUMGARTNER

Synonymy.-
Tetratrabs bulbosa BAUMGARTNER
BAUMGARTNER 1980, p. 295, pl. 5, fig. 1; pl. 6, figs. 1-3, 8.
BAUMGARTNER et al. 1980, p. 63, pl. 2, fig. 5.
KOCHER 1981, p. 99, pl. 16, fig. 34.
BAUMGARTNER 1984, p. 788, pl. 9, fig. 11.
DE WEVER et al. 1986, pl. 7, fig. 13.
Tetratrabs aff. *zealis* (OZVOLDOVA)
DE WEVER et al. 1986, pl. 7, figs. 14-15.

Original Definition.- Test as with genus; stout, large form. Central area and external beams strongly nodose, median beams commonly twice as thick as lateral beams with a tendency to bifurcate close to the central area. Pores on upper and lower sides small, situated in a narrow depression between external beams. Ray tips inflated bulbous, often with 2 spongy protrusions extending in axial direction with a surface of irregularly distributed small pores between broad nodes.

Original Remarks.- *T. gratiosa* n.sp. differs from this species in having slenderer rays, median and lateral external beams of equal size and ray tips not thicker than the width of rays.

Etymology.- Latin *bulbosus, a, um,* bulbous.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Length of rays AX:	410	386	318	427
Length of rays BX:	410	-	-	-
Length of rays CX:	420	-	-	-
Length of rays DX:	345	-	-	-
Width of rays:	82-90	81	65	96
Length of longest spine:	140	152	100	286
Width of ray tips:	120-130	113	90	165

Type Locality.- Locality B of Baumgartner (1980); Argolis Peninsula (Peloponennesus, Greece).

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

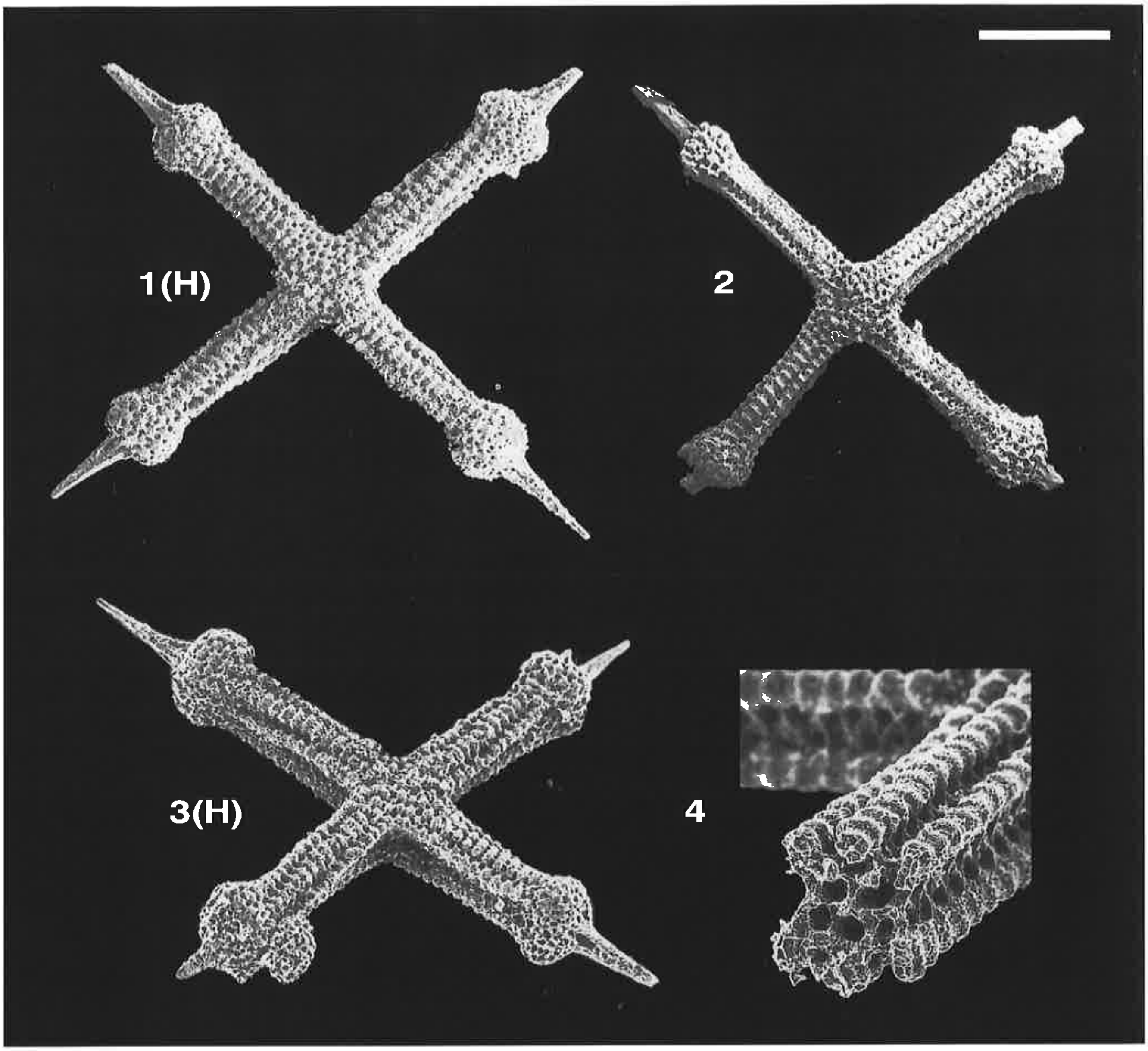


Plate 3122. ***Tetratrabs bulbosa*** **BAUMGARTNER.** Magnification x100, except Fig. 4 x300. **Fig. 1(H).** POB78/6494, POB899.54. **Fig. 2.** POB79/4700, POBS4. **Fig.3(H).** POB78/6550, POB899.54. **Fig. 4.** POB78/6496, POB899.54.

TETRATRABS IZEENSIS 3302

Tetratrabs izeensis YEH

Synonymy.-
Tetratrabs sp. A
WAKITA 1982, pl. 5, fig. 3.
Tetratrabs gratiosa BAUMGARTNER
SATO et al. 1982, pl. 3, fig. 8.
Tetratrabs zealis (OZVOLDOVA).
? BAUMGARTNER 1984, p. 788, pl. 9, fig. 10.
GORICAN 1987, p. 187, pl. 1, fig. 12.
Pseudocrucella sp. C
? CARAYON et al. 1984, pl. 1, fig. 1.
Tetratrabs izeensis YEH
YEH 1987a, p. 31, pl. 21, figs. 13-14; pl. 22, figs. 8, 15.
KITO 1989, p.119, pl. 7, figs. 17- 21.
KITO et al. 1990, pl. 1, fig. 10.
Tetratrabs sp. aff. *T. gratiosa* BAUMGARTNER
? CARTER et al. 1988, p. 30, pl. 7, fig. 10.

Original Definition.- Test as with genus, medium to large in size; central area moderately large, cortical shell with extremely large tetragonal, pentagonal, or hexagonal pore frames without nodes at vertices. Rays wide, medium in length, tapering with short massive triradiate spines. Each ray with six rows of widely spaced external beams visible laterally. Well-preserved specimens with short bars connecting two contiguous external beams and forming large rectangular pore frames above two rows of smaller polygonal pore frames.

Remarks.- In the present catalogue specimens with shorter rays than those of *T. zealis* are assigned to *T. izeensis*. In the previous zonation (Baumgartner, 1984) both morphotypes were attributed to *T. zealis*. Minimum length of rays of *T. zealis*: 240μm. Maximum length of rays of *T. izeensis*: 210μm.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	max	min
Length of ray (sp. excluded):	143	130	145	123
Width of ray :	57	52	57	40
Width of central area :	95	91	96	86
Length of spine :	66	50	66	38

Type Locality.- Snowshoe Formation, Oregon (USA).

UAZones.- 1-5, early-mid Aal. to latest Baj.-early Bath.

TETRATRABS RADIX 5209

Tetratrabs radix JUD

Synonymy.-
Tetratrabs sp. A
STEIGER 1992, p. 41, pl. 8, fig. 9.
Tetratrabs sp. B
STEIGER 1992, p. 41, pl. 8, fig. 10.
Tetratrabs radix JUD
JUD 1994, p. 112, pl. 23, figs. 1-2.

Original Definition.- Test with 4 rays which are not disposed in the same plane, 2 opposite rays being above the equatorial plane, the other 2 below it. Rays composed of 6 main slightly twisting beams connected with one another by oblique bars forming 2 rows of alternate pores between beams. Rays distally splitting up into several radiating, short, blunt branches, possessing the same structure as main rays.

Original Remarks.- *Tetratrabs radix* n.sp. differs from all the other species of the genus by the characteristic terminal splitting of the rays and by not having coplanar rays.

Etymology.- From the Latin *radix* = root.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Max. length rays:	568	408	296	568
Width of rays:	54	-	-	-

Type Locality.- Valdorbia, Umbria-Marche, Italy.

UAZones.- 12-17, early-early late Tith. to late Val.

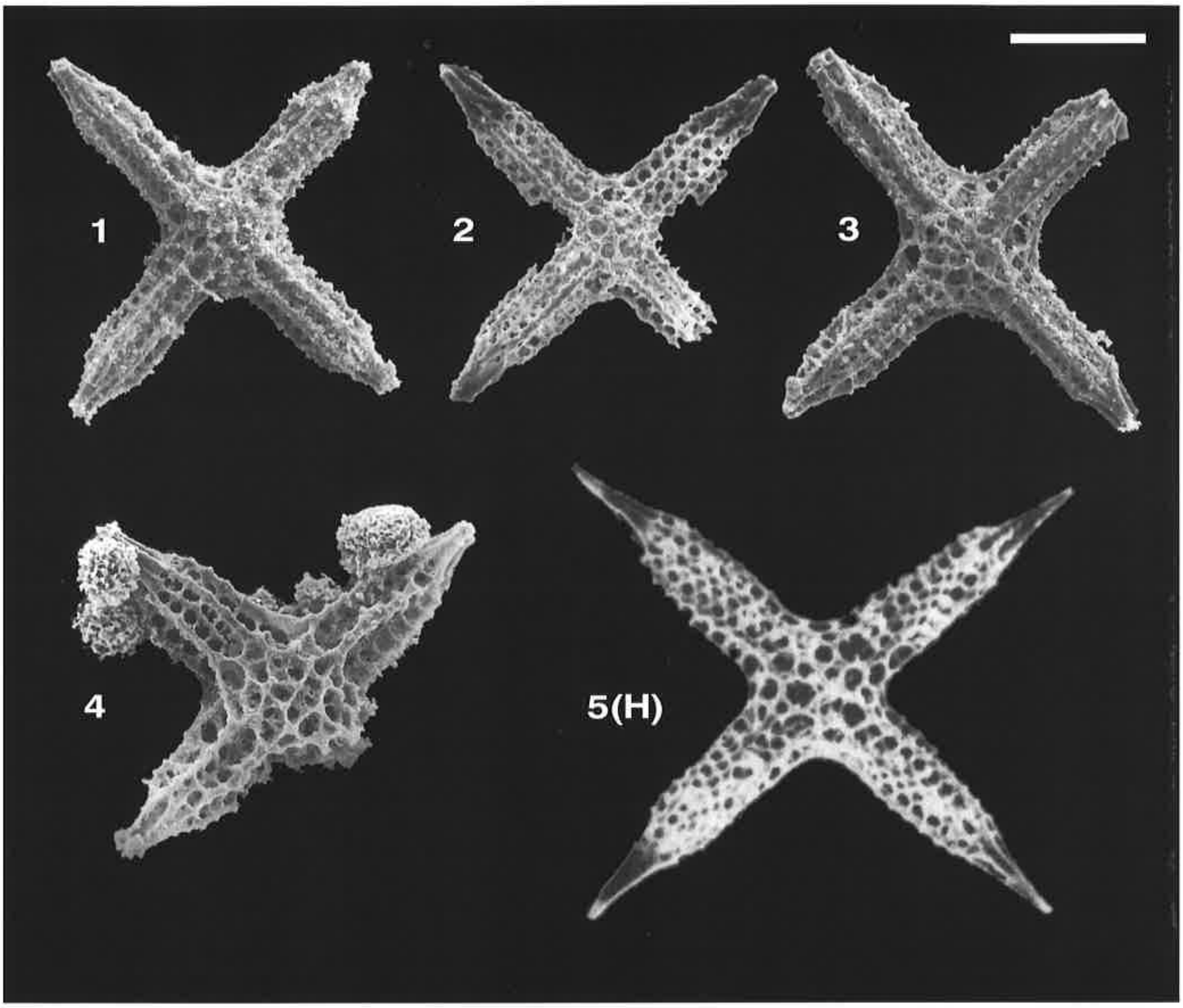


Plate 3302. *Tetratrabs izeensis* YEH. Magnification x200. **Fig. 1.** MA10553, MA12-MKM1. **Fig. 2.** MA10338, MA12-MKM1. **Fig. 3.** KI8741-18A, S68. **Fig. 4.** KI8711-8, S69. **Fig. 5(H).** YEH 1987, pl. 22. fig. 8.

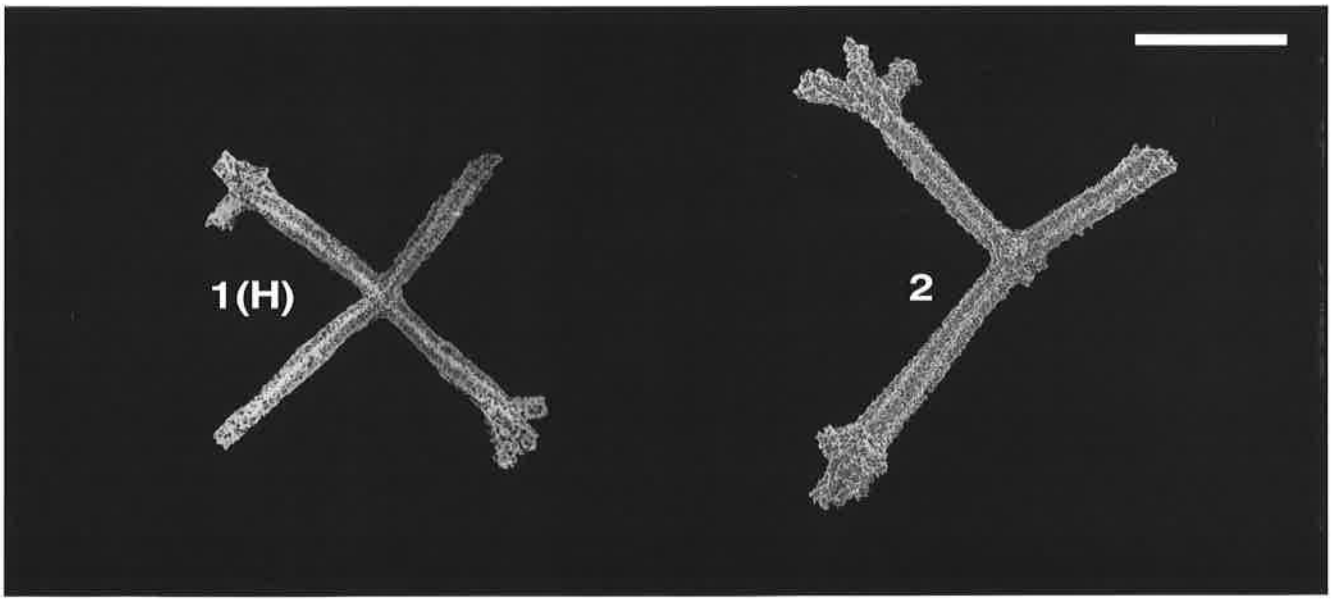


Plate 5209. *Tetratrabs radix* JUD. Magnification x100. **Fig. 1(H).** RJ14, V -6. **Fig. 2.** RJ58, V -6.

TETRATRABS ZEALIS 3121

Tetratrabs zealis (OZVOLDOVA)

***Synonymy*.-**
Crucella zealis OZVOLDOVA
OZVOLDOVA 1979, p. 254, pl. 2, fig. 1.
Tetratrabs gratiosa BAUMGARTNER
BAUMGARTNER 1980, p. 295, pl. 1, fig. 11; pl. 5, figs. 2-7; pl. 6, figs. 4-7, 9-14; pl. 11, figs. 7-9.
BAUMGARTNER et al. 1980, p. 63, pl. 2, fig. 6.
ISHIDA 1983, pl. 11, fig. 9.
IWATA et al. 1990, pl. 1, fig. 3.
Tetratrabs zealis (OZVOLDOVA)
KOCHER 1981, p. 99, pl. 17, fig. 1.
MATSUOKA 1992, pl. 5, fig. 12.

***Original Definition*.-** Test is cross-shaped. In central area, there is a small cell, surrounded by a concentric row of cells separated by radial bars. Four unequally long rays diverge crosswise to sides from the central part of the test. Meshwork of rays resembles maize ears. The rays are divided by deep grooves into three longitudinal rows of conspicuously protruding building elements of a semiannular shape. The elements are transversally separated by narrow slots. Number of the elements in individual rows is 14-18. Grooves between longitudinal rows of the elements are penetrated by small oval pores. Two and two opposite rays are of the same length. They terminate in a short massive spine.

***Original Remarks*.-** According to the diagnosis of the genus *Crucella* PESSAGNO 1971a, rays should be approximately equally long. Our specimens have always two opposite rays of equal length.

***Etymology*.-** After the shape and structure of rays; Latin *zea*, means maize.

Measurements (in μm).-
Diameter of test HT 80, PT 75-85; length of rays from the centre of test HT 440, 380, PT 280-380.

***Type Locality*.-** Podbiel, Pieniny Group of the Klippen Belt, Slovakia.

***UAZones*.-** 4-13, late Baj. to latest Tith.

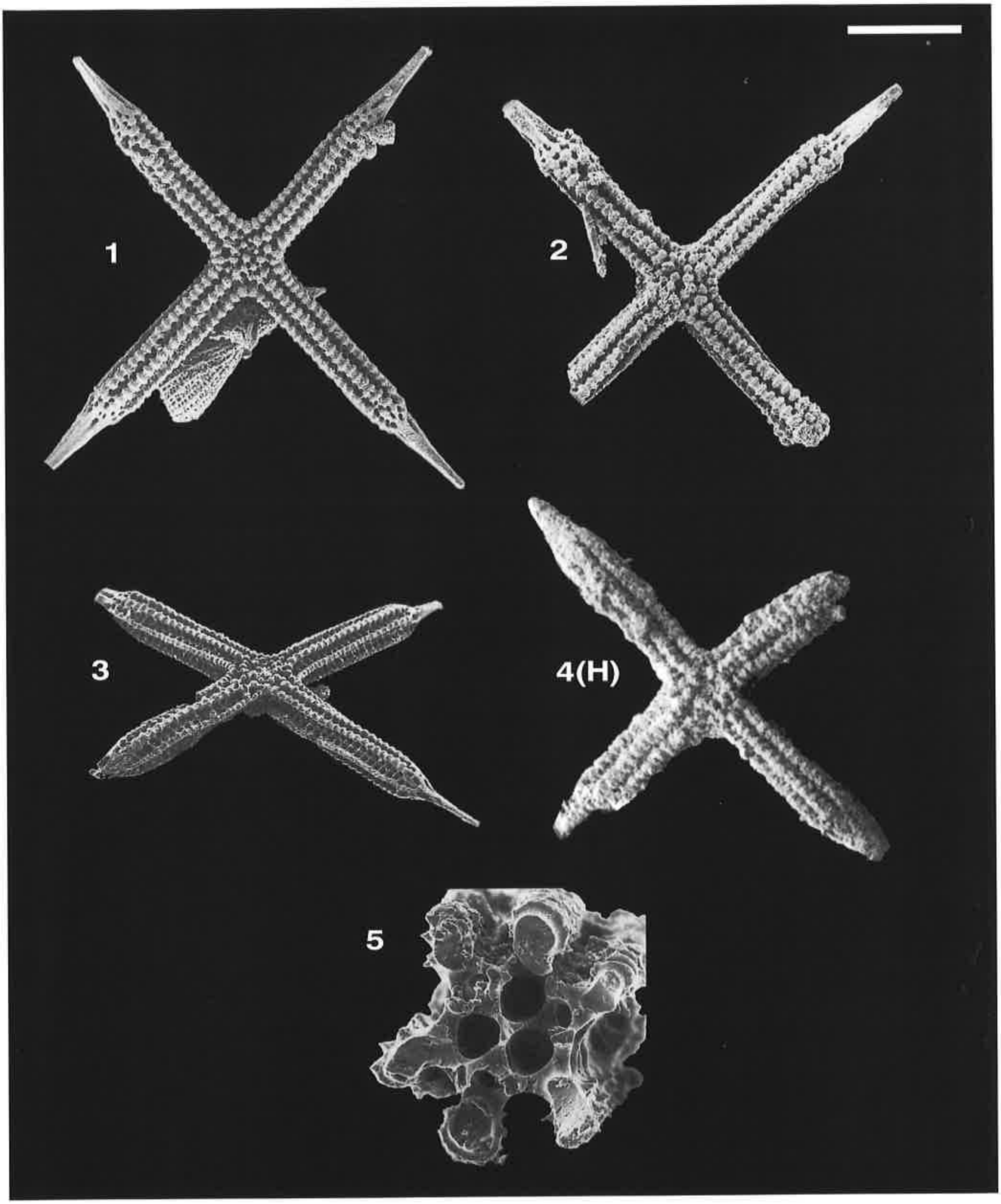


Plate 3121. ***Tetratrabs zealis*** **(OZVOLDOVA).** Magnification x100, except Fig. 5, x600. **Fig. 1.** POB79/1510, POB899.61. **Fig. 2.** POB78/6103, POB899.50. **Fig. 3.** POB78/6253, POB899.50. **Fig. 4(H).** OZVOLDOVA 1979b, pl. 2, fig. 1. **Fig. 5.** POB81/2413, 534.122.1.26.

THANARLA 6025

Genus: *Thanarla* PESSAGNO

Synonymy.-
Thanarla PESSAGNO
PESSAGNO 1977b, p. 45.

Type Species.- *Dictyomitra veneta* SQUINABOL 1903.

Original Definition.- Test multicyrtoid, costate with or without constrictions and with terminal feet; constrictions when present not occurring at joints; feet bladelike, closely spaced, equal in number to number of costae. Apical portion of test with relict pores; remainder of test with small circular to elliptical pores which remain open, but greatly restricted in size due to accreted shell material; pores set in large tetragonal pore frames. Number of postabdominal chambers always constant for a given species.

Original Remarks.- *Thanarla* n.gen. is closely related to *Archaeodictyomitra*. It differs from *Archaeodictyomitra* (1) by having relict pores only on the proximal portion of its test and (2) by possessing bladelike terminal feet rather than costal projections on its final postabdominal chamber (compare pl. 7, fig. 5 with pl. 6, fig. 1). *Archaeodictyomitra* develops pore frames that can be often seen between costal projections of well-preserved specimens. However, *Thanarla* has closely spaced feet, separated by sutures on its final postabdominal chamber. With the type species, *T. veneta* the middle of each foot is aligned with a costa on the proceeding postabdominal chamber. It appears likely that until the secretions of the feet of the final postabdominal chamber the test of *Thanarla* is secreted in the manner suggested by Pessagno (1976).

Included Taxa.-
5296 *Thanarla elegantissima* (CITA) sensu SANFILIPPO & RIEDEL
5904 *Thanarla gutta* JUD
5073 *Thanarla pulchra* (SQUINABOL) sensu SANFILIPPO & RIEDEL

THANARLA ELEGANTISSIMA 5296

Thanarla elegantissima (CITA) sensu SANFILIPPO & RIEDEL

Synonymy.-
Lithocampe elegantissima CITA
CITA 1964, p. 148, pl. 12, figs. 2-3.
RIEDEL & SANFILIPPO 1974, p. 779, pl. 6, figs. 8-10; pl.13, figs. 2-4.
NAKASEKO et al. 1979, p. 23, pl. 7, fig. 1.
Sethamphora pulchra (SQUINABOL)
MOORE 1973, p. 826, pl. 3, fig. 4 only.
Lithocampe (?) *elegantissima* CITA
PESSAGNO 1976, p. 55, pl. 3, fig. 6.
Thanarla elegantissima (CITA)
PESSAGNO 1977b, p. 46, pl. 7, fig. 10.
? OKAMURA 1980, pl. 21, fig. 1.
SCHMIDT-EFFING 1980, p. 246, figs. 2, 21, ? 22.
TAKETANI 1982a, p. 59, pl. 4, fig. 12; pl. 11, figs. 17-18.
YAMAUCHI 1982, pl. 1, fig. 16.
ORIGLIA-DEVOS 1983, p. 144, pl. 17, figs. 6-7.
SCHAAF 1984, p. 163, figs. 11a-b
SANFILIPPO & RIEDEL 1985, p. 600, text-figs. 8.1a-e.
SUYARI 1986a, pl. 1, figs. 1, 2, not 3-4.
TERAOKA & KURIMOTO 1986, pl. 4, fig. 14.
THUROW 1988, p. 407, pl. 4, fig. 11.
KATO & IWATA 1989, pl. 8, fig. 1.
Thanarla pulchra (SQUINABOL)
SCHAAF 1981, p. 439, pl. 4, fig. 10; pl. 19, figs. 7a-b.
NAKASEKO & NISHIMURA 1981, p. 163, pl. 7, figs. 4, 7; pl. 15, fig. 12.
TAKETANI 1982a, p. 59, pl. 11, fig. 19.
MURATA et al. 1982, pl. 2, fig. 9.
NISHIZONO & MURATA 1983, pl. 6, fig. 7.
SUYARI & KUWANO 1986, pl. 3, fig. 8.
? KATO & IWATA 1989, pl. 8, fig. 3.
TUMANDA 1989, p. 40, pl. 2, fig. 17.
Thanarla elegantissima (CITA) sensu SANFILIPPO & RIEDEL
JUD 1994, p. 113, pl. 23, fig. 3.

Original Definition.- "Test of middle size, consisting of 4 segments of which the first three (cephalis, thorax and abdomen) are forming a small pointed cone whereas the fourth one, much more developed than the others, has a subcylindrical and slightly inflated shape and tends to be constricted at its base. The surface is covered completely with thin costae which continue over the whole shell, a number of about 10 on half the circumference. They continue past the final segment and form a fringe. The base is concave: in its center there is a circular aperture of about half the diameter of the shell. The septa which separate the segments are visible in transparent light when immersed with Canada balm. But it is not possible to give precise measurements for their dimensions."

Actualized Definition.- (SANFILIPPO & RIEDEL, 1985) The shell probably comprises 4-5 segments (rarely distinguishable), which are narrow and conical above, much wider and subcylindrical below. The tangents above and below the concave change of contour form an angle of 100°-170°. Eighteen to 30 longitudinal costae separate single rows of pores and fragments of their lamellar prolongations terminate the shell. The distension of the terminal portion of shell (see definition under *T. pulchra*) is 25% or less. A well-developed internal septum constricts the mouth to about one-third of shell width.

Original Remarks.- "The examined specimen is not comparable to the species of *Lithocampe* described until now. It shows a certain analogy in its form with *Sethamphora squinaboli* HINDE of the Triassic (?) of the Indonesia by its dimensions, by the external shape of the

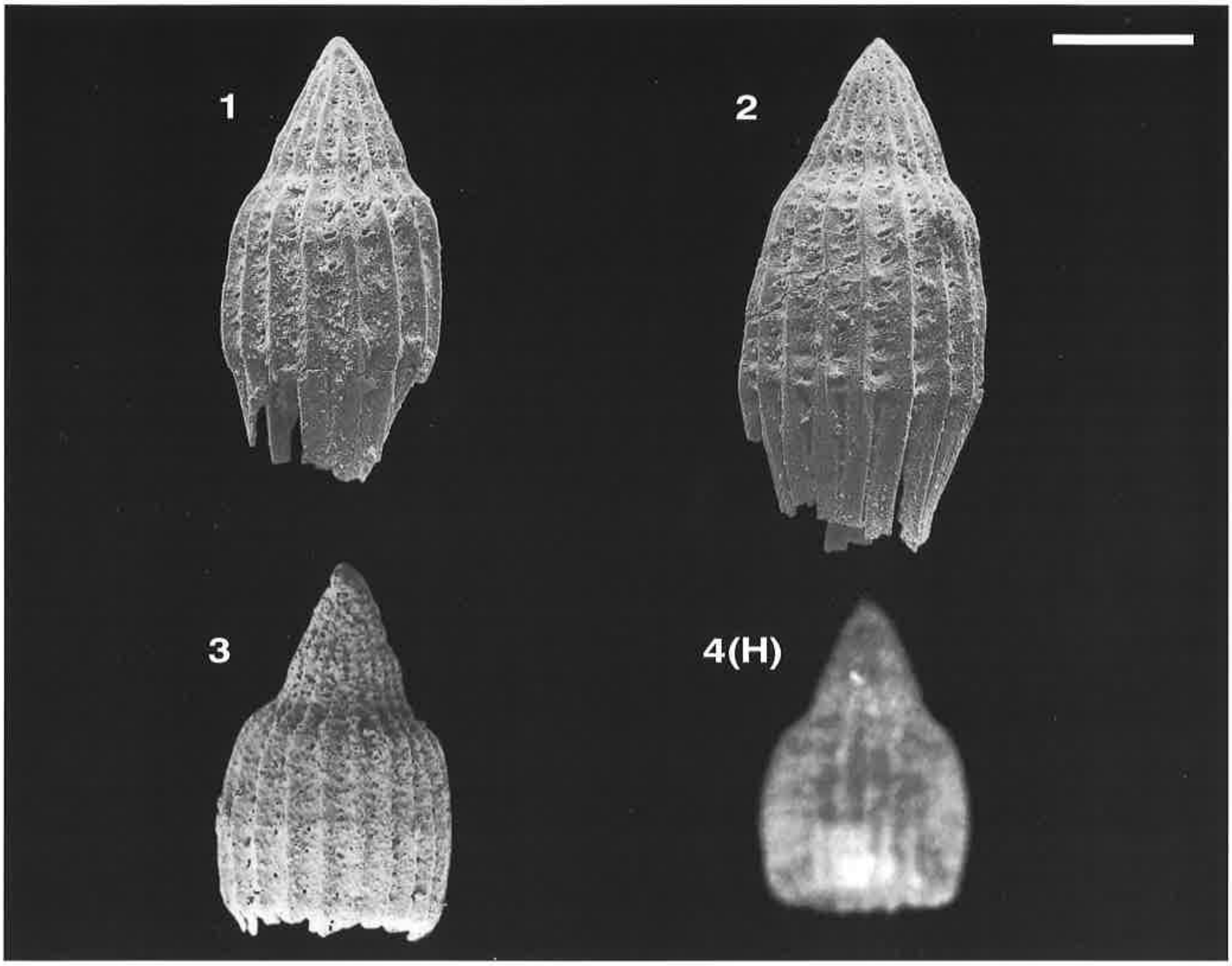


Plate 5296. ***Thanarla elegantissima*** **(CITA) sensu SANFILIPPO & RIEDEL.** Magnification x250. **Fig. 1.** DU3507, Mo46. **Fig. 2.** DU3501, Mo46. **Fig. 3.** RJ9, Bo685.20. **Fig. 4(H).** CITA 1964, pl. 12, fig. 2.

shell and by the presence of the continuing longitudinal costae; but the latter is consisting of only two segments. Other specimens described as *Cryptocephalus* ? by RIEDEL & SCHOCKLER 1956 in the Cretaceous (?) of California have the shape, the dimensions and ornamentation rather similar to our specimens, but differ by lacking distinct septa".

Actualized Remarks.- (SANFILIPPO & RIEDEL, 1985) Distinctions from other species see under *Thanarla pulchra*. The forms that Foreman (1975, pl. 2G, figs. 3, 4) and Muzavor (1977, pl. 8, fig. 1) illustrated as *Lithocampe elegantissima* would now be identified as *Thanarla pulchra*, the distension of the inflated terminal portion of the shell being more than 25%.

Etymology.- For the elegance of its form.

Measurements (in μm).-
Based on Cita's holotype : Total length 160-182, length of the last segment 95-115, maximum width 110-140. Sanfilippo & Riedel (1985): total length (excluding feet) 155-205, maximum width 100-150.

Type Locality.- Sample 2697, Spiazzia del Monte Baldo, Prov. Verona, Italy.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

THANARLA GUTTA 5904

Thanarla gutta JUD

Synonymy.-
Mita sp. A
TUMANDA 1989, pl. 3, fig. 13.
Thanarla gutta JUD
JUD 1994, p. 113, pl. 23, figs. 4-5.

Original Definition.- Inflated spindle-shaped test of probably 5 segments. Test with 11-12 longitudinal costae visible on half a perimeter. Intercostal depressions with a single row of generally slit-shaped pores. Costae continuous from cephalis to distal part, which is constricted, inverted conical, with a relatively wide aperture. Pores of this part tending to be larger and to become round.

Original Remarks.- *Thanarla gutta* n.sp. differs from *Thanarla pulchra* SQUINABOL by having a shorter apical part compared to the inflated postabdominal segment, by a generally greater number of longitudinal costae, generally larger size and inverted conical distal part. In samples of the section Presale there were found specimens which were generally smaller than those at Fiume Bosso, two such specimens measured having a total length of 204 and 225 μm respectively and a width of 156 and 161 μm. By their size these specimens are on the upper limit of the average measurements of *Thanarla pulchra* CITA sensu SANFILIPPO & RIEDEL 1985. Despite of this they differ clearly from *T. pulchra* in all the characters mentioned above in the definition of this new species. Some of our specimens resemble the paratypes of *Eucyrtidium brouweri* illustrated by TAN (1927, pl. 11, figs. 90-91) in their overall shape and size of test and in the shape of the pores. They differ from these paratypes by having generally less and continuous costae and by having the proximal part of test rather slightly concave. There is no resemblance at all to the holotype of *Eucyrtidium brouweri* TAN (figs. 89a-b). Some specimens have a small depression in the concave upper part of test.

Etymology.- From the Latin *gutta*, drop.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Total height:	350	312	272	345
Maximum width:	205	211	170	286

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 20-21, late Haut. to early Barr.

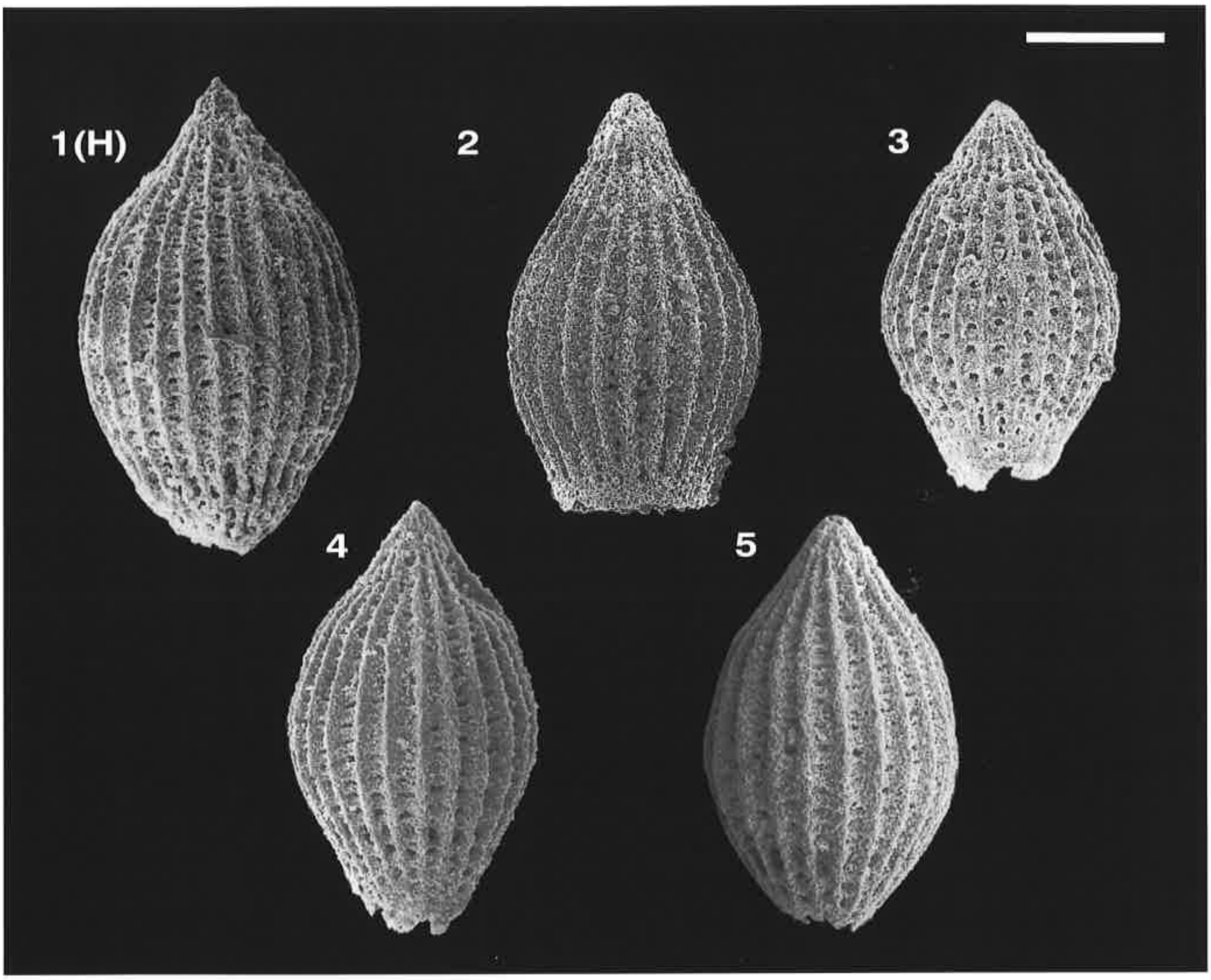


Plate 5904. *Thanarla gutta* JUD. Magnification x200. **Fig. 1(H).** RJ1830, Bo566.50. **Fig. 2.** RJ318, Br28.85. **Fig. 3.** DU3556, Mo46. **Fig. 4.** RJ635, Bo566.5. **Fig. 5.** RJ612, Bo566.5.

THANARLA PULCHRA 5073

Thanarla pulchra (SQUINABOL) sensu SANFILIPPO & RIEDEL

Synonymy.-
Sethamphora pulchra SQUINABOL
SQUINABOL 1904, p. 213, pl. 5, fig. 8.
MOORE 1973, p. 826, pl. 3, figs. 5-6, not 4.
Dictyomitra pulchra (SQUINABOL)
DUMITRICA 1975, p. 87, text-fig. 2.7.
Lithocampe elegantissima CITA
FOREMAN 1975, p. 616, pl. 2G, figs. 3-4
MUZAVOR 1977, p. 100, pl. 8, fig. 1.
AOKI 1982, pl. 3, figs. 11-12.
Thanarla pulchra (SQUINABOL)
PESSAGNO 1977b, p. 46, pl. 7, figs. 7, 21, 26.
NAKASEKO & NISHIMURA 1981, p. 163, pl. 15, fig. 11; not pl. 7, figs. 4-5, 7-8; pl. 15, fig. 12.
TAKETANI 1982a, p. 59, pl. 11, fig. 19
SCHAAF 1984, p. 133, figs. 7a-b, not all others.
SANFILIPPO & RIEDEL 1985, p. 600, figs. 8.2a-e.
SUYARI 1986b, pl. 2, fig. 1, not 2.
Lithocampe (?) *elegantissima* FOREMAN
NAKASEKO et al. 1979, p. 23, pl. 4, fig. 2.
Thanarla elegantissima (CITA)
SCHMIDT-EFFING 1980, p. 246, text-fig. 22.
MATSUYAMA et al. 1982, pl. 2, fig. 2.
Thanarla sp. cf. *T. pulchra* (SQUINABOL)
OKAMURA & UTO 1982, pl. 5, fig. 6.
YAO 1984, pl. 4, fig. 10.
Thanarla pulchra (SQUINABOL) sensu SANFILIPPO & RIEDEL
JUD 1994, p. 114, pl. 23, figs. 6-7.

Original Definition.-"Test elegantly formed like a filled bottle of goatskin, slender, slightly costate longitudinally with 16 delicate sharpcornered ribs; between the costae which begin about on the top of the test are small rather circular pores equally aligned in rows, 18 per row, not alternating. Aperture constricted. The conical, globose cephalis terminates in tapering thus to its extremity that it resembles a spine, the thorax is inflated, the partition between cephalis and thorax slightly marked by a little flexure of the test."

Actualized Definition.- (SANFILIPPO & RIEDEL, 1985) The campanulate shell is of 4-5 segments, the upper ones forming a narrow conical part and the last segment much larger and inflated. The angle between tangents above and below the concave change of contours is 130-170°. Single rows of pores are separated by 18-22 pronounced longitudinal costae. A pronounced internal septum constricts the mouth of the terminal segment, which is surrounded by lamellar feet colinear with costae in well-preserved specimens. Distension of the terminal segment (i. e. maximum breadth minus terminal breadth of shell, divided by distance between mouth and concave change of contour) is greater than 25 %.

Actualized Remarks.- (SANFILIPPO & RIEDEL, 1985) This form has frequently been confused with *Thanarla elegantissima* (CITA), and for this reason we here introduce a measure of the degree of distension of the last segment. In addition, a measure of the amount of change in contour will help stabilize its distinction from more simply conical forms such as *Cornutanna conica* ALIEV (1965). *Sethamphora squinaboli* HINDE (1908) is smaller, with a less pronounced change in marginal contour, and probably has fewer segments.

(JUD, 1994) Measurements of several specimens occurring in our samples have shown a total height of 180-211 μm, a width of 148-166 μm and a height of the proximal conical part of 63-72 μm, length of feet (1 specimen) 31 μm. These dimensions correspond to those done by Sanfilippo & Riedel 1985.

Measurements (in μm).-
Total length of test 181, maximum width of thorax 118 (Squinabol, 1904). Total length (excluding feet) 155-220, maximum width 100-160 (Sanfilippo & Riedel, 1985)

Type Locality.- Colli Euganei, soutern Venetian Alps, central Italy.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

THEOCAPSOMMA 3647

Genus: *Theocapsomma* HAECKEL, emend. FOREMAN

Synonymy.-
Theocapsomma HAECKEL
HAECKEL 1887, p. 1428.
emend. FOREMAN 1968, p. 29.

Type Species.- *Theocapsa linnaei* HAECKEL 1887.

Original Definition.- "Thorax much smaller than the abdomen, pores of the two nearly equal in size and similar in form."

Actualized Remarks.- (FOREMAN, 1968) The type species of *Theocapsa* (*Theocapsomma*), *T. linnaei* HAECKEL, seems to be sufficiently different from that of *Theocapsa* (*Theocapsa*), *T. gratiosa* RÜST 1885 (p. 309, pl. 12, fig. 16), in that the pores of the latter are in regular transverse rows, to justify the separation of these two taxa as genera rather than subgenera. There are in the upper Maestrichtian of California a number of closely related species with characters which, according to Haeckel's system, would require their placement in separate genera. They are now all included under *Theocapsomma* and the definition of that genus emended to include species with or without small apical horns, and with or without a small constricted aperture. Pores of the thorax and abdomen may or may not be similar, but none are assigned to *Theocapsura* or *Theocapsilla* because this evidently varies

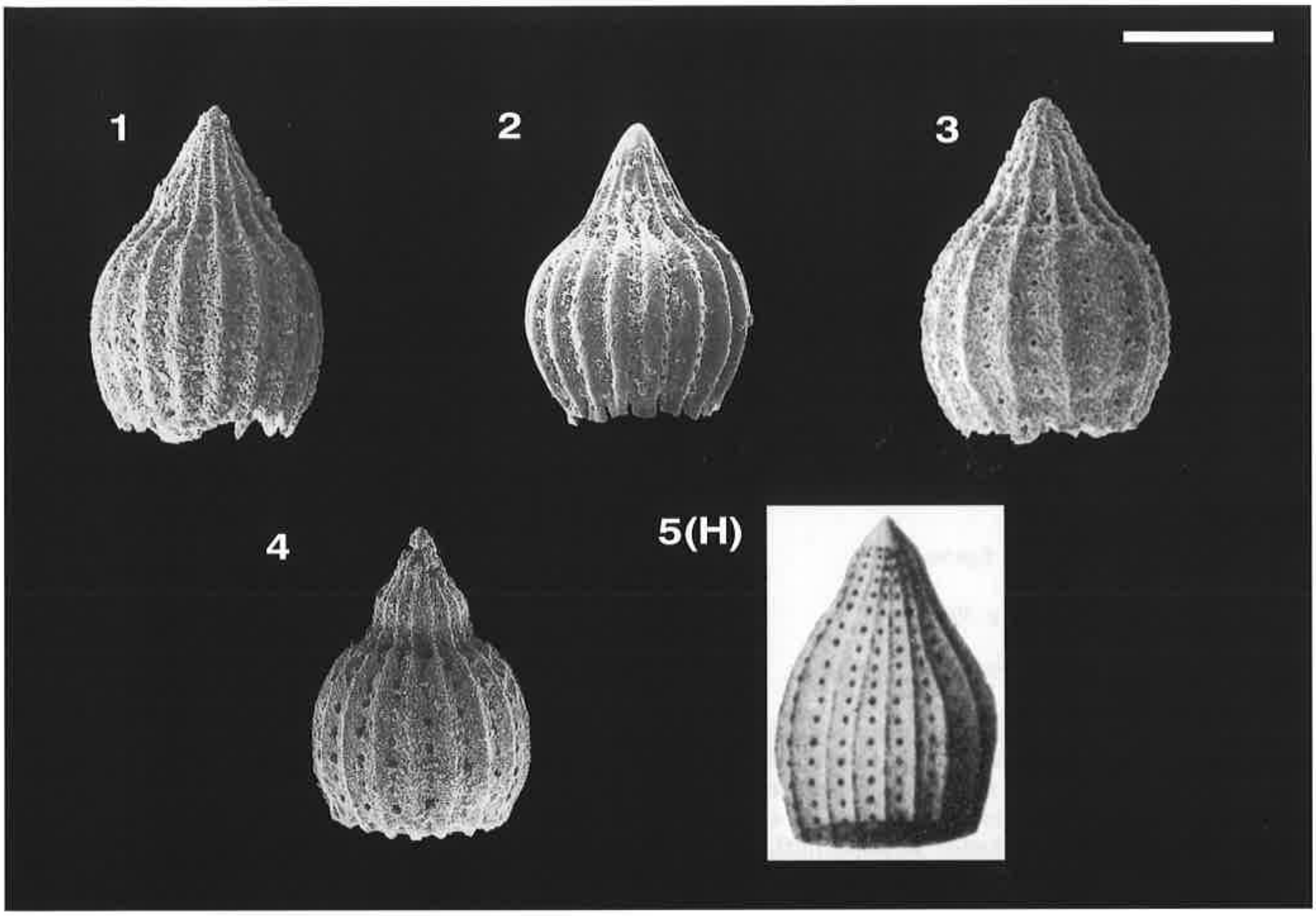


Plate 5073. *Thanarla pulchra* (SQUINABOL) sensu SANFILIPPO & RIEDEL. Magnification x200. **Fig. 1.** RJ66, Bo619.9. **Fig. 2.** POB81/0948, MO46a'. **Fig. 3.** RJ146, Pr225.3. **Fig. 4.** RJ29, Br141.55. **Fig. 5(H).** SQUINABOL 1904. pl. 5, fig. 8.

intraspecifically in the material here described, and because the type species of these latter have a pronounced neck between cephalis and thorax.

Remarks.- Species are determined on general test shape and distribution pattern of pores.

Etymology.- *Theocapsa* = Divine capsule.

Included Taxa.-
3276 *Theocapsomma bicornis* n.sp. BAUMGARTNER
3277 *Theocapsomma cordis* KOCHER
3047 *Theocapsomma cucurbiformis* n.sp. BAUMGARTNER
3043 *Theocapsomma* sp. A

THEOCAPSOMMA BICORNIS 3276

Theocapsomma bicornis n.sp. BAUMGARTNER

Synonymy.-
Cyrtocapsa (?) sp. B
MATSUOKA 1982a, pl. 2, figs 9a-b, 10.
? *Theocapsomma* sp. A
YAMAMOTO et al. 1985, p. 39, pl. 8, fig. 4.

Type Designation.- 82/9098, 534A.126.4.140.

Original Definition.- Small tricyrtid nassellarian with short, blunt vertical and apical horns. Cephalis included between base of horns, with almost no external separation to thorax. Thorax dome-shaped, separated by a gentle stricture from abdomen. Abdomen hemispherical, distally constricted, with a large circular basal pore. Test surface with faint ridges creating facets. Pores on entire test small, circular, widely spaced, sometimes in loose vertical rows.

Remarks.- This species differs form *Theocapsomma cordis* by the presence of two horns and by the faceted, sparsely porous surface.

Etymology.- *Bicornis*, Latin, with two horns.

Measurements (in μm).-
Based on 2 specimens.

	HT	av.	min.	max.
Length of horn:	16	18	16	21
H/W overall test:	136/76	118/69	100/62	136/76

Type Locality.- DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 126, Section 4, 140 cm.

UAZones.- 6-7, mid Bath. to late Bath.-early Call.

THEOCAPSOMMA CORDIS 3277

Theocapsomma cordis KOCHER

Synonymy.-
Theocapsomma cordis KOCHER
KOCHER 1981, p. 100, pl. 17, figs. 2-4.
BAUMGARTNER 1984, p. 789, pl. 9, figs. 16-17.
YAMAMOTO et al. 1985, p. 38, pl. 8, fig. 2.
AITA 1987, p. 68.
DANELIAN 1989, p. 196, pl. 8, fig. 17.
MATSUOKA 1990, pl. 2, fig. 3.

Original Definition.- "Test composed of three segments. A small oval cephalis is partly encased in a larger thorax. Thorax separated by a larger abdomen with a constriction. Cephalis seems to bear no horn. Abdomen is larger in the upper part and rounded at the base. Thorax and abdomen have small, rounded pores arranged in diagonal rows.Cephalis and thorax together somewhat shorter than abdomen which is also the widest of the three segments."

Original Remarks.- "This species differs from other species especially by the shape of the abdomen; in addition, it differs from *Theocapsa emiliae* RÜST (1885) by the position of cephalis and by lacking thorns on the surface; it is smaller than *Theocapsomma* sp. of FOREMAN (1971) and *Cyrtocapsella japonica* (NAKASEKO) in Foreman (1975). *Diabolocampe japonicum* NAKASEKO et al. (1979) is smaller and has an almost rounded abdomen. Only a few forms were recovered with a distinct elongated apical horn (samples S40 and S45). Four-segmented forms of the same dimensions with or without horn were found in samples S45 and 209."

Etymology.- Latin *cor* (m.) heart; the abdomen has the shape of a heart.

Measurements (in μm).-
Based on 32 specimens. Length: 85-107, width: 65-80.

Type Locality.- Saltrio, Italy.

UAZones.- 5-8, latest Baj.-early Bath. to mid Call.-early Oxf.

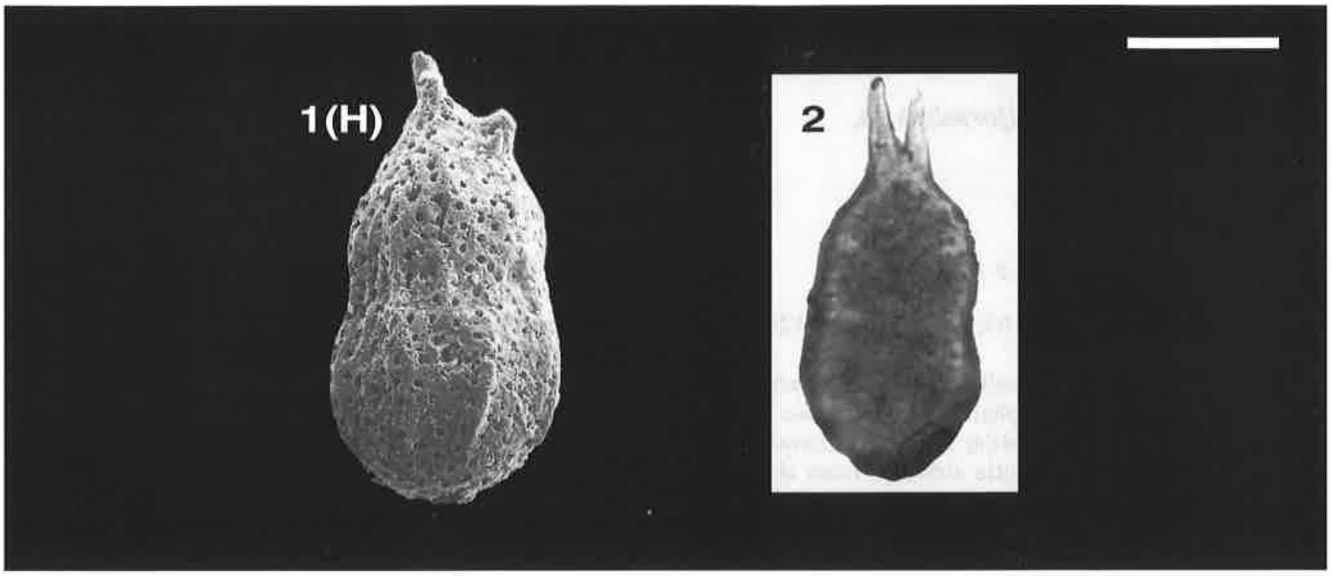


Plate 3276. *Theocapsomma bicornis* n.sp. BAUMGARTNER. Magnification x400. **Fig. 1(H).** POB82/9098, 534A.126.4.140. **Fig. 2.** MA1 Sakawa Town.

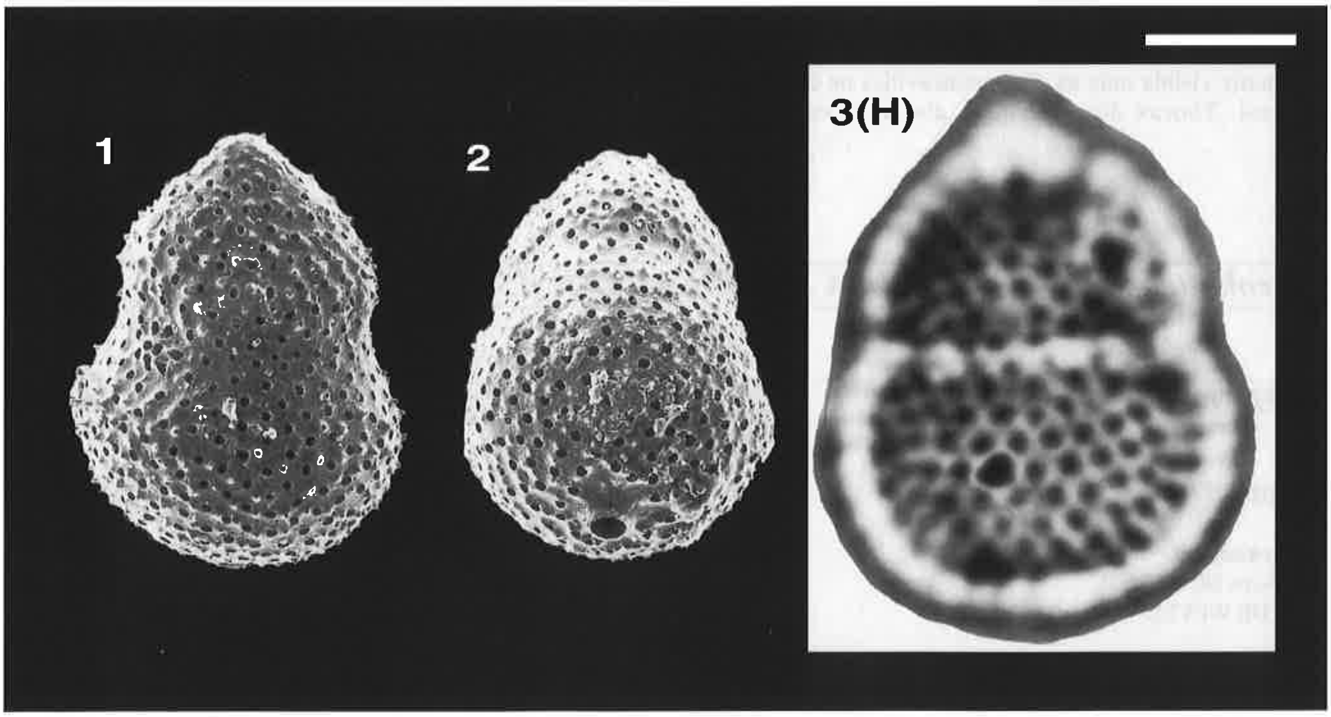


Plate 3277. *Theocapsomma cordis* KOCHER. Magnification x500. **Fig. 1.** POB82/9094, 534A.126.2.125. **Fig. 2.** POB82/9095, 534A.126.2.125. **Fig. 3(H).** KOCHER 1981, pl. 17, fig. 2.

THEOCAPSOMMA CUCURBIFORMIS 3047

***Theocapsomma cucurbiformis* n.sp. BAUMGARTNER**

***Synonymy*.-**
Theocapsa sp.
YAMAMOTO et al. 1985, p. 38, pl. 8, fig. 1.

***Type Designation*.-** 81/9163, 76.534A.126.2.125.

***Original Definition*.-** Small tricyrtid nassellarian with stout, club- shaped horn. Cephalis hidden at base of horn, with no clear external separation to thorax. Thorax dome-shaped, separated by a gentle stricture from abdomen. Abdomen broadly hemispherical, distally constricted, with a large circular basal pore. Test surface smooth except for faint ridges that run down from horn and cover sometimes cephalis and part of thorax. Similar ridges occur at stricture between thorax and abdomen. Pores on entire test small, circular, widely spaced, becoming denser at distal end of test, where surface becomes nodose.

***Remarks*.-** This species differs from *T. cordis* by the presence of a stout horn.

***Etymology*.-** *Cucurbiformis*, Latin for pumpkin-shaped.

***Measurements* (in μm).-**
Based on 2 specimens.

	HT	av.	min.	max.
Length of horn:	54	45	36	54
H/W cephalis-thorax:	64/66	66/70	64/66	68/74
H/W abdomen:	62/80	67/84	62/80	71/88

***Type Locality*.-** DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 126, Section 4, 140 cm.

***UAZones*.-** 6-7, mid Bath. to late Bath.-early Call.

THEOCAPSOMMA \ A 3043

***Theocapsomma* sp. A**

***Definition*.-** Small tricyrtid nassellarian with a slender horn. Cephalis, thorax and abdomen together forming a spindle, which is faceted by widely spaced vertical edges (about 8 on total circumference). Cephalis bears a slender blunt horn which has about 8 ridges and grooves. The ridges of the horn connect to the edges of the test. Segmental division between cephalis, thorax and abdomen externally visible only as slight concavities on the facets of the test. Thorax dome-shaped, abdomen cup-shaped, strongly constricetd at base.

Test surface between edges slightly concave, smooth, with 3-4 roughly vertical rows of small, circular pores on each facet. The rather irregular rows of pores may also run across the edges of the test. Distal end slightly nodose with denser, circular pores placed on nodes.

***Remarks*.-** This form differs from *Theocapsomma cucurbiformis* by its slenderer outline and its faceted test.

***UAZones*.-** 7-7, late Bath.-early Call.

theokaftensis >> *CRUCELLA THEOKAFTENSIS* 3131

THETIS 3650

Genus: *Thetis* DE WEVER

***Synonymy*.-**
Thetis DE WEVER
DE WEVER 1982a, p. 195.

***Type Species*.-** *Thetis oblonga* DE WEVER 1982a.

***Original Definition*.-** "Multicyrtid with a stout apical horn and three thoracic spines. Last segment is prolonged by a velum".

***Original Remarks*.-** "This genus differs from *Ectonocorys* by its hemispheric cephalis".

***Etymology*.-** Dedicated to *Thetis*, goddess of the seas, grand-daughter of *Tethys* and mother of *Achilles*.

***Included Taxa*.-**
3003 *Thetis* (?) *bernoulii* n.sp. BAUMGARTNER.

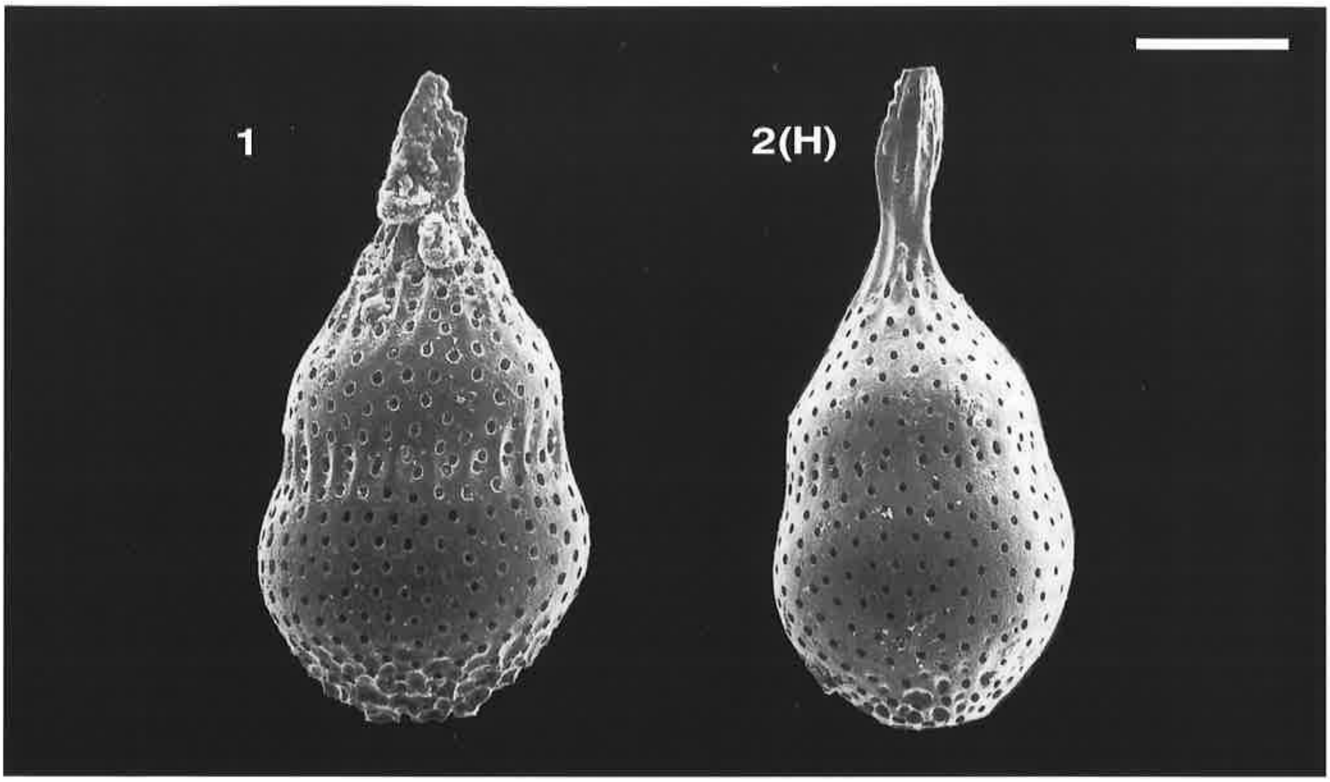


Plate 3047. ***Theocapsomma cucurbiformis*** **n.sp. BAUMGARTNER.** Magnification x500. **Fig. 1.** POB82/9092, 534A.126.4.140. **Fig. 2(H).** POB81/9163, 76.534A.126.2.125.

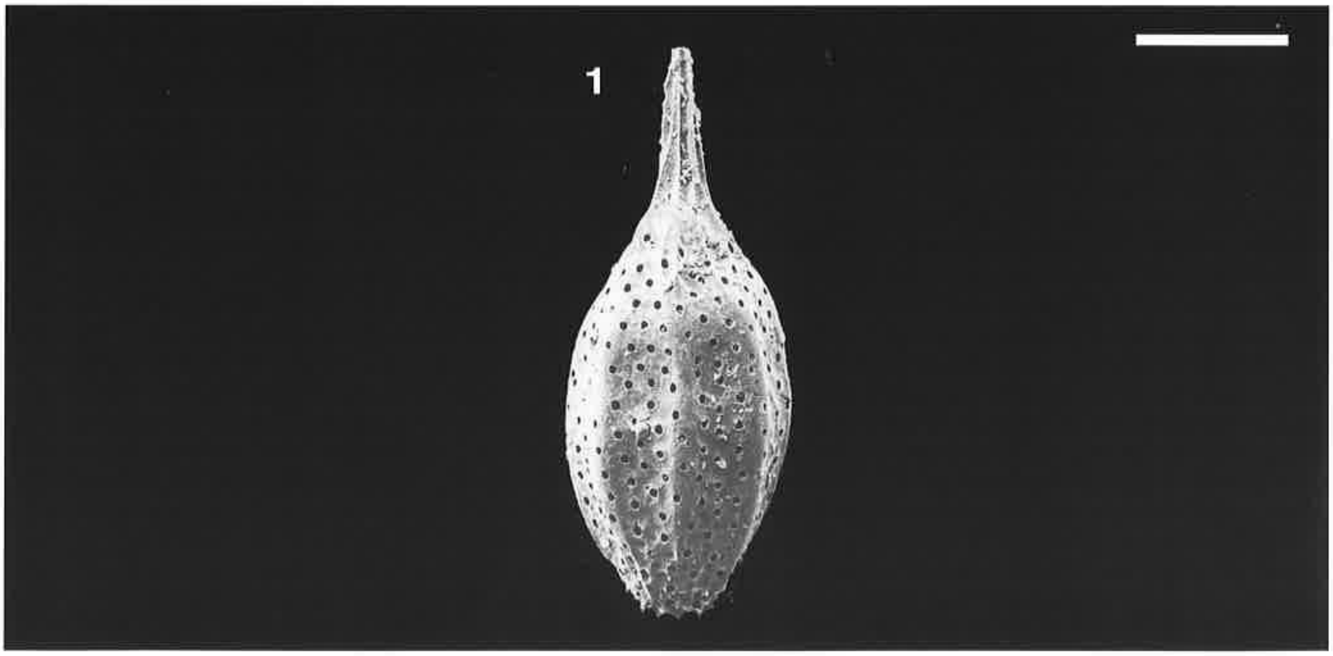


Plate 3043. ***Theocapsomma*** **sp A.** Magnification x500. **Fig. 1.** POB81/1469, 534A.125.2.36.

THETIS (?) BERNOULLII — *3003*

Thetis (?) *bernoullii* n.sp. BAUMGARTNER

Type Designation.- 81/9163, 534.124.1.52.

Original Definition.- Small monocyrtid nassellarian with a stout apical horn, prolonging the apical spine. The cephalic structure includes left and right primary and secondary lateral spines, a short median bar leading to a stout dorsal spine, and delicate vertical and apical spines. The left and right primary lateral spines and the dorsal spine have downwards directed extensions (legs), between which a delicate skirt (velum) is spread. On some specimens the secondary left and right lateral spines connect to an external protrusion. A large circular pore placed on a ridge marks externally the place where the apical spine meets the cephalic wall (comparable to the ditrema of *Saitoum*). Cephalis externally hemispherical with irregular ridges running down from the horn and sometimes meeting the legs. Pores on cephalis and on skirt large, circular, irregularly spaced. Some specimens show a sparsely porous, thickened skirt.

Original Remarks.- This species should be assigned to a yet undescribed new genus. It bears only distant resemblance to *Thetis*.

Etymology.- Dedicated to Daniel Bernoulli, ETH, Zurich, Switzerland, in honor of his contribution to the understanding of ancient passive continental margins in the Alpine-Mediterranean realm.

Measurements (in μm).-
Based on 2 specimens.

	HT	av.	min.	max.
Length of horn:	51	53	51	55
H/W cephalis-thorax:	56/50	64/57	56/50	73/64
Width between base of legs:	74	77	74	80

Type Locality.- DSDP Site 534, Blake Bahama Basin, Western North Atlantic, Core 124, Section 1, 52 cm.

UAZones.- 7-7, late Bath.-early Call.

tithonianum >> TRIACTOMA TITHONIANUM — *3097*

titirez >> STYLOSPONGIA (?) TITIREZ — *5090*

trachyostraca >> SETHOCAPSA TRACHYOSTRACA — *3063*

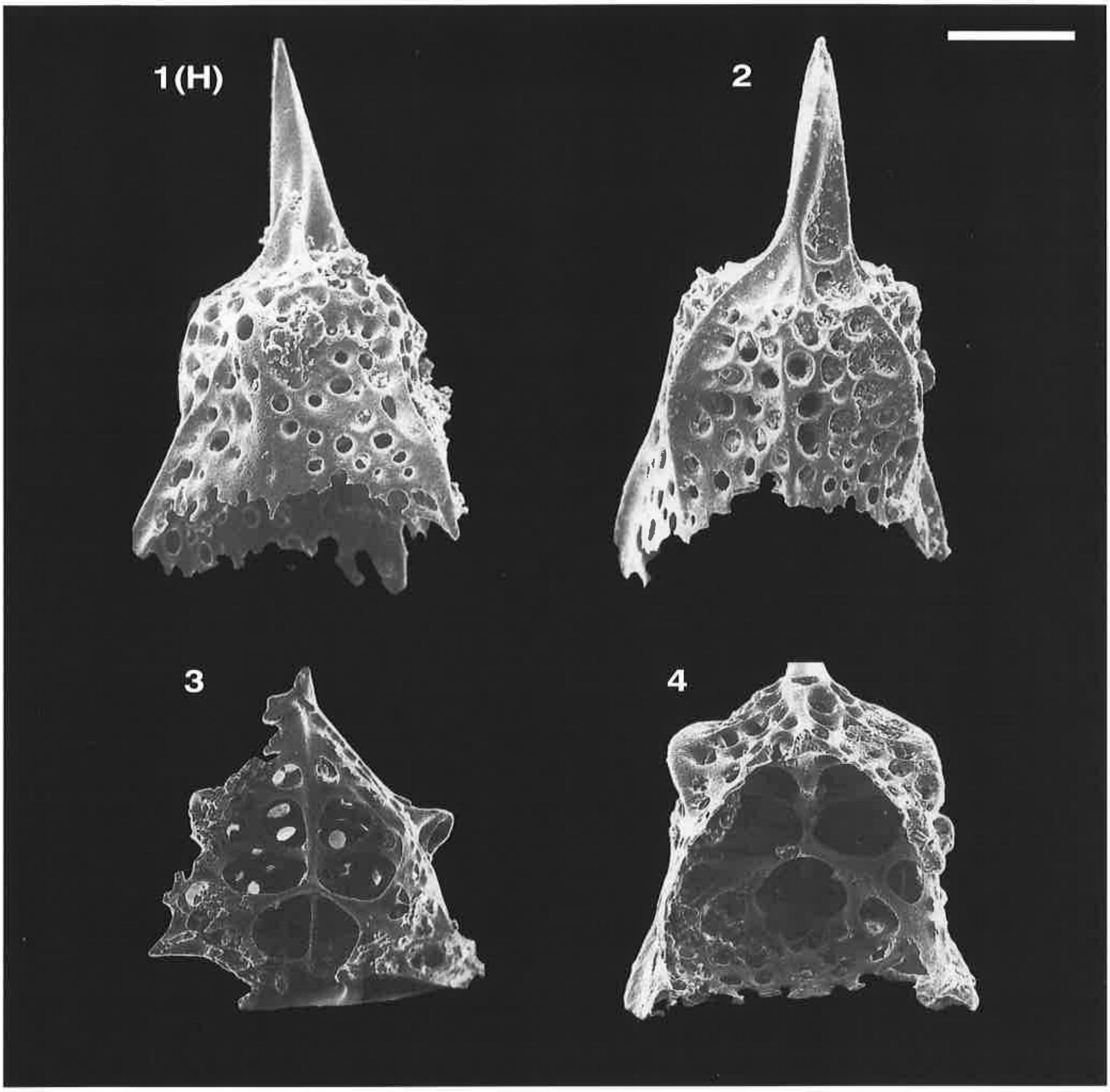


Plate 3003. *Thetis* (?) *bernoullii* n.sp. BAUMGARTNER. Magnification x700. **Fig. 1(H).** POB81/2645, 534.124.1.52. **Fig. 2.** POB81/2654, 534.124.1.52. **Fig. 3.** POB81/2713, 534.124.1.52. **Fig. 4.** POB81/2650, 534.124.1.52.

TRANSHSUUM 3809

Genus: *Transhsuum* TAKEMURA

Synonymy.-
Transhsuum TAKEMURA
TAKEMURA 1986, p. 51.

Type Species.- *Transhsuum medium* TAKEMURA 1986.

Original Definition.- Shell of multi-segments, conical or cylindrical, with or without apical horn. Cephalo-thorax usually poreless, usually with smooth surface. Abdomen and post-abdominal segments with both longitudinally and laterally arranged pores. Distinct longitudinal usually discontinuous costae, between which there are usually two or three rows of pores, covering almost all the surface or the distal part of the shell. MB, A, V, D, two L and two l as cephalic skeletal elements.

Original Remarks.- Distinct discontinuous costae of *Transhsuum* n.gen. had primarily appeared at the distal part of the shell of Middle Jurassic forms, just the same as distinct continuous costae of *Hsuum* PESSAGNO emend. Therefore Middle Jurassic forms bearing discontinuous costae at the distal part are the intermediate forms between *Parahsuum* and *Transhsuum* possessing costae all over the shell. *Transhsuum* n.gen. is distinguished from *Parahsuum* YAO or *Hsuum* s.s. PESSAGNO by the possession of distinct discontinuous costae.

Included Taxa.-
3181 *Transhsuum brevicostatum* gr. (OZVOLDOVA)
3194 *Transhsuum hisuikyoense* (ISOZAKI & MATSUDA)
3180 *Transhsuum maxwelli* gr. (PESSAGNO)
3278 *Transhsuum medium* TAKEMURA

TRANSHSUUM BREVICOSTATUM GR. 3181

Transhsuum brevicostatum gr. (OZVOLDOVA)

Synonymy.-
Dictyomitra sp. D.
BAUMGARTNER & BERNOULLI 1976, p. 617, fig. 12j.
Lithostrobus brevicostatus OZVOLDOVA
OZVOLDOVA 1975, p. 84, pl. 102, fig. 1.
OZVOLDOVA 1979, p. 259, pl. 5, fig. 2.
Hsuum brevicostatum (OZVOLDOVA)
KOCHER 1981, p. 73, pl. 14, fig. 13.
BAUMGARTNER 1984, p. 769, pl. 5, figs. 1-2.
DE WEVER & MICONNET 1985, p. 387, pl. 4, fig. 12.
DE WEVER et al. 1986b, pl. 11, fig. 2.
not MATSUOKA 1986, pl. 2, fig. 10.
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, fig. 3.
OZVOLDOVA 1988, pl. 6, figs. 1, 11.
WAKITA 1988, pl. 3, fig. 12; pl. 4, fig. 6.
MATSUOKA 1990, pl. 1, fig. 2.
OZVOLDOVA 1990, pl. 5, fig. 3.
MATSUOKA 1992, pl. 5, fig. 7.
WIDZ 1991, p. 247, pl. 2, fig. 9.
PESSAGNO et al. 1993, p. 136, pl. 6, figs. 3, 4, 21, 23.
Hsuum maxwelli PESSAGNO
MIZUTANI 1981, p. 176, pl. 59, fig. 5.
Hsuum cf. *maxwelli* PESSAGNO
? SASHIDA et al. 1982, pl. 2, fig. 7.

Original Definition.- The shell is conical, composed of 11 chambers, regularly broadening toward the basal shell mouth. The first chamber -cephalis is oval, provided with an apical horn; the next two -thorax and abdomen show indistinct sculpture. The walls of the outer chambers - postabdominal segments are distinctly convex, with short longitudinal ribs, separated by two longitudinal lines of pores, with 3 pores in each line.

The shell is shaped to a high cone consisting of 11 chambers. The chambers regularly broaden towards the basal shell mouth. The first chamber is circular, with a short apical horn. The next two show indistinct sculpture. The other chambers have markedly convex walls, with short longitudinal ridges. Among the ridges, in a depression, are two longitudinal lines of pores. The number and length of ridges in the individual chambers increase toward the basal shell mouth (8-11 ridges in a half of the shell). Sutures among chambers are depressed. The walls are irregularly convex. Towards the basal shell mouth, approx. to 2/3 of the chamber height, convexity slowly increases, and in the last third sudden constriction appears. In the first 2/3 of the chamber height are 2 pores in each longitudinal line, and in the last third is 1 pore in each line. The basal shell mouth is open, broad.

Etymology.- According to its short ribs. Latin *brevis*, short; *costa*, rib.

Measurements (in μm).-
Holotype: shell height, 270; shell width, 130; apical horn height, 12; ridge length, 6-16. Paratype: shell height, 270-300; shell width, 110-130.

Type Locality.- The Hill Keblie near Puchov; radiolarites of the Kysuca Series, Klippen Belt.

UAZones.- 3-11, early-mid Baj. to late Kimm.-early Tith.

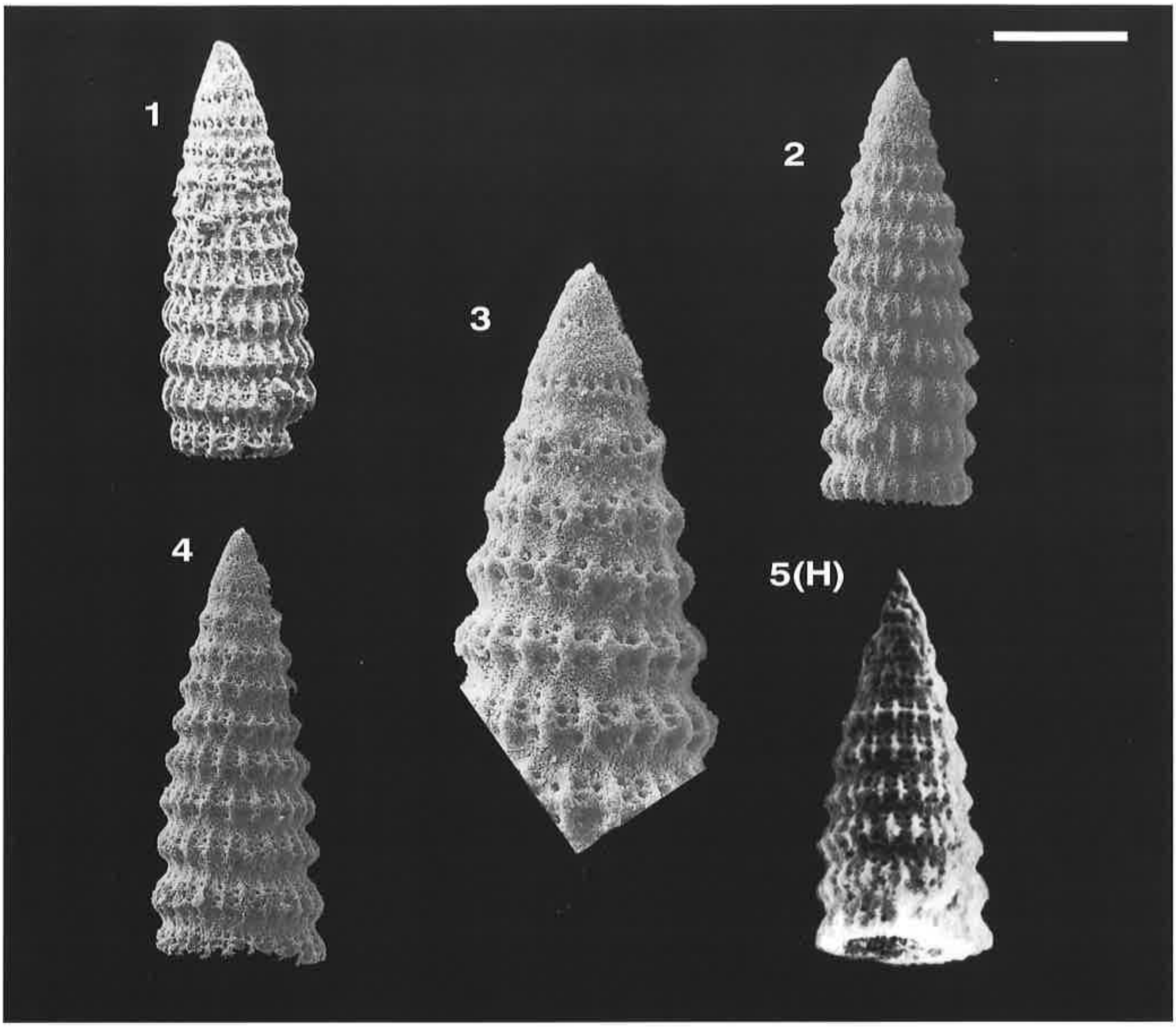


Plate 3181. *Transhsuum brevicostatum* gr. (OZVOLDOVA). Magnification x200, except Fig. 3, x400. **Fig. 1.** POB79/0360, POB28.53. **Fig. 2.** DU1865, R102. **Fig. 3.** DU1846, R102. **Fig. 4.** DU1844, R102. **Fig. 5(H).** OZVOLDOVA 1975, pl. 102, fig. 1.

TRANSHSUUM HISUIKYOENSE 3194

Transhsuum hisuikyoense (ISOZAKI & MATSUDA)

Synonymy.-
Hsuum sp. A
KOJIMA 1982, pl. 1, fig. 6.
Hsuum sp. A group
KIDO et al. 1982, pl. 2, fig. 4.
Hsuum sp. B
YAO et al. 1982, pl. 3, fig. 1.
YAO 1984, pl. 1, figs. 2, ? 1.
KISHIDA & HISADA 1986, pl. 7, figs. 2-3.
MATSUOKA 1986c, pl. 2, fig. 6.
Hsuum sp. D
SUNOUCHI et al. 1982, text-fig. 3.8.
Hsuum sp. G
KISHIDA & SUGANO 1982, pl. 8, figs. 13-14, not fig. 15.
? NISHIZONO & MURATA 1983, pl. 5, fig. 5.
SATO et al. 1986, pl. 2, figs. 15, ? 16.
Hsuum sp. cf. *H. parasolense* PESSAGNO & WHALEN
HATTORI & YOSHIMURA 1983, pl. 9, fig. 9.
Hsuum sp.
HATTORI & YOSHIMURA 1983, pl. 9, fig. 10.
Hsuum spp.
? BAUMGARTNER 1985, fig. 37.r, fig. 38.s.
Hsuum hisuikyoense ISOZAKI & MATSUDA
ISOZAKI & MATSUDA 1985, p. 437, pl. 2, figs. 10-18.
SASHIDA 1988, p. 18, pl. 4, figs. 3, 6-8, 19-20.
MATSUOKA & YAO 1986, pl. 1, fig. 8; pl. 3, fig. 4.
HATTORI 1988, pl. 13, fig. G.
HATTORI 1989, pl. 15, figs. C, E, not fig. D.
KITO 1989, p. 179, pl. 20, figs. 7-13.
HORI 1990, fig. 9.54.
KITO et al. 1990, pl. 1, fig. 2.
YAO 1991, pl. 2, fig. 16.
Hsuum bipartitus GRILL & KOZUR
GRILL & KOZUR 1986, p. 256, pl. 5, figs. 1-6.
Transhsuum medium TAKEMURA
TAKEMURA 1986, p. 51, pl. 5, fig. 25 only.
Hsuum brevicostatum (OZVOLDOVA)
YOKOTA & SANO 1986, pl. 1, fig. 9.
Transhsuum aff. *T. medium* TAKEMURA
HATTORI 1987, pl. 17, figs. 5-6, not fig. 15.
Hsuum sp. aff. H. *hisuikyoense* ISOZAKI & MATSUDA
HATTORI 1989, pl. 15, figs. F, H, not fig. G.
Hsuum sp. 1
KITO 1989, p. 180, pl. 20, figs. 14, 15, 21, 22, ? 16.

Original Definition.- Shell of 8 to 11 segments, possibly more, long conical. Cephalis conical, having thick wall with scarce pores and an apical horn ornamented by several shallow longitudinal grooves. Internally, 4 collar pores, divided by median bar, V-bar and 2 L-bars. Post-cephalic segments trapezoidal in longitudinal section; each segment slightly widening distally except for the distal-most one which is inversely trapezoidal in longitudinal section. Average ratio of height to width for a single post-abdominal segment approximately 1:4. Outer surface of post-abdominal segments ornamented with numerous discontinuous, short costal elements which are arranged in incomplete rhombic-latticed pattern, transversely between every 1 or 2 longitudinal rows of pores, 20-21 in number around each joint of segment, and longitudinally at every 1 or 2 joint of segment. Each costal element approximately as long as the average height of a single segment, culminating around junction with the joint, decreasing its height to both sides, submerging into costa in the middle part of every segment. Longitudinal section of inner surface of wall, convex outward in the middle part of each segment. Pores circular, uniform in size, aligned longitudinally between every neighbouring pair of costae, transversely in 4 rows for each segment. Internal planiform partitions, imperforate, circular in outline, slightly thickened at inner margin, terminating abruptly to leave a large centrally placed aperture.

Original Remarks.- *Hsuum hisuikyoense* n.sp. is characterized by its nearly regular arrangement of numerous short costal elements. The development of its costal elements, however, varies considerably among specimens, from one specimen possessing costal elements throughout the outer surface of shell to others with costal elements rather restricted in distal two-thirds of the shell. In most specimens, costal elements are almost absent on cephalis, thorax and abdomen; if present at all, they are no more than rudimentary ones.

H. hisuikyoense n.sp. is apparently similar to *H. maxwelli* PESSAGNO, *H. parasolense* PESSAGNO & WHALEN and *H. robustus* PESSAGNO & WHALEN in having numerous short, discontinuous costal elements. However, it can be distinguished from the latter 3 species by having rather long, slender shell and thick-walled, robust apical horn. In addition, the average ratio of height to width for a single post-abdominal segment of *H. hisuikyoense* n.sp. (1:3) is clearly different from those of the latter 3 species (1:4).

As shown in the synonymy list, specimens identical with *H. hisuikyoense* n.sp. have been reported by many authors from various localities throughout Japan. But range of morphological variation of the species has not been fully understood yet. Under the name of *Hsuum* sp. B YAO, 1984 illustrated two specimens in his plate, namely the one precisely referable to *H. hisuikyoense* n.sp. (pl. 1, fig. 2 in Yao 1984) and the other one with rather continuous costae in the distal 2 to 3 segments (pl. 1, fig. 1). Other features of the latter specimen are almost identical to those of *H. hisuikyoense* n.sp. Thus Yao's figured specimen of the latter type is here tentatively cited in the synonym list. Specimens from the study sample completely lack distal continuous costae.

H. hisuikyoense n.sp. also morphologically resembles *Parahsuum* sp. D (pl. 2, fig. 19 in Yao et al., 1982). *Parahsuum* sp. D YAO, however, can be discriminated from *H. hisuikyoense* n.sp. by having slenderer and more smooth-surfaced cephalic shell and restricted distribution of costal elements in distal portion shell. Except for these differences, most of their features are common between the two species. Because *Parahsuum* sp. D YAO has not been fully described yet, comparison with this species and possibility of their phylogenetic relation remain as future problems.

Remarks.- Included are all specimens with a *Parahsuum*-like wall structure of the proximal part of the test and strong short discontinuous costae distally. This species is very similar to *Parahsuum grande* HORI & YAO but differs from the latter by the discontinuous costae developing around more than final 2 or 3 segments, by the thicker wall around cephalis and by its smaller test.

Etymology.- The specific name comes from the type locality of this species, Hisuikyo Gorge, Gifu Prefecture, central Japan.

Measurements (in μm).-
Based on 9 specimens.

	min.	max.	av.
Heigth:	24	37	31
Maximum width:	110	140	130
Diameter of aperture at distal end:	60	70	70

Type Locality.- Sample 140, Hisuikyo, Kamiaso area, Gifu Prefecture, central Japan.

UAZones.- 2-7, late Aal. to late Bath.-early Call.

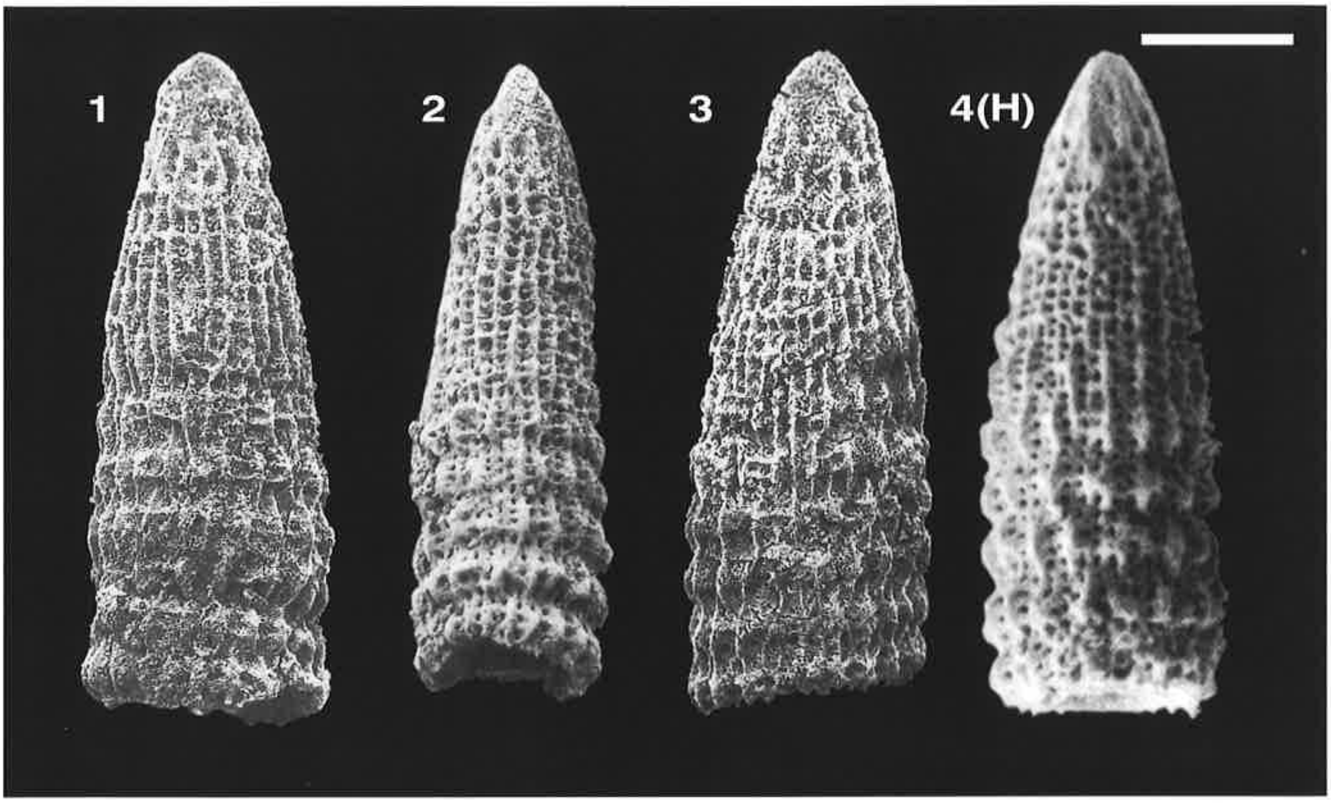


Plate 3194. *Transhsuum hisuikyoense* (ISOZAKI & MATSUDA). Magnification x300. **Fig. 1.** POB 80/2007, POB 1262. **Fig. 2.** MA 2892, 17-3007. **Fig. 3.** POB 80/2163, POB 1261. **Fig. 4(H).** ISOZAKI & MATSUDA 1985, pl. 2, Fig. 11.

TRANSHSUUM MAXWELLI GR. 3180

Transhsuum maxwelli gr. (PESSAGNO)

Synonymy.-
Hsuum maxwelli PESSAGNO
PESSAGNO 1977a, p. 81, pl. 7, figs. 14-16.
KOCHER 1981, p. 73, pl. 14, fig. 14.
DUMITRICA & MELLO 1982, pl. 4, figs. 1-3.
ORIGLIA-DEVOS 1983, p. 141, pl. 16, fig. 24.
EL KADIRI 1984, p. 139, pl. 24, fig. 2.
PESSAGNO et al. 1984, p. 25, pl. 1, fig. 6.
ISHIDA 1985, pl. 3, fig. 7.
DE WEVER & CORDEY 1986, pl. 1, fig. 1.
KISHIDA & HISADA 1986, fig. 2.10.
MATSUOKA 1986a, pl. 2, fig. 15.
MATSUOKA 1986b, pl. 2, figs. 11, 14, 16.
MATSUOKA & YAO 1986, pl. 2, fig. 16.
AITA 1987, p. 65.
WAKITA 1988, pl 4, figs. 4-5; pl. 5, fig. 11.
MATSUOKA 1990, pl. 1, fig. 12.
WIDZ 1991, p. 247, pl. 2, figs. 10-11.
YAO 1991, pl. 3, fig. 22.
MATSUOKA 1992, pl. 4, fig. 4.
PESSAGNO et al.1993, p. 136, pl. 6, fig. 1.
Hsuum sp. aff. *H. maxwelli* PESSAGNO
PESSAGNO 1977a, p. 82, pl. 8, figs. 1-2.
BAUMGARTNER 1985, fig. 43g.
Hsuum maxwelli PESSAGNO gr.
BAUMGARTNER 1984, p. 769, pl. 5, figs. 3-4.
DE WEVER & MICONNET 1985, p. 387.
OZVOLDOVA 1988, pl. 3, fig. 3; pl. 6, fig. 10.
Hsuum sp. A
YAMAMOTO et al. 1985, p. 35, pl. 5, fig. 2.
Hsuum sp. B
YAMAMOTO et al. 1985, p. 36, pl. 5, fig. 3.
Transhsuum maxwelli (PESSAGNO) gr.
DANELIAN 1989, p. 197, pl. 8, figs. 18-19.

Original Definition.- Test with discontinuous, diverging costae; width of costae expanding and contracting. Costal elements occasionally bifurcating. Two rows of square pore frames with circular pores present between costae. Horn short, circular in axial section.

Original Remarks.- This species differs from *H. cuestaensis* n.sp. by having (1) discontinuous costae whose width tends to expand and contract and (2) two rows of pore frames between costal elements.

Actualized Remarks.- (BAUMGARTNER, 1984) The studied material contains a number of morphotypes which come close to the cited forms in having a bluntly conical, smooth outline, often with a moderate distal constriction and poorly or undefined segmental divisions. Costae are discontinuous, merging, reaching over 1-3 segments. One or two irregular rows of pores between costae.

Etymology.- This species is named for Dr. John C. Maxwell (University of Texas at Austin) to honor his contributions to the study of California Coast Range geology.

Measurements (in μm).-
Based on 6 specimens. Height cephalis+thorax: 15-20; height of abdomen: 20 to 25; height PA 1-3: 20-35; height PA 4-8: 25-45.

Type Locality.- NSF 973. California Coast Ranges.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

TRANSHSUUM MEDIUM 3278

Transhsuum medium TAKEMURA

Synonymy.-
Transhsuum medium TAKEMURA
TAKEMURA 1986, p. 51, pl. 6, figs. 1-2; not pl. 5, figs. 25-26.
Hsuum sp.
HATTORI 1987, pl. 17, fig. 16.

Original Definition.- Shell conical to cylindrical, with 10 to 15 segments, with strictures at joints of distal segments. Cephalis conical and poreless, with or without conical apical horn. Thorax truncated-conical usually with a single transverse row of small pores. In some specimens some longitudinal ridges covering on the surface of cephalo-thorax. Abdomen and post-abdominal segments cylindrical with small pores, which are usually rectangularly arranged on the inner surface. Each post-abdominal segment bearing four to five transverse rows of pores. Indistinct discontinuous costae, their length is equal to the height of one segment, lying on distal segments. In mature specimens, small spines arising on the shell surface.

Original Remarks.- The shell structure of the proximal part of *Transhsuum medium* resembles that of the distal part of *Parahsuum cruciferum* (pl. 5, figs. 9, 11). Therefore it suggests that this new species represents the initial stage of the formation of *Transhsuum*-type discontinuous costae and that it is the intermediate form between *Parahsuum*-like form and *Transhsuum*.

Remarks.- Forms with a strong apical horn are assigned to this species.

Etymology.- The name *medium*, derived from *medius*, means intermediate.

Measurements (in μm).-
Based on 8 specimens. Length of shell, 265-385; Maximum width of shell, 100-135.

Type Locality.- Sample TKN-105, Komami, Yamato Village, Gifu Prefecture, central Japan.

UAZones.- 1-7, early-mid Aal. to late Bath.-early Call.

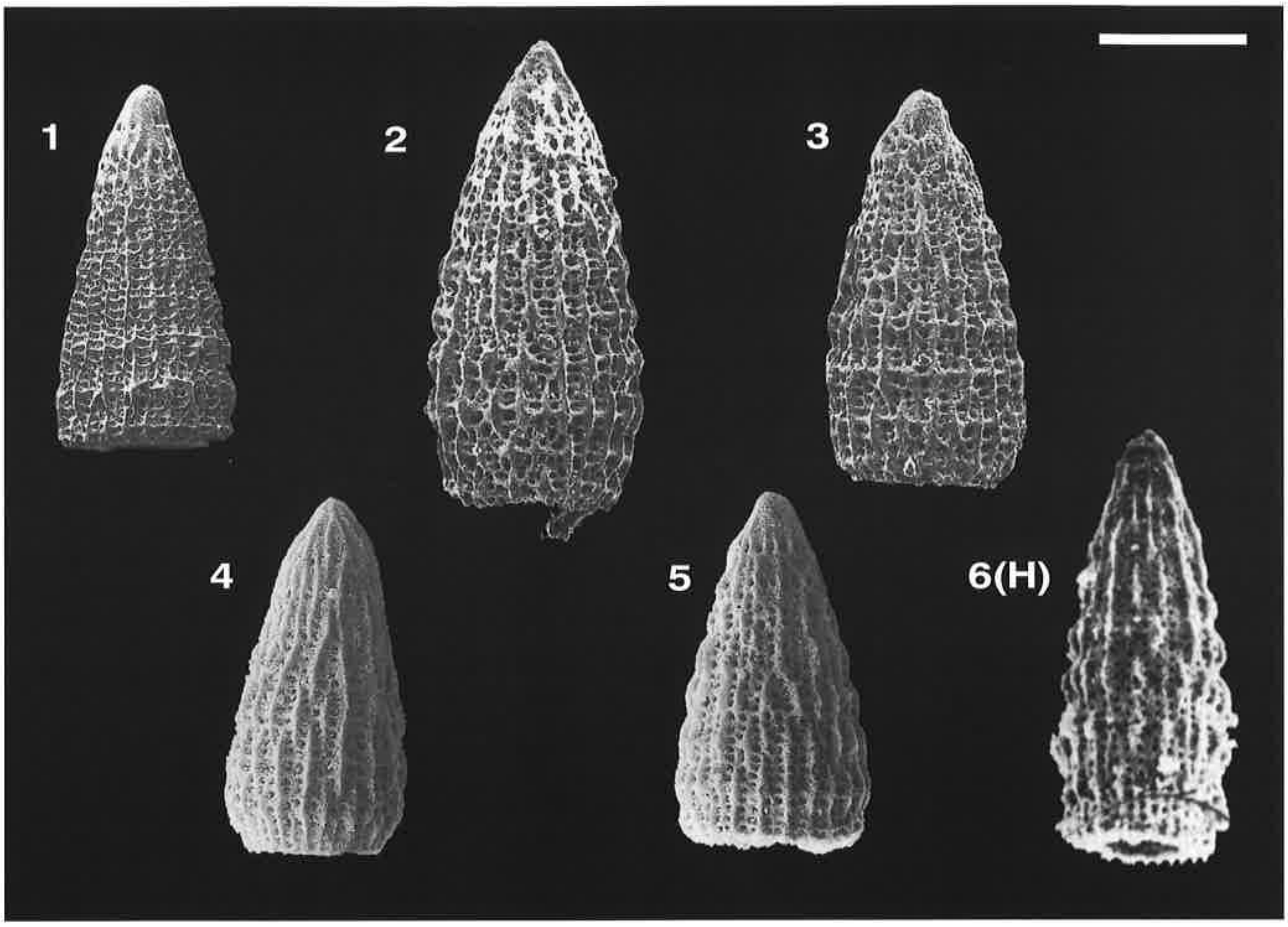


Plate 3180. ***Transhsuum maxwelli*** **gr. (PESSAGNO).** Magnification x200 **Fig. 1.** POB81/2460, 534.125.5.40. **Fig. 2.** POB78/3617, POB28.65. **Fig. 3.** POB78/3413, POB28.62. **Fig. 4.** DU3065, PJ9. **Fig. 5.** DU2930, PJ13. **Fig. 6(H).** PESSAGNO 1977a, pl. 7, Fig. 14.

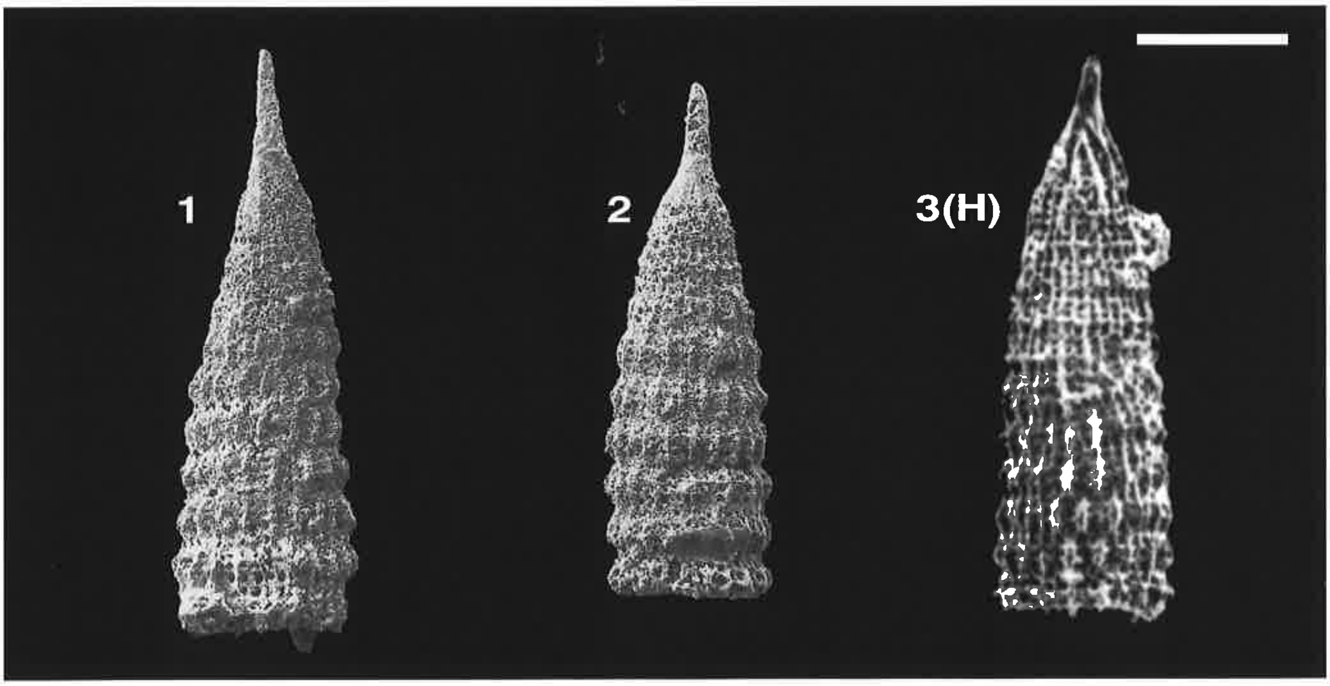


Plate 3278. ***Transhsuum medium*** **TAKEMURA.** Magnification x200. **Fig. 1.** POB81/2852, POB1341. **Fig. 2.** POB81/2851, POB1341. **Fig. 3(H).** TAKEMURA 1986, pl. 6, fig. 1.

triacanthus >> *ACAENIOTYLOPSIS VARIATUS TRIACANTHUS* 4066

TRIACTOMA 3655

Genus: *Triactoma* RÜST

Synonymy.-
Triactoma RÜST
RÜST 1885, p. 289.
Tripoyclia HAECKEL, emend PESSAGNO et al.
PESSAGNO et al. 1989, p. 212.
Neotripoyclia PESSAGNO & YANG
PESSAGNO et al. 1989, p. 204.
Zanola PESSAGNO & YANG
PESSAGNO et al. 1989, p. 241.

Type Species.- *Triactoma tithonianum* RÜST 1885, subsequent designation by Campbell (1954).

Original Definition.- "Spherical latticed test with three long, slender spines arranged in one plane. 10 rows of round pores, 10 per row. Not frequent. (HAECKEL 1881, p. 457) Spined Phacodiscida, with marginal spines situated in the equatorial plane of the lens; with three equidistant spines with the medullary shell single, and without a spiny zone".

Actualized Remarks.- (FOREMAN, 1973b) *Triactoma* RÜST p. 289 = *Triactis* HAECKEL 1881, p. 457. Loeblich & Tappan (1961, p. 244) indicate that "*Triactoma* was apparently used by Rüst as a substitute name for *Triactis* HAECKEL, 1881." However they validate the use of the name *Triactoma* because *Triactis* HAECKEL, 1881 is a junior homonym of *Triactis* KLUNZINGER, 1877.

Tripocyclia, *Neotripocyclia* and *Zanola* as defined by PESSAGNO & YANG (in Pessagno et al., 1989) are considered in this catalogue as synonyms of *Triactoma*.

Included Taxa.-
3095 *Triactoma blakei* (PESSAGNO)
3166 *Triactoma cornuta* BAUMGARTNER
4068 *Triactoma foremane* MUZAVOR
3409 *Triactoma jakobsae* n.sp. CARTER
3096 *Triactoma jonesi* (PESSAGNO)
5055 *Triactoma luciae* JUD
3412 *Triactoma mexicana* PESSAGNO & YANG
3413 *Triactoma parablakei* YANG & WANG
3097 *Triactoma tithonianum* RÜST

TRIACTOMA BLAKEI 3095

Triactoma blakei (PESSAGNO)

Synonymy.-
Tripocyclia blakei PESSAGNO
PESSAGNO 1977a, p. 80, pl. 6, figs. 15-16.
ISHIDA 1983, pl. 4, fig. 15.
Triactoma blakei (PESSAGNO)
FOREMAN 1978, p. 743, pl. 1, fig. 15.
KOCHER 1981, p. 101, pl. 17, fig. 5 only.
not MIZUTANI 1981, p. 175, pl. 57, figs. 5-6.
not ADACHI 1982, pl. 5, fig. 3.
not BAUMGARTNER 1984, p. 789, pl. 10, fig. 3.
not YAMAMOTO et al. 1985, p. 39, pl. 8, fig. 5.
DE WEVER et al. 1986, pl. 6, fig. 23, not fig. 15.
not OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 5.
not WAKITA 1988, pl. 5, fig. 23.
PESSAGNO et al. 1989, p. 206, pl. 7, figs. 17, 19, 24.
OZVOLDOVA 1990, pl. 1, fig. 1.
WIDZ 1991, p. 256, pl. 4, fig. 13.
Triactoma cf. *blakei* (PESSAGNO)
DUMITRICA & MELLO 1982, pl. 3, fig. 4.
Triactoma sp.
DE WEVER & MICONNET 1985, pl. 4, fig. 15.
Triactoma (?) sp. A
PESSAGNO et al. 1989, p. 212, pl. 10, figs. 23-24.

Original Definition.- Test rounded, globular with large, uniform hexagonal pore frames with circular pores and three relatively short spines; length of spines somewhat over one-half the diameter of test. Spines with complicated system of longitudinal ridges and grooves. Primary system with three wide grooves on each spine; secondary system with three narrow grooves on each spine. Six ridges of equal width distributed between primary and secondary grooves.

Original Remarks.- This species differs from *T. jonesi* in having a more globular test with proportionally larger pore frames and shorter spines. Both species share hexagonal pore frames and spines with the same structure.

Remarks.- See also remarks under *Triactoma foremanae* MUZAVOR.

Etymology.- *T. blakei* is named for Dr. M. C. Blake, Jr. (U. S. Geological Survey, Menlo Park, California) in honor of his contributions to the geology of the California Coast Ranges.

Measurements (in μm).-
Based on 10 specimens. Diameter 160-250, length of spines 90-125.

Type locality.- Sample NSF 907, Point Sal, Santa Barbara County, California.

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

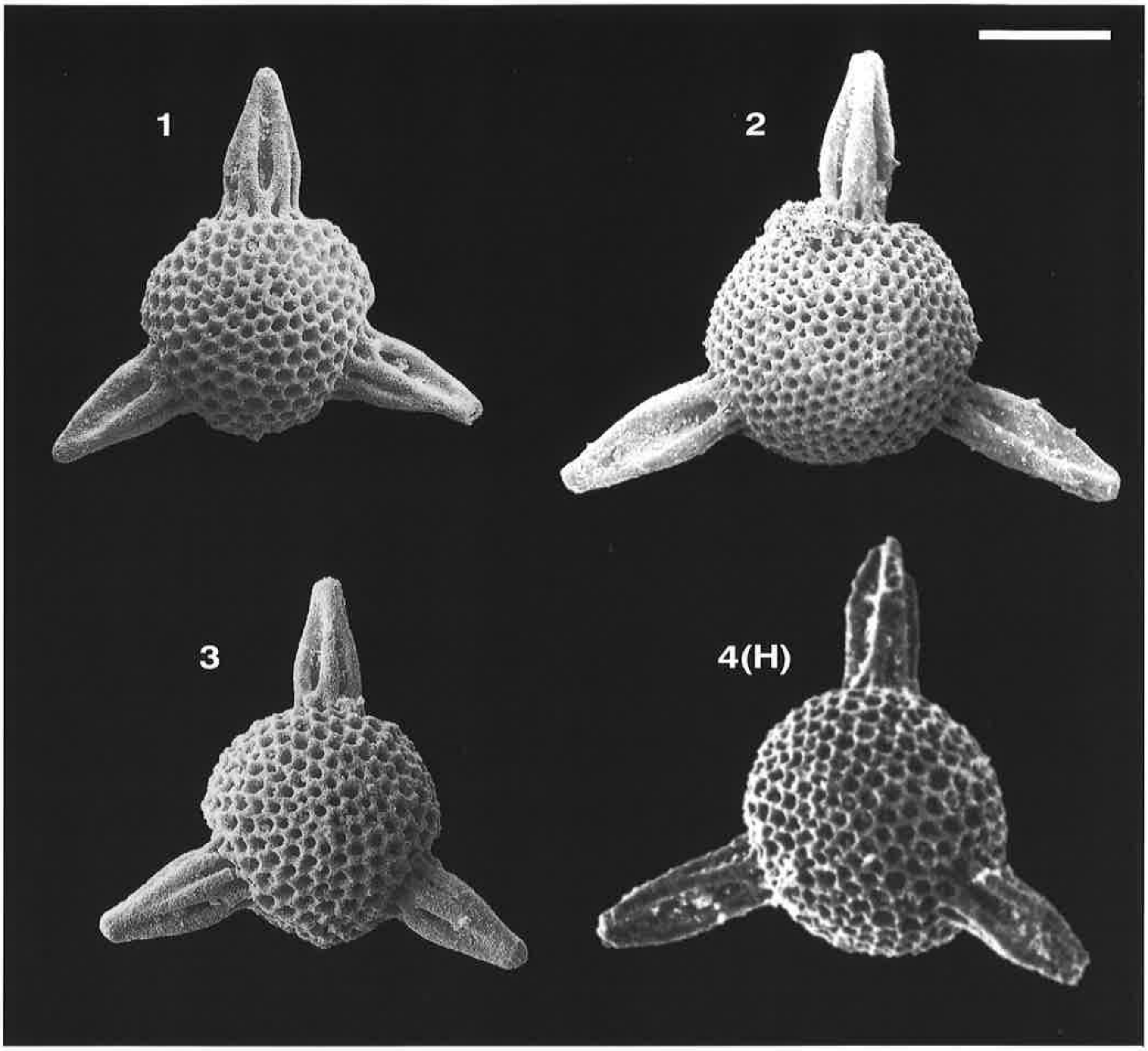


Plate 3095. *Triactoma blakei* (PESSAGNO). Magnification x200. **Fig. 1.** DU2011, R102. **Fig. 2.** POB78/3559, POB28.65. **Fig. 3.** DU1778, R102. **Fig. 4(H).** PESSAGNO 1977a, pl. 6, fig. 15.

TRIACTOMA CORNUTA 3166

Triactoma cornuta BAUMGARTNER

***Synonymy*.-**
Gen et sp. indet.
OZVOLDOVA 1979, p. 260, pl. 2, fig. 3.
Triactoma cornuta BAUMGARTNER
BAUMGARTNER et al. 1980, p. 63, pl. 2, figs. 2-3.
KOCHER 1981, p. 101, pl. 17, fig. 7.
DE WEVER & CABY 1981, pl. 2, fig. F.
ISHIDA 1983, pl. 4, figs. 12-13.
ORIGLIA-DEVOS 1983, p. 42, pl. 1, figs. 12, ? 13.
BAUMGARTNER 1984, p. 789, pl. 10, fig. 1.
EL KADIRI 1984, p. 44, pl. 21, fig. 4.
DE WEVER & MICONNET 1985, p. 391.
DE WEVER & CORDEY 1986, pl. 1, fig. 19.
AITA 1987, p. 64.
DANELIAN 1989, p. 200, pl. 9, fig. 2.
Triactoma cornuta
KISHIDA & HISADA 1986, pl. 2, fig. 23.
CONTI & MARCUCCI, pl. 4, fig. 6.
Zanola sp. cf. *Zanola cornuta* (BAUMGARTNER)
PESSAGNO et al. 1989, p. 241, pl. 7, fig. 13.

***Original Definition*.-** Test globular, with uniform hexagonally arranged circular pores. Three triradiate spines are symmetrically placed; two of them are long, curved towards each other; the third is small, slender, straight. The curved spines are usually longer than the diameter of the shell, and often do not lie in the same plane. Their ends may come quite close to each other or be far when spines are less curved. The straight spine is always shorter than the diameter of the shell. As for other members of this genus, the spines have no internal continuation or have any medullary shell(s) been observed.

***Etymology*.-** *Cornutus, a, um,* Latin, bearing horns.

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Width of shell:	230	234	210	290
Length of straight spine:	-	48	30	152
Length of curved spines:	278-300	275	161	364
Width of curved spines at base:	45	53	45	64
Width of pores:	13-15	15	11	18

***Type Locality*.-** Angelokastron, Greece.

***UAZones*.-** 8-10, mid Call.-early Oxf. to late Oxf.-early Kimm.

TRIACTOMA FOREMANAE 4068

Triactoma foremanae MUZAVOR

***Synonymy*.-**
Triactoma foremane MUZAVOR
MUZAVOR 1977, p. 55, pl. 1, fig. 11.
Tripocyclia blakei PESSAGNO
MIZUTANI 1981, p. 175, pl. 57, figs. 5-6.
ADACHI 1982, pl. 5, fig. 3.
Triactoma kellumi PESSAGNO & YANG
PESSAGNO et al. 1989, p. 208, pl. 8, figs. 12-13, 15, 21-22.

***Original Definition*.-** "Test spherical. Upper layer covered with big rounded pores arranged in concentrical rows. They form a hexagonal meshwork. The bars among the pores are about half as wide as the pores. The shell surface of well preserved specimens is covered with small thorns. Three strong non porous spines equal in length extend from the shell. They are threebladed and possess longitudinal grooves. They lie in one plane at the angles of 120 degrees".

***Remarks*.-** *Triactoma foremane* has often been synonymized with *T. blakei* (PESSAGNO) (see the synonymy list). It differs from the latter by having no buttresses at the base of the spines and by more pointed spines. Both morphotypes differ from *T. jonesi* (PESSAGNO) and *T. tithonianum* RÜST by the spines being never longer than the diameter of the shell.

***Type locality*.-** Oberaudorf, Germany.

***UAZones*.-** 7-11, late Bath.-early Call. to late Kimm.-early Tith.

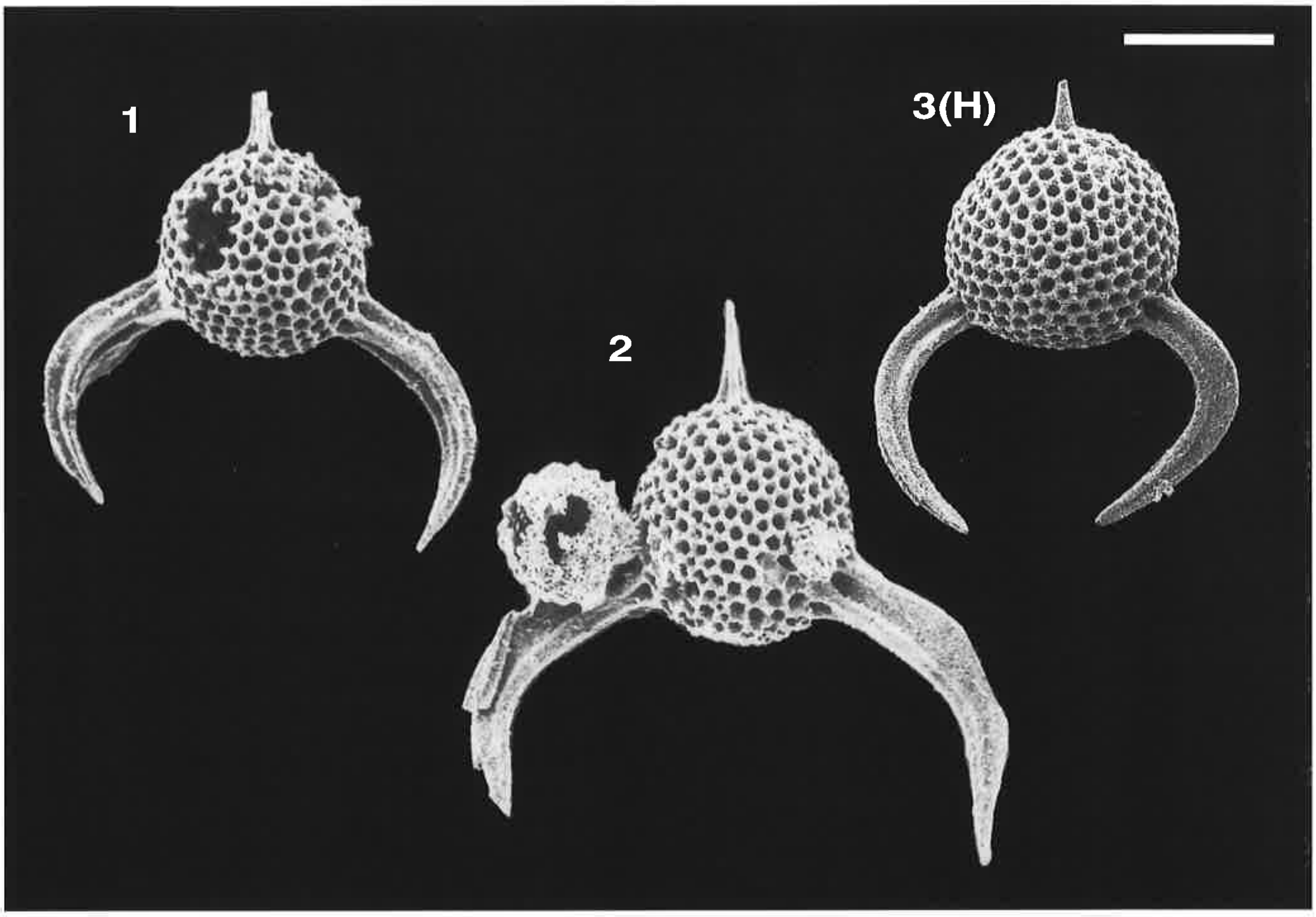


Plate 3166. ***Triactoma cornuta*** **BAUMGARTNER.** Magnification x150. **Fig. 1.** POB78/6085, POB899.50. **Fig. 2.** POB78/6089, POB899.50. **Fig. 3(H).** POB78/6086, POB899.50.

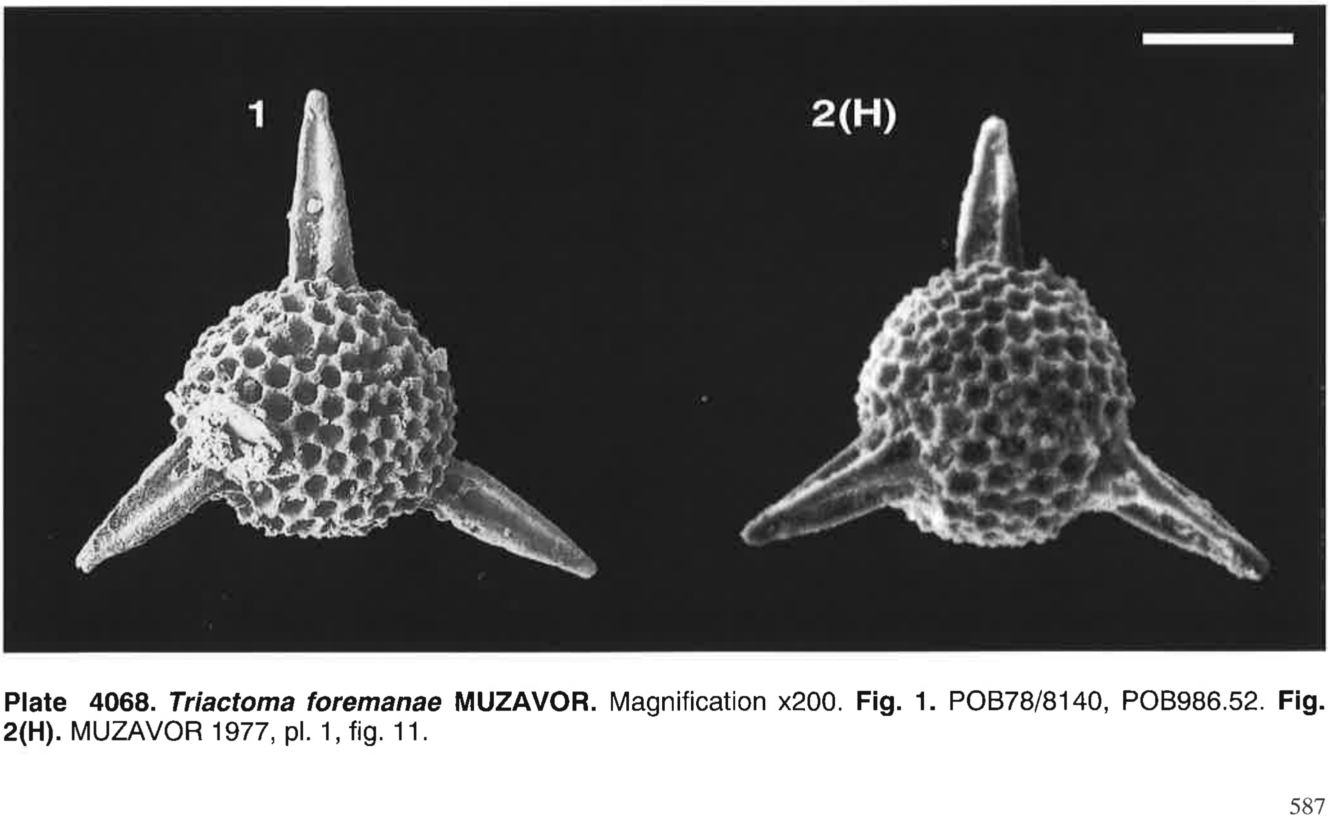


Plate 4068. ***Triactoma foremanae*** **MUZAVOR.** Magnification x200. **Fig. 1.** POB78/8140, POB986.52. **Fig. 2(H).** MUZAVOR 1977, pl. 1, fig. 11.

TRIACTOMA JAKOBSAE 3409

Triactoma jakobsae n.sp. CARTER

Synonymy.-
Tripocyclia sp. B
CARTER et al. 1988, p. 27, pl. 10, figs. 2-3.

Type Designation.- GSC 99440, 47-3.

Original Definition.- Cortical shell spherical to subspherical. Outer latticed layer thick, composed of small, mostly hexagonal pore frames with small, rather sharp nodes at vertices of pore frames. Spines short to moderate in length but length never exceeds diameter of cortical shell. Spines robust, triradiate, composed of longitudinal ridges and grooves. Ridges rounded with small to medium-sized tear drop-shaped subsidiary grooves tapering towards distal part of spine. Longitudinal grooves narrow and deep, tapering distally but open to spine tips. Spine tips bluntly terminating with the three longitudinal ridges turned outward to form crown-like structures. On well preserved specimens a short, robust, central spine extends beyond ridge terminations. Cortical buttresses weakly developed.

Original Remarks.- *Triactoma jacobsae* n.sp. is larger than *Tripocyclia wickiupensis* PESSAGNO & YANG in all respects and further differs from that species in having a spherical to subspherical cortical shell composed of larger pore frames, and in having spine tips with better developed triradiate structures.

Etymology.- Named for Dr. Giselle K. Jacobs for her contribution to the biostratigraphy of the Toarcian and Aalenian of Western North America.

Measurements (in μm).-
Based on 13 specimens.

	HT	av.	max.	min.
Diameter of cortical shell:	155	154	169	150
Length secondary spines:	127	120	135	99
Width of spine base :	59	53	60	43

Type Locality.- GSC loc. C-176579- Section 12, Yankoun River, central Graham Island, Queen Charlotte Islands, Canada.

UAZones.- 1-4, early-mid Aal. to late Baj.

TRIACTOMA JONESI 3096

Triactoma jonesi (PESSAGNO)

Synonymy.-
Tripocyclia jonesi PESSAGNO
PESSAGNO 1977a, p. 80, pl. 7, figs. 1-5.
Tripocyclia trigonum RÜST
PESSAGNO 1977a, p. 80, pl. 7, figs. 6-7.
Triactoma jonesi (PESSAGNO)
? FOREMAN 1978, p. 743, pl. 1, figs. 13-14.
KOCHER 1981, p. 102, pl. 17, fig. 10.
ORIGLIA-DEVOS 1983, p. 44, pl. 2, figs. ? 6, 7.
BAUMGARTNER 1984, p. 790, pl. 10, fig. 4.
not OZVOLDOVA & SYKORA 1984, p. 272, pl. 11, fig. 5; pl. 10, fig. 4.
? CARAYON et al. 1984, pl. 1, fig. 6.
not DE WEVER et al. 1986, pl. 6, fig. 16 (*T. tithonianum*).
KISHIDA & HISADA 1986, pl. 2, fig. 22.
GORICAN 1987, p. 187, pl. 1, fig. 16.
KITO et al. 1990, pl. 1, fig. 5.
CONTI & MARCUCCI 1991, pl. 4, figs. 7-8.
Tripocyclia trigonum RÜST
SASHIDA et al. 1982, pl. 1, fig. 5.
ISHIDA 1983, pl. 4, fig. 14.
Tripocyclia jonesi PESSAGNO, emend. PESSAGNO & YANG
PESSAGNO et al. 1989, p. 222, pl. 7, figs. 5, 11, 21.
PESSAGNO et al. 1993, p. 134, pl. 5, figs. 3, 21.
Tripocyclia sp. B
PESSAGNO et al. 1989, p. 229, pl. 7, figs. 2, 10.
Tripocyclia sp. H
PESSAGNO et al. 1989, p. 230, pl. 6, figs. 12, 13, 15.
Tripocyclia sp. B
WIDZ 1991, p. 257, pl. 4, fig. 12.

Original Definition.- Test rounded in outline, somewhat flattened in plane of spines with medium-sized, uniform, hexagonal pore frames. Three long spines with complicated system of alternating ridges and grooves. Primary system with three wide grooves on each spine; secondary system with three narrow grooves on each spine. Six ridges of equal width distributed between primary and secondary grooves.

Original Remarks.- *T. jonesi* differs from *T. echiodes* (FOREMAN) by virtue of the structure of its spines.

Remarks.- It differs from *T. echiodes* by the structure and the arrangement of the spines and of the central shell, which is globular instead of being cylindrical.

According to the emended definition by Pessagno & Yang (in Pessagno et al., 1989) specimens with three spinal tips instead of bluntly terminating spines should be excluded from *T. jonesi*. This phenomenon is regarded as an intraspecific variability, therefore the emended definition is not followed.

Etymology.- *T. jonesi* is named for Dr. David L. Jones (U. S. Geological Survey, Menlo Park, California) in honor of his many contributions to the understanding of the geology of the California Coast Ranges.

Measurements (in μm).-
Based on 8 specimens. Diameter 130-150, length spines 160-190.

Type Locality.- Sample NSF907, Point Sal, Santa-Barbara County, California.

UAZones.- 2-13, late Aal. to latest Tith.

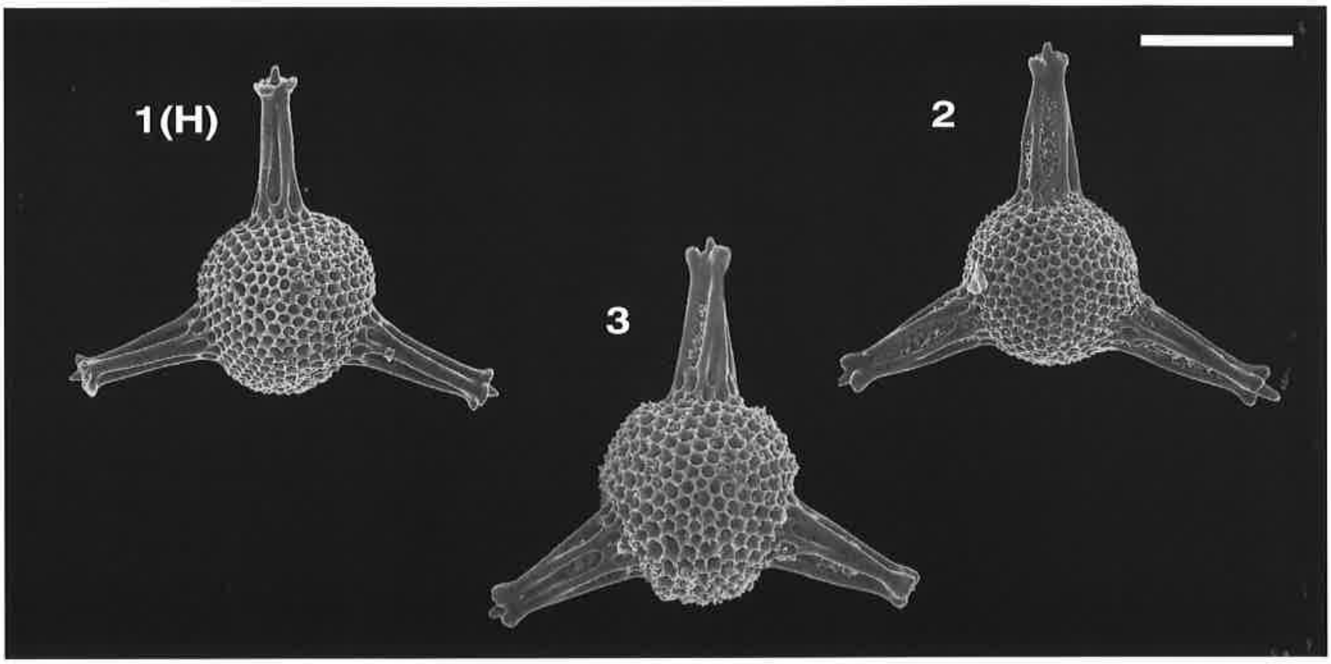


Plate 3409. ***Triactoma jakobsae*** **n.sp. CARTER.** Magnification x150. **Fig. 1(H).** CA GSC 99440, 47-3; C-176579. **Fig. 2.** CA GSC 99442, 47-5; C-176579. **Fig. 3.** CAGSC 99441, 47-22; C-176399.

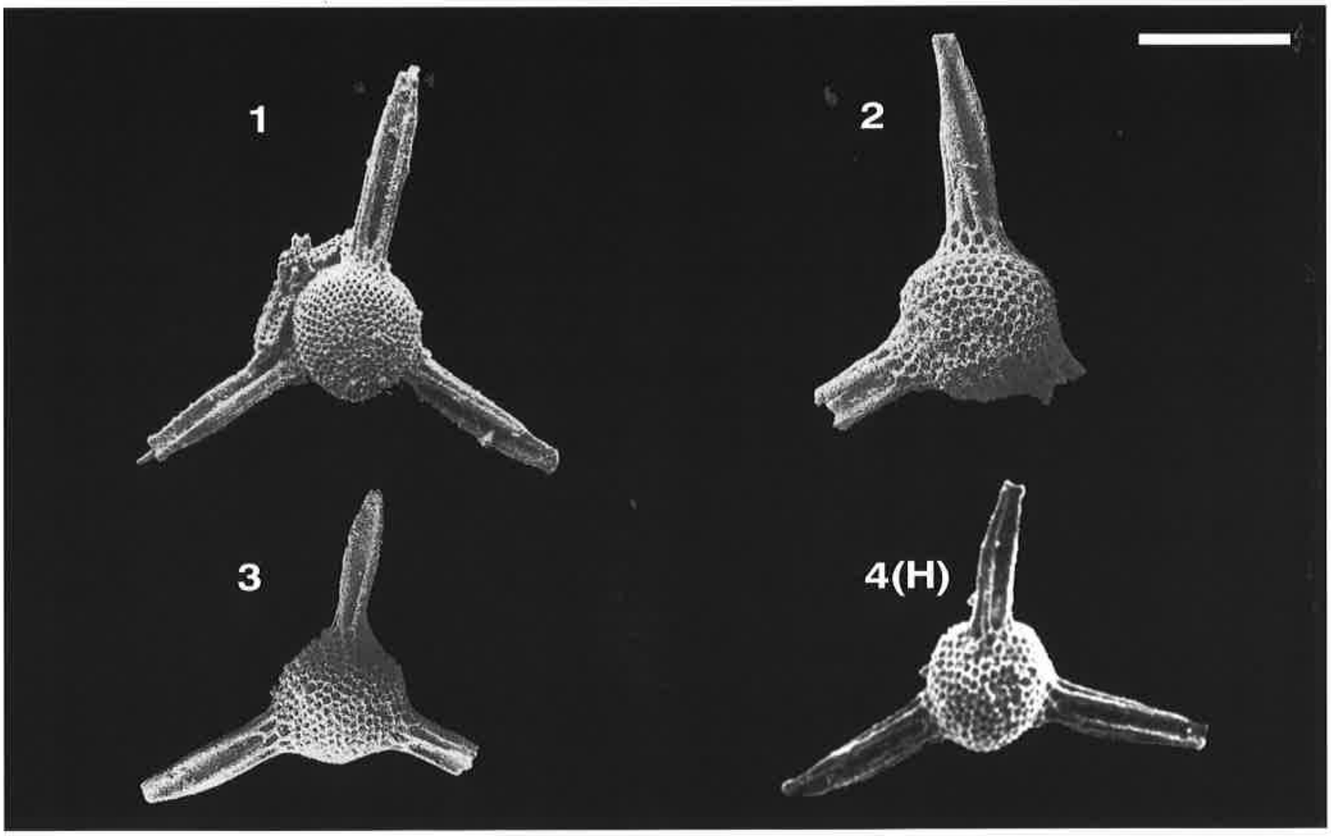


Plate 3096. ***Triactoma jonesi*** **(PESSAGNO).** Magnification x150. **Fig. 1.** POB78/6248, POB899.52. **Fig. 2.** DU3245, P139/10. **Fig. 3.** DU3271, P139/8. **Fig. 4(H).** PESSAGNO 1977a, pl. 7, fig. 1.

TRIACTOMA LUCIAE — 5055

Triactoma luciae JUD

***Synonymy*.-**
Triactoma echiodes FOREMAN
SCHAAF 1984, p. 109, figs. 2-4, not fig. 1.
Triactoma sp. 2
ORIGLIA-DEVOS 1983, p. 47, pl. 3, figs. 1-2.
Triactoma luciae JUD
JUD 1994, p. 115, pl. 23, figs. 8-9.

***Original Definition*.-** Cortical shell small, subcircular to subtriangular in outline, subelliptical in cross-section with small hexagonally framed pores. Three coplanar spines, usually disposed quite irregularly, sometimes two of them placed opposite in an axis, the third oblique to this axis. Spines equal or subequal, approximately twice as long as the diameter of shell or longer, their sides parallel or slightly subparallel or convex in the middle or distal parts. They are three-bladed, usually bluntly terminating, yielding crown-like tips. Minute centrally placed short spine is frequently present.

***Original Remarks*.-** *Triactoma luciae* n.sp. may be compared with *Tripocyclia foremanae* PESSAGNO & YANG, a species known from the Upper Tithonian from Mexico, but differs from it by the position and the submedial expansion of the spines.

***Etymology*.-** This species is dedicated to Lucia Santini, a mineralogist at University of Lausanne, Switzerland, honouring her help and her friendship.

***Measurements* (in μm).-**
Based on 9 specimens.

	HT	av.	min.	max.
Length of spines:	238	213	175	256
Width central part:	95	110	92	154

***Type Locality*.-** Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland.

***UAZones*.-** 13-21, latest Tith. to early Barr.

TRIACTOMA MEXICANA — 3412

Triactoma mexicana PESSAGNO & YANG

***Synonymy*.-**
Triactoma mexicana PESSAGNO & YANG
PESSAGNO et al. 1989, p. 210, pl. 1, fig. 5; pl. 9, figs. 9, 16, 20.

***Original Definition*.-** Cortical shell large for genus, spherical with thick outer layer (pl. 1, fig. 5). Pore frames of outer latticed layer massive, hexagonal and pentagonal in shape (predominantly hexagonal) with massive nodes at vertices. Nine to eleven large pore frames visible on test surface in line with axis of a given spine. Three secondary spines short, massive, bluntly terminating; length of each spine about one third to one fourth of the diameter of the cortical shell. Three longitudinal ridges of each spine maintaining approximately the same width as grooves and alternating with three deep longitudinal grooves which rapidly decrease in width distally.

***Original Remarks*.-** *Triactoma mexicana* n.sp. can be distinguished by its large, spherical cortical shell and very short, massive, bluntly terminating, secondary spines. It is compared to *T. paramexicana* n.sp. under the latter species.

***Etymology*.-** This species is named for the Republic of Mexico.

***Measurements* (in μm).-**
Based on 10 specimens.

	HT	av.	SD	max	min
Diameter of cortical shell:	225	209	14	225	181
Length of spines:	59	59	6	69	50
Width of spinal base:	31	29	3	36	25

***Type Locality*.-** Sample MX- 85- 26, Taman, Mexico.

***UAZones*.-** 5-9, latest Baj.-early Bath. to mid-late Oxf.

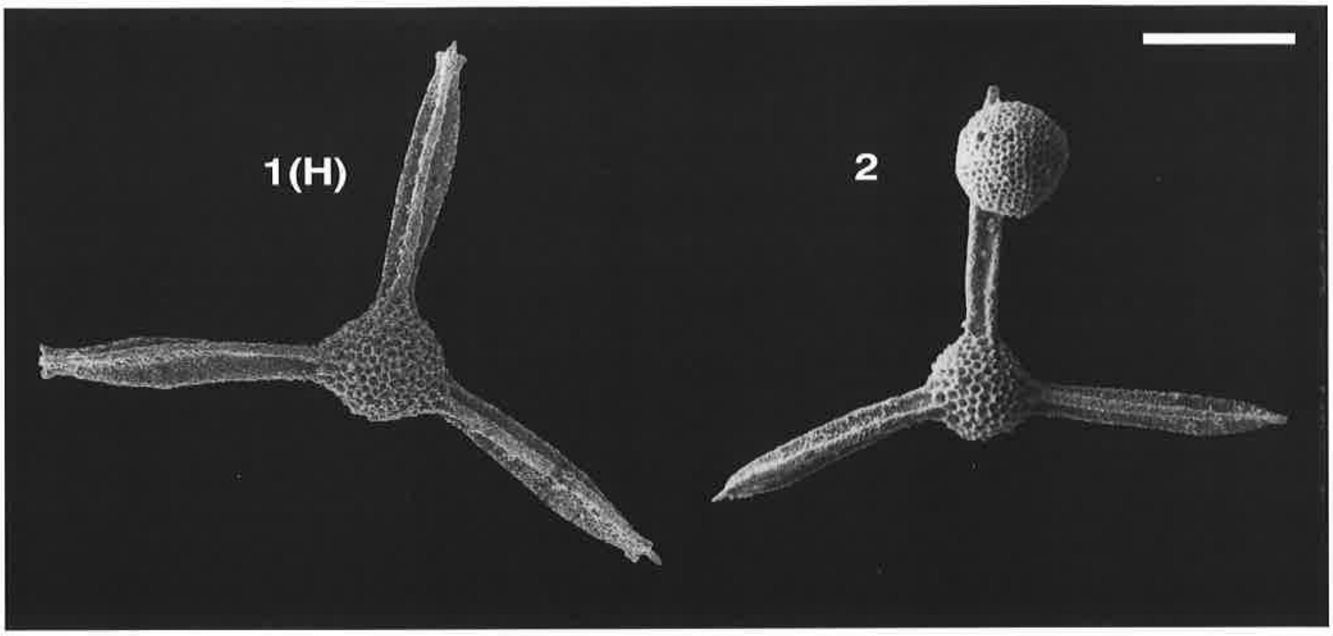


Plate 5055. ***Triactoma luciae*** **JUD.** Magnification x150. **Fig. 1(H).** RJ80, Br1330. **Fig. 2.** RJ1810, Ru135.5.

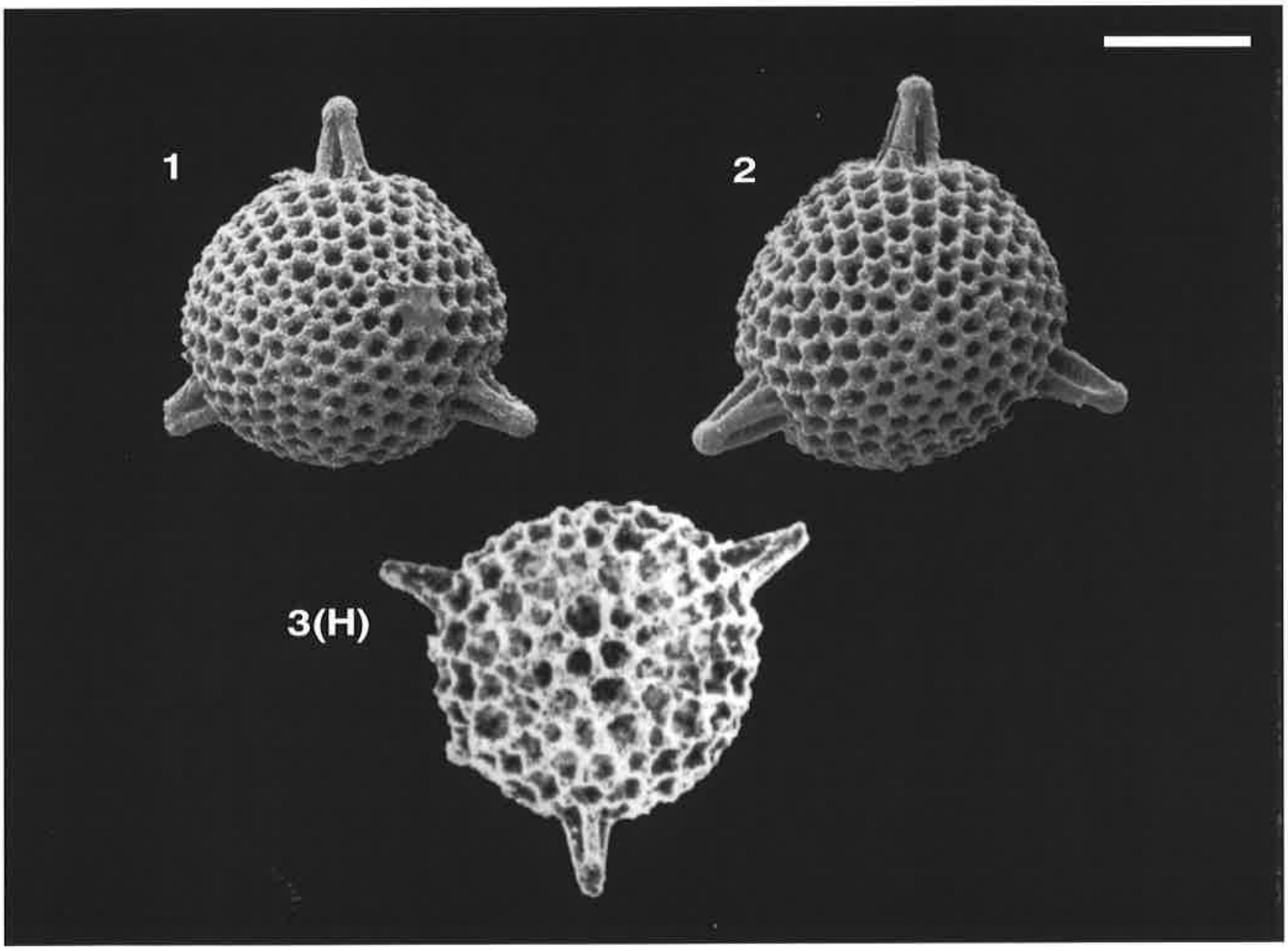


Plate 3412. ***Triactoma mexicana*** **PESSAGNO & YANG.** Magnification x200. **Fig. 1.** POB78/3604, POB28.65. **Fig. 2.** POB 78/3603, POB28.25. **Fig. 3(H).** PESSAGNO et al. 1989, pl. 9, fig. 9.

TRIACTOMA PARABLAKEI 3413

Triactoma parablakei YANG & WANG

Synonymy.-
Triactoma blakei (PESSAGNO)
BAUMGARTNER 1984, p. 789, pl. 10, fig. 3.
YAMAMOTO et al. 1985, p. 39, pl. 8, fig. 5.
OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 5.
Triactoma sp.
? DE WEVER & MICONNET 1985, pl. 4, fig. 15.
Triactoma parablakei YANG & WANG
YANG & WANG 1990, p. 206, pl. 3, figs. 9, 15.

Original Definition.- Cortical shell relatively large, subspherical, slightly depressed where spines are attached. Pore frames of cortical shell regular, hexagonal, and equal-sized. Three secondary spines massive, each with three massive, primary longitudinal ridges each of which gives rise to two subsidiary ridges; subsidiary ridges developed throughout almost entire length of primary ridges. Tip of spine with a crown-like structure consisting of four massive nodes.

Original Remarks.- This species differs from *Triactoma blakei* (PESSAGNO 1977a) in having (1) three more massive, shorter secondary spines; (2) a relatively larger cortical shell which is slightly depressed where the spines are attached; (3) more well-developed subsidiary ridges present almost throughout the spines, while the subsidiary ridges of *T. blakei* are developed only at spinal bases; and (4) nodose crown-like spinal tips with are lacking in *T. blakei*.

Etymology.- *Para-*, derived from Latin word *para* (equal; like); plus *blakei* from *Triactoma blakei* (PESSAGNO).

Measurements (in μm).-
Diameter of cortical shell: 193-210 (holotype 193); length of spines: 90-110 (holotype 110); width of spine at base: 60-65 (holotype 64).

Type Locality.- Rutog county, Xizang, Tibet.

UAZones.- 4-7, late Baj. to late Bath.-early Call.

TRIACTOMA TITHONIANUM 3097

Triactoma tithonianum RÜST

Synonymy.-
Triactoma tithonianum RÜST
RÜST 1885, p. 289, pl. 28 (3), fig. 5.
FOREMAN 1973b, p. 260, pl. 2, fig. 1.
FOREMAN 1975, p. 610, pl. 3, fig. 13.
ORIGLIA-DEVOS 1983, p. 45, pl. 2, figs. 8-9.
BAUMGARTNER 1984, p. 790, pl. 10, fig. 5.
OZVOLDOVA & SYKORA 1984, p. 272, pl. 12, fig. 9; pl. 14, fig. 1.
SCHAAF 1984, p. 142-143, figs. 1-4.
OZVOLDOVA & PETERCAKOVA 1987, pl. 35, figs. 6-7.
JUD 1994, p. 115, pl. 23, figs. 10-11.
Triactis tithoniana (RÜST)
RÜST 1888, p. 197.
Triactiscus tithonianus (RÜST)
RÜST 1898, p. 20.
Triactoma tithonianum RÜST s.l.
KOCHER 1981, p. 102, pl. 17, fig. 12.
Triactoma jonesi PESSAGNO
OZVOLDOVA & SYKORA 1984, p. 272, pl. 10, fig. 4; pl. 11, fig. 5.
DE WEVER et al. 1986, pl. 6, fig. 16.
Triactoma aff. *blakei* (PESSAGNO)
AITA & OKADA 1986, p. 122, pl. 1, fig. 4.
Triactoma sp. C
PESSAGNO et al. 1989, p. 212, pl. 7, fig. 8; pl. 8, figs. 19, 24.
Tripocyclia spinosa PESSAGNO & YANG
PESSAGNO et al. 1989, p. 226, pl. 10, figs. 6, 8, 12, 25.

Original Definition.- "Round latticed test with three blunt spines equatorially arranged. The round pores are disposed in 10 rows of 10 pores".

Actualized Definition.- Spherical to subtriangular test with usually hexagonal to pentagonal pore frames. Three slender, triradiate spines equatorially placed, enclosing mostly equal angles. No buttresses developed at base of spines.

Remarks.- For biostratigraphic data we included in *T. tithonianum* RÜST specimens with the spines slender, about equal or a little longer than the diameter of the central body. These forms do not exactly correspond to this species as illustrated by Rüst (1885).

Measurements (in μm).-
Diameter of the test 204, length of spines 265, diameter of the pores 13.

Type Locality.- Aptychus Beds, Urschlau, Germany.

UAZones.- 6-22, mid Bath. to late Barr.-early Apt.

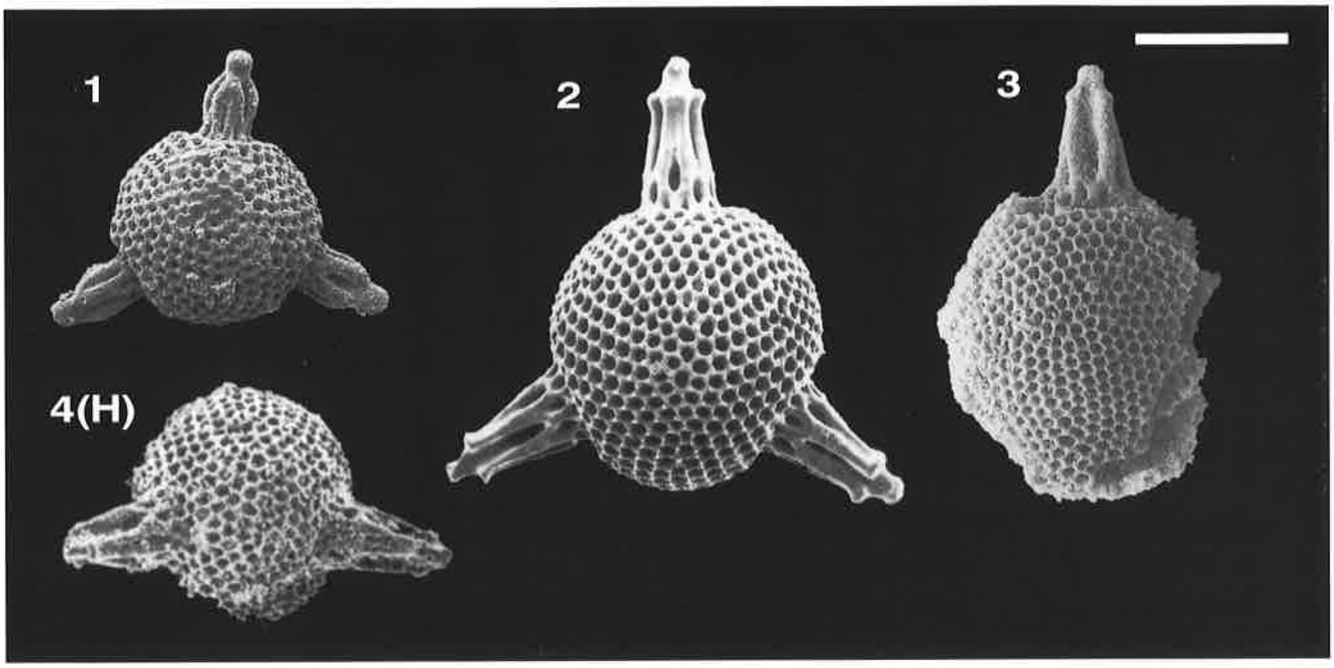


Plate 3413. *Triactoma parablakei* YANG & WANG. Magnification x150 **Fig. 1.** POB78/3746, POB28.66. **Fig. 2.** POB81/9132, 76.534A.126.2.125. **Fig. 3.** DU3059, PJ9. **Fig. 4(H).** YANG & WANG 1990, pl. 3, fig. 15.

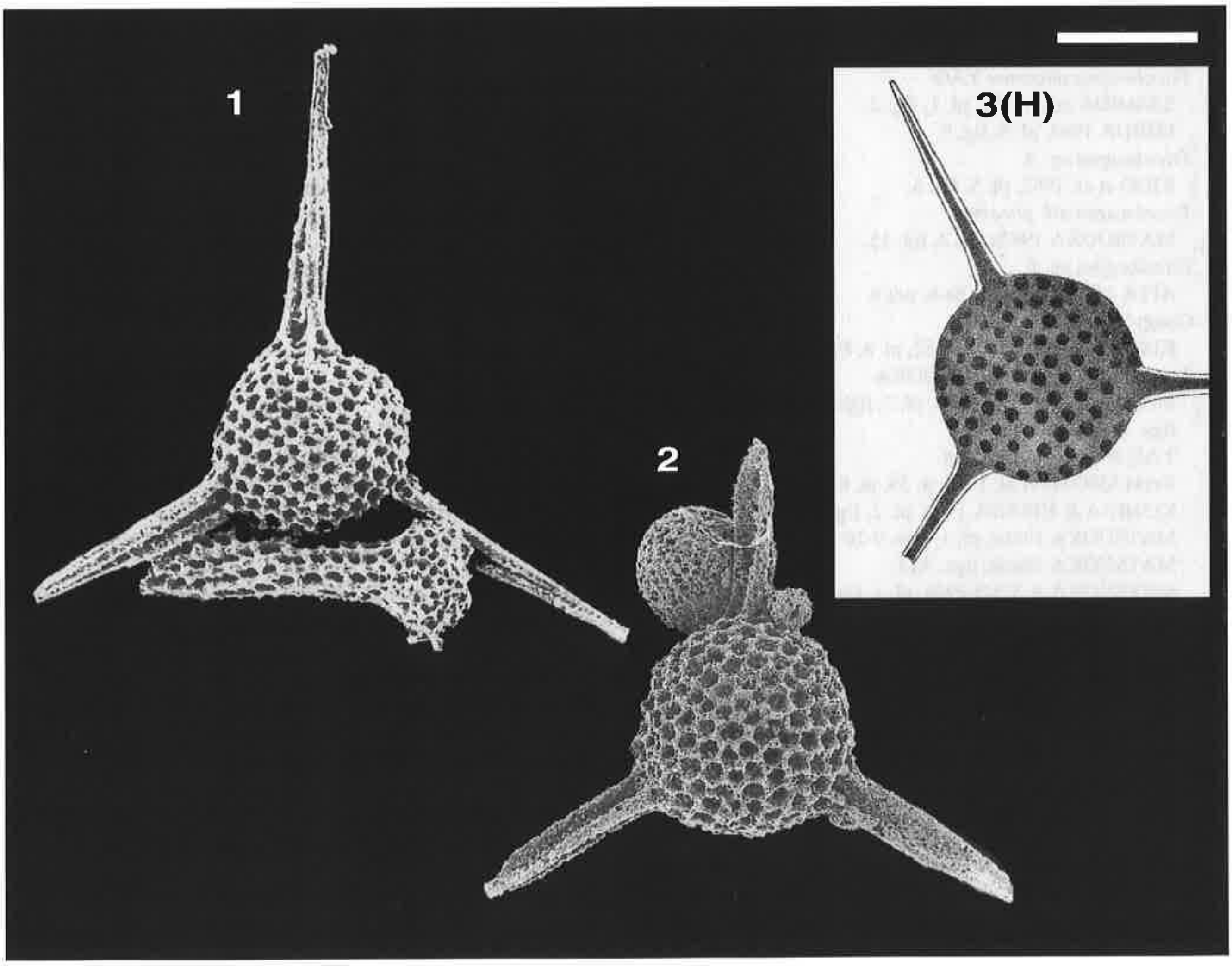


Plate 3097. *Triactoma tithonianum* RÜST. Magnification x150. **Fig. 1.** POB78/6173, POB899.52. **Fig. 2.** RJ38, V -6. **Fig. 3(H).** RÜST 1885, pl. 28(3), fig. 5.

trichylum >> *SAITOUM TRICHYLUM* 3021

TRICOLOCAPSA 3657

Genus: *Tricolocapsa* HAECKEL

Synonymy.-
Tricolocapsa HAECKEL
HAECKEL 1881, p. 436.
HAECKEL 1887, p. 1431.

Type Species.- *Tricolocapsa theophrasti* HAECKEL 1887, subsequent designation by Cambpell, 1954.

Original Definition.- "Theocapsida (vel Tricyrtida eradiata clausa), without apical horn with a terminal lattice-plate on the mouth."

Etymology.- *Tricolocapsa*, three-jointed capsule; *tricolon*, *capsa* (Greek).

Included Taxa.-
3297 *Tricolocapsa conexa* MATSUOKA
4049 *Tricolocapsa* (?) *fusiformis* YAO
4050 *Tricolocapsa* (?) sp. aff. *T. fusiformis* YAO sensu MATSUOKA
3051 *Tricolocapsa plicarum* s.l. YAO
4053 *Tricolocapsa plicarum plicarum* YAO
4052 *Tricolocapsa plicarum* ssp. A
4054 *Tricolocapsa tetragona* MATSUOKA
4056 *Tricolocapsa* sp. M
4057 *Tricolocapsa* sp. S

TRICOLOCAPSA CONEXA 3297

Tricolocapsa conexa MATSUOKA

Synonymy.-
Tricolocapsa plicarum YAO
SASHIDA et al. 1982, pl. 1, fig. 2.
ISHIDA 1983, pl. 8, fig. 9.
Tricolocapsa sp. A
KIDO et al. 1982, pl. 5, fig. 5.
Tricolocapsa aff. *plicarum*
MATSUOKA 1982a, pl. 3, fig. 15.
Tricolocapsa sp. E
AITA 1982, pl. 2, figs. 5a-b, not 4.
Gongylothorax ? sp.
KISHIDA & SUGANO 1982, pl. 8, fig. 22, not 21.
Tricolocapsa conexa MATSUOKA
MATSUOKA 1983a, p. 20, pl. 3, figs. 3-7; pl. 7, figs. 11-14.
YAO 1984, pl. 2, figs. 2-4.
YAMAMOTO et al. 1985, p. 39, pl. 8, figs. 7a-b.
KISHIDA & HISADA 1986, pl. 2, fig. 17.
MATSUOKA 1986a, pl. 1, figs. 9-10.
MATSUOKA 1986b, figs. 3d-f.
MATSUOKA & YAO 1986, pl. 1, fig. 17; pl. 3, fig. 18.
AITA 1987, p. 68, pl. 7, figs. 9a-b.
MATSUOKA 1988, pl. 1, figs. 3-5.
ÒZVOLDOVA 1988, pl. 7, figs. 9-10.
MATSUOKA 1989, pl. 1, figs. 3-5.
DANELIAN 1989, p.204, pl. 9, figs. 7-10.
MATSUOKA 1990, pl. 1, fig. 13; pl. 2, fig. 13.
KOZUR 1991, pl. 3, fig. 1.
YAO 1991, pl. 3, fig. 2.

Original Definition.- Shell of three segments, drop-like shaped. Cephalis spherical internally. Thorax truncate conical. Lumber stricture slightly recognizable or distinct externally. Abdomen subspherical with a constricted aperture and a circular depression near aperture. Aperture shifted slightly off-center by presence of circular depression. Aperture covered by pored, small, thin-walled appendage in well preserved specimens. Circular depression near aperture possessing densely spaced pores which are larger in diameter than pores on main part of outer shell surface. Outer surface of shell ornamented with continuous longitudinal plicae and transverse ridges connecting adjacent two longitudinal plicae; plicae and ridges forming tetragonal frames. Pores at the center of the tetragonal frames small, circular and uniform in size.

Original Remarks.- This species is very similar to *T. plicarum* YAO in outer shape, proportion among the segments, longitudinal plicae and dish-like basal appendage, but differs from the latter by possessing transverse ridges connecting adjacent two longitudinal plicae. Judging from morphological features and vertical distribution of *T. plicarum* and *T. conexa* (fig. 9.), it is conceivable that the former is ancestral to the latter species.

Etymology.- This species is named for the Latin adjective *conexus*, meaning connected.

Measurements (in μm).-
Based on 25 specimens. Total height, 105-157 (129); maximum width of shell, 88-123 (103); diameter of cephalis, 16-20 (18); height of thorax, 25-32 (29); of abdomen, 80-108 (99).

Type Locality.- Sample S-17, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 4-7, late Baj. to late Bath.-early Call.

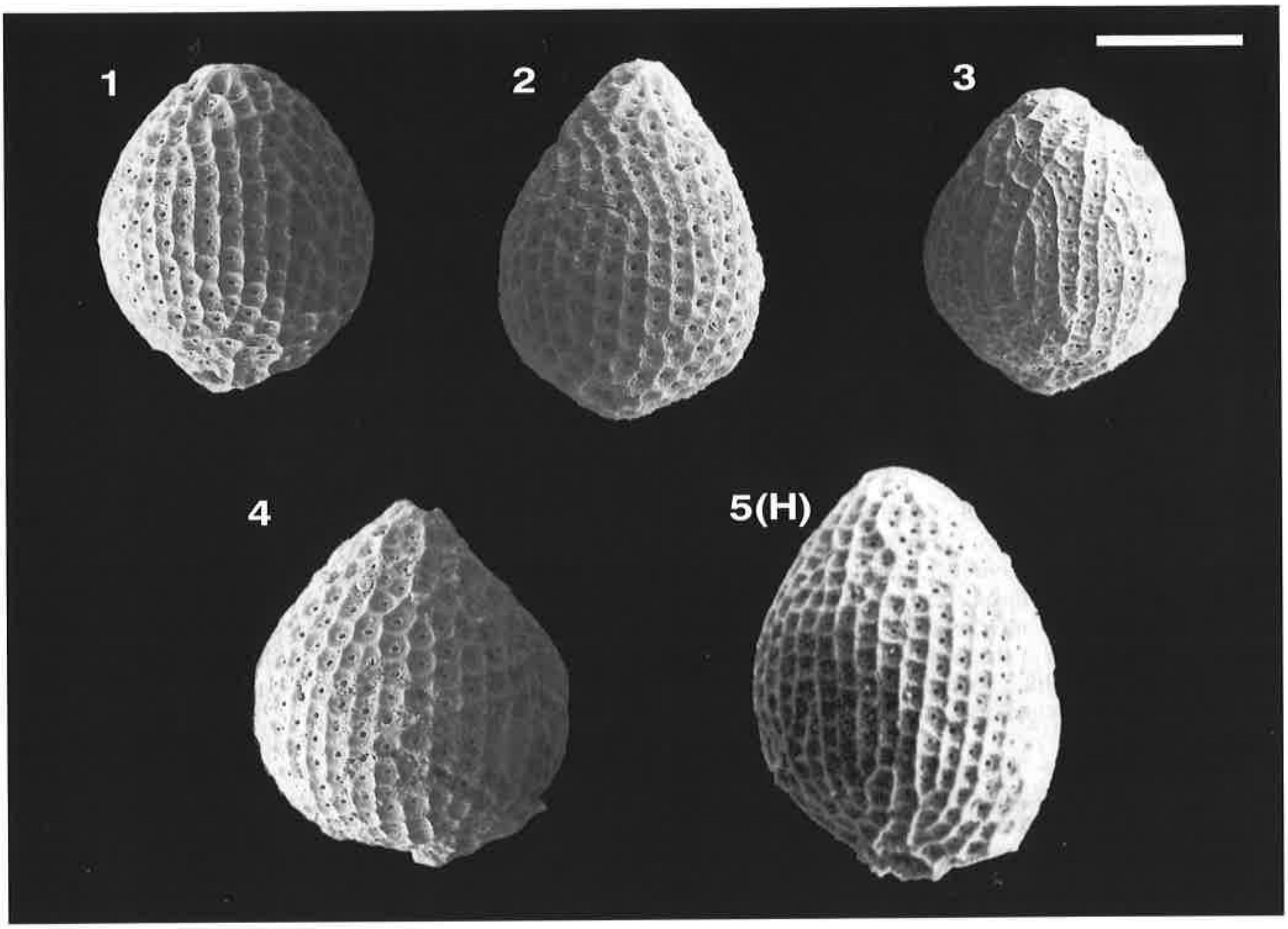


Plate 3297. *Tricolocapsa conexa* MATSUOKA. Magnification x400. **Fig. 1.** GO901022, GL207. **Fig. 2.** GO900518, UPC18. **Fig. 3.** GO901039, GL207. **Fig. 4.** GO901038, GL207. **Fig. 5(H).** MATSUOKA 1983a, pl. 3, fig. 3.

TRICOLOCAPSA (?) FUSIFORMIS 4049

Tricolocapsa (?) *fusiformis* YAO

Synonymy.-
Tricolocapsa (?) *fusiformis* YAO
YAO 1979, p. 33, pl. 4, figs. 12-18; pl. 5, figs. 1-4.
WAKITA & OKAMURA 1982, pl. 7, fig. 10.
KOJIMA 1982, pl. 2, fig. 2.
WAKITA 1982, pl. 3, fig. 4.
KIDO et al. 1982, pl. 5, fig. 3.
MATSUOKA 1982b, pl. 1, figs. 17-19.
MATSUOKA 1983a, p. 19, pl. 2, fig. 11; pl. 8, fig. 1.
MATSUOKA & YAO 1986, pl. 1, fig. 14; pl. 3, fig. 8.
YAO 1991, pl. 3, fig. 2.

Original Definition.- Shell of four segments, fusiform. Cephalis spherical, poreless, partly depressed in thoracic cavity. Thorax truncate-conical, porous with indistinct stricture externally at thorax-abdomen joint. Abdomen subspherical, sparsely pored with thick wall and smooth surface. Abdominal base flat with a large central opening. Fourth segment dish-like, sparsely pored, with thin wall, and large pores at proximal part.

Original Remarks.- This species is distinguished from other species of *Tricolocapsa* by having the fourth segment which is dish-like and covers the abdominal central opening. In the same sense as in *Diacanthocapsa* (?) *operculi* YAO described above, it is not clear whether the fourth segment of this species is certainly an independent one or not.

Actualized Remarks.- (MATSUOKA, 1983a) I pointed out that the dish-like basal appendage of *T.* (?) *fusiformis* YAO becomes systematically small in size from *Unuma echinatus* Assemblage-zone through *Lithocampe* (?) *nudata* Assemblage-zone to *Gongylothorax sakawaensis-Stichocapsa* sp. C Assemblage-zone (Matsuoka, 1982b). I use the ratio of maximum width of the shell (MW) to apendage width (AW) as indicator of the relative size of appendage in this paper (see fig. 10). In figured-specimens of *T.* (?) *fusiformis* YAO (Yao, 1979, pl. 4, figs. 12-18, pl. 5, figs. 1-4), the ratio (MW/AW) ranges between 1.4 and 1.9. I assign specimens with the ratio (MW/AW) of less than 2.0 (inclusive) to *T.* (?) *fusiformis* YAO and specimens with the ratio (MW/AW) of more than 2.0 to *T.* (?) sp. aff. *T.* (?) *fusiformis* YAO. According to this criterion, *T.* (?) *fusiformis* changes gradually into *T.* (?) sp. aff. *T.* (?) *fusiformis* near the biohorizon of the first occurrence of *Tricolocapsa conexa* n.sp. (see fig. 9).

Etymology.- This species is named from the Latin adjective *fusiformis*, meaning fusiform.

Measurements (in μm).-
Based on 10 specimens. Height overall, 95-130 (116); of cephalis, 18-23 (20); of thorax, 18-28 (23); of abdomen, 38-87 (60); of fourth segment, 15-25 (22); maximum width of shell, 72-96 (82).

Type Locality.- Manganese carbonate ore taken at the river side of the Kiso, east of Unuma, Kagamigahara City, Gifu Prefecture, Japan.

UAZones.- 3-5 , early-mid Baj. to latest Baj.-early Bath.

TRICOLOCAPSA (?) FUSIFORMIS AFF. 4050

Tricolocapsa (?) sp. aff. *T. fusiformis* YAO sensu MATSUOKA

Synonymy.-
Tricolocapsa (?) sp. aff. *T.* (?) *fusiformis* YAO
MATSUOKA 1983a, p. 20, pl. 2, figs. 12-13; pl. 8, figs. 2-3.

Remarks.- See remarks under *Tricolocapsa* (?) *fusiformis.*

UAZones.- 4-6, late Baj. to mid Bath.

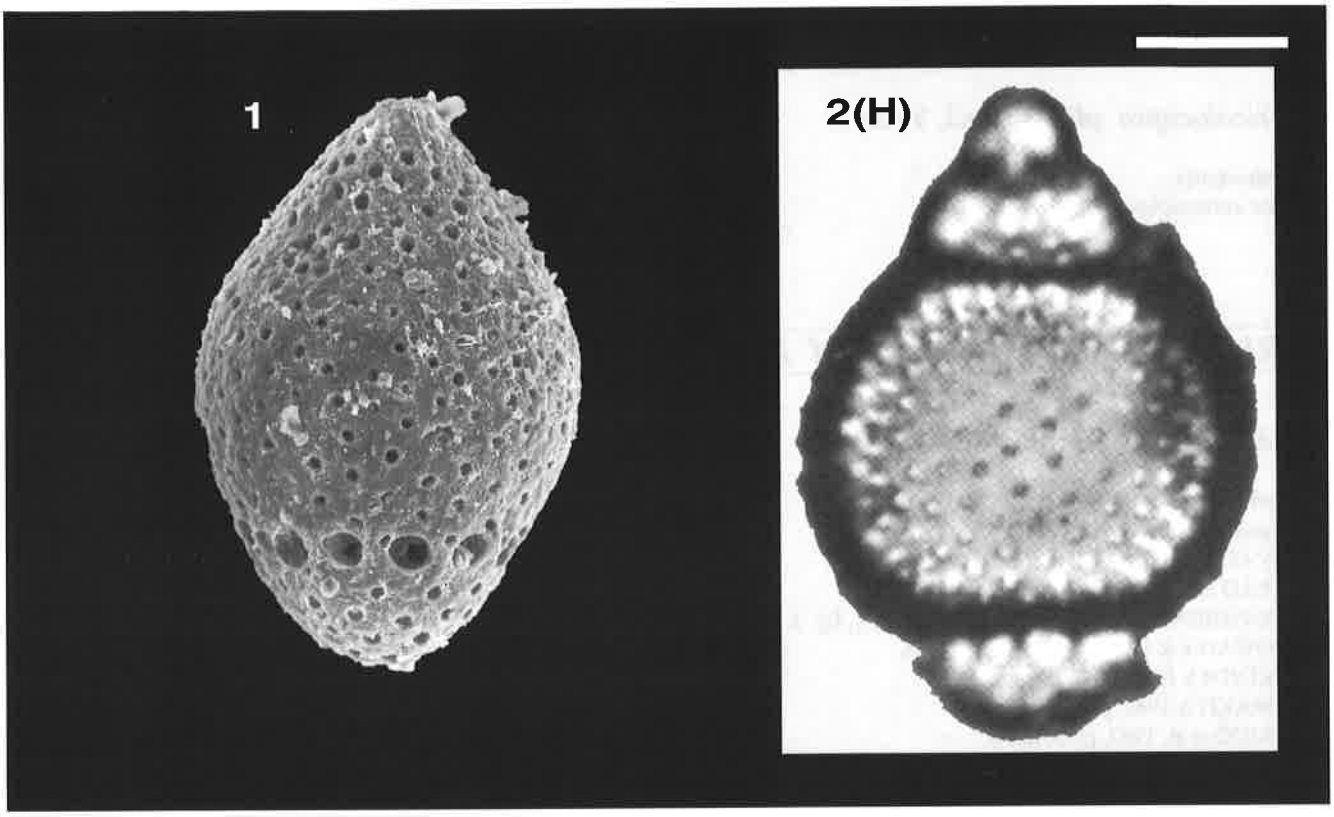


Plate 4049. *Tricolocapsa* (?) *fusiformis* YAO. Magnification x700. **Fig. 1.** MA8698, MIN-1, Ch-1-A. **Fig. 2(H).** YAO 1979, pl. 4, fig. 12a.

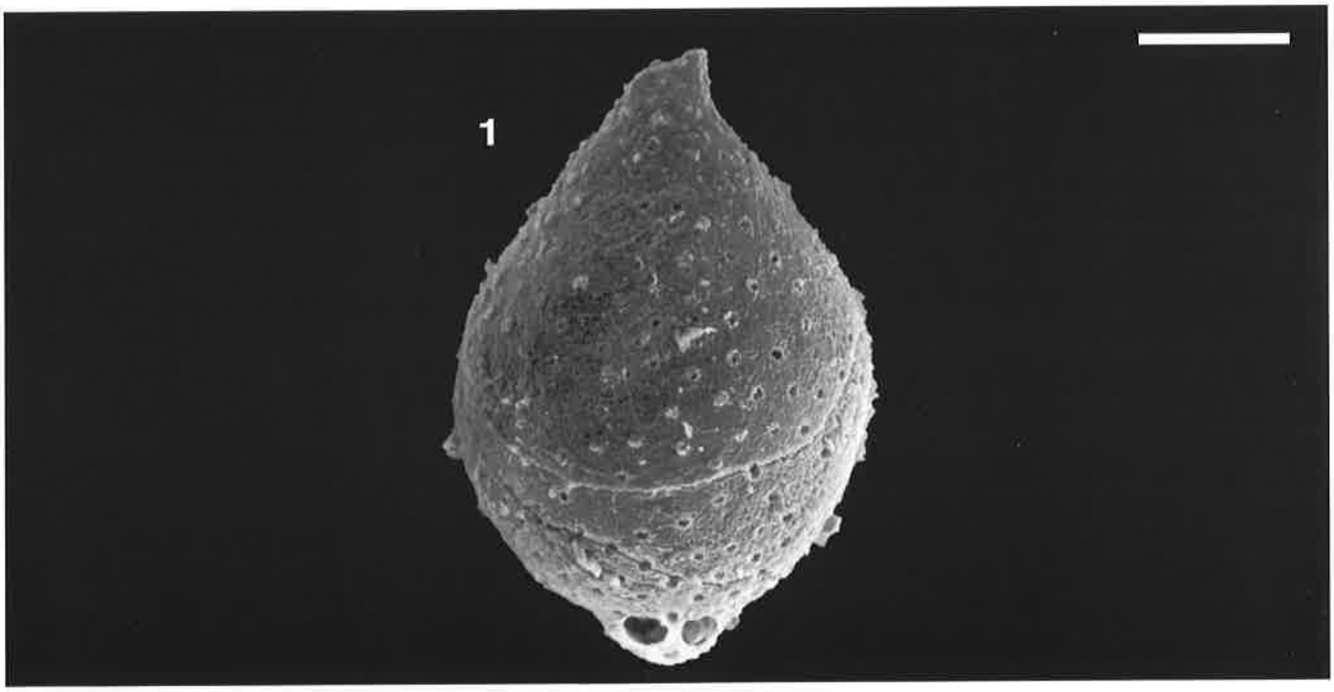


Plate 4050. *Tricolocapsa* (?) sp. aff. *T. fusiformis* sensu MATSUOKA. Magnification x700. **Fig. 1.** MA8710, MIN-1, Ch-1-A.

TRICOLOCAPSA PLICARUM S.L. 3051

Tricolocapsa plicarum s.l. YAO

Synonymy.-
See subspecies

Included Taxa.-
4053 *Tricolocapsa plicarum plicarum* YAO
4052 *Tricolocapsa plicarum* ssp. A

UAZones.- 3-8 , early-mid Baj. to mid Call.-early Oxf.

TRICOLOCAPSA PLICARUM PLICARUM 4053

Tricolocapsa plicarum plicarum YAO

Synonymy.-
Tricolocapsa plicarum YAO
YAO 1979, p. 32, pl. 4, figs. 1-11.
YAO et al. 1982, pl. 3, fig. 12.
SASHIDA et al. 1982, pl. 2, fig. 1; not pl. 1, fig. 2.
OWADA & SAKA 1982, pl. 2, fig. 15.
KOJIMA 1982, pl. 2, fig. 1.
WAKITA 1982, pl. 3, fig. 3.
KIDO et al. 1982, pl. 5, fig. 1.
IMOTO et al. 1982, pl. 2, figs. 1-2.
NISHIZONO et al. 1982, pl. 2, fig. 16.
WAKITA & OKAMURA 1982, pl. 7, fig. 9.
not ISHIDA 1983, pl. 8, fig. 9.
KASHIMA 1983, pl. 2, fig. 1.
SAKA 1983, pl. 6, figs. 2, 4; not fig. 3
BAUMGARTNER 1984, p. 790, pl. 10, fig. 6, not fig. 7.
BAUMGARTNER 1985, fig. 37. f.
MATSUOKA & YAO 1986, pl. 1, fig. ? 16; pl. 3, fig. 15.
MATSUOKA 1986b, fig. 3a only.
SATO et al. 1986, pl. 2, fig. 12.
YOKOTA & SANO 1986, pl. 1, fig. 5.
HATTORI 1987, pl. 13, fig. 3.
MATSUOKA 1988, pl. 1, fig. 1, not fig. 2.
Striatojaponocapsa plicarium (YAO)
KOZUR 1984, pl. 7, fig. 3.

Original Definition.- Shell of three segments. Cephalis spherical, poreless, partly depressed in thoracic cavity. Thorax truncate-conical, sparsely pored. Thoracic base flat with somewhat constricted opening. Abdomen spherical with thick wall, longitudinal plicae, and small, numerous, circular pores arranged in longitudinal rows. One row of pores present between neighbouring two longitudinal plicae. Longitudinal plicae extend to thoracic and often cephalic surface. Aperture constricted, and covered by a pored, thin-walled mamma.

Original Remarks.- This species is characterized by the basal appendage, which is not considered as an independent segment. This species is similar to *Hemicryptocapsa capita* TAN (1927, p. 50, pl. 9, fig. 67) in having the basal appendage, but differs frorn the latter in that the thorax is not depressed in the abdominal cavity, and in having the longitudinal plicae on the shell surface.

Etymology.- This species is named from the Latin noun *plicae* (plural), meaning plicae.

Measurements (in μm).-
Based on 12 specimens.

	HT	av.	min.	max
Width of skeleton:	105	98	78	106
Overall heigth:	150	135	104	150
Height of 1st chamber:	20	21	20	26
Height of 2nd chamber:	28	26	23	30
Height of 3rd chamber:	70	78	55	90
Height of 4th chamber:	18	15	7	20

Type Locality.- Sample IN 7, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 4-5, late Baj. to latest Baj.-early Bath.

TRICOLOCAPSA PLICARUM | *A* 4052

Tricolocapsa plicarum ssp. A

Synonymy.-
Tricolocapsa plicarum YAO
MATSUOKA 1983a, p. 20, pl. 3, figs 2, ? 1.
SAKA 1983, pl. 6, fig. 3 only.
YAO 1984, pl. 2, figs. 11-12.
BAUMGARTNER 1984, p. 790, pl. 10, fig. 7 only.
ISHIDA 1985, pl. 3, fig. 12.
YAMAMOTO et al. 1985, p. 39, pl. 8, fig. 8.
MATSUOKA 1986b, figs. 3b-c.
AITA 1987, p. 68, pl. 7, figs. 10a-b.
MATSUOKA 1988, pl. 1, fig. 2, not fig. 1.

Remarks.- Forms possessing a circular depression near aperture are included. The dish-like basal appendage is smaller than that of *T. plicarum plicarum*.

UAZones.- 4-5, late Baj. to latest Baj.-early Bath.

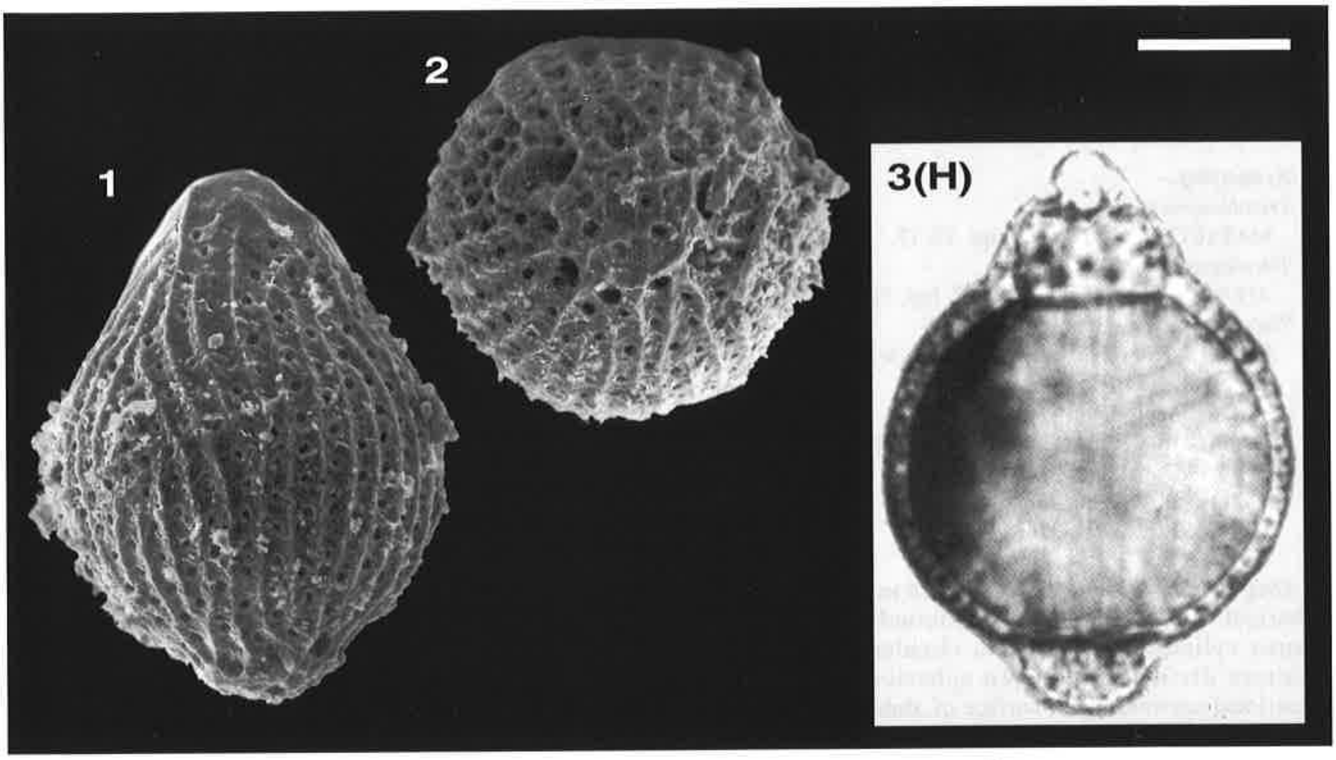


Plate 4053. *Tricolocapsa plicarum plicarum* YAO. Magnification x500. **Fig. 1.** MA, MIN-1, Ch-1-A. **Fig. 2.** MA, MIN-1, Ch-1-A. **Fig. 3(H).** YAO 1979, pl. 4, fig. 1a.

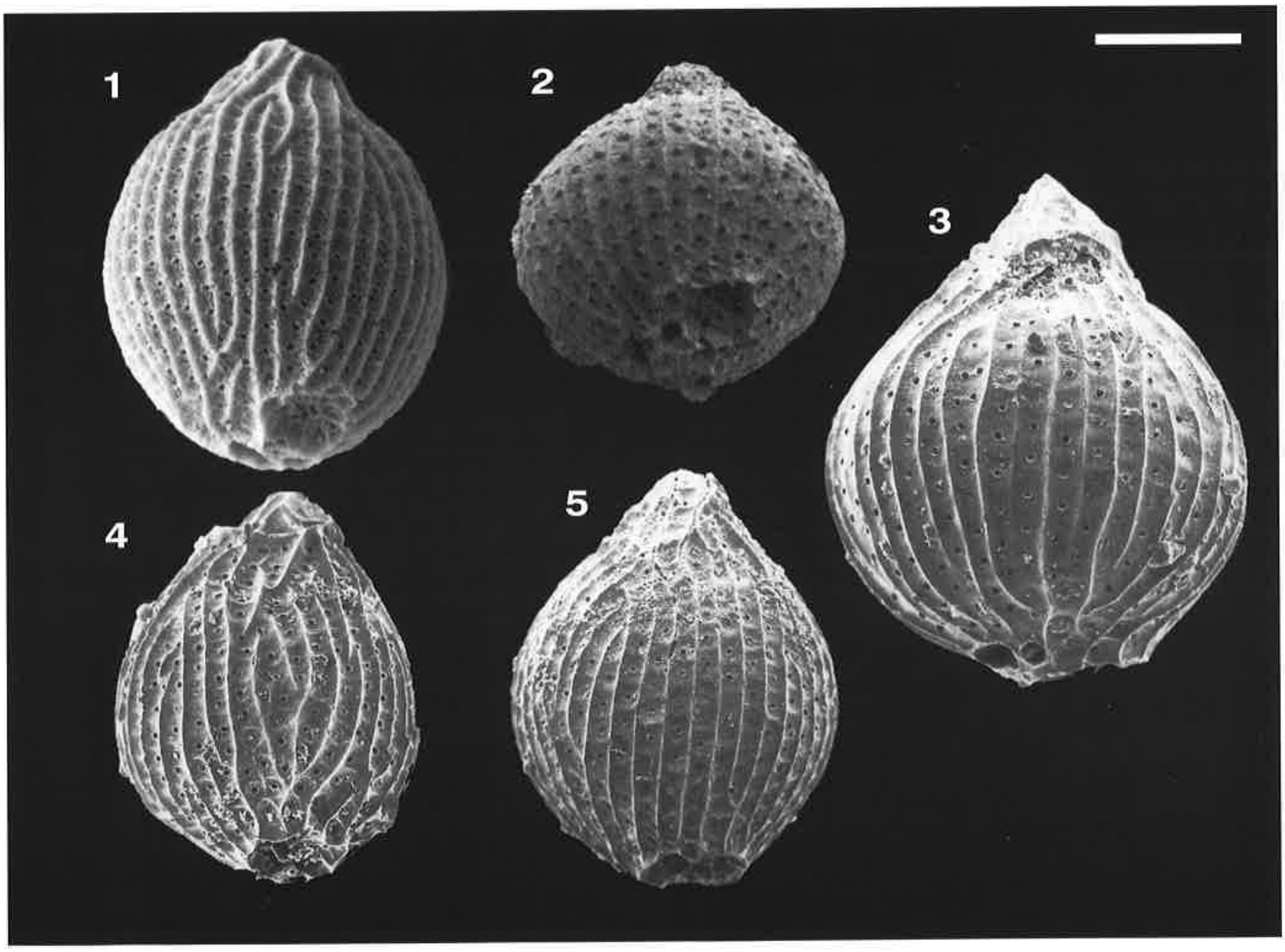


Plate 4052. *Tricolocapsa plicarum* ssp. A. Magnification x500. **Fig. 1.** MA1126, S-02. **Fig. 2.** MA, S-02. **Fig. 3.** POB81/2242, 534.122.1.43. **Fig. 4.** POB81/2256, 534.122.1.43. **Fig. 5.** POB81/2255, 534.122.1.43.

TRICOLOCAPSA TETRAGONA 4054

Tricolocapsa tetragona MATSUOKA

Synonymy.-
Tricolocapsa sp. N
MATSUOKA 1982a, pl. 2, figs. 13, 17.
Tricolocapsa sp. E
AITA 1982, pl. 4, fig. 4, not pl. 2, figs. 5a-b.
Tricolocapsa tetragona MATSUOKA
MATSUOKA 1983a, p. 22, pl. 3, figs. 8-12; pl. 8, figs. 4-10.
YAO 1984, pl. 2, figs. 5-6.
MATSUOKA & YAO 1986, pl. 1, fig. 18.
AITA 1987, p. 68, pl. 7, figs. 11a-b.
SATO et al. 1986, pl. 2, fig. 18.
YAO 1991, pl. 3, fig. 3.

Original Definition.- Shell of three segments. Cephalis spherical internally, rounded externally, imperforate. Thorax cylindrical with small, circular pores. Lumbar stricture distinct. Abdomen spherical with a small constricted aperture. Shell surface of abdomen ornamented with longitudinal plicae and transverse ridges connecting adjacent two longitudinal plicae. Thirteen to 14 longitudinal plicae visible in lateral view. The plicae and transverse ridges forming tetragonal frames, which change distally to pentagonal and hexagonal frames. Small, circular pores present at the center of the frames.

Original Remarks.- Ornament of outer shell surface varies among specimens. Besides type specimens with characteristic tetragonal frames, some specimens have only longitudinal plicae on the upper hemisphere of abdomen, where tetragonal frames are not formed (pl. 3, figs. 9, 12).

Tricolocapsa tetragona n.sp. is similar to *Tricolocapsa* sp. cf *T. ruesti* TAN (Yao 1979, p. 30-31, pl. 3, figs. 8-10, 12-20; not fig. 11) in proportion of each segment, but differs from the latter by having tetragonal frames on abdominal surface. This species is distinguished from *T. conexa* n.sp. by having distinct lumbar stricture, more widely spaced longitudinal plicae and transverse ridges and by lacking dish-like basal appendage.

Measurements (in μm).-
Based on 25 specimens. Total height, 115-150 (131); maximum width of shell, 91-132 (115); diameter of cephalis, 12-15 (13); height of thorax, 15-28 (23); of abdomen, 88-120 (105), diameter of aperture, 5-7 (6).

Type Locality.- Sample S-03, Shiraishigawa 1 section, Togano Group, Kochi Prefecture, southwest Japan.

UAZones.- 5-5, latest Baj.-early Bath.

TRICOLOCAPSA | *M* 4056

Tricolocapsa sp. M

Definition.- Shell of three segments, ovoidal. Cephalis spherical internally, without apical horn. Thorax cylindrical. Abdomen ovoidal with a constricted aperture. Collar stricture indistinct. Lumbar stricture distinct. Pores small, circular and uniform in size. Outer shell surface ornamented by very small spines.

UAZones.- 5-5, latest Baj.-early Bath.

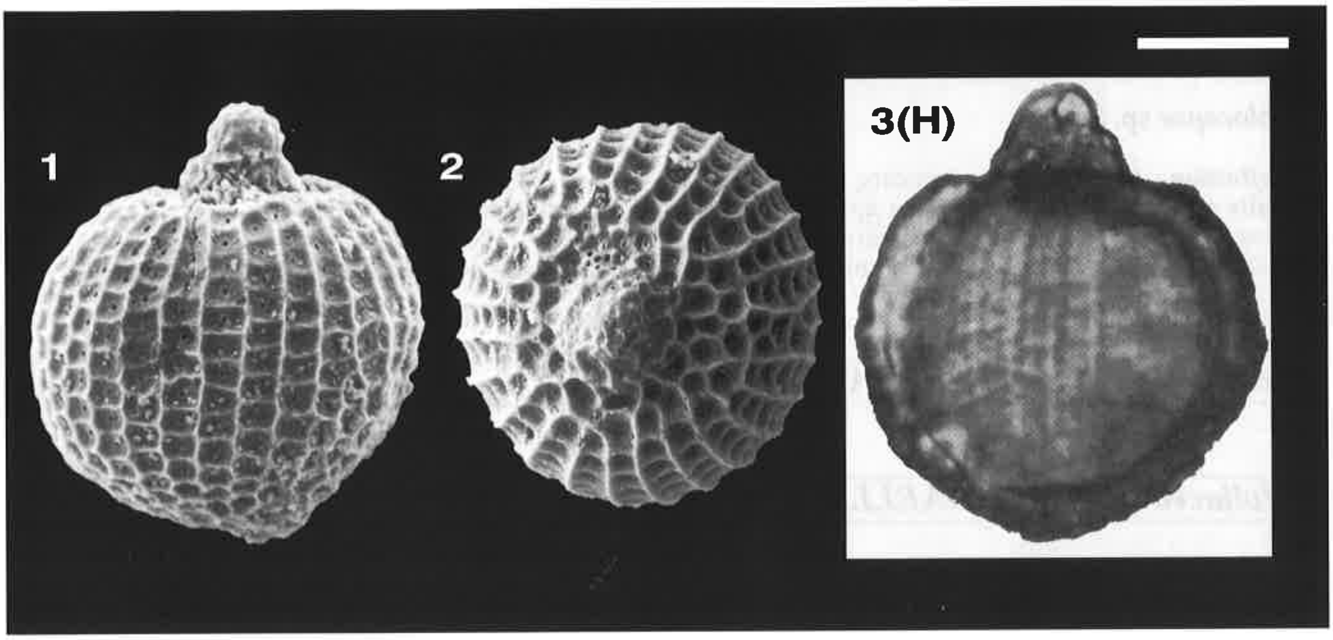


Plate 4054. *Tricolocapsa tetragona* MATSUOKA. Magnification x500. **Fig. 1.** MA1103, OCUMR2658, S-02. **Fig. 2.** MA1113, OCUMR2659, S-02. **Fig. 3(H).** MATSUOKA 1983, pl. 8, fig. 5a.

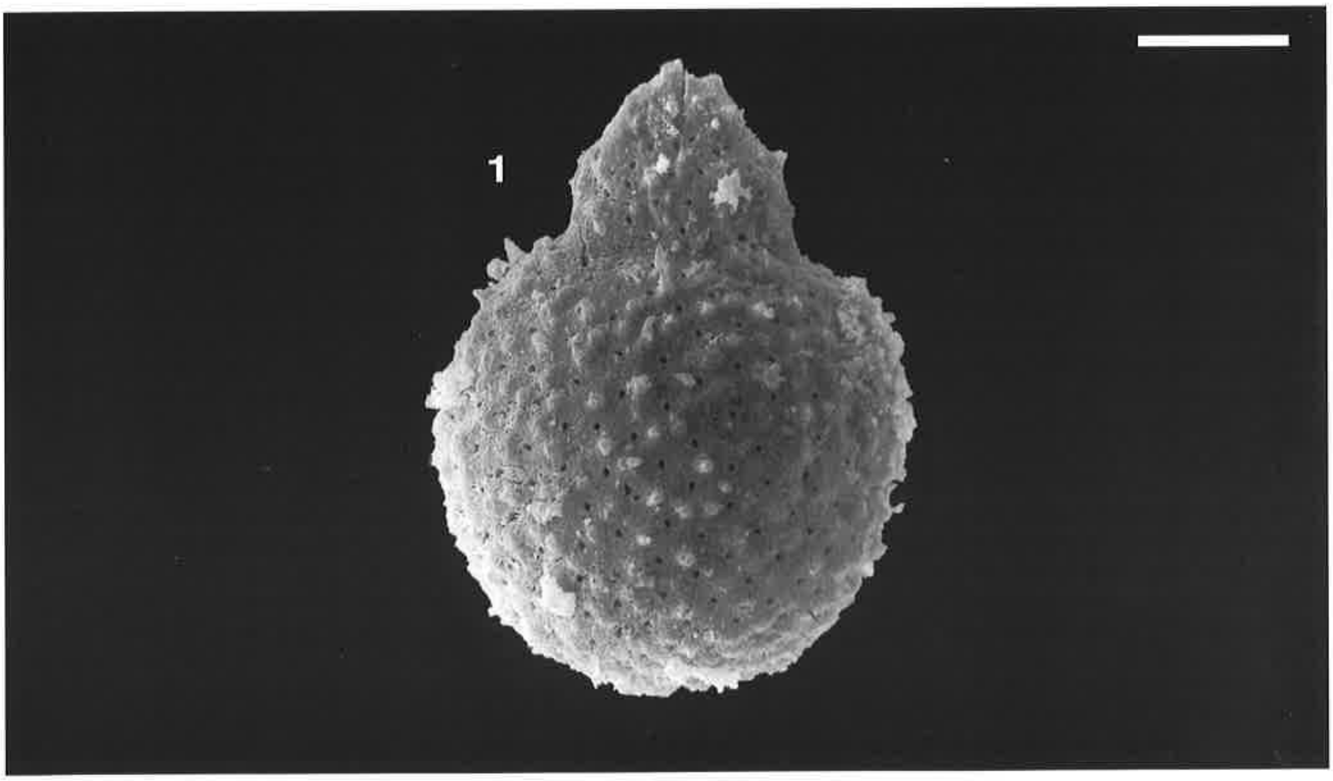


Plate 4056. *Tricolocapsa* sp. M. Magnification x700. **Fig. 1.** MA10620, MKS-18.

TRICOLOCAPSA | S 4057

Tricolocapsa sp. S

Definition.- Shell of three segments, subspherical. Cephalis spherical internally without apical horn and poreless. Thorax truncate-conical and porous. Abdomen spherical with a constricted aperture. Lumbar stricture distinct. Outer shell surface except for cephalis ornamented by polygonal (mainly hexagonal, rarely pentagonal) frames. Pores small, circular and set in the center of polygonal frames.

UAZones.- 4-5, late Baj. to latest Baj.-early Bath.

tricornis >> SETHOCAPSA TRICORNIS 5510

trifoliacea >> PARONAELLA TRIFOLIACEA 5186

trigonum >> CYCLASTRUM (?) TRIGONUM 5901

TRILLUS 3659

Genus: *Trillus* PESSAGNO & BLOME

Synonymy.-
Trillus PESSAGNO& BLOME
PESSAGNO & BLOME 1980, p. 248.

Type Species.- *Trillus seidersi* PESSAGNO & BLOME 1980.

Original Definition.- Cortical shell with well developed raised median band comprised of pore frames which are greatly thickened in Z direction (text-fig. 5). Pore frames of raised median band lacking massive secondary spines.

Original Remarks.- *Trillus* n.gen. differs from *Zartus* n.gen. in possessing a raised median band without large, massive secondary spines. It differs from *Pantanellium* PESSAGNO in possessing a well-developed median band. The phylogenetic relationship of *Trillus* to other genera of Pantanellinae is discussed elsewhere in this report.

Remarks.- Species differ in the number and character of the pore frames and the shape of the polar spines in axial section.

Etymology.- *Trillus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. 6, recommendation 40, p. 113).

Included Taxa.-
3039 *Trillus* spp.

TRILLUS | SPP. 3039

Trillus spp.

Remarks.- This taxon is treated on the generic level.

UAZones.- 1-5, early-mid Aal. to latest Baj.-early Bath.

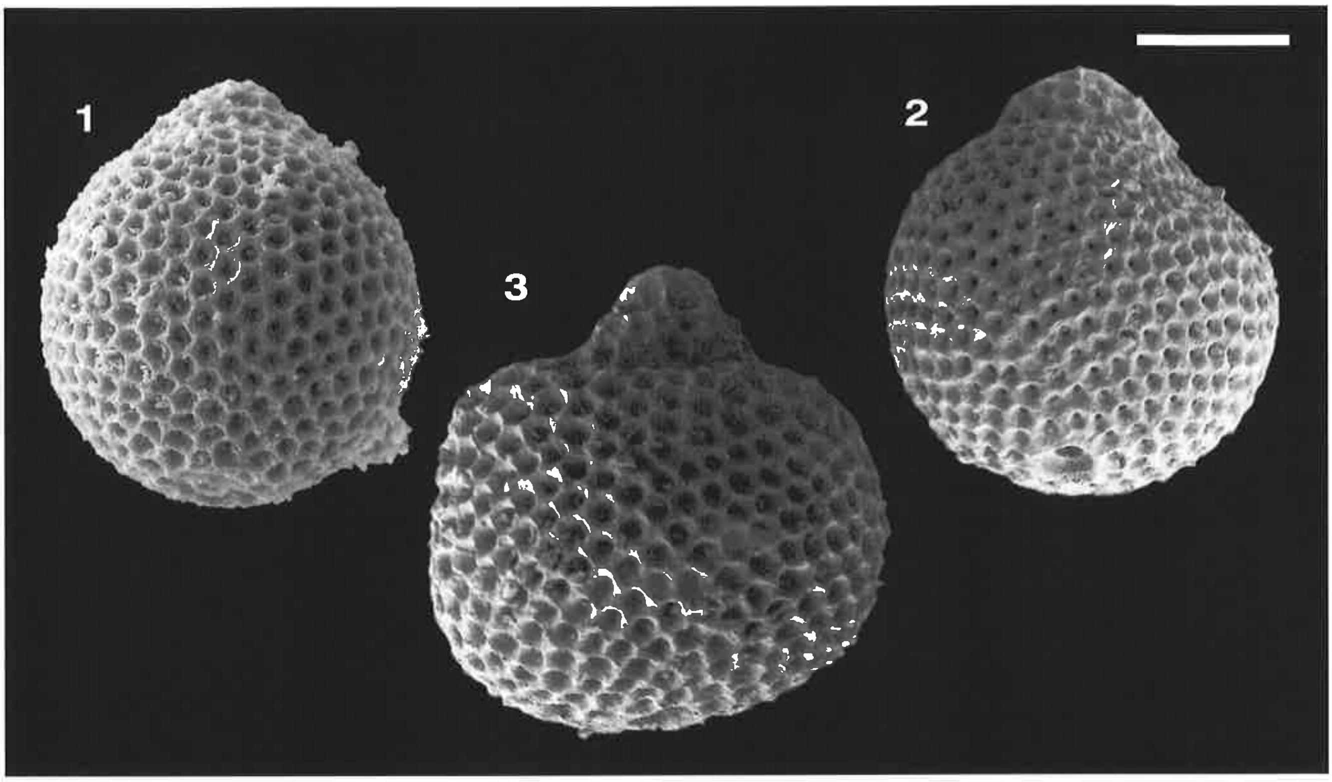


Plate 4057. *Tricolocapsa* sp. S. Magnification x500. **Fig. 1.** MA9844, MIN-1, Ch-1-A. **Fig. 2.** MA7647, MKS-7SA. **Fig. 3.** MA7860, MKS-8A.

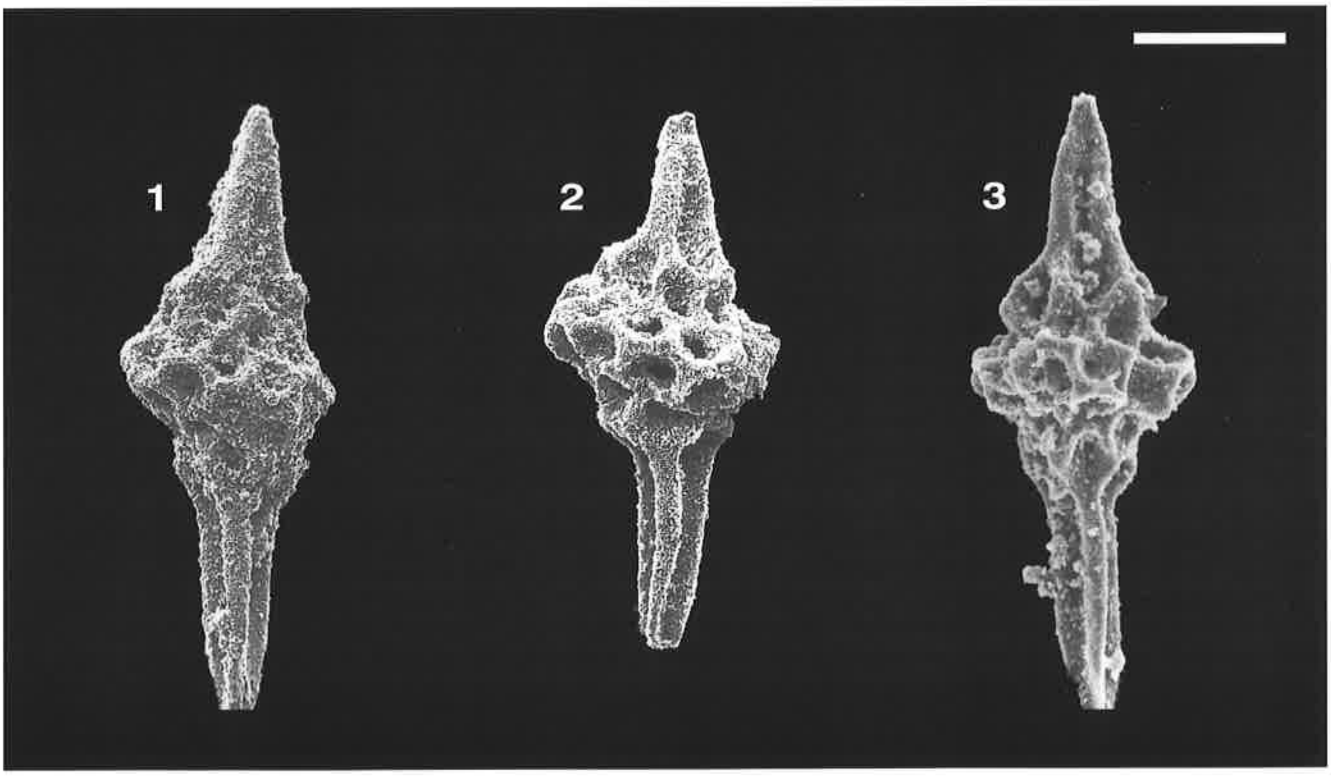


Plate 3039. *Trillus* spp. Magnification x400. **Fig. 1.** POB80/2134, POB1262. **Fig. 2.** POB80/3957, POB1262. **Fig. 3.** GO890237, GL127.

tripes >> *SPONGOCAPSULA (?) TRIPES* 5526

TRITRABS 3662

Genus: *Tritrabs* BAUMGARTNER

***Synonymy*.-**
Tritrabs BAUMGARTNER
BAUMGARTNER 1980, p. 293.
KITO & DE WEVER 1992, p. 131.

***Type Species*.-** *Paronaella* (?) *casmaliaensis* PESSAGNO 1977a.

***Original Definition*.-** Test as with subfamily, composed of 3 slender rays with variously shaped ray tips. Bracchiopile and patagium are lacking.

***Actualized Definition*.-** (KITO & DE WEVER, 1992) Test composed of a small central part and 3 rays having 3 primary canals, 3 secondary canals, the primary beam, 6 secondary beams, 3 tertiary beams and 3 quaternary beams. The tertiary and the quaternary beams constitute external beams.

***Etymology*.-** Latin: *tri-*, three-; *trabs trabis* (feminine), beam, rafter composed of 3 rafters.

***Included Taxa*.-**
3117 *Tritrabs casmaliaensis* (PESSAGNO)
3113 *Tritrabs ewingi* s.l. (PESSAGNO)
3115 *Tritrabs ewingi worzeli* (PESSAGNO)
3119 *Tritrabs exotica* (PESSAGNO)
3116 *Tritrabs hayi* (PESSAGNO)
3118 *Tritrabs rhododactylus* BAUMGARTNER
3303 *Tritrabs simplex* KITO & DE WEVER

TRITRABS CASMALIAENSIS 3117

Tritrabs casmaliaensis (PESSAGNO)

***Synonymy*.-**
Paronaella (?) *casmaliaensis* PESSAGNO
PESSAGNO 1977a, p. 69, pl. 1, figs. 6-8.
Tritrabs casmaliaensis (PESSAGNO)
BAUMGARTNER 1980, p. 293, pl. 1, fig. 10, pl. 4, fig. 11; pl. 11, fig. 10.
KOCHER 1981, p. 105, pl. 17, fig. 18.
ISHIDA 1983, pl. 10, fig. 6.
not ORIGLIA-DEVOS 1983, p. 83, pl. 10, fig. 2.
BAUMGARTNER 1984, p. 791, pl. 10, fig. 9.
BAUMGARTNER 1985, fig. 43a.
AITA 1987, p. 64.
OZVOLDOVA 1988, pl. 8, fig. 8.
DANELIAN 1989, p. 206, pl. 9, figs. 13-14.
KITO 1989, pl. 8, fig. 1.
OZVOLDOVA 1990, pl. 1, fig. 8.
CONTI & MARCUCCI 1991, pl. 4, fig. 11.
WIDZ 1991, p. 257, pl. 4, fig. 17.
STEIGER 1992, p. 41, pl. 8, fig. 1, not figs. 2-3.
Tritrabs sp. A
ISHIDA 1983, pl. 10, fig. 8.
Tritrabs aff. *casmaliaensis* (PESSAGNO)
ORIGLIA-DEVOS 1983, p. 83, pl. 10, fig. 3.
DE WEVER et al. 1986, pl. 8, fig. 12.
Tritrabs rhododactylus BAUMGARTNER
CONTI & MARCUCCI 1991, pl. 4, fig. 10.

***Original Definition*.-** Rays moderately long, each with wedge-shaped tips in side view. Two short spines diverging from corner of ray tips; extremely small spine on each ray tip centrally. Three nodose parallel ridges on tops and bottoms of each ray; two parallel ridges on side of ray. Central ridges on tops and bottoms of each ray converging in central area of test to outline large triangular area. Triangular area with massive nodes at vertices of polygonal (mostly triangular) pore frames. Square pore frames with large circular pores between median and lateral ridges on top and bottom surfaces of each ray. Two rows of polygonal (square?) pore frames occurring on sides of rays.

***Etymology*.-** This species is named for the Casmalis Hills near Point Sal, Santa Barbara County, California.

Measurements (in μm).-
Based on 7 specimens. Length of rays: 150 to 280; width of rays : 50 to 70.

***Type Locality*.-** Point Sal, California, USA.

***UAZones*.-** 4-10, late Baj. to late Oxf.-early Kimm.

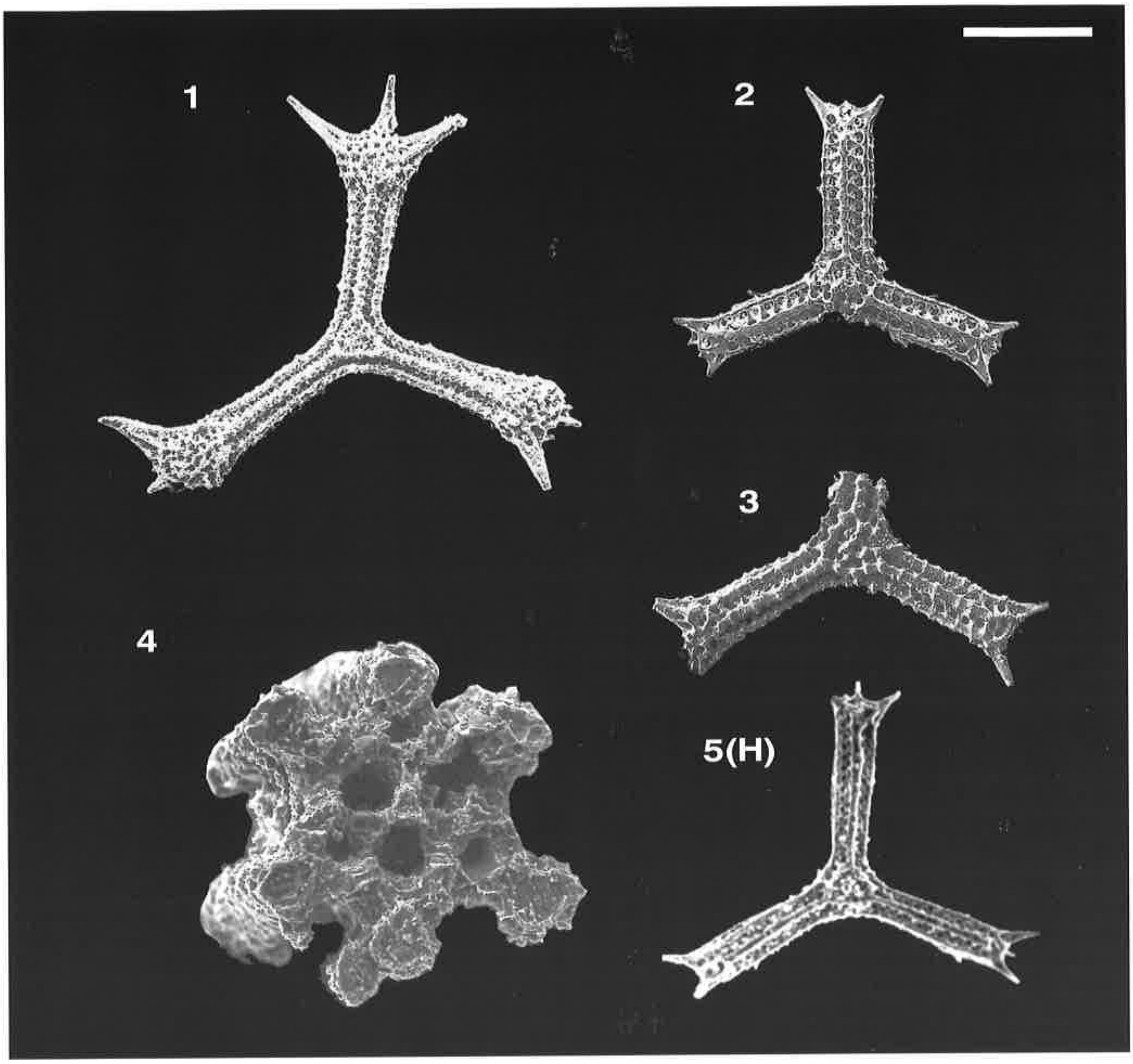


Plate 3117. *Tritrabs casmaliaensis* (PESSAGNO). Magnification x150, except Fig. 4 x900. **Fig. 1.** POB78/6509, POB899.54. **Fig. 2.** POB81/2674, 534.124.1.52. **Fig. 3.** POB81/2819, 534.121.1.25. **Fig. 4.** POB79/1492, POB899.61. **Fig. 5(H).** PESSAGNO 1977a, pl. 1, fig. 6.

TRITRABS EWINGI S.L. 3113

Tritrabs ewingi s.l. (PESSAGNO)

Synonymy.-
Paronaella (?) *ewingi* PESSAGNO
PESSAGNO 1971a, p. 47, pl. 19, figs. 2-5.
PESSAGNO 1977a, p. 70, pl. 1, figs. 14-15.
HOLZER 1980, p. 159, pl. 1, figs. 15-17.
Tritrabs ewingi (PESSAGNO)
BAUMGARTNER 1980, p. 293, pl. 4, figs. 5, 7, 17-18.
? KOCHER 1981, pl. 17, fig. 19.
BAUMGARTNER 1984, p. 791, pl. 10, fig. 10.
AITA 1987, p. 64.
OZVOLDOVA & SYKORA 1984, p. 273, pl. 14, fig. 5; pl. 15, fig. 5.
DE WEVER et al. 1986, pl. 7, fig. 4.
OZVOLDOVA 1988, pl. 3, fig. 10.
TUMANDA 1989, p. 35, pl. 2, fig. 5
Tritrabs ewingi ewingi PESSAGNO
STEIGER 1992, p. 38, pl. 7, figs. 3-4.
PESSAGNO et al. 1993, p. 127, pl. 3, fig. 8.
Tritrabs ewingi worzeli PESSAGNO
STEIGER 1992, p. 38, pl. 7, fig. 5.
Tritrabs ewingi gr. (PESSAGNO)
JUD 1994, p. 116, pl. 23, figs. 12-13.

Original Definition.- Test with extremely elongated, slender rays of nearly equal length having expanded ellipsoidal tips. Ray tips terminating in five to seven minute spines. Meshwork on rays comprised of square to rectangular frames arranged in two markedly linear rows. Rays subrectangular in axial section.

Original Remarks.- ? *Paronaella ewingi* n.sp. is tentatively assigned to *Paronaella* n.gen. Although it lacks a bracchiopyle as do all species of *Paronaella* the strong linearity of its pore frames suggests the presence of tabulae similar to those of *Halesium* n.gen. It is likely that this species should be assigned to a new and yet undescribed genus. ? *P. ewingi* n.sp. is analogous to "*Chitonastrum*" *tricuspidatum* RÜST (1885, p. 9, fig. 8) from the "Kieselkalk von Cittiglio". Like the latter species it possesses markedly linear rows of pore frames and three slender, straight, long rays. However, ? *P. ewingi* n.sp. possesses five to seven spines on its ray tips whereas "*Chitonastrum*" *tricuspidatum* RÜST possesses two long lateral spines and a long central spine on each ray.

Remarks.- In our material the specimens assignable to *Tritrabs ewingi* gr. (PESSAGNO) show the same considerable variation in ratio of length and thickness of rays as indicated by Pessagno (1971). In this species we have also included a morphotype possessing twisted rays.

Etymology.- This species is named for Dr. Maurice Ewing (Lamont-Doherty Geological Observatory), Co-Chief of JOIDES Leg 1.

Measurements (in μm).-
Length of rays HT 390, 400, 400; PT 310, 330, 330; PT 420, 450, 450; PT 380, 410, 420; PT 400, 380, 380.

Type Locality.- DSDP Leg 1, Site 5A, Blake-Bahama Basin.

UAZones.- 4-22, late Baj. to late Barr.-early Apt.

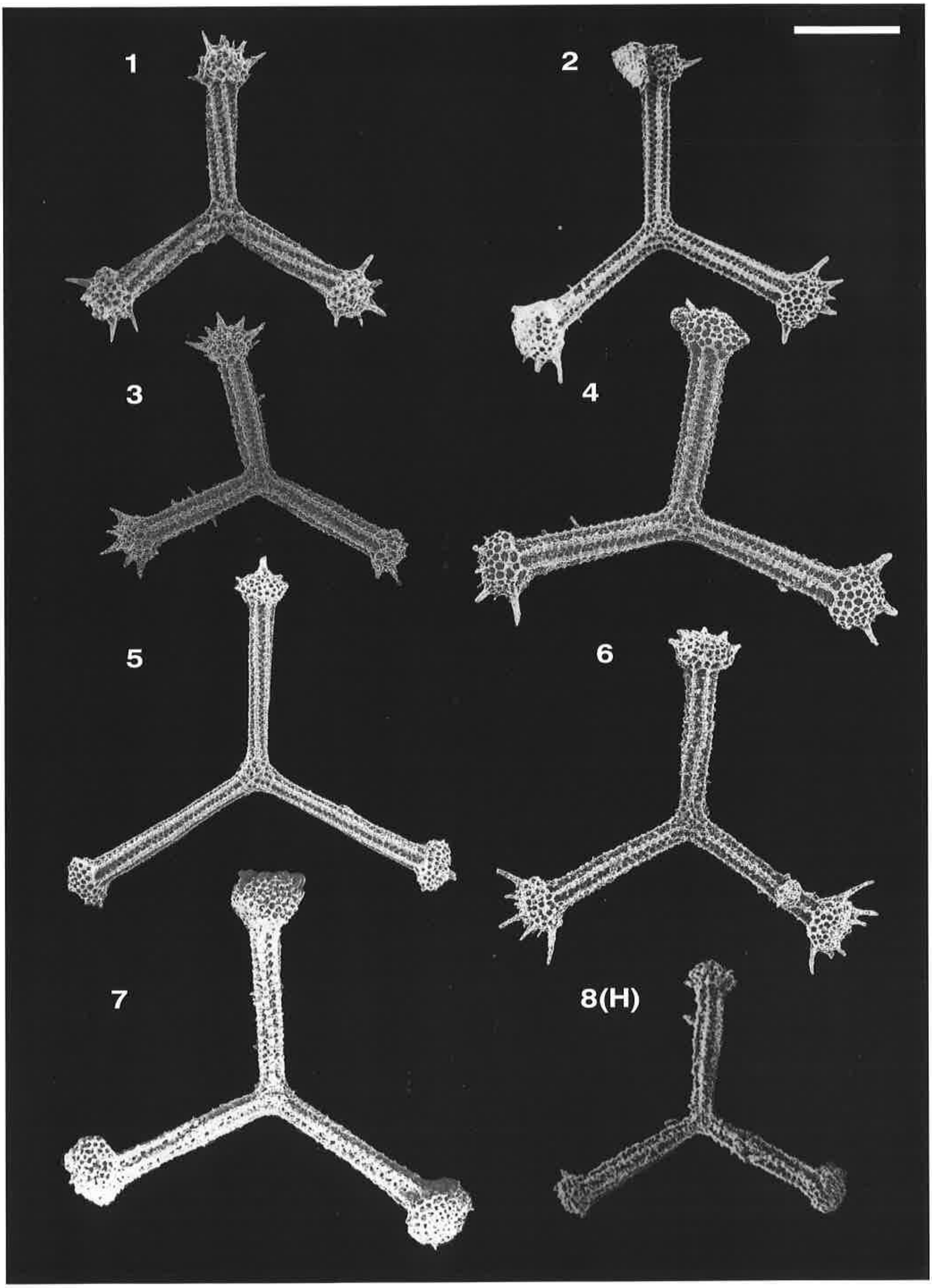


Plate 3113. *Tritrabs ewingi* s.l. (PESSAGNO). Magnification x100. **Fig. 1.** RJ7, Br1330. **Fig. 2.** RJ31, Br28.85. **Fig. 3.** RJ4, Br1330. **Fig. 4.** RJ17, Br28.85. **Fig. 5.** RJ38, Br1330. **Fig. 6.** RJ 6, Br1330. **Fig. 7.** POB75/4689, POBS4. **Fig. 8(H).** PESSAGNO 1971a, pl. 19, fig. 2.

TRITRABS EWINGI WORZELI 3115

Tritrabs ewingi worzeli (PESSAGNO)

Synonymy.-
? *Paronaella worzeli* PESSAGNO
PESSAGNO 1971a, p. 50, pl. 19, fig. 6.
Paronaella (?) *worzeli* PESSAGNO
HOLZER 1980, p. 160, pl. 1, fig. 18.
Tritrabs worzeli (PESSAGNO)
BAUMGARTNER 1980, p. 294, pl. 4, fig. 8.
ISHIDA 1983, pl. 10, fig. 9.
DE WEVER et al. 1986, pl. 8, figs. 9, not 8.

Original Definition.- Test with three rays of nearly equal length ending with heart-shaped tips. Pore frames square to variously tetragonal; arranged in three markedly linear rows on rays. Rays terminating in prominent central spines. Rays subrectangular in axial section. Patagium not observed.

Original Remarks.- ? *P. worzeli* n.sp. is tentatively placed in *Paronaella* n. gen. even though it lacks a bracchiopyle. Like ? *P. ewingi* n.sp. ? *P. worzeli* possesses meshwork on its rays arranged in three markedly linear rows. This suggests the presence of tabulae as with *Halesium* n.gen. (See ? *P. ewingi* n.sp.). ? *P. worzeli* n.sp. appears to be closely related to "*Rhopalastrum*" *trixiphus* RÜST (1885, p. 27, pl. 8, fig. 14) from the "Kiesellkalke von Cittiglio". It differs from the latter species by having distinctly heart-shaped ray tips. It is likely that both of these species will have to be placed in a new genus once their morphology is better understood. The somewhat recrystallized nature of the JOIDES material (Leg I, Site 5A, Core 7) prohibits establishing a new genus at the present time.

Actualized Remarks.- (BAUMGARTNER, 1980) *T. worzeli* and *T hayi* have the same relationship as *Tetratrabs bulbosa* n.sp. and *T. gratiosa* n.sp. Intermediate specimens with ray tips of various thickness suggest that both species are closely related. See detailed remarks under *Tetratrabs gratiosa*. Internal structure as with subfamily.

Etymology.- This species is named for Dr. J. Lamar Worzel (Lamont-Doherty Geological Observatory), Co-chief Scientist of JOIDES Leg 1.

Measurements (in μm).-
Based on 3 specimens.

	HT	av.	min.	max.
Length of rays AX:	310	350	310	430
Length of rays BX:	350	361	340	400
Length of rays CX:	310	350	310	430

Type Locality.- Blake Bahama Basin (West Atlantic).

UAZones.- 7-12, late Bath.-early Call. to early-early late Tith.

TRITRABS EXOTICA 3119

Tritrabs exotica (PESSAGNO)

Synonymy.-
Paronaella (?) *exotica* PESSAGNO
PESSAGNO 1977a, p. 70, pl. 1, figs. 12-13.
Tritrabs exotica (PESSAGNO)
BAUMGARTNER 1980, p. 294, pl. 4, fig. 16.
? KOCHER 1981, pl. 17, fig. 20.
BAUMGARTNER 1984, p. 791, pl. 10, fig. 11.
DE WEVER et al. 1986, pl. 8, fig. 19.
Tritrabs cf. *exotica* (PESSAGNO)
DE WEVER et al. 1986, pl. 8, fig. 14.

Original Definition.- Test with three nearly equal-sized rays of medium length having broad tips subcircular in outline; tips with five to seven short spines. Central area with irregular polygonal meshwork. Rays between tips and central area with three parallel longitudinal ridges.

Original Remarks.- This species is somewhat analogous to *P.* (?) *worzeli* PESSAGNO 1971a. It differs from the latter species in the shape of its ray tips and by possessing numerous short spines.

Etymology.- This species is named from the Latin adjective *exoticus*, meaning foreign, exotic, outlandish.

Measurements (in μm).-
Based on 10 specimens. Length of rays: 210 to 340; width of ray tips: 120 to 190.

Type Locality.- Point Sal, California, USA.

UAZones.- 4-11, late Baj. to late Kimm.-early Tith.

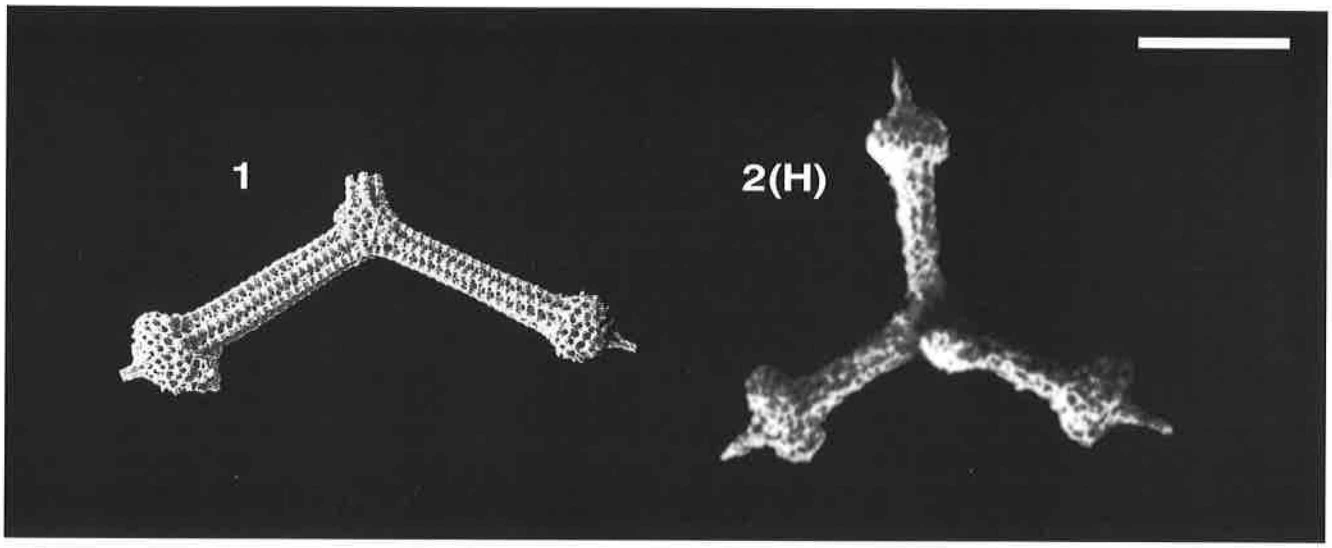


Plate 3115. ***Tritrabs ewingi worzeli*** **(PESSAGNO).** Magnification x100. **Fig. 1.** POB78/8157, POB986.52. **Fig. 2(H).** PESSAGNO 1971a, pl. 19, fig. 6.

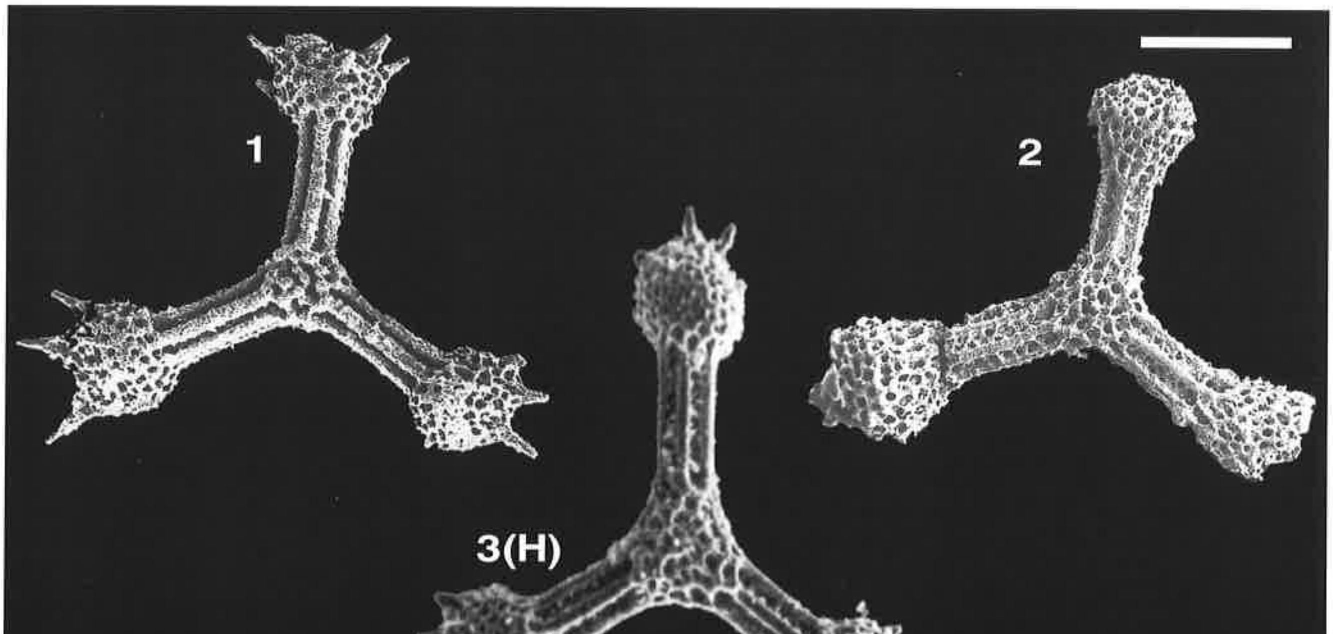


Plate 3119. ***Tritrabs exotica*** **(PESSAGNO).** Magnification x150. **Fig. 1.** POB78/6222, POB899.52. **Fig. 2.** POB81/2401, 534.122.1.26. **Fig. 3(H).** PESSAGNO 1977a, pl. 1, fig. 12.

TRITRABS HAYI 3116

Tritrabs hayi (PESSAGNO)

Synonymy.-
Paronaella (?) *hayi* PESSAGNO
PESSAGNO 1977a, p. 70, pl. 1, fig. 16; pl. 2, fig. 1.
Tritrabs hayi (PESSAGNO)
BAUMGARTNER 1980, p. 294, pl. 4, figs. 10, 21-22.
KOCHER 1981, p. 106, pl. 17, fig. 21.
ISHIDA 1983, pl. 10, fig. 7.
BAUMGARTNER 1984, p. 791, pl. 10, fig. 12.
OZVOLDOVA & PETERCAKOVA 1987, pl. 36, fig. 3.
ORIGLIA-DEVOS 1983, p. 86, pl. 9, fig. 7.
EL KADIRI 1984, p. 130.
DANELIAN 1989, p. 208.
? KITO 1989, p. 121, pl. 8, fig. 2.
PESSAGNO et al. 1993, p. 128, pl. 3, fig. 5.

Original Definition.- Rays long, each with single centrally placed spine of medium length. Ray tips with massive nodes at vertices of square to triangular pore frames. Three longitudinal ridges on rays diverging in a distal direction. Central area with massive nodes at vertices of triangular to square pore frames.

Original Remarks.- The presence of longitudinal ridges on the rays of members of this species suggests that it may need to be included in a new genus among the Patulibracchiinae.

Etymology.- This species is named for Dr. William W. Hay in honor of his contributions to micropaleontology and stratigraphy.

Measurements (in μm).-
Based on 7 specimens. Length of rays: 210-370; width of rays: 50-70.

Type Locality.- Point Sal, California, USA.

UAZones.- 3-10, early-mid Baj. to late Oxf.-early Kimm.

TRITRABS RHODODACTYLUS 3118

Tritrabs rhododactylus BAUMGARTNER

Synonymy.-
Tritrabs rhododactylus BAUMGARTNER
BAUMGARTNER 1980, p. 294, pl. 4, figs. 12-15; pl. 11, fig. 15.
? ISHIDA 1983, pl. 10, fig. 10.
BAUMGARTNER 1984, p. 791, pl. 10, fig. 13.
DE WEVER et al. 1986, pl. 8, fig. 11.
DANELIAN 1989, p. 208, pl. 10, figs. 2-5.
KITO 1989, p. 122, pl. 13, figs. 12-14.
Tritrabs rhododactyla BAUMGARTNER
KOCHER 1981, p. 106, pl. 17, fig. 22.
ORIGLIA-DEVOS 1983, p. 86, pl. 10, figs. 8-9.
Tritrabs casmaliaensis (PESSAGNO)
ORIGLIA-DEVOS 1983, pl. 10, fig. 2.

Original Definition.- Relatively small form, composed of 3 rays of usually unequal length at varying subequal to unequal interradial angles. Central area of cortical shell with irregularly arranged nodes and small pores. External beams of rays strong, with or without nodes. Double pore rows between external beams deeply depressed and therefore often difficult to observe. A superimposed layer of widely spaced, irregular oblique bars between adjacent beams may cover the double pore rows (see pl. 4, fig. 15).

Ray tips of variable shape, wedge-shaped and axially flattened or slightly inflated. Simple forms have a central spine and equally developed lateral spines. Many forms have 2 to 4 smaller central and 2 longer lateral spines; some forms have 4 lateral spines. Small spines may also be placed on beams in the distal half of rays (see pl. 11, fig. 15). Ray tips may be twisted with respect to the ray axis, causing spines to stand considerably out of the equatorial plane. Internal structure as in text figure 4C.

Original Remarks.- This species is rather broadly defined to include a variety of morphotypes which do not fit either *T. ewingi* or *T. casmaliaensis*. *Tritrabs rhododactylus* differs from *T. casmaliaensis* in having shorter rays of unequal length at unequal angles; an irregular nodose central area; and 1 or more well-developed central spines and 2 or more lateral spines. It differs from *T. ewingi* in having shorter rays, less inflated ray tips and proportionally longer spines. It differs from *Halesium* sp. A in lacking a bracchiopyle.

Etymology.- Greek: *rhododactylus*, with roselike fingers (Homer).

Measurements (in μm).-
Based on 11 specimens.

	HT	av.	min.	max.
Length of rays AX:	153	-	-	-
Length of rays BX:	187	178	140	233
Length of rays CX:	233	-	-	-
Interradial angles AB:	92’	-	-	-
Interradial angles BC:	126’	-	-	-
Interradial angles CA:	142’	-	-	-
Width of rays:	47-50	52	46	57
Central ray A(2):	37	-	-	-
Central ray B(1):	55	42	25	64
Central ray C(1):	53	-	-	-
Lateral ray A(2):	60	-	-	-
Lateral ray B(2):	50	46	33	66
Lateral ray C(2):	33	-	-	-

Type Locality.- Angelokastron, Greece.

UAZones.- 3-13, early-mid Baj. to latest Tith.

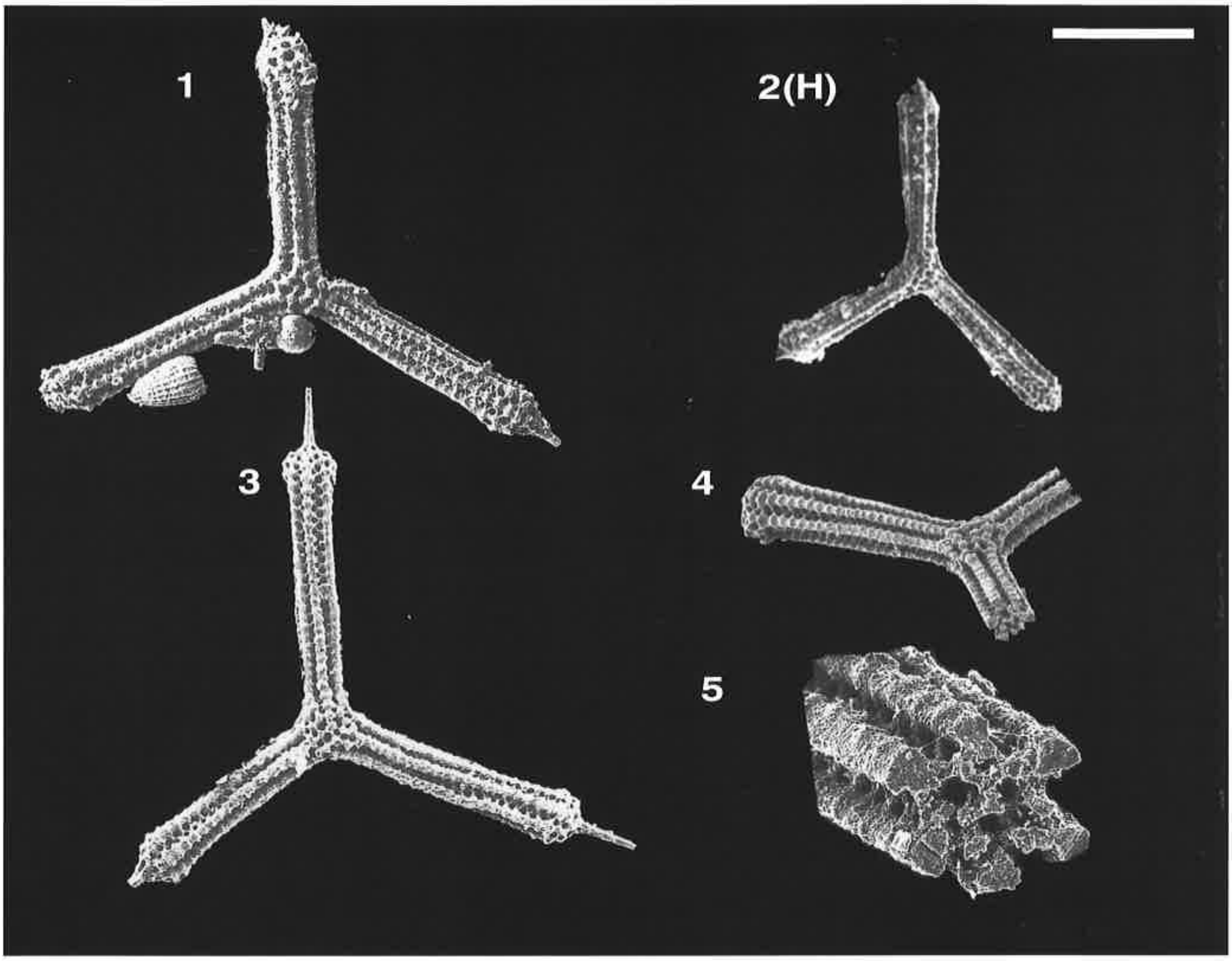


Plate 3116. *Tritrabs hayi* (PESSAGNO). Magnification x100, unless otherwise indicated. **Fig. 1.** POB78/6292, POB899.53. **Fig. 2(H).** PESSAGNO 1977a, pl. 1, fig. 16. **Fig. 3.** POB78/6095, POB899.50. **Fig. 4.** POB78/6493, POB28.67. **Fig. 5.** POB78/6492, POB28.67, x500.

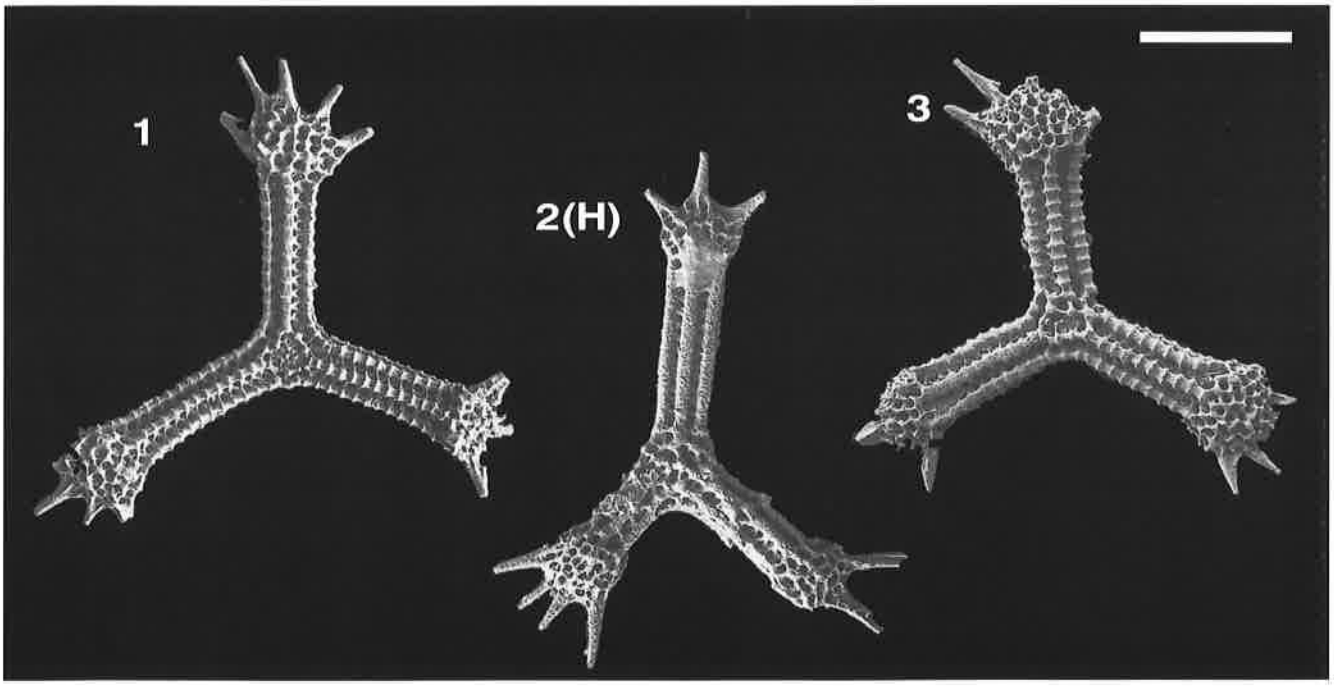


Plate 3118. *Tritrabs rhododactylus* BAUMGARTNER. Magnification x150. **Fig. 1.** POB78/8214, POB986.51. **Fig. 2(H).** POB79/1495, POB899.61. **Fig. 3.** POB79/1631, POB79.4.

TRITRABS SIMPLEX 3303

Tritrabs simplex KITO & DE WEVER

Synonymy.-
Tritrabs sp. G
HATTORI 1987, pl. 4, figs. 3-4.
Tritrabs sp.
HATTORI 1988a, pl. 6, figs. H-I.
Tritrabs simplex KITO & DE WEVER
KITO & DE WEVER 1992, p. 131, text-fig. 4; pl. 1, figs. 3-7,9.

Original Definition.- "Test composed of relatively short three rays. Six external beams have nodes which develop well at distal portion of rays. Central spines strong and triradiate. Central area has some nodes. Some specimens have slightly developed spongy ray tips.The system of canals is constituted of 3 primary subtriangular canals and 3 secondary semicircular canals. The orientation of the plane of symmetry of the ray is unstable."

Remarks.- *Tritrabs simplex* is distinguished from *T. hayi* by having shorter rays. The difference is the same as between *Tetratrabs zealis* and *T. izeensis*.

Etymology.- Latin *simplex* (adj.), simple, refers to the form of this species.

Measurements (in μm).-
Based on 11 specimens.

	min.	max.	av.	HT
Length of ray:	152	281	190	155
Length of central spine:	51	132	72	59
Width of ray:	51	85	62	52

Type Locality.- Contrada La Ferta (Sicily, Italy).

UAZones.- 1-6, early-mid Aal. to mid Bath.

trizonalis >> ACANTHOCIRCUS TRIZONALIS ANGUSTUS 3082

trizonalis >> ACANTHOCIRCUS TRIZONALIS DICRANACANTHOS 3087

trizonalis >> ACANTHOCIRCUS TRIZONALIS S.L. 3065

trizonalis >> ACANTHOCIRCUS TRIZONALIS TRIZONALIS 3083

tsunoensis >> AMPHIPYNDAX TSUNOENSIS 2025

tuberculatus >> NOVIXITUS (?) TUBERCULATUS 5693

tubulata >> PARONAELLA (?) TUBULATA 5183

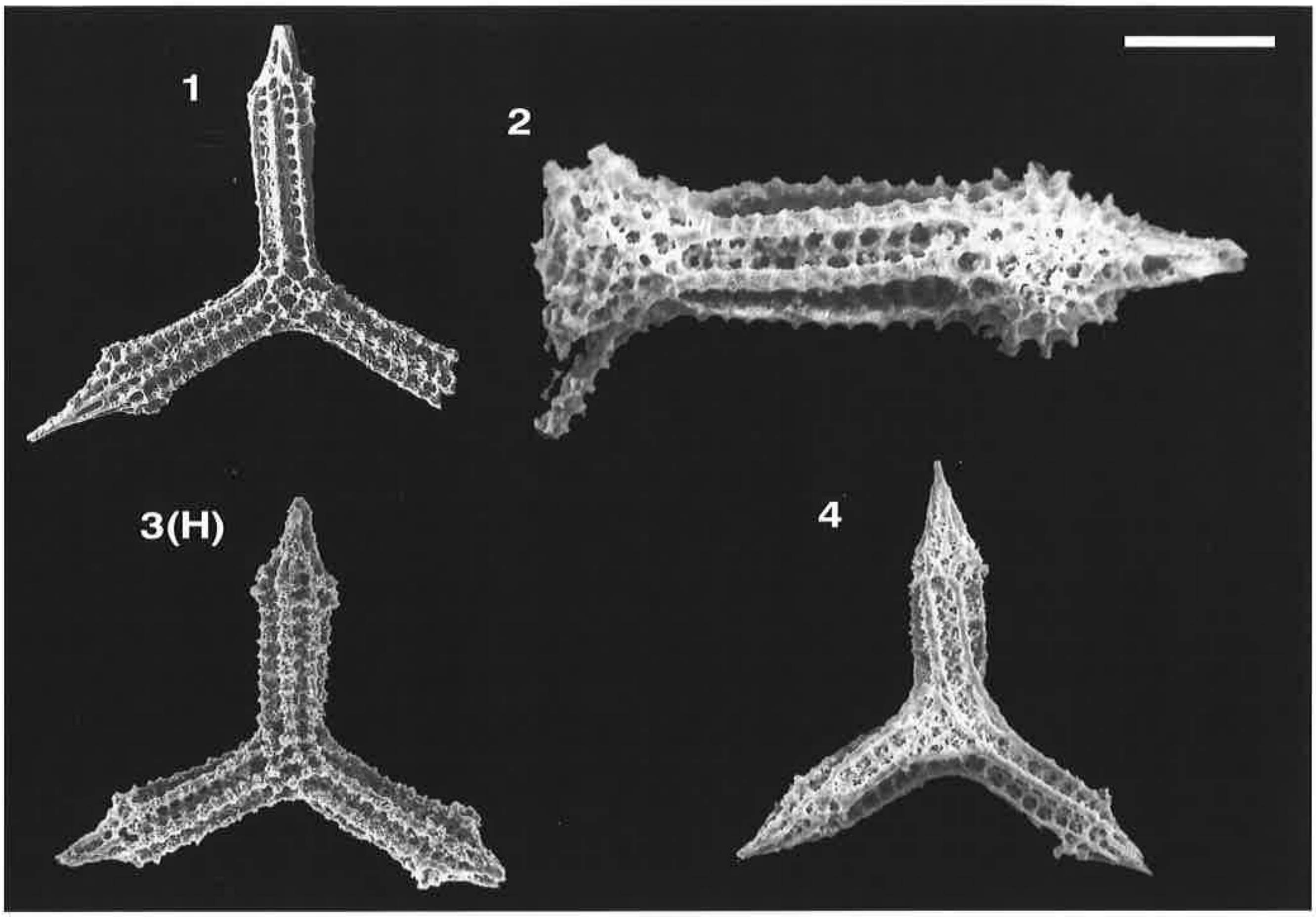


Plate 3303. *Tritrabs simplex* KITO & DE WEVER. Magnification x150, except Fig. 2 x250. **Fig. 1.** POB79/4445, IN7. **Fig. 2.** KI8739-33, S70. **Fig. 3(H).** KI8731-6, S66. **Fig. 4.** KI8739-29, S70.

TURANTA 3663

Genus: *Turanta* PESSAGNO & BLOME

Synonymy.-
Turanta PESSAGNO & BLOME
PESSAGNO & BLOME 1982, p. 296.

Type Species.- *Turanta capsensis* PESSAGNO & BLOME 1982.

Original Definition.- Test dicyrtid. Cephalic wall incompletely formed, mostly open, partially lacking sides and roof, but possessing well-developed cyrtoid collar plate (pl. 3, figs. 2-3, 11-12). Thorax with two feet connected with and in line with vertical and dorsal bars (pl. 4, fig. 17). Horns and feet varying in length and curvature with species, typically triradiate in axial section with alternating ridges and grooves. Horn and feet usually in same plane; distance between horn and vertical foot always differing from distance between horn and dorsal foot. Thorax subspherical, often somewhat compressed at right angles to the plane of the horn and feet; flattened area occurring between horn and vertical foot; thorax lacking mouth and with symmetrical pentagonal and hexagonal pore frames.

Original Remarks.- *Turanta* n.gen. differs from all other Mesozoic dicyrtid Nassellariina by virtue of the partially formed, naked nature of its cephalis. It may well be that the missing cephalic walls were extremely thin and fragile in character and were not capable of being fossilized; they are for the most part missing on all specimens of *Turanta* observed during this study.

The spumellarian-like test of *Turanta* at first suggests a kinship to *Tripocyclia* RÜST. However, the two genera can be easily distinguished externally by the asymmetrical placement of the horn and feet of *Turanta* as well as the flattened area between the horn and vertical foot.

Actualized Remarks: (TAKEMURA, 1986) PESSAGNO & BLOME (1982) described Turanta as dicyrtid Nassellaria, of which cephalis was naked. However, *Turanta* possesses all the cephalic skeletal elements and specially A, originated at the point where MB, D and two I join, prolonging into an apical spine (pl. 11, 17-18), penetrating inside the shell which is described as "thorax" by PESSAGNO & BLOME (1982). This fact clearly indicates that the large subspherical latticed shell of *Turanta* is the cephalis. Therefore, the horn described by PESSAGNO & BLOME (1982) is the dorsal spine and the two feet are the apical and vertical spines.

Remarks.- Species have been distinguished by a slight variation in the shape of the thorax, the number and size of pore frames on the thorax and by variations in the size and shape of the respective horns and feet.

Etymology.- *Turanta* (f.) is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. VI, Recommendation 40, p. 113).

Included Taxa.-
2024 *Turanta flexa* PESSAGNO & BLOME
3247 *Turanta morinae* gr. PESSAGNO & BLOME

TURANTA FLEXA 2024

Turanta flexa PESSAGNO & BLOME

Synonymy.-
Turanta flexa PESSAGNO & BLOME
PESSAGNO & BLOME 1982, p. 298, pl. 6, figs. 5-6.

Original Definition.- Remnants of cephalic wall with small polygonal (dominantly pentagonal) pore frames. Thorax subspherical with relatively massive hexagonal pore frames; pore frames increasing in size and showing more prominent nodes in a distal direction. Horn short, thin, slightly curved, triradiate in axial section with three narrow grooves alternating with three wide rounded ridges; grooves wedging out distally. Feet quite long and curved, triradiate in axial section with three narrow grooves alternating with three wide, rounded ridges. Distal half of one foot curved out of equatorial plane of test.

Original Remarks.- *Turanta flexa* n.sp. differs from all other species of *Turanta* by having very long, curved feet coupled with a short, slender horn. In addition, the distal half of one foot displays curvature outside of the equatorial plane of the test.

Etymology.- *Flexus-a-um,* Latin (adj.), bending, turning, curved.

Measurements (in μm).-
Based on 7 specimens.

	HT	av.	min.	max.
Length of thorax:	225	262	255	282
Width of thorax:	225	233	225	250
Length of foot:	400	337	300	400
Length of horn:	142	129	100	150

Type Locality.- Holotype from NSF 908. Paratypes from NSF 973. Pelagic strata overlying the Coast Range Ophiolite at Point Sal and Stanley Mountain, California.

UAZones.- 6-8, mid Bath. to mid Call.-early Oxf.

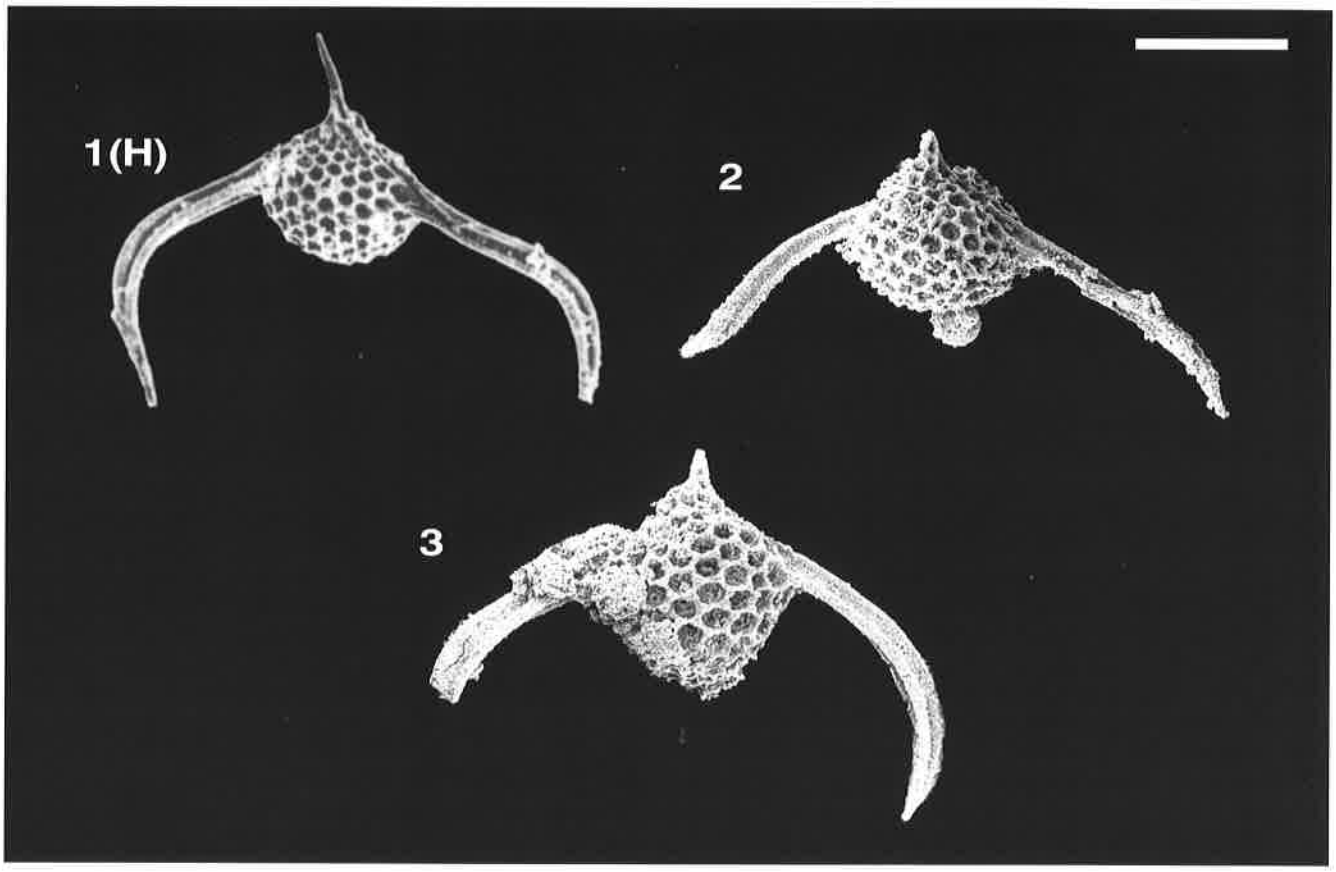


Plate 2024. ***Turanta flexa*** **PESSAGNO & BLOME.** Magnification x200. **Fig. 1(H).**PESSAGNO & BLOME 1982, pl. 6, fig. 6. **Fig. 2.** AB 3639, TM165.80.g4. **Fig. 3.** AB2239, TM163.05.b40.

TURANTA MORINAE GR. 3247

Turanta morinae gr. PESSAGNO & BLOME

Synonymy.-
Turanta morinae PESSAGNO & BLOME
PESSAGNO & BLOME 1982, p. 300, pl. 1, figs. 3-4, 8, 11, 16.
Turanta officerense PESSAGNO
PESSAGNO & BLOME 1982, p. 301, pl. 2, figs. 2-3; pl. 8, fig. 1.
Turanta sp. A
cf. PESSAGNO & BLOME 1982, p. 302, pl. 2, fig. 1.
CARTER & JAKOBS 1991, p. 351, pl. 3, fig. 13.

Original Definition.- Cephalis as with genus. Thorax subspherical with equal number of pentagonal and hexagonal pore frames having weakly developed nodes at vertices; hexagonal pore frames somewhat larger than pentagonal pore frames. Horn and feet relatively long, triradiate in axial section with grooves and ridges of equal width; grooves and ridges gradually decreasing in width distally. Proximal 1/2 of horn curved; distal 1/2 straight. Feet straight, widely separated, nearly at right angles to horn.

Original Remarks.- *Turanta morinae* n.sp. differs from *Turanta silviensis* n.sp. by having a longer horn, longer feet and fewer pore frames. Furthermore, whereas *T. morinae* tends to have about the same number of hexagonal and pentagonal pore frames, *T. silviensis* has predominantly hexagonal pore frames.

Remarks.- Forms with massive horn and feet are included.

Etymology.- This species is named for Karen E. Morin in honor of her recent contributions to the study of Upper Cretaceous Radiolaria.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	min.	max.
Length of thorax:	162	154	125	175
Width of thorax:	137	146	126	175
Length of foot:	150	165	100	225
Length of horn:	150	122	87	150

Type Locality.- Sample OR 580, Snowshoe Formation, East-central Oregon.

UAZones.- 1-5, early-mid Aal. to latest Baj.-early Bath.

turbo >> PROTUNUMA TURBO 4034

turpicula >> RISTOLA (?) TURPICULA 3543

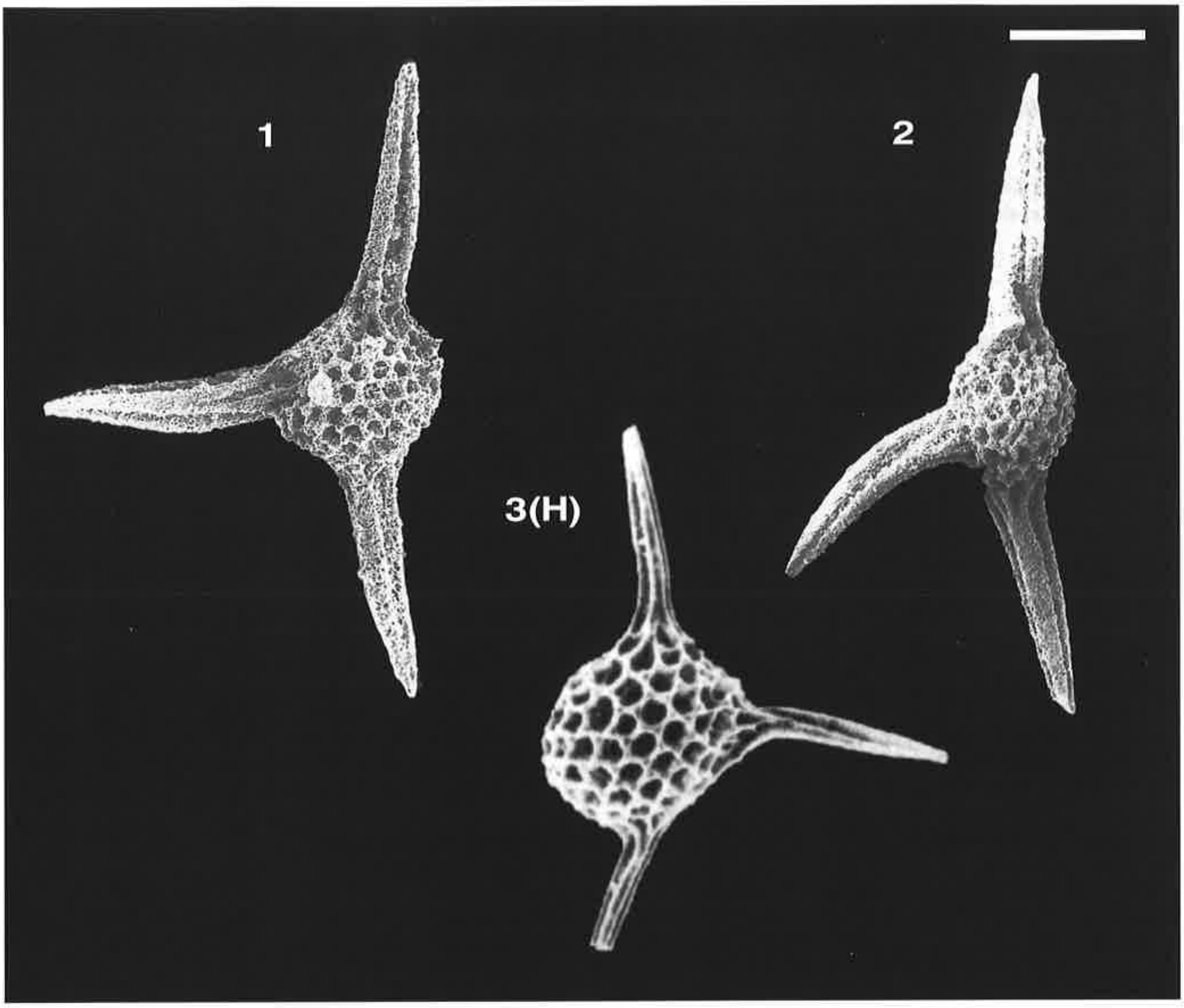


Plate 3247. *Turanta morinae* gr. PESSAGNO & BLOME. Magnification x150. **Fig. 1.** POB81/2979, POB1341. **Fig. 2.** POB81/2829, POB1341. **Fig. 3(H).** PESSAGNO & BLOME 1982, pl. 1, fig.3.

TYMPANEIDES 0007

Genus: *Tympaneides* CARTER

Synonymy.-
Tympaneides CARTER
CARTER et al. 1988, p. 37.

Type Species.- *Tympaneides charlottensis* CARTER 1988.

Original Definition.- Test is a flattened sphere (drum-shaped) with four spines extending from sides to form a cross in one plane. Top and bottom surfaces planiform, sides vertical to slightly concave. Latticed cortical shell composed of two layers of pore frames on planar surfaces and a single layer on the sides. Nodes on outer layer interconnected by fragile bars to form triangular or tetragonal pore frames.

Original Remarks.- *Tympaneides* n.gen. is assigned to the Staurolonchidae HAECKEL because of its shape, mode of shell construction and spine structure. It differs from *Emiluvia* FOREMAN in having a test that is circular and drum-shaped rather than rectangular, and from *Staurolonche* HAECKEL in having a double-, rather than single-layered cortical shell.

Etymology.- Greek, *tympanon* (n.), drum.

Included Taxa.-
3408 *Tympaneides charlottensis* CARTER

TYMPANEIDES CHARLOTTENSIS 3408

Tympaneides charlottensis CARTER

Synonymy.-
Tympaneides charlottensis CARTER
CARTER et al. 1988, p. 37, pl. 9, figs. 4-5.
CORDEY 1988, p. 235, pl. 19, fig. 10.
TIPPER et al. 1991, pl. 9, fig. 10.
CARTER & JAKOBS 1991, p. 344, pl. 2, fig. 2.

Original Definition.- Test circular, drum-shaped. Meshwork on planar surfaces very fine, pore frames triangular, nodes minute. Equatorial spines long, slender and triradiate. Test circular (drum-shaped) with four long spines extending from sides of test at 90° to one another. Outer layer of cortical shell covered with very small triangular pore frames composed of thin bars with fine nodes at their vertices. Spines long (one to three times test diameter), slender and of uniform width. Spines with alternating ridges and grooves. Ridges rounded and approximately twice as wide as grooves, which are narrow and deep.

Etymology.- This species is named for Queen Charlotte (wife of George III of England) after whom the Queen Charlotte Islands were named.

Measurements (in μm).-
Based on 14 specimens.

	HT	av.	max.	min.
Diameter of test:	129	118	150	80
Length of longest spine:	162	170	238	123

Type Locality.- GSC Locality C-080583. Phantom Creek Formation, Graham Island, British Columbia.

UAZones.- 1-3, early-mid Aal. to early-mid Baj.

typicus >> *UNUMA TYPICUS* 4059

tytthopora >> *DIBOLACHRAS TYTTHOPORA* 5422

ultima >> *EMILUVIA OREA ULTIMA* 4070

umbilicata >> *ACAENIOTYLE UMBILICATA* 3092

umbriensis >> *OBESACAPSULA RUSCONENSIS UMBRIENSIS* 5796

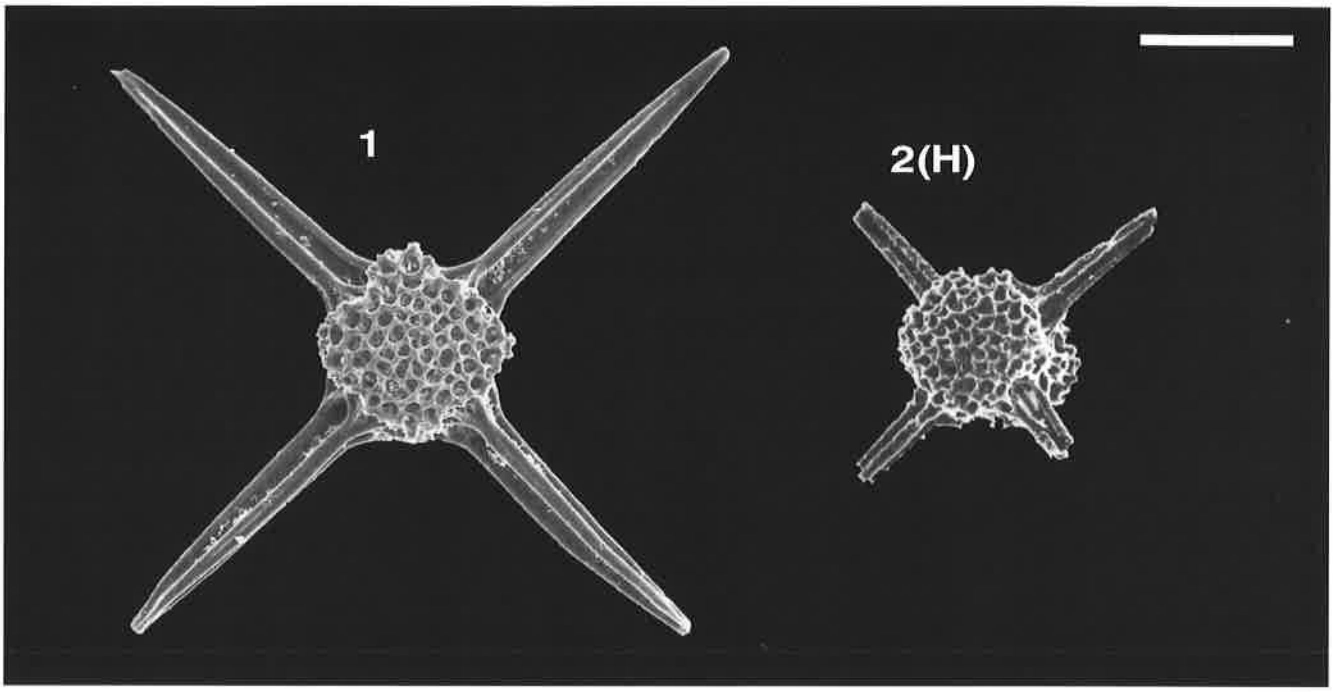


Plate 3408. *Tympaneides charlottensis* CARTER. Magnification x150. **Fig. 1.** CA37/11, GSC85965, GSC-C156399. **Fig. 2(H).** CARTER et al. 1988, pl. 9, fig. 4.

UNUMA 3669

Genus: *Unuma* ICHIKAWA & YAO

Synonymy.-
Unuma ICHIKAWA & YAO
ICHIKAWA & YAO 1976, p. 111.
TAKEMURA 1986, p. 58.

Type Species.- *Unuma* (*Unuma*) *typicus* ICHIKAWA & YAO 1976.

Original Definition.- Spindle-shaped multisegmented form with inversely subconical basal appendage which has pores much larger than those of the preceding main segments. Junction of segments not externally expressed as an indentation. Numerous small circular pores on the surface, aligned in longitudinal and diagonal rows. Numerous longitudinal plicae on the surface generally running continuously through segments. Apical horn may be minute or large; radial spines and basal spine may or may not be present.

Original Remarks.- A spindle-shaped form with small pores, the absence of an externally expressed stricture, the presence of large pores on the inversely subconical basal appendage and of longitudinal plicae are stable diagnostic features of the genus *Unuma*.

The last segment is represented by the distal part of the main spindle-shaped shell with small pores. The basal portion with large pores may be considered as a lid-like appendage of the last segment rather than as the last segment itself.

Two subgenera, *Unuma* (*Unuma*) and *Unuma* (*Spinunuma*), are distinguished on the basis of the presence or absence of a distinct apical horn, radial spines, and basal spine. The morphological difference between the type species of these subgenera may appear to be significantly great at first glance, but there exist some forms transitional with respect to the degree of development of radial spines, so that a separation at subgeneric level is applied here.

Remarks.- This genus is divided into two subgenera by Ichikawa & Yao 1976, *Unuma* (*Unuma*) and *Unuma* (*Spinuma*). The authors compare *Unuma* to *Stichophatna* HAECKEL 1882, and *Stichophaenoma* HAECKEL 1887.

Etymology.- From the locality of the type specimens of the type species. *Unuma* (regarded as masculine).

Included Taxa.-
3231 *Unuma echinatus* ICHIKAWA & YAO
4058 *Unuma latusicostatus* (AITA)
4059 *Unuma typicus* ICHIKAWA & YAO
3309 *Unuma* sp. A

UNUMA ECHINATUS 3231

Unuma echinatus ICHIKAWA & YAO

Synonymy.-
Unuma echinatus ICHIKAWA & YAO
ICHIKAWA & YAO 1976, p. 112, pl. 1, figs. 5-6; pl. 2, figs. 5-7.
YAO et al. 1982, pl. 3, fig. 5
MIZUTANI & KOIKE 1982, pl. 2, fig. 6.
WAKITA 1982, pl. 3, figs. 11-12.
MATSUOKA 1982a, pl. 1, figs. 1a-b, 21.
NISHIZONO et al. 1982, pl. 2, fig. 20.
KISHIDA & SUGANO 1982, pl. 11, figs. 6-8.
ISHIDA 1983, pl. 4, figs. 7-8.
BAUMGARTNER 1984, p. 792, pl. 10, figs. 14-15.
YAO 1984, pl. 1, fig. 13.
KOZUR 1984, pl. 1, fig. 1.
BAUMGARTNER 1985, figs. 37.l-m.
ISHIDA 1985, pl. 1, fig. 10.
DE WEVER & CORDEY 1986, pl. 1, fig. 12.
GRILL & KOZUR 1986, pl. 1, fig. 1.
MATSUOKA & YAO 1986, pl. 1, fig. 11; pl. 3, fig. 11.
TAKEMURA 1986, p. 58, pl. 8, figs. 14-15.
GORICAN 1987, p. 188, pl. 2, fig. 5.
HATTORI 1987, pl. 14, figs. 2-3.
HATTORI 1988a, pl. 8, fig. B.
HATTORI & SAKAMOTO 1989, pl. 8, figs. L-M; pl. 9, fig. A.
KITO 1989, p. 213, pl. 24, figs. ? 10, 11-12.
KITO et al. 1990, pl. 2, fig. 4.
YAO 1991, pl. 3, fig. 8.
Unuma sp. cf. *U. echinatus* ICHIKAWA & YAO
KIDO et al. 1982, pl. 3, fig. 10.
Unuma sp. aff. *U. echinatus* ICHIKAWA & YAO
HATTORI 1988a, pl. 8, fig. C.
Unuma sp. B
HATTORI 1987, pl. 14, fig. 4.

Original Definition.- Spindle-shaped shell of six to seven segments, fourth or fifth segment largest and widest. Cephalis small, subspherical internally, partly hidden in the thorax, with a large, stout, apical horn. Sixteen to 19 longitudinal plicae generally consisting of primary (strong) and secondary (weak) plicae arranged in an alternating order. Primary ones beginning on the thorax; secondary ones, mostly on the third segment and becoming obsolete in the last segment. Two to four (rarely five) longitudinal rows of small circular pores between adjacent longitudinal plicae; pores uniform in size throughout and tend to be arranged diagonally. Numerous stout radial spines arise from the primary plicae and in some cases short ones from the secondary plicae. The last segment of the main shell body with small pores constricts at the juncture with the inversely subconical basal appendage. This appendage bears larger pores, several of them as large as 13-15 μm, and a distinct basal spine.

Original Remarks.- The holotype (pl. 1, figs. 5a-b) has seven segments, followed by the basal appendage. As in the case of *Unuma typicus* there exists an externally similar but smaller form with four segments of which the fourth segment is proportionally very large. This species is readily distinguished from *Unuma typicus* in the morphology of the basal appendage in addition to the differences given in the subgeneric diagnosis.

Actualized Remarks.- (TAKEMURA, 1986) Although Ichikawa & Yao (1976) described this species as a spindle-shaped shell of six to seven segments, some specimens from TKN-105 have more compact shells with five segments.

Measurements (in μm).-
Based on 18 specimens. Total length (excluding apical horn and basal spine) 154-230; length of cephalis 14-20, of thorax 17-30, of third segment 15-22, of fourth segment 15-31, of fifth segment 22-32, of sixth segment 17-31, of apical horn 11-30, of basal spine 4-15, of radial spines 14-40; diameter of pores on post-cephalic segments 4-5, of pores on basal appendage 6-15; maximum width 98-150.

Type Locality.- Sample IN 1, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 1-6, early-mid Aal. to mid Bath.

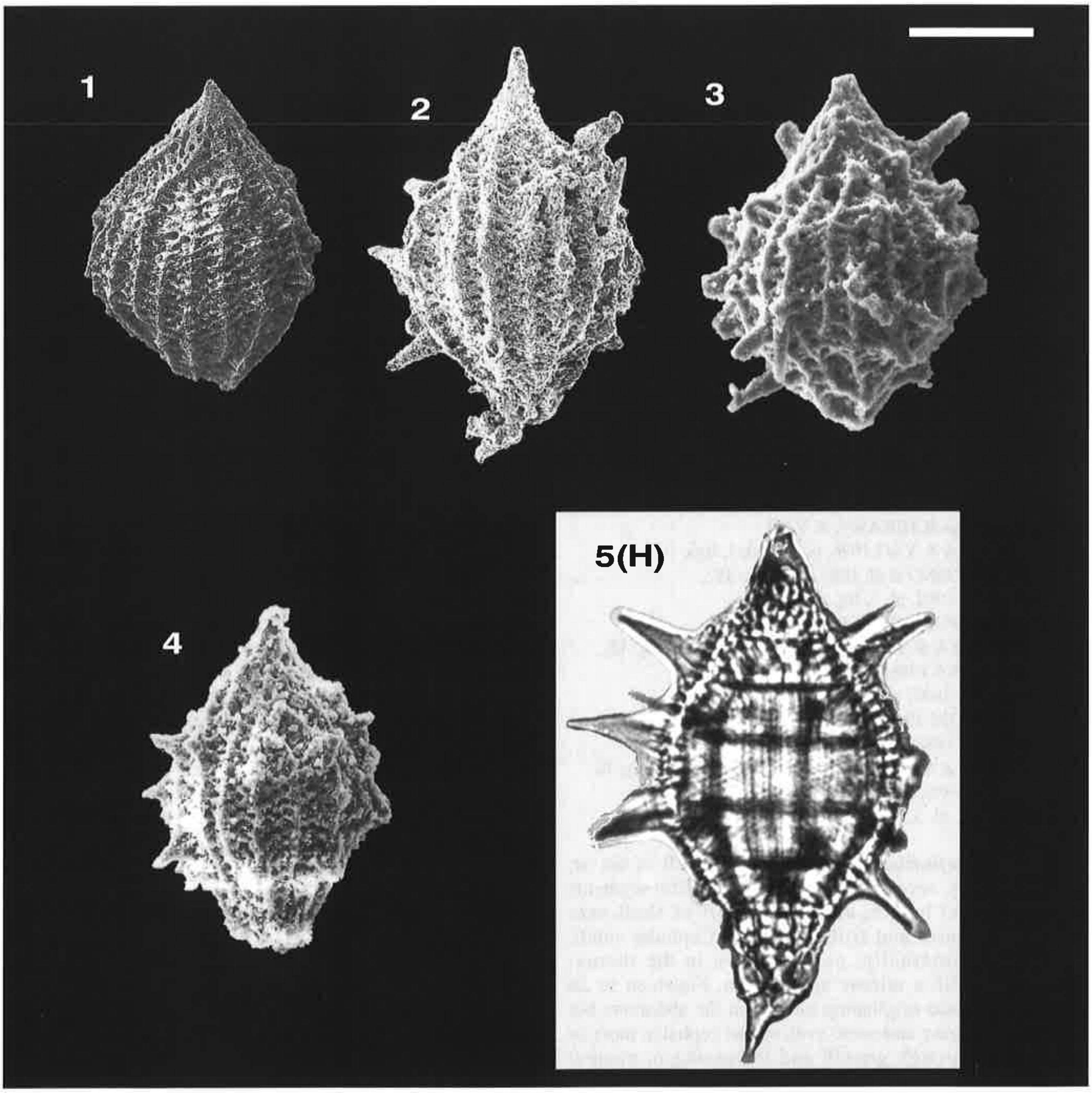


Plate 3231. *Unuma echinatus* ICHIKAWA & YAO. Magnification x350. **Fig. 1.** POB80/2856, POB1262. **Fig. 2.** GO892135, GL132. **Fig. 3.** GO890133, ZB28. **Fig. 4.**GO890241, GL-127 **Fig. 5(H).** ICHIKAWA & YAO 1976, pl. 1, fig. 5a.

UNUMA LATUSICOSTATUS 4058

Unuma latusicostatus (AITA)

Synonymy.-
Unuma ? sp. C
ISHIDA 1983, pl. 8, fig. 4.
Unuma sp. B
ISHIDA 1983, pl. 8, fig. 5.
Unuma sp.
? YAO 1984, pl. 1, fig. 17.
Tricolocapsa laticostata AITA
AITA 1985, text-figs. 7.8-9.
Tricolocapsa latusicostata AITA
AITA 1987, p. 76, pl. 4, figs. 7a-8b; pl. 10, figs. 8-9.
CSONTOS et al. 1991, pl. 1, fig. 2.

Original Definition.- Shell of three segments; cephalis small, spherical, poreless, without apical horn; thorax annular, porous with irregular nodes; abdomen inflated, annular with broad longitudinal plicae, and with usually inverted-conical to hemispherical apertural cap; abdominal pores small, elongate longitudinally aligned in five lines between plicae.

Original Remarks.- This species includes such morphotypes as those ornamented with continuous plicae, discontinuous and nodose plicae, and entirely nodose surface on the abdomen.

Etymology.- This specific name is from the Latin adjective *latus*, broad and adjective *costatus*, ribbed.

Measurements (in μm).-
Based on 18 specimens.

	HT	max.	min.	av.
Overall height:	135	135	110	115
Height of abdomen:	75	75	73	74
Width of abbdomen:	125	125	95	112

Type Locality.- Sample SOG-1, Sogatani section, Irazuyama Formation (Togano Group), Kochi Prefecture, southwest Japan.

UAZones.- 2-5, late Aal. to latest Baj.-early Bath.

UNUMA TYPICUS 4059

Unuma typicus YAO

Synonymy.-
Unuma typicus ICHIKAWA & YAO
ICHIKAWA & YAO 1976, p. 112, pl. 1, figs. 1-3.
not NISHIZONO et al. 1982, pl. 2, fig. 19.
YAO et al. 1982, pl. 3, fig. 6.
ISHIDA 1983, pl. 4, fig. 9.
MATSUOKA & YAO 1986, pl. 1, fig. 12; pl. 3, fig. 12.
TAKEMURA 1986, p. 58, pl. 8, fig. 16.
GORICAN 1987, p. 188, pl. 2, fig. 4.
not HATTORI 1987, pl. 14, fig. 6.
HATTORI 1988a, pl. 8, fig. A.
HATTORI & SAKAMOTO 1989, pl. 8, fig. J, not fig. K.
not KITO 1989, p. 214, pl. 24, figs. 7-9.
YAO 1991, pl. 3, fig. 9.

Original Definition.- Spindle-shaped shell of six or, more commonly, seven segments; fourth and fifth segments of nearly equal length, and widest part of shell near stricture of fourth and fifth segments. Cephalis small, subspherical internally, partly hidden in the thorax, imperforate with a minute apical horn. Fourteen to 20 longitudinal plicae originating mostly on the abdomen, but a few on the thorax and some even on the cephalis, more or less twisted through growth and increasing in number through insertion. Two to four longitudinal rows of small circular pores between adjacent longitudinal plicae; pores uniform in size throughout, even on the thorax, being widely spaced, tending to be arranged diagonally. The last segment constricted and provided with a lid-like appendage prolonged downward, with circular large pores about twice as small pores on main segments, but apparently absent from others. Very short, incipient, radial spines on some points of longitudinal plicae.

Original Remarks.- The holotype (pl. 1, figs. 1a-b) has seven segments. The characteristic basal appendage, which is separated from the seventh segment by a constriction, is not considered as an independent segment. In samples from the Unuma locality there exists a form that is externally similar to this species, but it is smaller and has only four segments. Its fourth segment occupies the main portion of the shell and is about 66-70 μm in length. This form is placed outside of *Unuma typicus*.

Etymology.- This species is named for the Latin adjective *typicus*, meaning typical.

Measurements (in μm).-
Based on 16 specimens. Total length (excluding horn) 158-220, length of cephalis 16-22, of thorax 17-25, of third segment 16-36, of fourth segment 22-36, of fifth segment 20-37, of apical horn 7, of basal spine 6; diameter of pores on post-cephalic segments 3-5 (usually 4), of pores on basal appendage 6-12 (usually 8); maximum width 91-128.

Type Locality.- Sample IN 4, Inuyama area, Gifu Prefecture, central Japan.

UAZones.- 3-4, early-mid Baj. to late Baj.

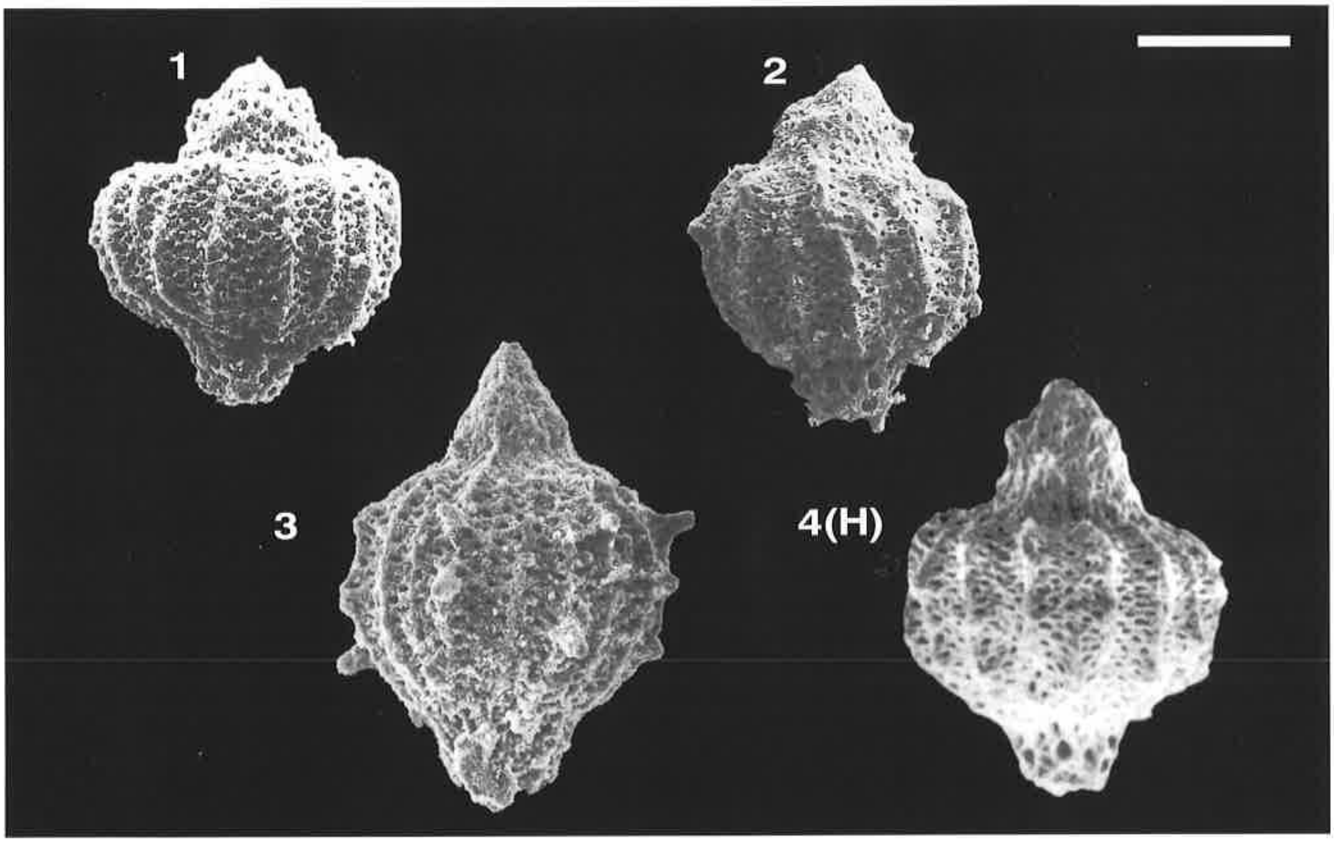


Plate 4058. ***Unuma latusicostatus*** **(AITA).** Magnification x350. **Fig. 1.** MA312, S-03. **Fig. 2.** MA611, S-03. **Fig. 3.** GO890339, ZB28. **Fig. 4(H).** AITA 1987, pl. 10, fig. 8.

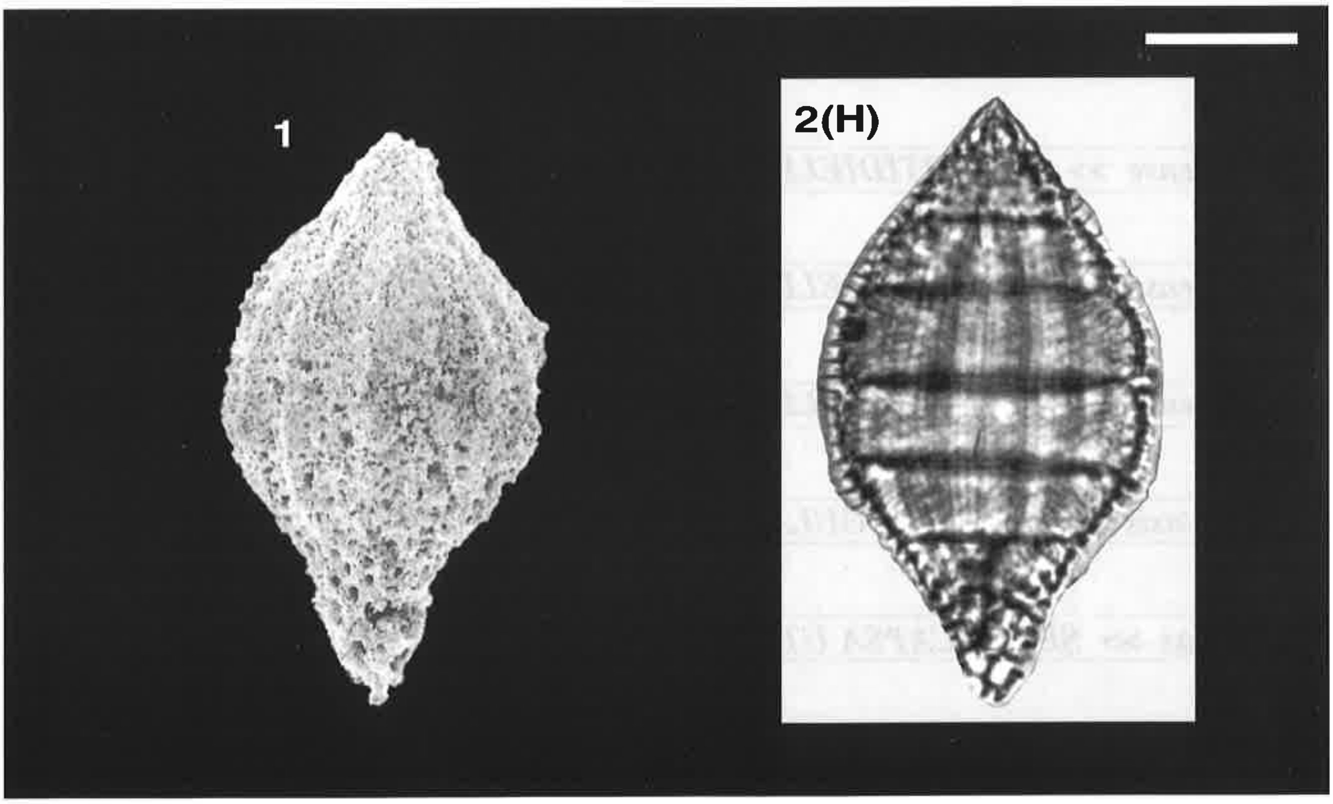


Plate 4059. ***Unuma typicus*** **YAO.** Magnification x400. **Fig. 1.** GO910231, Bj10. **Fig. 2(H).** ICHIKAWA & YAO 1976, pl. 1, fig. 1a.

UNUMA | *A* 3309

Unuma sp. A

Definition.- Shell of four segments, ovoidal. Cephalis spherical internally without apical horn, partly encased in thoracic cavity. Thorax and abdomen truncate-conical. Fourth segment large, inverted conical with a small appendage at the distal end in well-preserved specimens. Eight to 12 longitudinal plicae visible in lateral view. One to three rows of pores arranged longitudinally between neighbouring longitudinal plicae. Pores circular and medium sized.

Remarks.- This species is distinguished from *Unuma typicus* ICHIKAWA & YAO by its smaller size and by consisting of four segments.

UAZones.- 4-6, late Baj. to mid Bath.

unumaense >> *EUCYRTIDIELLUM UNUMAENSE DENTATUM* 3015

unumaense >> *EUCYRTIDIELLUM UNUMAENSE PUSTULATUM* 3013

unumaense >> *EUCYRTIDIELLUM UNUMAENSE S.L.* 3052

unumaense >> *EUCYRTIDIELLUM UNUMAENSE UNUMAENSE* 3012

usotanensis >> *PARVICINGULA USOTANENSIS* 5712

uterculus >> *SETHOCAPSA UTERCULUS* 5462

valdorbiense >> *BISTARKUM VALDORBIENSE* 3919

variabilis >> *ACANTHOCIRCUS VARIABILIS* 5011

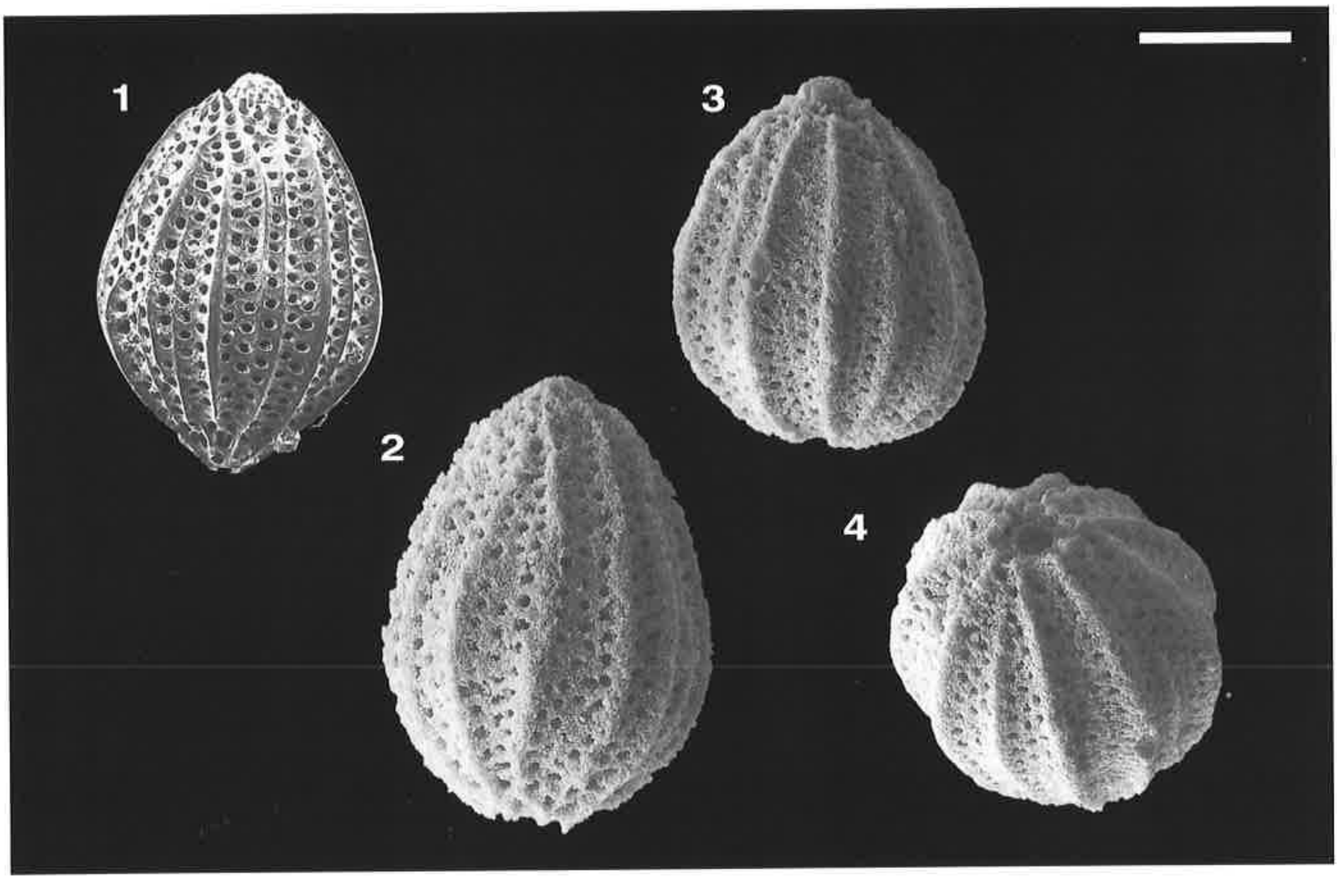


Plate 3309. ***Unuma* sp. A.** Magnification x400. **Fig. 1.** POB81/2658, 534.122.1.52. **Fig. 2.** DU3161, PJ7. **Fig. 3.** DU2710, PJ14. **Fig. 4.** DU2711, PJ14.

variatus >> ACAENIOTYLOPSIS VARIATUS S.L.	*4063*

variatus >> ACAENIOTYLOPSIS VARIATUS TRIACATHUS	*4066*

variatus >> ACAENIOTYLOPSIS VARIATUS VARIATUS	*3270*

ventricosum >> ZHAMOIDELLUM VENTRICOSUM	*3308*

verbana >> OBESACAPSULA VERBANA	*3202*

vicetina >> SYRINGOCAPSA VICETINA	*5409*

wintereri >> HIGUMASTRA WINTERERI	*3148*

WILLIRIEDELLUM 3674

Genus: *Williriedellum* DUMITRICA

***Synonymy*.-**
Williriedellum DUMITRICA
DUMITRICA 1970, p. 69.

***Type Species*.-** *Williriedellum crystallinum* DUMITRICA 1970.

***Original Definition*.-** Cryptothoracic tricyrtids with large inflated abdomen having a constricted aperture and a complex sutural pore; cephalis free, poreless, with four collar pores, with or without a short apical horn; thorax porous, campanulate, small, without descending spines and partly depressed into abdomen.

***Original Remarks*.-** *Williriedellum* is morphologically rather similar to *Zhamoidellum* n. gen. *Cryptamphorella* n.gen. and *Hemicryptocapsa* TAN. It differs from the first two ones particularly in having a constricted aperture, which constitutes the first external distinctive character. From the last one, with which it seems to be closely related by their constricted aperture, it differs in lacking the three descending thoracic spines and in the complex structure of its sutural pore.

***Remarks*.-** Species differ primarily in wall surface characteristics, i.e. distribution, size and shape of nodes, pores and pore frames.

***Etymology*.-** This genus is dedicated to William R. Riedel (Scripps Institution of Oceanography) as a homage for his sustained and indefatigable work in the study of Radiolaria. Neuter gender.

***Included Taxa*.-**
4055 *Williriedellum carpathicum* DUMITRICA
3069 *Williriedellum crystallinum* DUMITRICA
4060 *Williriedellum* sp. A sensu MATSUOKA

WILLIRIEDELLUM CARPATHICUM 4055

Williriedellum carpathicum DUMITRICA

***Synonymy*.-**
Williriedellum carpathicum DUMITRICA
DUMITRICA 1970, p. 70, pl. 9, figs. 56a-b, 57-59; pl. 10, fig. 61.
AITA 1982, pl. 3, fig. 6.
OZVOLDOVA 1990, pl. 5, figs. 2, 4.
WIDZ & DE WEVER 1993, p. 88, pl. 2, figs. 4-6.
Tricolocapsa sp. O
YAO et al. 1982, pl. 4, fig. 21.
YAO 1984, pl. 2, figs. 31-32.
MATSUOKA & YAO 1986, pl. 2, fig. 13.
Tricolocapsa yaoi MATSUOKA
MATSUOKA 1986c, p. 106, pl. 2, figs. 1-4; pl. 3, figs. 1-8.
YAO 1991, pl. 4, fig. 16.
MATSUOKA 1992, pl. 4, fig. 6.
Tricolocapsa cf. *yaoi* MATSUOKA & YAO
? WAKITA 1988, pl. 5, fig. 18.
Tricolocapsa sp. B
OZVOLDOVA 1988, p.389, pl. 2, fig. 4; pl. 7, fig. 4.
OZVOLDOVA 1992, p. 115, pl. 2, fig. 9.

***Original Definition*.-** Shell large, inflated, with two polar prominences: one upper given by the cephalo-thoracic couple, other lower given by the apertural tube. Cephalis poreless, without apical horn; collar suture generally indefinite. Thorax campanulate, perforated by small pores and half depressed in the abdominal cavity. Thoracic opening large, circular. Abdomen globose, with slightly rough surface and perforated by cylindrical pores, closely and more or less regularly arranged. Aperture constricted, circular, open at the end of a short tube. Sutural pore always present but not too clearly visible, set in the angle limited by the vertical and left lateral spines. It is resulted from the thinning and slightly depressing of a portion of the abdominal wall at its limit with the thorax. Looking at the shell from apical position, the sutural pore can be observed as a lighter area.

***Remarks*.-** *Tricolocapsa yaoi* MATSUOKA is herein considered as a junior synonym of *W. carpathicum* DUMITRICA to which it resembles by its whole morphology. This species differs from *Williriedellum* sp. A MATSUOKA in lacking a basal appendage.

***Type Locality*.-** Pojorita, Suceava district, Moldova valley, Romania.

***UAZones*.-** 7-11, late Bath.-early Call. to late Kimm.-early Tith.

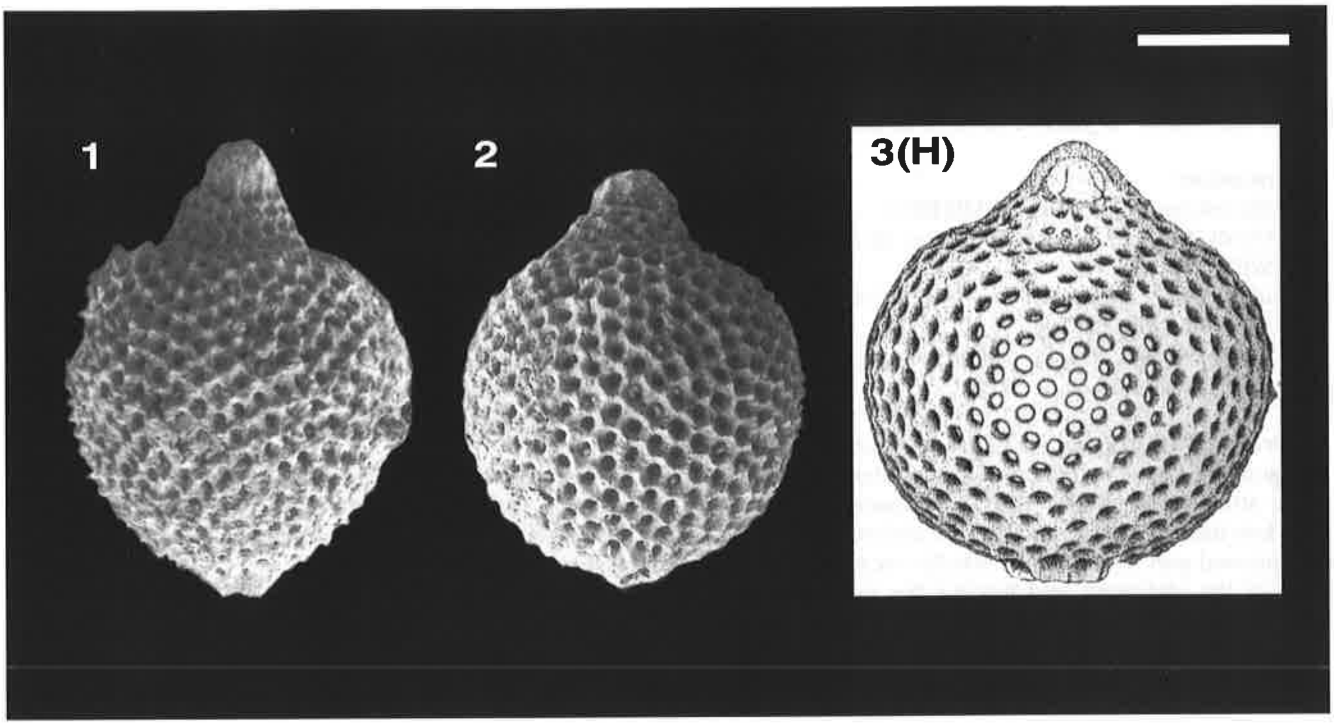


Plate 4055. *Williriedellum carpathicum* DUMITRICA. Magnification x400. **Fig. 1.** MA1639, OCUMR2773, 11-0909. **Fig. 2.** MA1695, OCUMR2772, 11-0909. **Fig. 3(H).** DUMITRICA 1970, pl. 9, fig. 56a.

WILLIRIEDELLUM CRYSTALLINUM 3069

Williriedellum crystallinum DUMITRICA

Synonymy.-
Williriedellum crystallinum DUMITRICA
DUMITRICA 1970, p. 69, pl. 10, figs. 60 a-c, 62-63.
WIDZ 1991, p. 257, pl. 4, figs. 21-22.
Williriedellum cf. *crystallinum* DUMITRICA
ADACHI 1982, pl. 4, figs. 8, ? 9.
WAKITA 1988, pl. 5, fig. 25; pl. 6, fig. 18.
KIESSLING 1992, pl. 1, fig. 14.

Original Definition.- Shell oval, cut by numerous polygonal facets. Cephalis poreless, without apical horn; collar stricture indefinite. Thorax campanulate, porous, a little less than half depressed into the abdominal cavity, the undepressed part being almost wholly encased in the thick wall of the abdomen and having the same polygonal surface and the same kind of pores as it. Thoracic opening large, simple, subcircular. Abdomen globose, thick-walled, with its surface cut by numerous polygonal depressing facets, which are limited by more or less prominent ridges. Pores cylindrical, very small and set closely in oblique rows, except on the ridges where the pores are rare. Aperture rather large, with protruding rim. Sutural pore oval, well-defined, located in the angle formed by the vertical and right lateral spines; at the inner side it is shut by a porous plate which unites it with the depressed wall of the thorax.

Original Remarks.- This species, well individualized by its superficial ornamentation, has an evident variability in the shape of the shell. The majority of the specimens are oval, but there are other ones with lower and more inflated abdomen and with the lumbar suture more evident.

Measurements (in μm).-
Based on 5 specimens. Height of shell 135-155, of cephalis 20, of cephalo-thoracic couple 50-55, of abdomen 100-115, diameter of abdomen 110-125, of aperture 15-20.

Type Locality.- Pojorita, Suceava district, Moldova valley, Romania.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

WILLIRIEDELLUM | *A* 4060

Williriedellum sp. A sensu MATSUOKA

Synonymy.-
Hemicryptocapsa capita TAN
DUMITRICA & MELLO 1982, pl. 3, fig. 3.
Tricolocapsa sp. I
MATSUOKA 1982a, pl. 2, fig. 14; pl. 3, fig. 14.
YAO et al. 1982, pl. 4, fig. 14.
Williriedellum sp. A gr.
MATSUOKA 1983a, p. 23, pl. 4, figs. 1-3; pl. 8, figs. 11-15.
Williriedellum sp. A gr. MATSUOKA
GORICAN 1987, p. 188, pl. 3, figs. 15-16.
WAKITA 1988, pl. 4, fig. 22.
Williriedellum sp. A
MATSUOKA 1985, pl. 1, fig. 6.
MATSUOKA 1986a, pl. 1, fig. 8; pl. 2, fig. 6.
AITA 1987, p. 68, pl. 7, figs. 15a-b.
MATSUOKA 1992, pl. 4, fig. 7.
Williriedellum sp.
YAMAMOTO et al. 1985, p. 40, pl. 9, fig. 8.

Original Definition.- Shell of three segments, with two polar prominences; one upper given by the cephalo-thoracic couple, the other lower given by the basal appendage. Abdomen barrel-shaped with or without small spines. Outer surface of shell covered with hexagonal (rarely pentagonal) frames. One, small, circular pore present in the center of the frames. Ornament of outer shell surface varying in prominence from distinct to obscure according to degree of occlusion.

Original Remarks.- Various forms are included under this name. There are several factors in variation; degree of occlusion of outer shell surface, degree of encasement of thorax into abdomen and degree of prominence of apical horn and spines on abdomen. This group may be divided into some species.

UAZones.- 4-8, late Baj. to mid Call.-early Oxf.

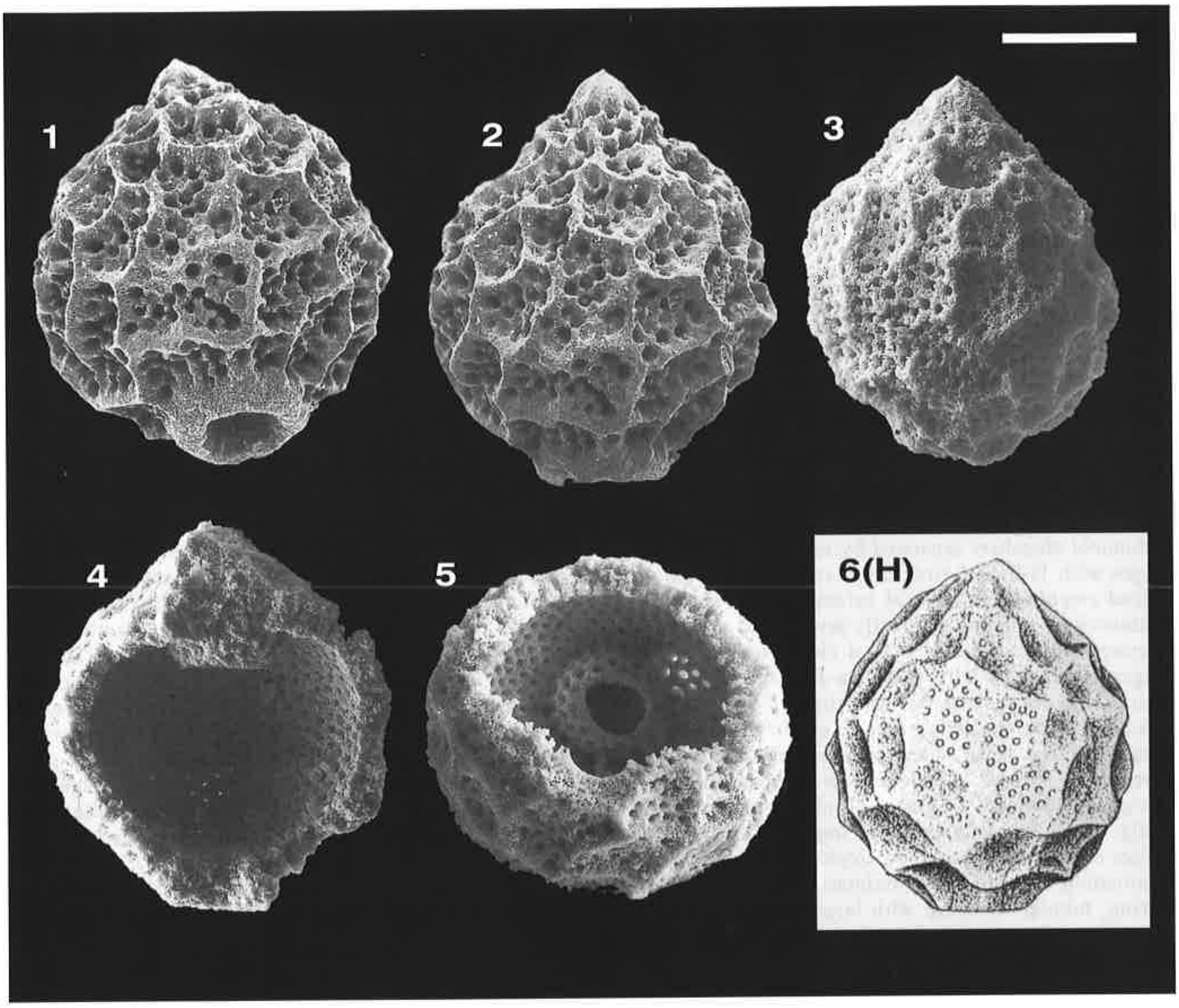


Plate 3069. ***Williriedellum crystallinum*** **DUMITRICA.** Magnification x400. **Fig. 1.** POB79/0150, POB668. **Fig. 2.** POB79/0149, POB668. **Fig. 3.** DU2438, PJ25. **Fig. 4.** DU2441, PJ25. **Fig. 5.** DU2658, PJ15. **Fig. 6(H).** DUMITRICA 1970, pl. 10, fig. 60a.

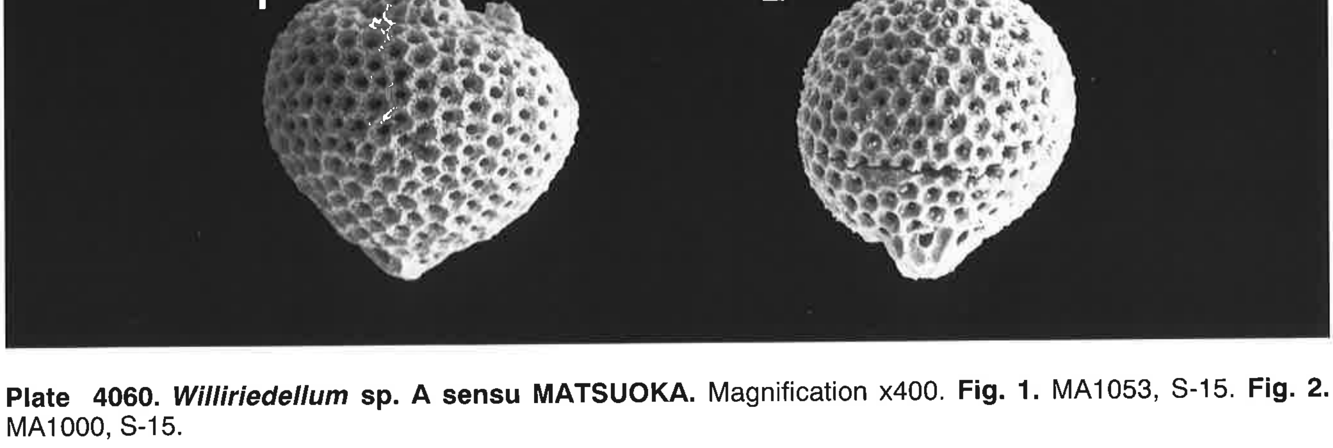


Plate 4060. ***Williriedellum*** **sp. A sensu MATSUOKA.** Magnification x400. **Fig. 1.** MA1053, S-15. **Fig. 2.** MA1000, S-15.

worzeli >> *TRITRABS EWINGI WORZELI* 3115

WRANGELLIUM 3804

Genus: *Wrangellium* PESSAGNO & WHALEN, emend. YEH

Synonymy.-
Wrangellium PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 126.
emend. YEH 1987b, 67.

Type Species.- *Wrangellium thurstonense* PESSAGNO & WHALEN 1982.

Original Definition.- Test conical, multicyrtoid, large, lobulate in outline with numerous closely spaced post-abdominal chambers separated by nodose circumferential ridges with H-linked structure. Longitudinally aligned, paired circular to elliptical primary pores situated in symmetrical, polygonal (mostly tetragonal) pore frames sloping steeply to either side of circumferential ridges; ridges continuous with platform-like septal partitions possessing large, circular apertures. Post-abdominal chambers with medially situated constrictions in areas between ridges. Single transverse row of large polygonal pore frames situated in constrictions between ridges, often completely obscured by veneer of microgranular silica (pl. 3, fig. 10). Cephalis and thorax imperforate, covered by veneer of microgranular silica. Cephalis lacking horn. Test terminating in a large (approximately 1/3 length of test) flaring, tubular structure with large irregular pores and longitudinal ridges (pl. 3, fig. 18); tubular structure lacking septal partitions.

Actualized Definition.- (YEH, 1987b) As with that of Pessagno & Whalen (1982, p. 126), but including forms with 3 pores aligned perpendicular to each circumferential ridge, and also including forms with spine on the cephalis.

Original Remarks.- *Wrangellium* n.gen. differs from *Canoptum* PESSAGNO by having large primary pores on its circumferential ridges which remain open during ontogeny and by having a single row of large symmetrical pore frames in the constrictions between ridges. It is likely that *Wrangellium* was derived from a *Canoptum* stock with H-linked circumferential ridges.

Actualized Remarks.- (YEH, 1987b) The inner latticed layer of *Wrangellium* PESSAGNO & WHALEN is similar to that of *Neowrangellium* n.gen. by having 3 transverse rows of regular pentagonal and hexagonal pore frames staggered arranged in each chamber. *Wrangellium* PESSAGNO & WHALEN differs from *Neowrangellium* n.gen. and *Paracanoptum* n.gen. by having two or three rows of pores open along the circumferential ridges, and by having a thinner layer of microgranular silica covering the central row of the pore frames of each chamber. It is noteworthy that the closing of the central row of pore frames takes place in two steps: 1) subdividing each primary pore into three or four small pores; and 2) gradually closing the small pores by covering them with a veneer of microgranular silica. Furthermore, large pores along circumferential ridges may be subdivided into two small pores by a regular transverse partition, and forming three pores aligned perpendicularly to each ridge.

Etymology.- *Wrangellium* is named for the Mesozoic terrane of Wrangellia (Jones, Silberling & Hillhouse, 1977).

Included Taxa.-
5580 *Wrangellium* (?) *columnum* (RÜST)
3284 *Wrangellium depressum* (BAUMGARTNER)
3179 *Wrangellium okamurai* (MIZUTANI)
5636 *Wrangellium puga* (SCHAAF)

WRANGELLIUM (?) COLUMNUM 5580

Wrangellium (?) *columnum* (RÜST)

Synonymy.-
Lithocampe columna RÜST
RÜST 1898, p. 63, pl. 13, fig. 5.
JUD 1994. pl.23, fig. 17
Lithocampe exaltata RÜST
? FISCHLI 1916, text-fig. 65, not 66.
Lithocampe columna RÜST
? FISCHLI 1916, text-fig. 67.
Wrangellium (?) *columnarium* JUD
JUD 1994, p. 116, pl. 23, figs. 14-16.

Original Definition.- "Long cylindrical, slender shell of 16 segments, with ridges of the segmental divisions,the segments depressed between the ridges. Pores of middle sizes in regular, horizontal rows, two rows on the first and the last, four rows on the eighth, tenth anf eleventh, three rows on the other segments."

Actualized Definition.- (JUD, 1994) Long, cylindrical, slender test of 9-15 segments. Proximal part conical, with rounded cephalis and surface smooth, poreless except for two rows of pores separating the first three segments. The second row of pores is on a slightly elevated circumferential ridge. Following segments separated by strong, tuberculate circumferential ridges. Segments between ridges deeply depressed, concave, forming a poreless band. Connection of this band with the adjoining ridges effected by one row of 8-10 large pores on half the perimeter. Last segment narrower than the previous ones, with three alternately arranged rows of pores.

Actualized Remarks.- (JUD 1994) In *Wrangellium columnarium* n.sp. are included two morphotypes which represent probably two species, a) a shorter, very slightly inflated form of 9-10 segments, and b) a longer, slender, cylindrical form of 14-15 segments.

Measurements (in μm).-
Holotype: heigth 524, maximal width 150.

Based on 10 specimens (Jud, 1994).

	av.	min.	max.
Total length short forms:	274	263	285
Total length long forms:	430	337	512
Maximum width:	-	-	110

Type Locality.- Cittiglio, Prov. Varese, Italy.

UAZones.- 13-20, latest Tith. to late Haut.

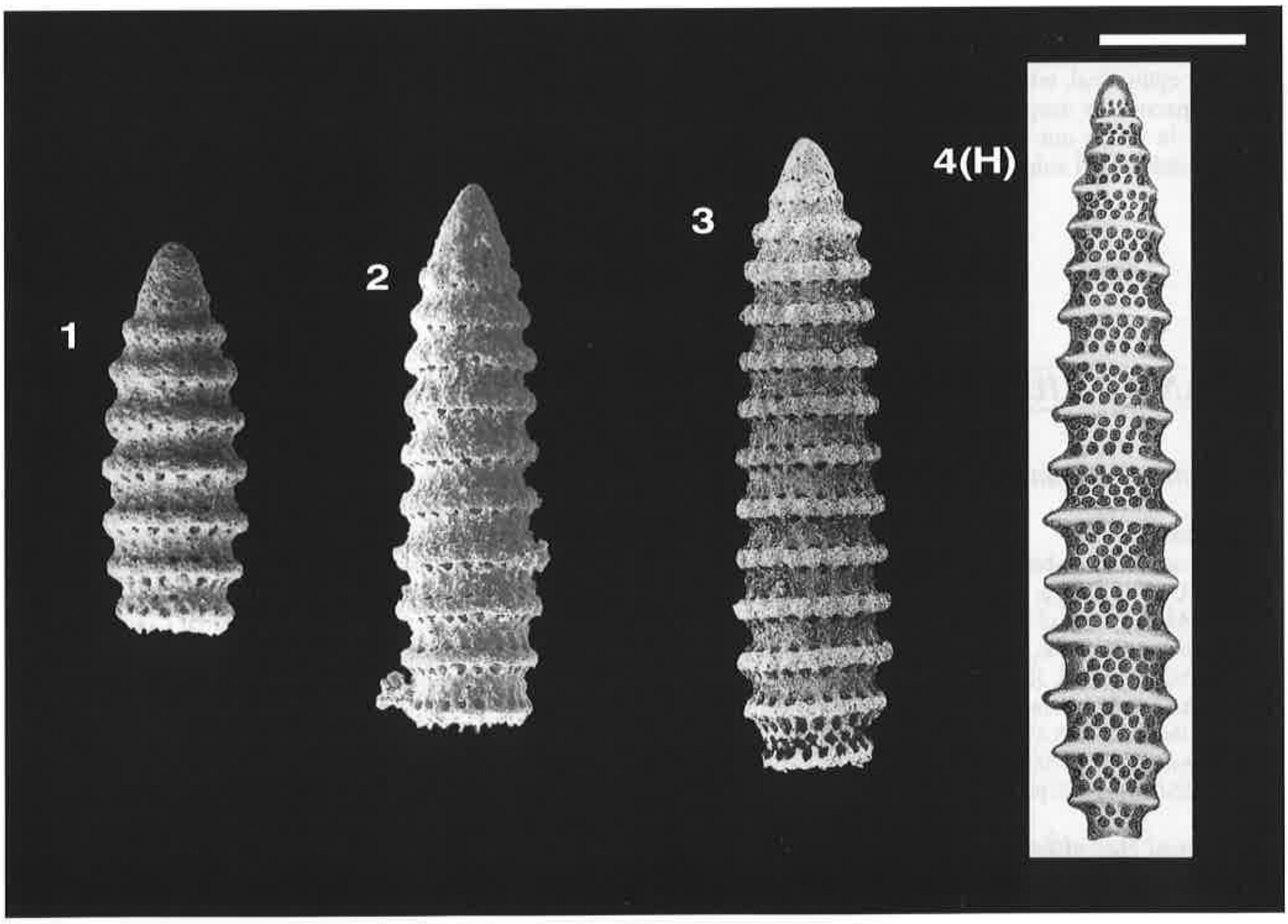


Plate 5580. *Wrangellium (?) columnum* (RÜST). Magnification x200. **Fig. 1.** RJ5, Ru146.5. **Fig. 2.** RJ71, Bo566.5. **Fig. 3.** DU396, Mo46. **Fig. 4(H).** RÜST 1898, pl. 13, fig 5.

WRANGELLIUM DEPRESSUM 3284

Wrangellium depressum (BAUMGARTNER)

Synonymy.-
Pseudodictyomitra sp.
OKAMURA 1980, pl. 20, figs. 6, 11.
Unnamed nassellariid F
WU & LI 1982, pl. 2, fig. 19.
Archaeodictyomitra carpatica (LOZYNIAK)
OKAMURA & UTO 1980, pl. 2, fig. 3.
Pseudodictyomitra carpatica (LOZYNIAK)
OKAMURA & UTO 1982, pl. 8, figs. 7a-b.
AOKI 1982, pl. 2, figs. 14-15.
TUMANDA 1989, p. 38, pl. 2, fig. 8.
Pseudodictyomitra depressa BAUMGARTNER
BAUMGARTNER 1984, p. 782, pl. 8, figs. 2, 7-8, 11.
TAKETANI & KANIE 1992, fig. 4.13.
STEIGER 1992, p. 87, pl. 25, figs. 4-5.
Pseudodictyomitra cf. *carpatica* (LOZYNIAK)
? SUYARI & ISHIDA 1985, pl. 3, fig. 6.
Wrangellium depressum (BAUMGARTNER)
JUD 1994, p. 117, pl. 23, fig. 18; pl. 24, fig. 1.

Original Definition.- Overall shape of test broadly conical proximally and slightly constricted distally, the widest segments being the 7th to 9th segment. Cephalis, thorax and abdomen together smooth, conical, without external strictures. Thorax and abdomen with one horizontal row of pores at base. First postabdominal segment cylindrical, with weak ornamentation and one row of pores at base. Following five to six postabdominal segments cylindrical, with very pronounced circumferential ridges separated by deeply depressed grooves at segmental divisions in which one or two rows of pores are visible. The circumferential ridges are of round cross section and bear costae (about 12 visible per half circumference) which are regularly spaced between the pores. Well preserved specimens show faint horizontal ribs between costae. Last postabdominal segment clearly narrower than second last, with two well exposed, staggered rows of pores and less pronounced circumferential ridge and costae at base.

Original Remarks.- This species differs from other *Pseudodictyomitra* by having deeply depressed segmental divisions and a distally constricted overall shape.

Remarks.- For biostratigraphy we took into account specimens resembling those illustrated by Baumgartner (1984, pl. 8, figs. 2, 7-8, 11). These specimens show a high variation in the shape of the whole test, of the ridges, costae and the depressed segmental divisions.

Etymology.- Latin d*epressa* referring to the depressed segmental divisions.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Total length of test:	51	53	51	55
Width:	48	53	48	60
Width of widest segment:	140	130	110	147
Width of last segment:	123	113	97	123
Total length of test:	239	245	202	306

Type Locality.- POB MO22. Locality no. 16 of locality descriptions (Baumgartner, 1984).

UAZones.- 13-18, latest Tith. to latest Val.-earliest Haut.

WRANGELLIUM OKAMURAI 3179

Wrangellium okamurai (MIZUTANI)

Synonymy.-
Pseudodictyomitra okamurai MIZUTANI
MIZUTANI 1981, p. 178, pl. 60, figs. 3-5.
? WAKITA 1988, pl. 5, fig. 5; pl. 6, fig. 11.
Unnamed multicyrtoid nassellarian
ADACHI 1982, pl. 3, fig. 4.
Hsuum (?) *brevicostatum* (OZVOLDOVA)
BAUMGARTNER 1985, fig. 38.r.
Hsuum okamurai (MIZUTANI)
KIESSLING 1992, pl. 1, fig. 6.

Original Definition.- Shell elongated subconical, separated into equally-spaced eight to nine segments. Because of distinct development of strictured girdle, costae become so discontinuous that they form high nodes, around which small circular pores are arranged. Cephalic wall is smooth and has small circular pores irregularly arranged.

Original Remarks.- This species is much like *Pseudodictyomitra* sp. C PESSAGNO 1977b (p. 52, pl. 8, fig. 6), but differs in having pores arranged around the basal high of the discontinuous costae.

Etymology.- This species is named for Mr. Okamura for his contribution to the radiolarian biostratigraphy of the Mino area.

Measurements (in μm).-
Holotype: height 282, width 143; Paratypes: height 258-294, width 138-153.

Type Locality.- Sample 124, Mazegawa Formation, Gifu Prefecture, central Japan.

UAZones.- 7-11, late Bath.-early Call. to late Kimm.-early Tith.

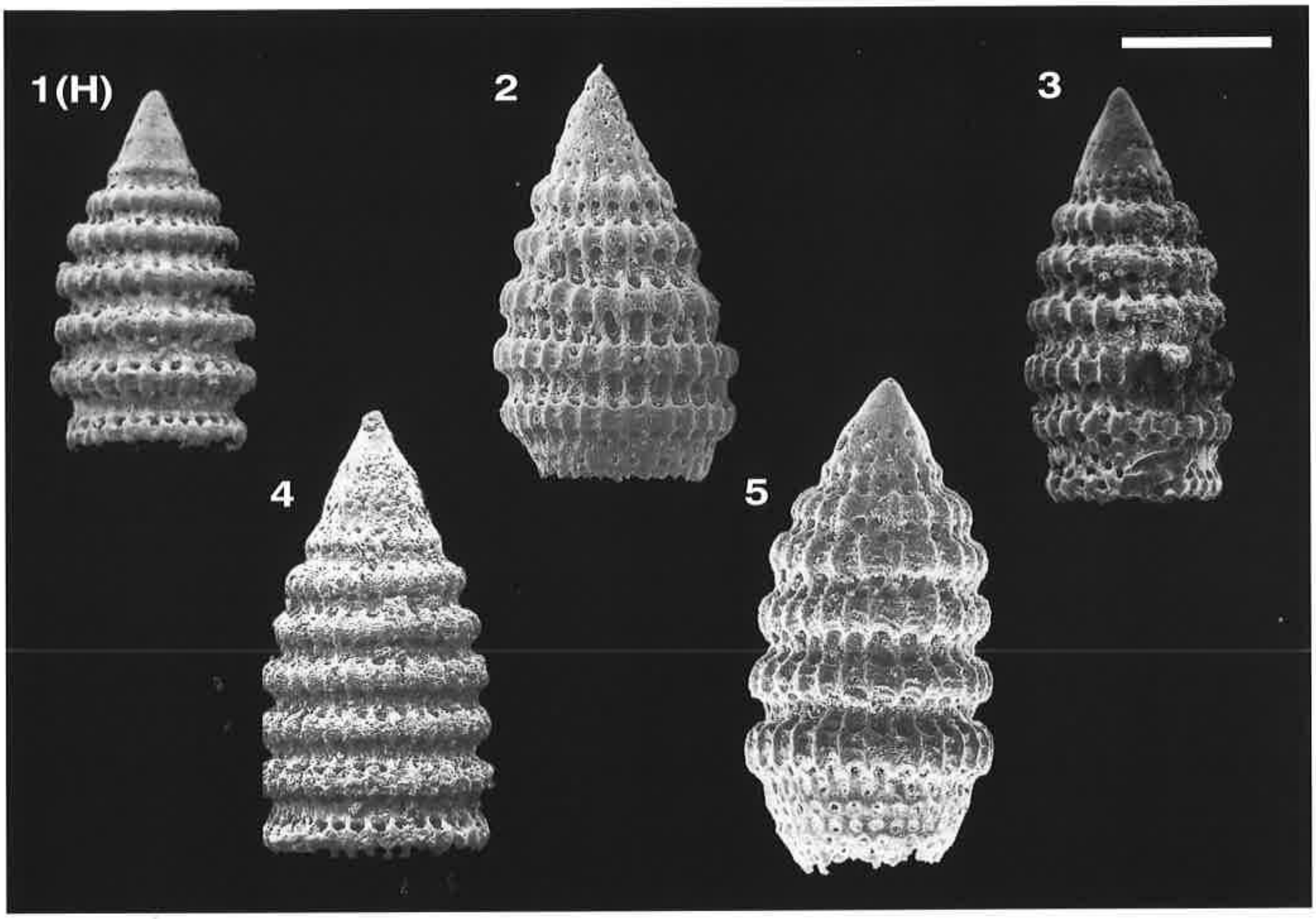


Plate 3284. *Wrangellium depressum* (BAUMGARTNER). Magnification x250. **Fig. 1(H).** POB79/0163, MO22. **Fig. 2.** DU3375, Mo37. **Fig. 3.** POB81/9099, 534A-81-2-3. **Fig. 4.** POB80/2263, POB1134. **Fig. 5.** DU1233, V40.

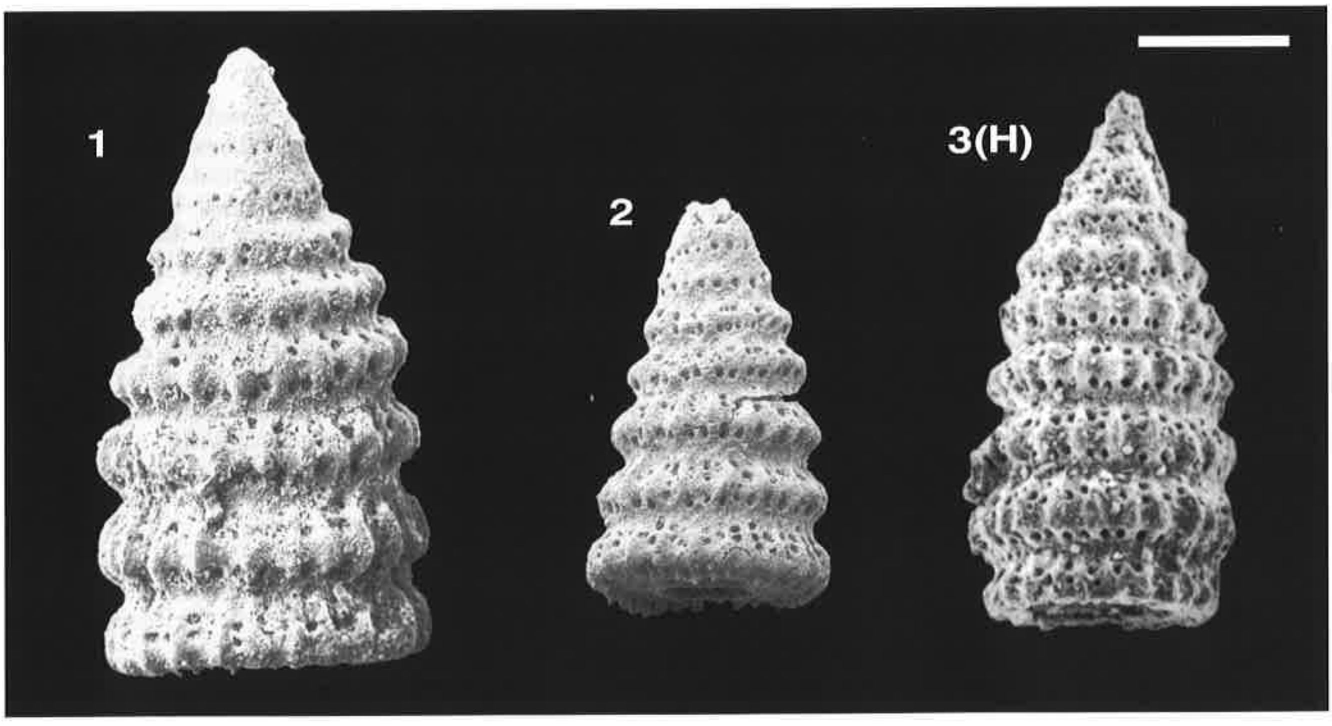


Plate 3179. *Wrangellium okamurai* (MIZUTANI). Magnification x250. **Fig. 1.** POB80/2165, POB1261A. **Fig. 2.** POB80/2845, POB1262. **Fig. 3(H).** MIZUTANI 1981, pl. 60, fig. 3.

WRANGELLIUM PUGA 5636

Wrangellium puga (SCHAAF)

Synonymy.-
Dictyomitra (?) sp.
DUMITRICA 1972, pl. 4, figs. 4, 7.
Dictyomitra carpatica LOZYNYAK
NAKASEKO et al. 1979, p. 21, pl. 3, fig. 9.
NAKAGAWA et al. 1980, pl. 2, fig. 7.
Archaeodictyomitra puga SCHAAF
SCHAAF 1981, p. 432, pl. 3, fig. 7; pl. 21, figs. 11a-b.
SCHAAF 1984, p. 157, fig. 1.
THUROW 1988, p. 398, pl. 6, fig. 15.
OZVOLDOVA 1990, p. 140, pl. 3, fig. 8, not fig. 9; pl. 4, fig. 7.
Pseudodictyomitra puga (SCHAAF)
NAKASEKO & NISHIMURA 1981, p. 160, pl. 9, fig. 8.
MURATA et al. 1982, pl. 2, fig. 14.
NISHIZONO & MURATA 1983, pl. 6, fig. 11.
SUYARI 1986b, pl. 1, figs. 5-6.
PAVSIC & GORICAN 1987, p. 28, pl. 4, fig. 12.
IGO et al. 1987, text-figs. 2.n-r.
TUMANDA 1989, p. 39, pl. 2, fig. 6.
TAKETANI & KANIE 1992, text-fig. 5.3.
Pseudodictyomitra sp.
OKAMURA & UTO 1982, pl. 5, fig. 1.
Pseudodictyomitra cf. *puga*
IWASAKI et al. 1984, pl. 1, figs. 1, ? 2.
Pseudidictyomitra cf. *carpatica*
SUYARI & ISHIDA 1985, pl. 3, fig. 7; pl. 4, fig. 7, not figs. 5-6.
Wrangellium (?) *medium* WU
WU 1986, p. 358, pl. 3, figs. 2, 7, 19, not fig. 23.
Dictyomitrella (?) *puga* (SCHAAF)
MATSUOKA 1992, pl. 2, fig. 1.
Wrangellium puga (SCHAAF)
JUD 1994, p. 117, pl. 24, figs. 2-3.

Original Definition.- Conical skeleton of usually 8 to 11 segments, and more or less pronouncedly undulating outline. At the wide levels of the shell are intersegmental septa, each of them associated with two transverse rows of pores. The pores of each row are longitudinally aligned, and alternate with costae which are continuous from segment to segment. Some specimens with no evident costae tend to have somewhat wider skeletons.

Original Remarks.- This species is distinguished from all others of the genus by the two rows of pores at junctions between segments.

Remarks.- By the disposition of pores in a single transverse row on either side of the circumferential ridges the species is better assignable to the genus *Wrangellium* PESSAGNO than to the genus *Pseudodictyomitra* and is closely related to *W. depressum* from which it differs only by the wide conical shape.

Etymology.- *Puga*, name formed by an arbitrary combination of letters.

Measurements (in μm).-
Based on 6 specimens. Length of the 8th first segments 180 to 210, no. pores per half circumference of the 5th segment 10 to 12.

Type Locality.- DSDP Leg 62 Site 463, Mid-Pacific Mountains.

UAZones.- 13-22, latest Tith. to late Barr.-early Apt.

XIPHOSTYLUS 3700

Genus: *Xiphostylus* HAECKEL, emend PESSAGNO & YANG

Synonymy.-
Xiphostylus HAECKEL
HAECKEL 1881, p. 449.
emend. PESSAGNO et al. 1989, p. 232.

Type Species.- *Xiphostylus attenuatus* RÜST, subsequent dessignation by Campbell (1954).

Actualized Definition.- (PESSAGNO et al., 1989) Test with subspherical to ellipsoidal cortical shell with opposed secondary spines. Secondary spines subequal in length, predominantly triradiate in axial section with three longitudinal grooves alternating with three longitudinal ridges. Shorter spine often more massive and wider than longer spine. Spines attached to latticed cortical shell by means of latticed protrusions of cortical shell referred to herein as cortical buttresses (pl. 1, figs. 3-4). Outer latticed layer of cortical shell usually not as thick as that of *Tripocyclia* HAECKEL or *Triactoma* RÜST (cf. pl. 1, figs. 2, 5-6, 8, 10-11, 13).

Actualized Remarks.- (PESSAGNO et al., 1989) *Xiphostylus* HAECKEL differs from *Triactoma* RÜST by possessing two opposed secondary spines with cortical buttresses, and a less spherical cortical shell.

Included Taxa.-
3700 *Xiphostylus* spp.

XIPHOSTYLUS \ *SPP.* 3414

Xiphostylus spp.

Remarks.- This Taxon is treated on the generic level.

UAZones.- 1-6, early-mid Aal. to mid Bath.

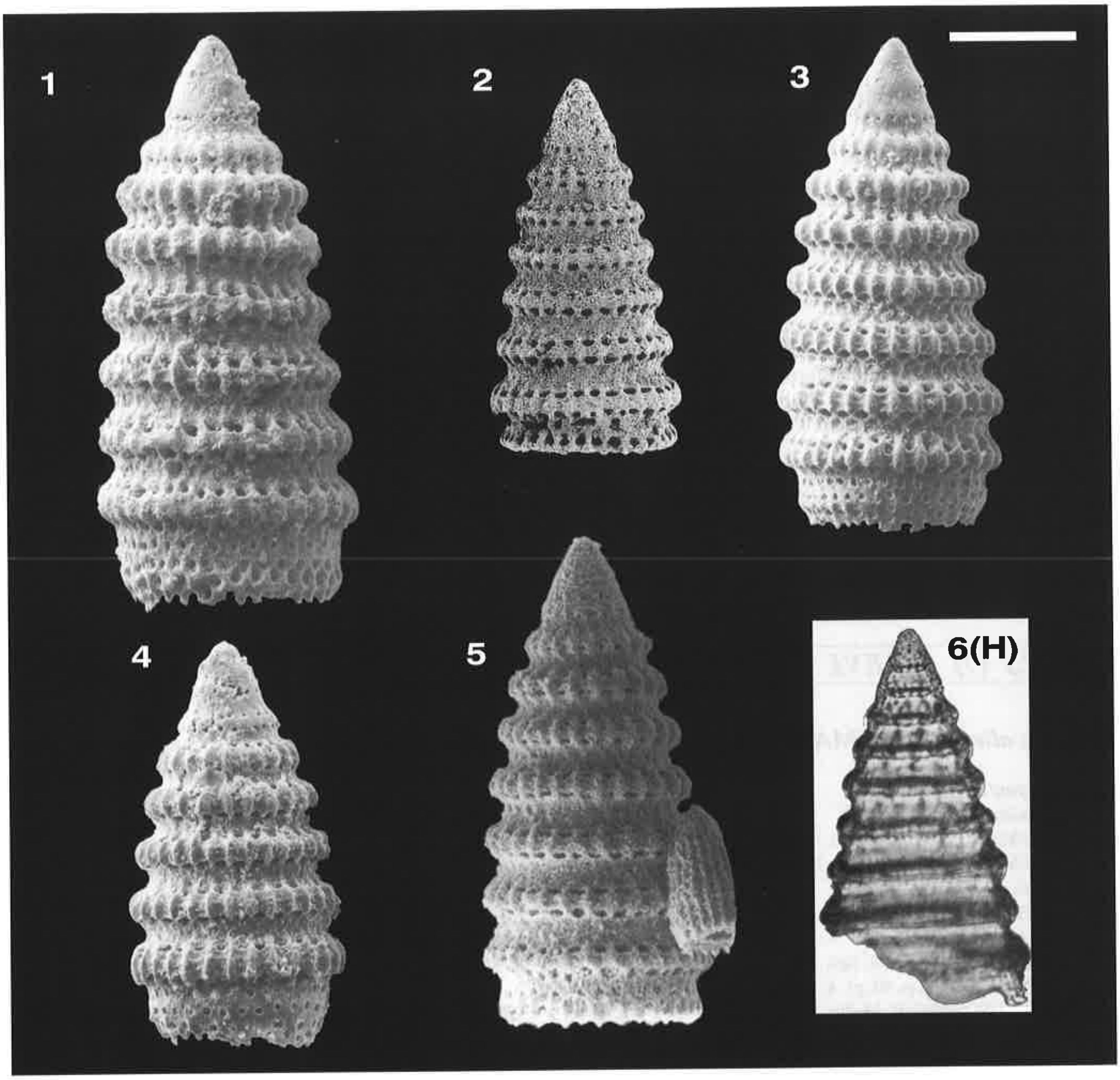


Plate 5636. *Wrangellium puga* (SCHAAF). Magnification x250. **Fig. 1.** DU3421, Mo45. **Fig. 2.** RJ39, Bo566.5. **Fig. 3.** DU1215, V40. **Fig. 4.** DU3425, Mo45. **Fig. 5.** RJ7, Bo566.5. **Fig. 6(H).** SCHAAF 1981, pl. 21, fig. 11b.

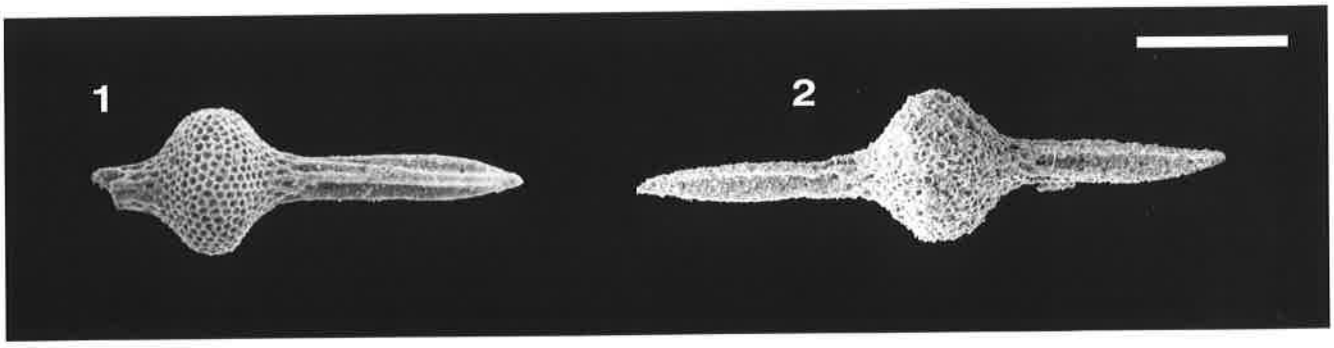


Plate 3414. *Xiphostylus* spp. Magnification x150. **Fig. 1.** GO86/142/10, ZB28. **Fig. 2.** AB1825, TM109.25i9.

XITUS 3676

Genus: *Xitus* PESSAGNO

Synonymy.-
Xitus PESSAGNO
PESSAGNO 1977b, p. 55.

Type Species.- *Xitus plenus* PESSAGNO 1977b.

Original Definition.- Test as with family. Cephalis with horn. Final postabdominal chamber terminating in tubular extension with a large aperture. Tubular extension lacking double layer structure and planiform partition with smaller circular aperture. Test cone shaped; circular in axial section; with or without strictures at joints.

Original Remarks.- *Xitus* n.gen. differs from *Crolanium* n.gen. (1) by being circular in outline in axial section and (2) by having a tubular postabdominal extension which is nearly the same diameter as the final postabdominal chamber and (3) by lacking spinose ridges.

Remarks.- Species are differentiated by variation in test shape and by surface characteristics. The postabdominal tubular extension is an important diagnostic feature of this genus and complete specimens should be used for illustrations when possible.

Etymology.- *Xitus* is a name formed by an arbitrary combination of letters.

Included Taxa.-
5674 *Xitus* (?) *alievi* (FOREMAN)
5673 *Xitus* (?) *channelli* JUD
3294 *Xitus gifuensis* MIZUTANI
5725 *Xitus horridus* JUD
3259 *Xitus magnus* n.sp. BAUMGARTNER
3258 *Xitus* sp. aff. *X. pulcher* PESSAGNO
5668 *Xitus sandovali* JUD
3295 *Xitus* sp. aff. *X. spicularius* (ALIEV)
3261 *Xitus* (?) sp. D

XITUS (?) ALIEVI 5674

Xitus (?) *alievi* (FOREMAN)

Synonymy.-
Dictyomitra alievi FOREMAN
FOREMAN 1973b, p. 263, pl. 9, fig. 10; pl. 16, fig. 4.
FOREMAN 1975 , p. 613, pl. 2H, figs, 8, 9; not pl. 7, fig. 2.
Xitus alievi (FOREMAN)
SCHAAF 1981, p. 440, pl. 5, figs. 4a-b; pl. 19, figs. 8a-b, not figs. 1a-b.
SCHAAF 1984, p. 88-89, figs. 1-5.
TUMANDA 1989, p. 40, pl. 4, fig. 12.
KITO 1989, p. 198, pl. 23, fig. 2.
Xitus sp.
? OKAMURA & UTO 1982, pl. 2, fig. 6.
Parvicingula cosmoconica
OKAMURA & MATSUGI 1986, pl. 2, fig. 13.
Parvicingula cf. *dhimenaensis* BAUMGARTNER
OZVOLDOVA & PETERCAKOVA 1992, p. 316, pl. 4, fig. 2.
Xitus (?) *alievi* (FOREMAN)
JUD 1994, p. 117, pl. 24, fig. 4.

Original Definition.- The shell is conical, of 10 to at least 15 segments. The cephalis and thorax have no, or only a few pores, and the cephalis bears a small slender horn, generally only a little stub. The first two or three segments are conical, smooth, with no external segmental divisions. The remaining segments are clearly defined by a row of small nodes along each division. Slender ridges extend between these nodes and onto the adjacent segments, sometimes forming a pattern of triangles. Pores are rounded, closely spaced, arranged in transverse rows generally three, rarely four, to a segment. After the first three segments, the remaining ones are uniform, increasing in length and width only very gradually. The distal margin is ragged.

Original Remarks.- This species is distinguished from *D. cosmoconica* by its smaller size, smaller, less regularly arranged pores, and segmental division which externally consists of individual more widely separated nodes.

Remarks.- This species is tentatively included in the genus *Xitus* PESSAGNO because of the absence of a second row of tubercles on segments. Complete specimens prove that this species terminates with a funnel-like tube. The tube is variable in width, single-layered, and has small pores arranged in transverse rows.

Etymology.- It is named for Dr. K. S. Aliev in recognition of his work with Early Cretaceous Radiolaria.

Measurements (in μm).-
Based on 10 specimens. Length of longest specimen of 15 segments, 335; of first 10 segments, 210-230; width, 120-175.

Type Locality.- DSDP Leg 20, Site 196, northwest Pacific basin.

UAZones.- 11-22, late Kimm.-early Tith. to late Barr.-early Apt.

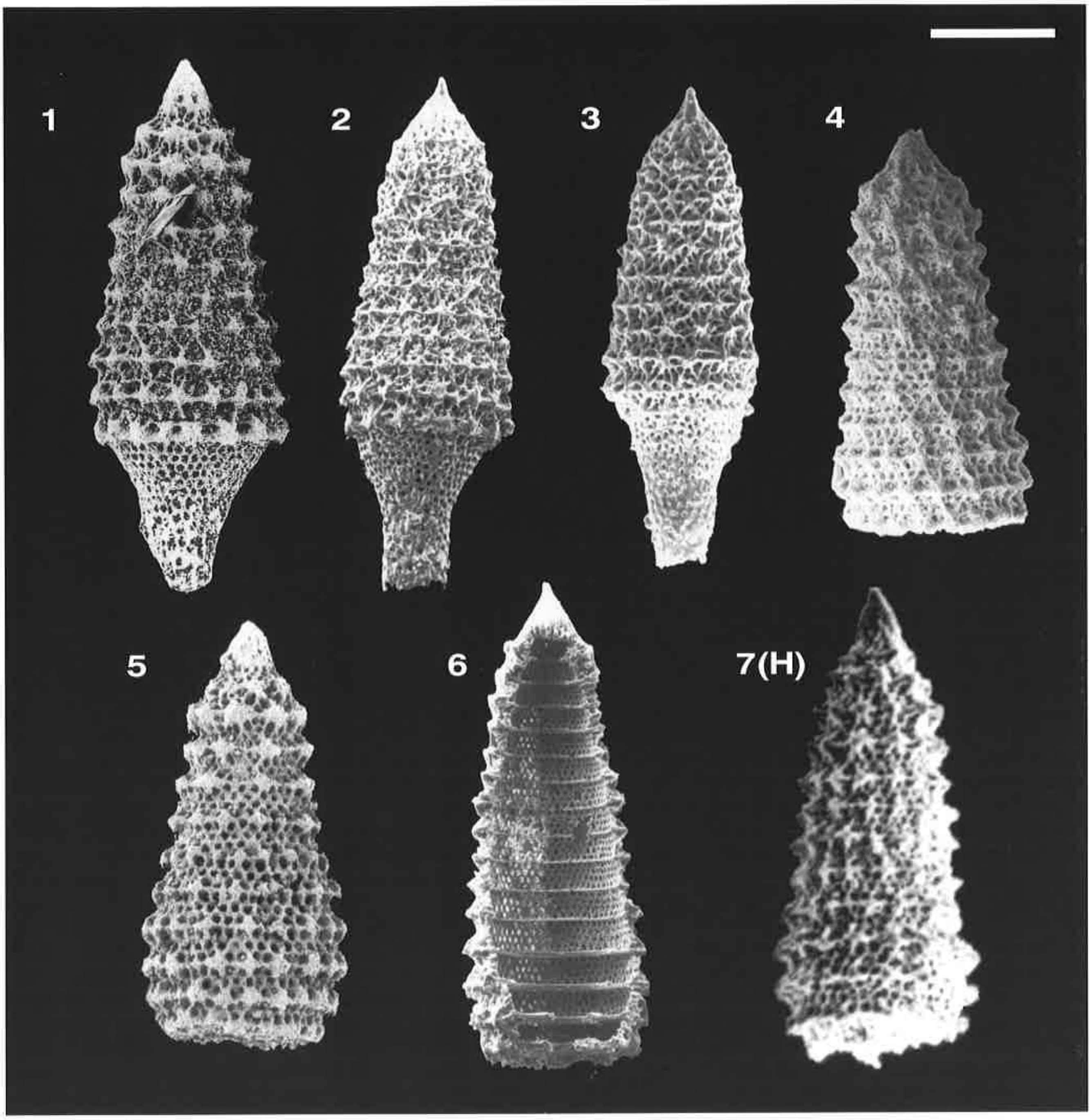


Plate 5674. ***Xitus* (?) *alievi* (FOREMAN).** Magnification x200. **Fig. 1.** RJ179, Bo566.5. **Fig. 2.** POB81/0985, MO46a'. **Fig. 3.** DU344, Mo46. **Fig. 4.** RJ11, Bo566.5. **Fig. 5.** RJ13, Bo566.5. **Fig. 6.** DU3467, Mo46. **Fig. 7(H).** FOREMAN 1973b, pl. 9, fig. 10.

XITUS (?) CHANNELLI 5673

Xitus (?) *channelli* JUD

***Synonymy*.-**
Parvicingula profunda PESSAGNO & WHALEN
ORIGLIA-DEVOS 1983, p. 175, pl. 20, figs. 12-13.
Xitus (?) *channelli* JUD
JUD 1994, p. 117, pl. 24, figs. 5-6.

***Original Definition*.-** Long conical test of 15-18 segments with apical horn and distal tube. Apical horn conical, long, sturdy, terminating with crown-like structure. Segments double-layered: an inner layer of 4-5 transverse rows of small pores per segment and an outer layer consisting of circumferential ridges on segmental suture with spiny nodes. Nodes small, interconnected by irregularly to obliquely disposed bars, forming more or less triangular to irregular meshes on the surface of test. Terminal part with a broad, open tube, a little narrower than the last segment, thin-walled, representing the prolongation of the inner layer. Pores on tube small, arranged in rather regular transverse rows.

***Original Remarks*.-** *Xitus* (?) *channelli* n.sp. is questionably assigned to the genus *Xitus* PESSAGNO because of the absence of the 2nd row of tubercles. By this character it seems closely related to *Xitus* (?) *alievi* (FOREMAN).

***Etymology*.-** This species is dedicated to Prof. J.E.T. Channell, Department of Geology, University of Florida, USA, honouring his work in paleomagnetics.

Measurements (in μm).-
Based on 9 specimens.

	HT	av.	min.	max.
H. excl.horn & tube:	387	373	324	461
Width of test:	173	172	135	200
Length of tube:	-	90	87	94
Width of tube:	-	106	91	126
H. of apical horn:	53	79	52	103

***Type Locality*.-** Fiume Bosso, Umbria-Marche, Italy.

***UAZones*.-** 16-21, early Val. to early Barr.

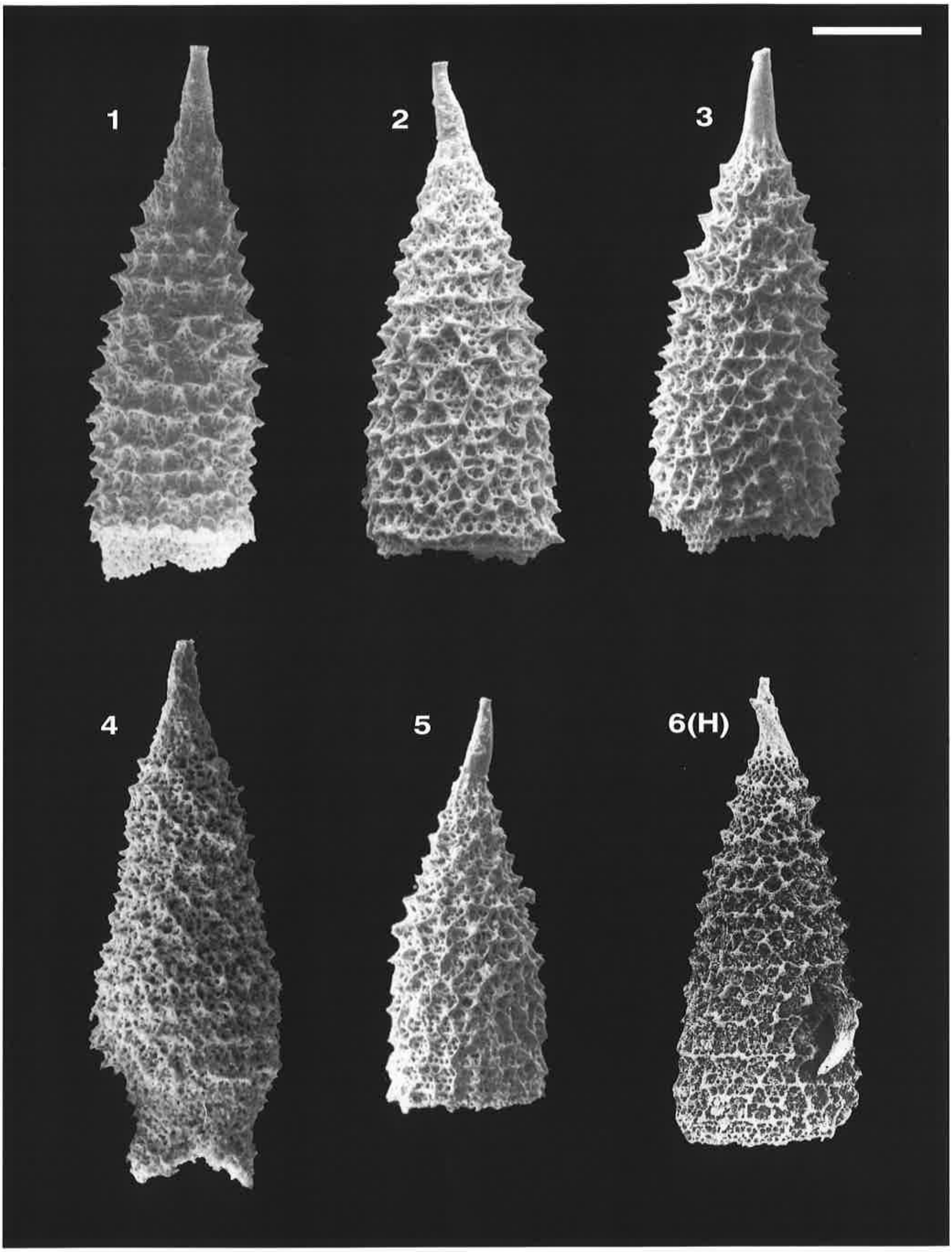


Plate 5673. *Xitus* (?) *channelli* JUD. Magnification x200. **Fig. 1.** DU885, Mo46. **Fig. 2.** DU734, Mo46. **Fig. 3.** DU691, Mo46. **Fig. 4.** RJ15, Pr225.3. **Fig. 5.** DU357, Mo46. **Fig. 6(H).** RJ17, Bo566.5.

XITUS GIFUENSIS 3294

Xitus gifuensis MIZUTANI

Synonymy.-
Xitus gifuensis MIZUTANI
MIZUTANI 1981, p. 180, pl. 59, figs. 1, 2a-b, 3-4.
ADACHI 1982, pl. 3, figs. 1-2.
WAKITA 1988, pl. 5, fig. ? 9; pl. 6, fig. 20.

Original Definition.- Test subconical or campanulate with coarse meshwork consisting of thick but small massive tubercles interconnected by numerous short bars. Cephalis irregularly perforated and terminated with massive solid part. Stricture indistinct. Development of tubercles obscures the layered structure. Basal aperture distinct.

Original Remarks.- The shell structure of this species is similar to *Xitus plenus* PESSAGNO (1977b, p. 55, pl. 9, figs. 15, 21-22, 26). *Xitus gifuensis* is distinguished from the other species of *Xitus* in its short and stout form.

Etymology.- The name is derived from Gifu Prefecture.

Measurements (in μm).-
Based on 11 specimens. Height of shell ranging 185-225 (196), width of shell ranging 130-160 (148).

Type Locality.- Sample 142, Mazegawa Formation, Hida-Kanayama, Gifu Prefecture, cetral Japan.

UAZones.- 11-16, late Kimm.-early Tith. to early Tith. to early Val.

XITUS HORRIDUS 5725

Xitus horridus JUD

Synonymy.-
Xitus horridus JUD
JUD 1994, p. 118, pl. 24, figs. 7-8.

Original Definition.- Test conical to spindle-shaped with apical horn and distal tube. Number of segments unknown. Cephalis and thorax poreless, separated from one another by a single row of pores. Cephalis with a short, conical spine. Thorax smooth or slightly tuberculate. Post-thoracic segments double-layered. Inner layer completely screened by the outer layer, which is very robust, rough, with strong tubercles interconnected by bars forming an irregular network of meshes. On some specimens several circumferential tuberculate ridges were recognizable, the tubercles bearing very strong, conical, pointed spines. Terminal part of test inverted conical, ending with a broad, open tube with irregularly disposed pores of variable size and shape. Rim of the tube bearing, on well preserved specimens, several small, short, obliquely directed spines.

Original Remarks.- *Xitus horridus* n.sp. differs from all other species of the genus by its extremely spiny, irregular surface.

Etymology.- From the Latin *horridus* = terrible, horrid.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Heigth of test:	323	329	273	373
Height excluding tube:	255	259	229	289
Width excluding spines:	167	156	138	175

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 19-20, early Haut. to late Haut.

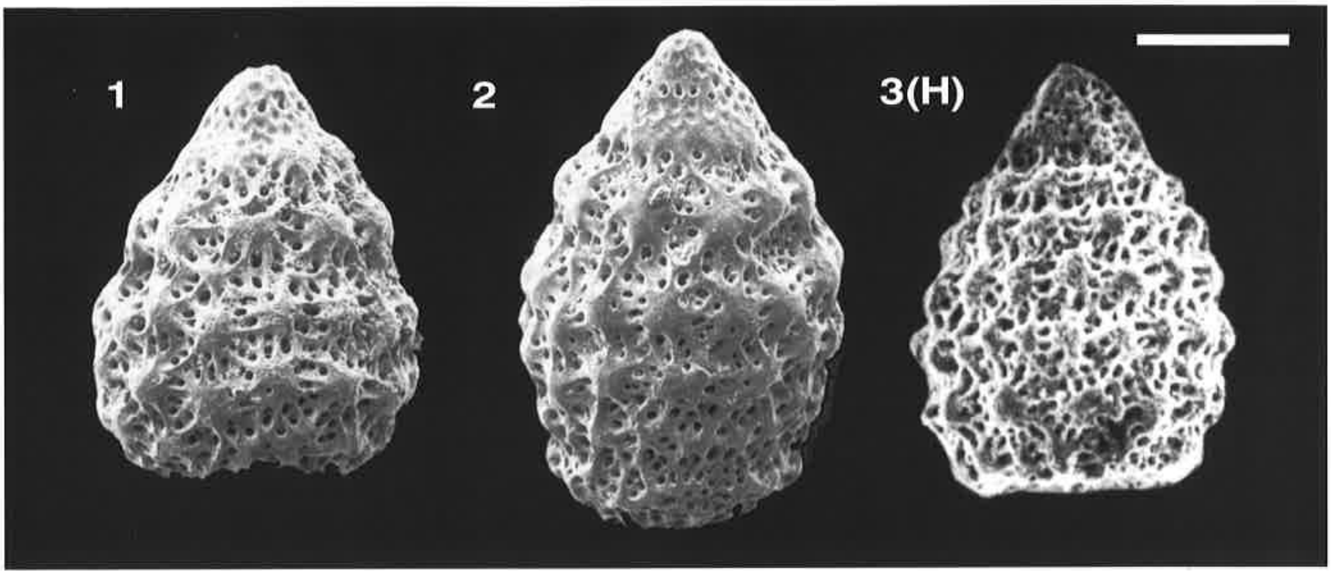


Plate 3294. *Xitus gifuensis* MIZUTANI. Magnification x300. **Fig. 1.** POB80/2783, V-37. **Fig. 2.** POB80/2784, V-37. **Fig. 3(H).** MIZUTANI 1981, pl. 59, fig. 3.

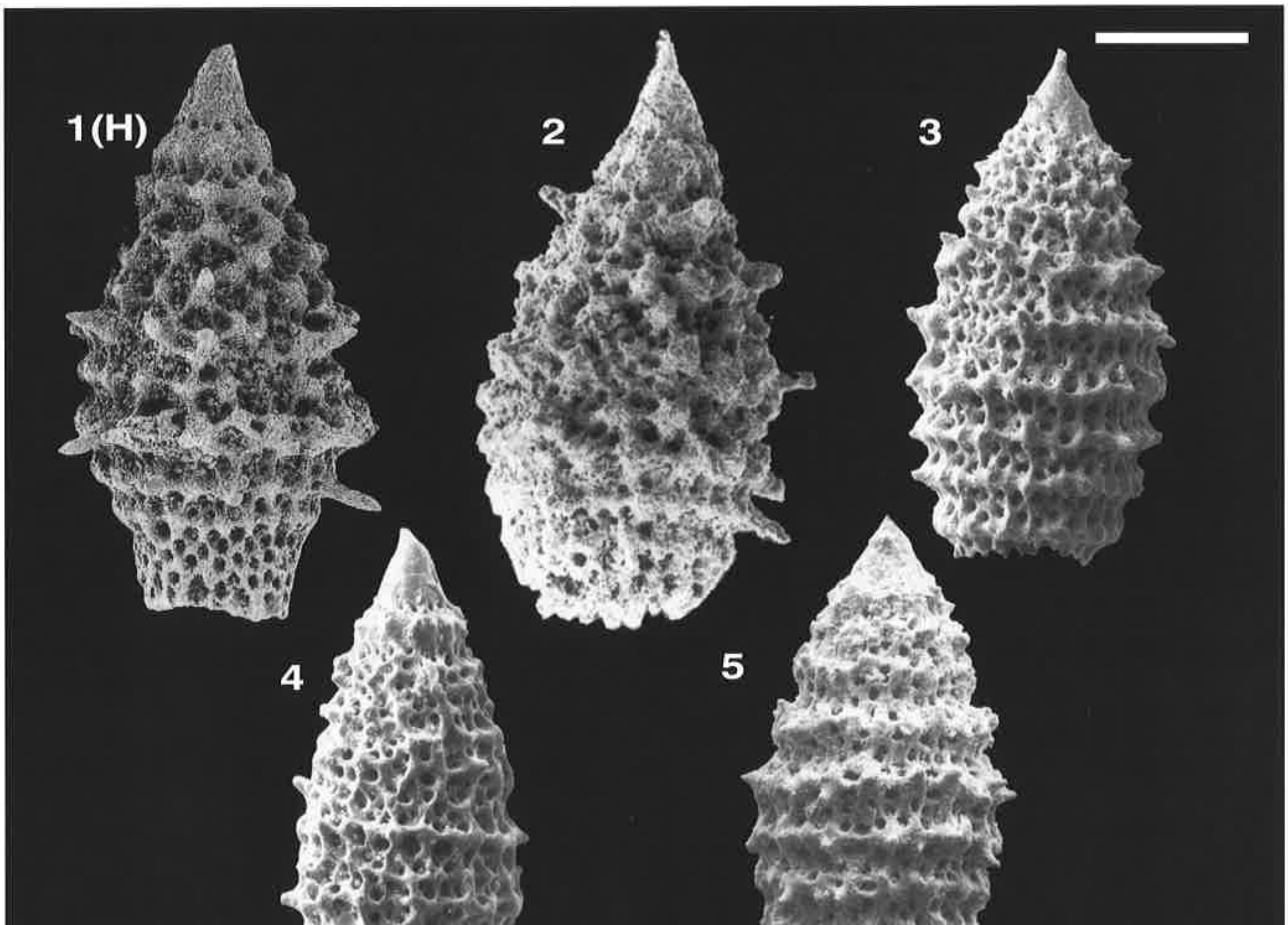


Plate 5725. *Xitus horridus* JUD. Magnification x250. **Fig. 1(H).** RJ102, Bo566.5. **Fig. 2.** RJ57, Bo569.6. **Fig. 3.** DU3419, Mo45. **Fig. 4.** DU3359, Mo37. **Fig. 5.** DU3424, Mo45.

XITUS MAGNUS 3259

Xitus magnus n.sp. BAUMGARTNER

***Synonymy*.-**
Xitus cf. *spicularius* (ALIEV)
DE WEVER et al. 1986, pl. 11, fig. 4.
Xitus aff. *spicularius* (ALIEV)
DE WEVER et al. 1986, pl. 11, fig. 5.
Xitus sp. A
WIDZ 1991, p. 257, pl. 4, fig. 26.

***Type Designation*.-** 79/0118, POB284.5.

***Original Definition*.-** Large xitid nassellarian with 10-12 segments. Cephalis thorax and abdomen together conical, smooth. cephalis spherical, without horn, one irregular row of small pores at joint to thorax. Thorax trapezoidal, with one row of pores at joint to abdomen. Abdomen trapezoidal, with first xitid pore structure and faint nodes at base, marking joint to next segment. First postabdominal segments trapezoidal gradually growing in height and width forming a conical portion. All remaining postabdominal segments, except last one, cylindrical about of same height and width. Last segment slightly higher and narrower than second last. One row of regular xitid nodes (7-9 per half circumference) is placed at each segmental division. 4-6 irregular rows of pores are present on each segment. Pore frames appear to form diagonally running ridges connecting adjacent nodes.

***Remarks*.-** This species differs from *Xitus spicularius* (ALIEV) by having equally sized nodes on each segmental division instead of alternating small and large ones.

***Etymology*.-** *Magnus, -a, -um*, Latin, *great.*

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	min.	max.
Width of test:	213	180	152	213
Height of test:	533	485	340	533

***Type Locality*.-** Sample POB 284, Base of Kandhia Formation, near Kandhia, Central Argolis Peninsula, Greece.

***UAZones*.-** 8-11, mid Call.-early Oxf. to late Kimm.-early Tith.

XITUS PULCHER AFF. 3258

Xitus sp. aff. *X. pulcher* PESSAGNO

***Synonymy*.-**
Xitus pulcher PESSAGNO
aff. PESSAGNO 1977b, p. 55, pl. 9, figs. 8, 13, 23, 27.

***Remarks*.-** This morphotype differs from *Xitus pulcher* PESSAGNO by possessing less segments and by having stronger tubercles.

***UAZones*.-** 9-11, mid-late Oxf. to late Kimm.-early Tith.

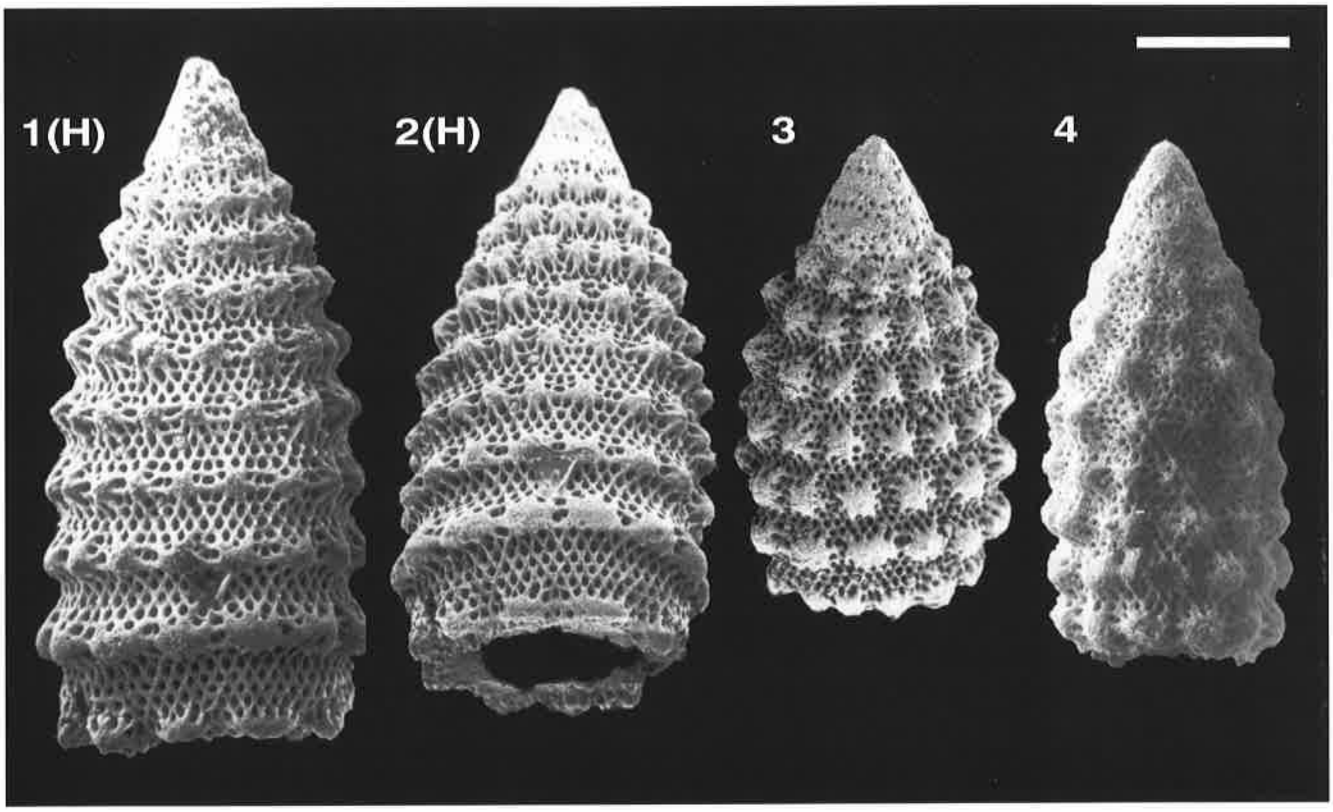


Plate 3259. ***Xitus magnus*** **n.sp. BAUMGARTNER.** Magnification x200. **Fig. 1(H).** POB79/0118, POB284.5. **Fig. 2(H).** POB79/0087, POB284.5. **Fig. 3.** GOB10/1106, KRS2. **Fig. 4.** DU1817, R102.

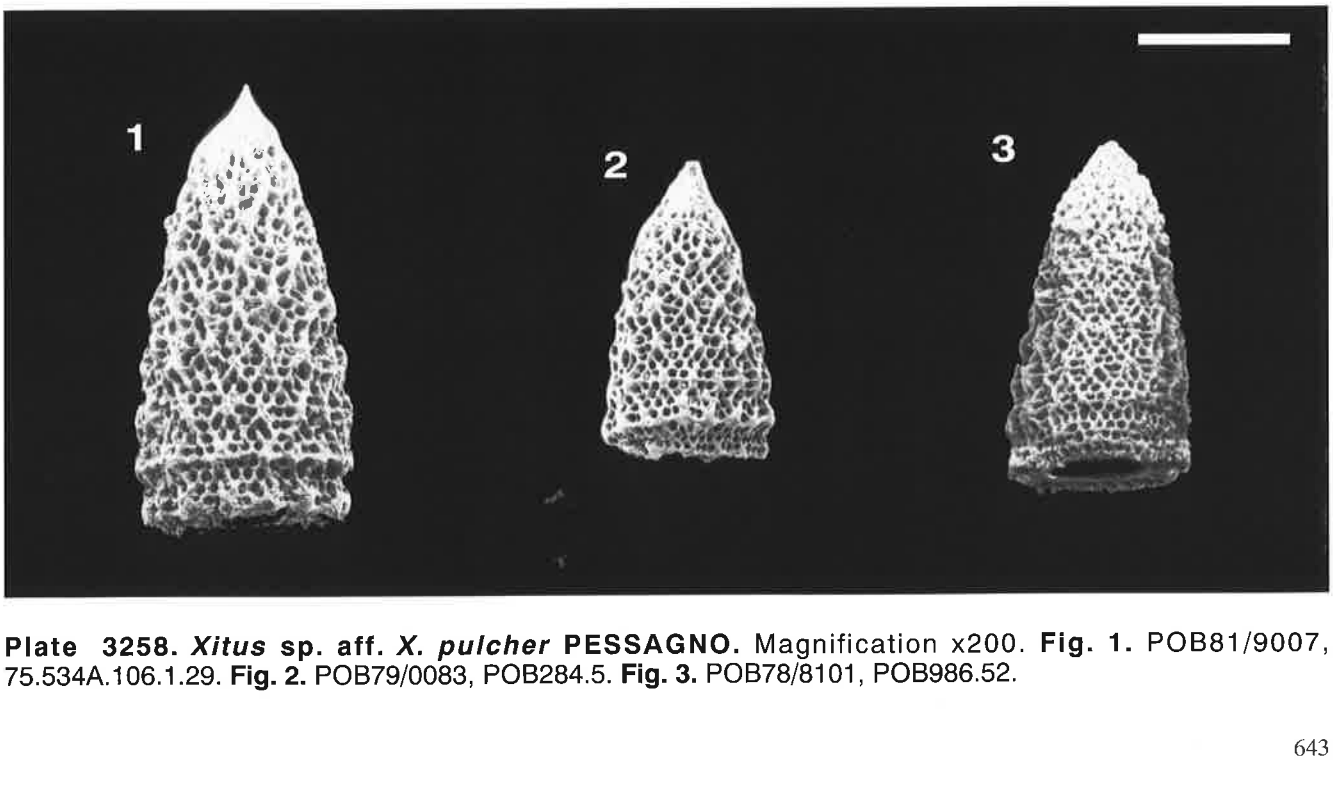


Plate 3258. ***Xitus*** **sp. aff.** ***X. pulcher*** **PESSAGNO.** Magnification x200. **Fig. 1.** POB81/9007, 75.534A.106.1.29. **Fig. 2.** POB79/0083, POB284.5. **Fig. 3.** POB78/8101, POB986.52.

XITUS SANDOVALI 5668

Xitus sandovali JUD

Synonymy.-
Xitus sp. A
SCHAAF 1981, p. 441, pl. 5, figs. 9a-b; pl. 18, figs. 7a-b.
Parvicingula altissima (RÜST)
ORIGLIA-DEVOS 1983, p. 170, pl. 19, fig. 6, not fig. 5.
Xitus sandovali JUD
JUD 1994, p. 118, pl. 24, figs. 9-10.

Original Definition.- Test long, slender, conical with distal tube. Apical part thickened, sometimes globular, enclosing the thorax and probably also the abdomen. Cephalis globular, poreless, its upper part outside of the thickened portion, bearing a very short apical horn. Remaining part of test subcylindrical, composed of 7-10 segments, which represent postabdominal segments, is increasing gradually and slowly in width. Segmentation very well marked by a row of small nodes corresponding to internal partition and a row of large tubercles with acute tips, corresponding to the middle part of the segments. Pores very small, arranged in about 8 more or less regular transverse rows per segment. Last distal segments decreasing in height, loosing the tuberculate circumferential ridges and terminating with a funnel-shaped or broad tube of variable diameter and with irregularly disposed small pores.

Original Remarks.- *Xitus sandovali* n.sp. differs from *Xitus* (?) *alievi* (FOREMAN) in having generally a bulbous apical portion without nodose ridges, more than 3 rows of pores per segment, a terminal tube with only few, irregularly disposed pores and two circumferential nodose ridges on the distal postabdominal segments.

Etymology.- This species is dedicated to Prof. José Sandoval, Department of Paleontology at University Granada, Spain, honouring his contributions to the knowledge of ammonites.

Measurements (in μm).-
Based on 10 specimens.

	HT	av.	min.	max.
Height excluding tube:	329	407	329	488
Maximum width of tube:	162	161	133	195
Length of tube:	219	152	83	219
Minimum width of tube:	36	63	36	88

Type Locality.- Fiume Bosso, Umbria-Marche, Italy.

UAZones.- 15-22, late Berr.-earliest Val. to late Barr.-early Apt.

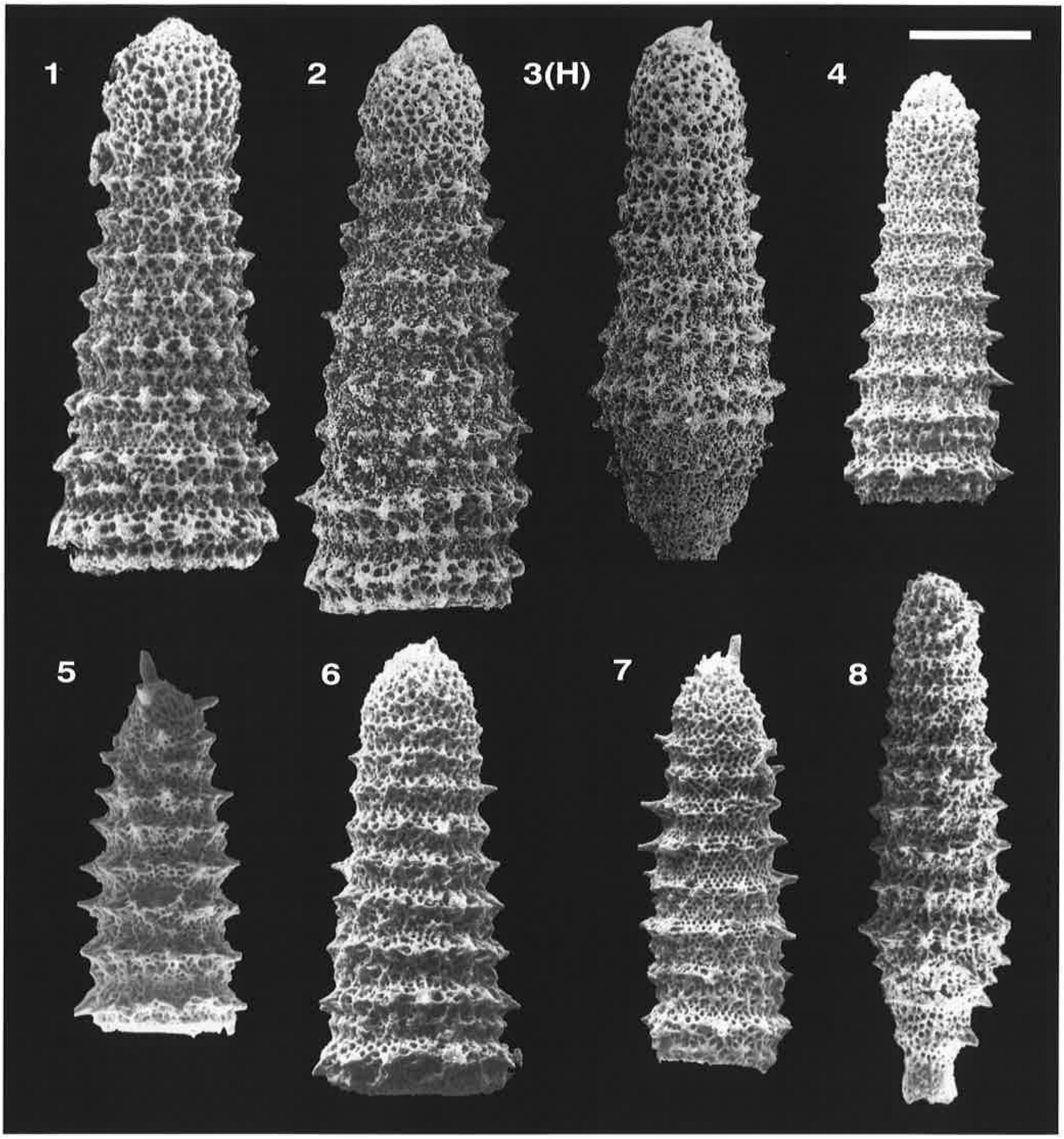


Plate 5668. ***Xitus sandovali* JUD.** Magnification x200. **Fig. 1.** RJ7, Bo566.5. **Fig. 2.** RJ16, Bo566.5. **Fig. 3(H).** RJ66, Bo566.5. **Fig. 4.** POB81/0944, Mo46a'. **Fig. 5.** DU740, Mo46. **Fig. 6.** DU3428, Mo45. **Fig. 7.** DU3487, Mo46. **Fig. 8.** DU129, Mo46/11.

XITUS SPICULARIUS AFF. 3295

Xitus sp. aff. *X. spicularius* (ALIEV)

Synonymy.-
? *Dictyomitra spicularia* ALIEV
ALIEV 1965, p. 39, pl. 6, fig. 9.
Dictyomitra sp. cf. *D. spicularia* ALIEV
FOREMAN 1973b, p. 264, pl. 9, figs. 8-9.
NAKASEKO et al. 1979, pl. 3, fig. 5.
Xitus spicularius (ALIEV)
not PESSAGNO 1977a, p. 56, pl. 9, fig. 7; pl. 10, fig. 5.
POLUZZI et al. 1983, p. 47, pl. 2, figs. 14-16.
KIMINAMI et al. 1985, pl. 2, fig. 5.
VELLEDITS et al. 1986, pl. 4, fig. 3.
IGO et al. 1987, text-fig. 2.3.
YASUDA 1989, pl. 1, fig. 22.
OZVOLDOVA 1990, p. 144, pl. 3, figs. 5-7.
OZVOLDOVA & PETERCAKOVA 1992, pl. 4, figs. 4, 6.
STEIGER 1992, p. 89, pl. 26, figs. 9-11.
Novixitus normalis WU & LI
WU & LI 1982, pl. 2, fig. 5.
Xitus transversus WU & LI
WU & LI 1982, pl. 2, fig. 7, not fig. 8.
Novixitus sp.
KANIE et al. 1981, pl. 1, fig. 17.
Xitus sp.
OKAMURA & UTO 1984, pl. 4, fig. 17.
Xitus sp. cf. *X. spicularius* (ALIEV)
BAUMGARTNER 1984, p. 792, pl. 10, figs. 16-17.
IWATA 1990, pl. 2, fig. 16.
Xitus spicularia (ALIEV)
VISHNEVSKAYA 1984, pl. 10, figs. 5-8.
Xitus aff. *X. plenum*
VISHNEVSKAYA 1984, pl. 11, figs. 3-5.
Xitus sp. aff. *X. spicularius* (ALIEV)
JUD 1994, p. 119, pl. 24, fig. 11.

Definition.- (JUD, 1994) Apical part conical, smooth, except for one row of small pores in the median zone of this part. Cephalis rounded and bearing a short, pointed horn in axial position. Postabdominal segments with 2 rows of tubercles, the upper one having larger and more prominent tubercles than the lower one. On the surface of shell they are expressed by circumferential rows of large nodes alternating with rows of small nodes. Segmental partition marked by a constriction placed just below the row of smaller tubercles. Tubercles rounded, smooth, apically poreless, their base and the intertuberculate area with irregular pore frames. The 4th row of tubercles on most specimens is characteristic in having smaller tubercles which are interconnected with each other to form in the extreme cases a tuberculate to nodose ridge with a row of pores developed on each side of the ridge.

Remarks.- (JUD, 1994) We included in *Xitus* sp. aff. *X. spicularius* (ALIEV) specimens with a subconical to slightly inflated test, possessing invariably rows of markedly stronger tubercles and rows of small tubercles. All these specimens differ from *X. spicularius* (ALIEV) in having an apical horn and a generally shorter and wider test. By possessing an apical horn these specimens are assignable to the genus *Xitus* PESSAGNO from which they differ by having rows of very strong tubercles. They could be also assigned to the genus *Novixitus* PESSAGNO by having one row of pores separating cephalis and thorax, by having in the proximal part of test some rows of very prominent tubercles and even a terminal tube in well preserved specimens. They differ however from the species assigned to the genus *Novixitus* in having an apical horn and by lacking the extremely prominent tubercles on the uppermost postabdominal segment. In this situation subsequent investigations are needed to propose a suitable classification for the group of species which are at present only questionably assignable to either of the two genera.

UAZones.- 10-22, late Oxf.-early Kimm. to late Barr.-early Apt.

XITUS (?) \ D 3261

Xitus (?) sp. D

Synonymy.-
Droltus aff. *hecataensis* PESSAGNO & WHALEN
DE WEVER et al. 1986, pl. 11, fig. 7.

Definition.- Conical nassellarian of 5-7 segments. Cephalis hemispherical bearing a long cylindrical horn, externally smooth or faintly nodose, with one row of pores at base. Thorax and abdomen hemispherical, or inflated trapezoidal, externally nodose with depressions corresponding to small pores. Postabdominal segments increasingly covered by a braided meshwork of costae sometimes entirely covering pores.

Remarks.- This species is only doubtfully included with *Xitus* as its ornamentation is not typically xitid.

UAZones.- 7-9, late Bath.-early Call. to mid-late Oxf.

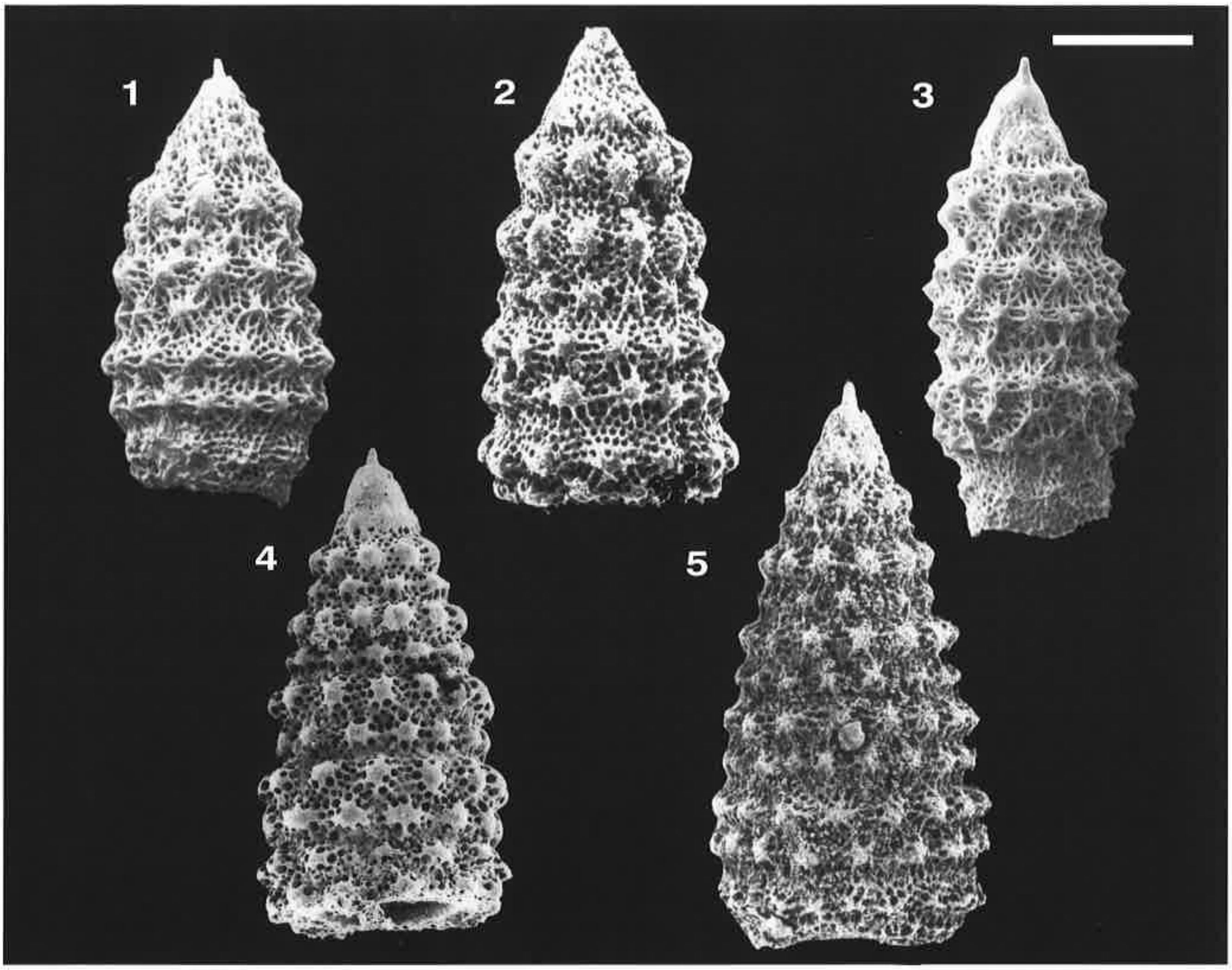


Plate 3295. *Xitus* sp. aff. *X. spicularius* (ALIEV). Magnification x200. **Fig. 1.** POB79/0177, MO22. **Fig. 2.** POB81/9104, 76.534A.81.2.64. **Fig. 3.** DU3384, Mo37. **Fig. 4.** RJ48, Br141.55. **Fig. 5.** RJ221, Bo566.5.

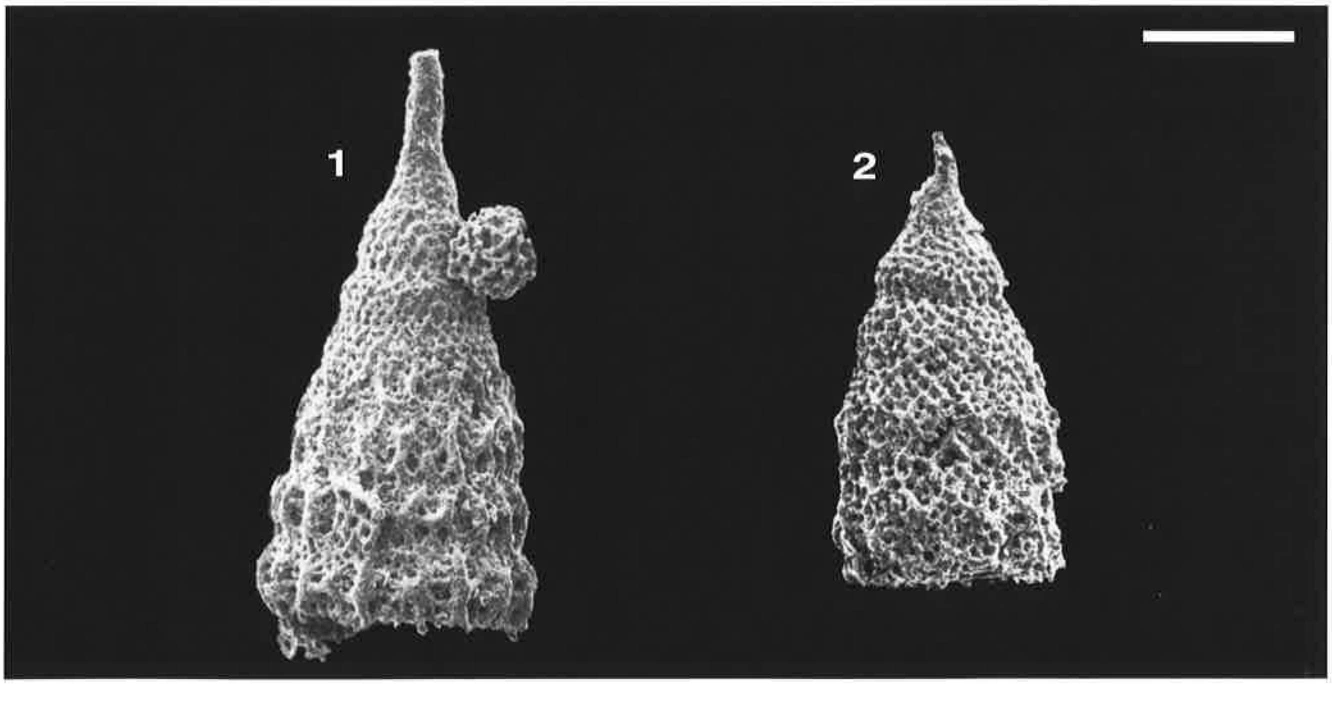


Plate 3261. *Xitus* (?) sp. D. Magnification x300. **Fig. 1.** POB78/3782, POB28.66. **Fig. 2.** POB78/3819, POB28.67.

YAMATOUM 6024

Genus: *Yamatoum* TAKEMURA

Synonymy.-
Yamatoum TAKEMURA
TAKEMURA 1986, p. 55.

Type Species.- *Yamatoum elegans* TAKEMURA 1986.

Original Definition.- Shell consisting of four segments, spherical to spindle-shaped, with several to many, usually tri- or more radiate spines. Cephalo-thorax small, conical and perforated, with well developed and usually triradiate apical horn. Abdomen inflated and subspherical with several or many spines. Terminal segment deflated distally or cylindrical, with one to three terminal spines, and with or without aperture. MB, A, V, D, two L and I as cephalic skeletal elements, with ring-like VB on the inside surface of cephalis. The upper chamber of cephalis smaller than the lower.

Original Remarks.- The cephalis of *Yamatoum* n.gen. bears VB on its internal surface. This kind of cephalic skeletal structure accords with that of the Cretaceous *Amphipyndax* FOREMAN 1966. However, it is usual that the upper chamber is larger than the lower one in the case of cephalis of Cretaceous Amphipyndacidae (Foreman, 1966; 1968; 1978; Schaaf, 1981; Nakaseko & Nishimura, 1981).

Five new species belonging to this new genus are described. Among them, *Y. elegans* and *Y. komaniensis* possess an aperture on the terminal (fourth) segment. However, the other three new species bear no aperture. In this case, it is difficult to observe the internal cephalic structure. Foreman (1973b) defined the subfamily Syringocapsinae as "Cyrtoidea with the multiple segments of the proximal part very small and the single of the distalmost part very large and expanded", and she did not relate this subfamily to the family Amphipyndacidae. The genus *Yamatoum* differs from all the genera belonging to the subfamily Syringocapsinae in possession of an *Amphipyndax*-type cephalic structure and a not expanded distalmost segment. This genus is also different from *Quarticella* n.gen. in the possession of an inflated abdomen bearing larger pores, cephalis with pores and terminal spines."

Etymology.- The genus name, *Yamatoum* derives from the Yamato Village, Gujo County, Gifu Prefecture, Japan.

Included Taxa.-
2016 *Yamatoum caudatum* TAKEMURA
2020 *Yamatoum komamiensis* TAKEMURA
4077 *Yamatoum spinosum* TAKEMURA

YAMATOUM CAUDATUM 2016

Yamatoum caudatum TAKEMURA

Synonymy.-
Yamatoum caudatum TAKEMURA
TAKEMURA 1986, p. 57, pl. 8 figs. 7-9.

Original Definition.- Cephalis small, hemispherical and perforated, with a stout, straight and usually triradiate apical horn. Thorax small and truncated-conical with circular pores. In some specimens, collar stricture observed. Lumbar stricture distinct. Abdomen large, inflated and subspherical, with hexagonally and longitudinally arranged, or irregularly distributed pores, and with ten to twelve or more stout and tri- or tetraradiate spines. Abdominal spines arranged in two transverse lines or irregularly distributed. The terminal segment tube-like and deflated distally, with pores and two or three terminal spines without aperture.

Original Remarks.- *Yamatoum caudatum* n.sp. differs from the other species of *Yamatoum* in the possession of the terminal (fourth) segment with two or three terminal spines without aperture.

Etymology.- The name, *caudatum,* means bearing a tail.

Measurements (in μm).-
Based on 4 specimens. Length of shell including horn and terminal spines, 250-335. Length of shell exclusive of horn and terminal spines, 160-210. Maximum width of shell including spines, 215-295. Width of abdomen, 115-135.

Type Locality.-Sample TKN-105, Gujo-Hachiman area in the Mino terrane, central Japan.

UAZones.- 2-2, late Aal. to late Aal.

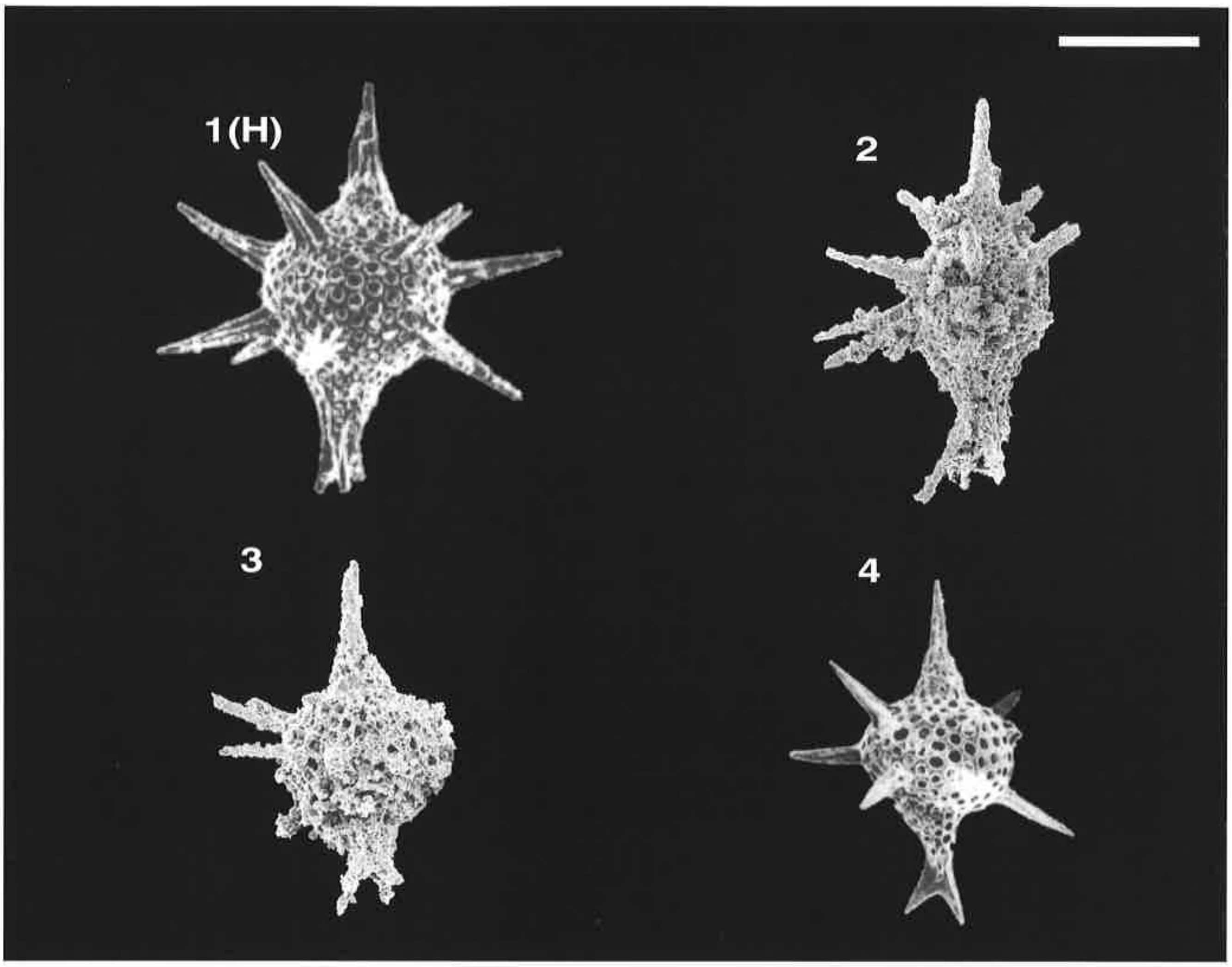


Plate 2016. ***Yamatoum caudatum*** **TAKEMURA.** Magnification x200. **Fig. 1(H).** TAKEMURA 1986, pl. 8, fig. 7. **Fig. 2.** AB 0104, TM48.35.a149. **Fig. 3.** AB 0125, TM48.35.b32. **Fig. 4.** TAKEMURA 1986, pl. 8, fig. 9.

YAMATOUM KOMAMIENSIS 2020

Yamatoum komamiensis TAKEMURA

Synonymy.-
Yamatoum komamiensis TAKEMURA
TAKEMURA 1986, p. 56, pl. 7, figs. 19-22.

Original Definition.- Cephalis small, hemispherical and perforated, with a stout and usually rod-like apical horn. Thorax small and truncated-conical with irregularly distributed pores. Neither a distinct constriction nor a transverse ridge exist on the surface between cephalis and thorax. Lumber stricture distinct. Abdomen large, inflated and subspherical, with usually irregularly arranged pores, and with ten to twelve or more rod-like spines. Abdominal spines regularly arranged transversely in two rows. The fourth segment deflated distally, with irregularly distributed pores, and with two or three terminal spines around circular aperture. Terminal spines usually triangularly conical.

Original Remarks.- Among the species belonging to *Yamatoum, Y. komamiensis* n.sp. and *Y. elegans* n.sp. possess an aperture on the terminal segment. *Y komamiensis* is different from *Y. elegans* in the number and the arrangement of the abdominal spines.

Etymology.- The name *komamiensis* is derived from Komami, Yamato Village, Gujo County, Gifu Prefecture.

Measurements (in μm).-
Based on 3 specimens. Length of shell including horn and terminal spines, 250-260; Length of shell exclusive of horn and terminal spines, 155-185; Maximum width of shell including spines, 195-230; Width of abdomen, 105-125.

Type Locality.- Sample TKN-105, Gujo-Hachiman area in the Mino terrane, central Japan.

UAZones.- 2-2, late Aal. to late Aal.

YAMATOUM SPINOSUM 4077

Yamatoum spinosum TAKEMURA

Synonymy.-
Yamatoum spinosum TAKEMURA
TAKEMURA 1986, p. 56, pl. 8, figs. 1-3.

Original Definition.- Cephalis small, hemispherical and perforated, with a stout apical horn, which usually possesses grooves and ridges. Thorax small and truncated-conical or cylindrical, with irregularly distributed pores. Neither a distinct constriction nor a transverse ridge exist on the surface between cephalis and thorax. Lumbar stricture distinct. Abdomen large, inflated and subspherical, with hexagonally and longitudinally arranged, or irregularly arranged, circular pores, and with ten to twelve or more stout and straight spines. Abdominal spines usually arranged in two transverse lines, or irregularly distributed, and usually possessing grooves and ridges. The fourth segment with or without stricture at the abdominal boundary, deflated distally, with longitudinally or irregularly distributed pores and a single stout terminal spine without aperture. Terminal spine usually possessing grooves and ridges, and in many specimens situated outside the axis of the shell.

Original Remarks.- The shape of the terminal (fourth) segment of some specimens of *Yamatoum spinosum* n.sp. is similar to that of the cephalo-thorax of each specimen. In this case, it is not easy to distinguish the direction of the shell, and the aspect of this species is similar to that of spumellarians.

Y. spinosum differs from *Y. elegans* n.sp. and *Y. komaniensis* n.sp. in the lack of an aperture. *Y. spinosum* is different from *Y. connicinum* n.sp. in the number and the arrangement of abdominal spines. *Y. spinosum* is also distinguished from *Y. caudatum* by the number and the situation of terminal spines.

Etymology.- The name, *spinosum*, means thorny.

Measurements (in μm).-
Based on 8 specimens. Length of shell including horn and terminal spines, 240-290; Length of shell exclusive of horn and terminal spine, 130-200; Maximum width of shell including spines, 180-255; Width of abdomen, 100-140.

Type Locality.- Maganese carbonate ore deposit, TKN-105. Gujo-Hachiman area, Mino Terrane, central Japan.

UAZones.- 1-4, early-mid Aal. to late Baj.

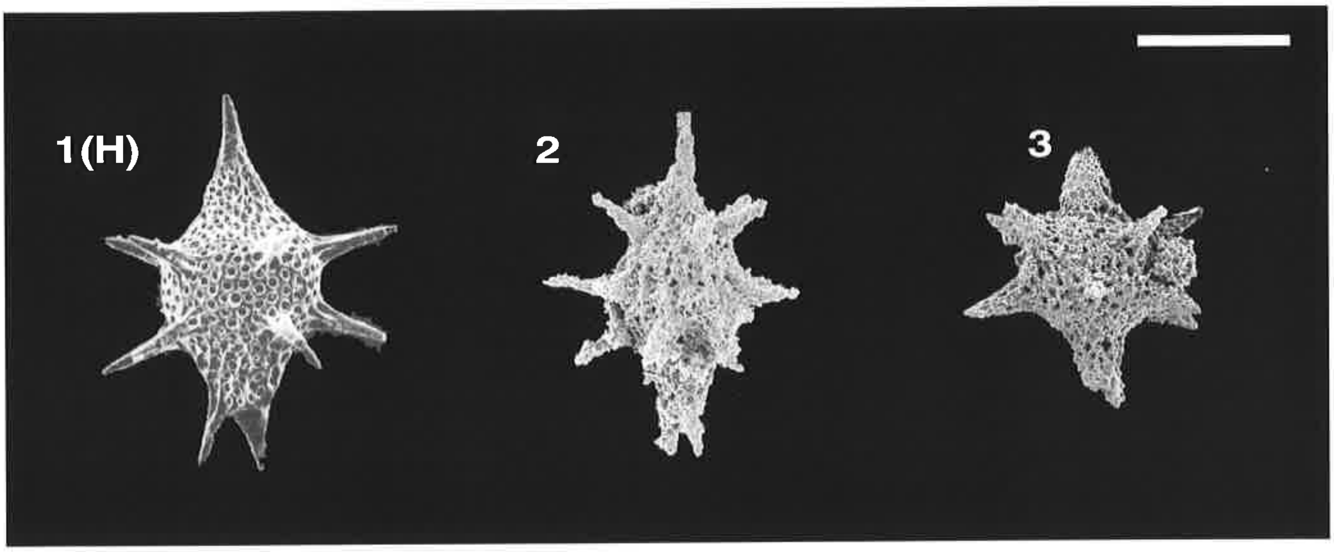


Plate 2020. *Yamatoum komamiensis* TAKEMURA. Magnification x200. **Fig. 1(H).**TAKEMURA 1986, pl. 7, fig. 19. **Fig. 2.** AB 0094, TM48.35.a133. **Fig. 3.** AB 0070, TM48.35.1/91.

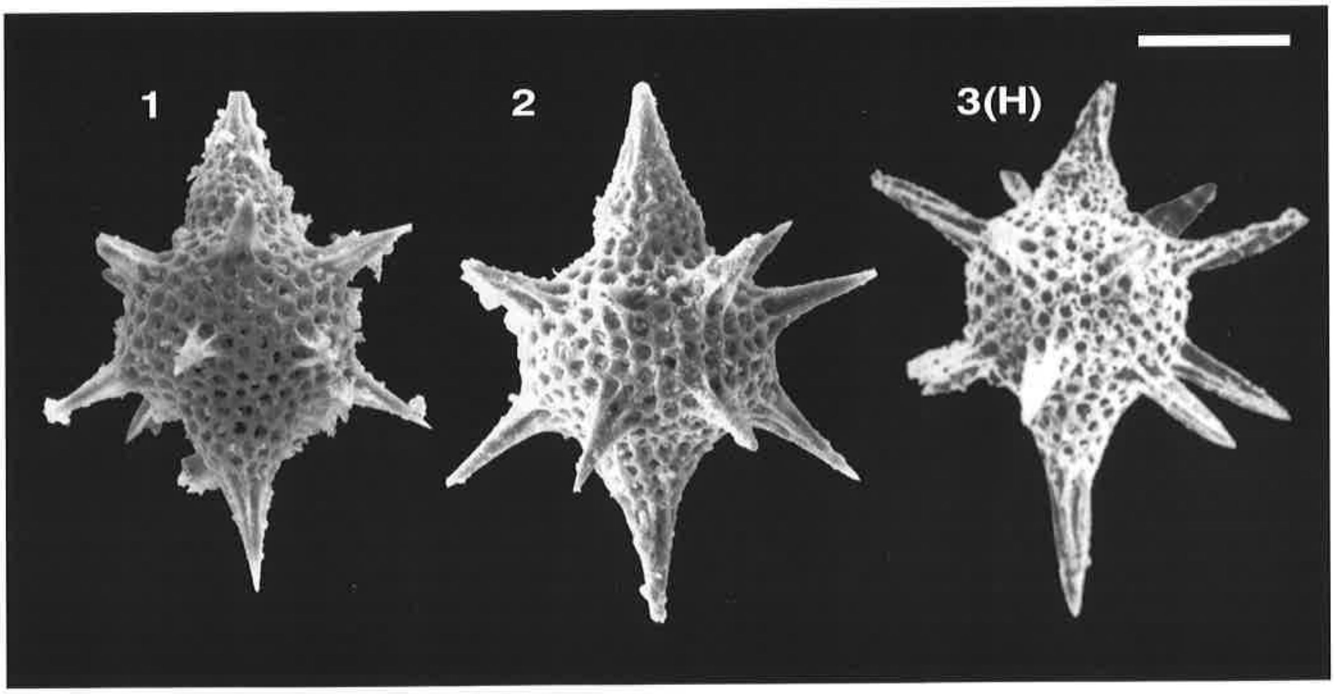


Plate 4077. *Yamatoum spinosum* TAKEMURA. Magnification x300. **Fig. 1.** MA10155, MIN-1, Ch-1-A. **Fig. 2.** MA9981, MIN-1, Ch-1-A. **Fig. 3(H).** TAKEMURA 1986, pl. 8, fig. 1.

ZARTUS 3686

Genus: *Zartus* PESSAGNO & BLOME

Synonymy.-
Zartus PESSAGNO & BLOME
PESSAGNO & BLOME 1980, p. 249.

Type Species.- *Zartus jonesi* PESSAGNO & BLOME 1980.

Original Definition.- Cortical shell spherical to ellipsoidal with well developed raised median band. Pore frames on median band thicker in Z direction (text-fig. 5) than those of remainder of test. Raised median band with short, broad, often massive, triradiate secondary spines; secondary spines centered on pore frame vertices with ridges of spines extending onto 3 bars of adjacent pore frames. Test width with 2 polar spines of different length; polar spines usually triradiate but sometimes partially circular in axial section. First medullary shell with thin, fragile pore frames.

Original Remarks.- The triradiate secondary spines of *Zartus* n.gen. are centered on the pore frame vertices along the center of the median band. Their ridges extend distally onto the bars of 3 adjacent pore frames (pl. 7, figs. 6, 12). The pore frames of *Zartus*, which are normally quite thick in the Z direction (text-fig. 5), are even thicker in the Z direction along the median band. Such an increase in thickness along the median band may offer stouter support for the massive secondary spines. *Zartus* n.gen. differs from *Pantanellium* PESSAGNO in possessing a well-developed, raised median band with triradiate secondary spines. The phylogenetic relationship of *Zartus* to other genera of the Pantanellinae is discussed elsewhere in this report.

Remarks.- Species are differentiated on the characteristics of the polar spines, on variations of the character of the median band and on variations of the shape of the cortical shell.

Etymology.- *Zartus* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. IV, Recommendation 40, p. 113).

Included Taxa.-
3041 *Zartus dickinsoni* gr. PESSAGNO & BLOME
3040 *Zartus imlayi* gr. PESSAGNO & BLOME

ZARTUS DICKINSONI GR. 3041

Zartus dickinsoni gr. PESSAGNO & BLOME

Synonymy.-
Zartus dickinsoni PESSAGNO & BLOME
PESSAGNO & BLOME 1980, p. 250, pl. 8, figs. 1-2, 17-18, 23.
DE WEVER & CORDEY 1986, pl. 1, fig. 14.
KITO et al. 1990, pl. 1, fig. 13.
Zartus sp. cf. *Z. dickinsoni* PESSAGNO & BLOME
YAO 1984, pl. 1, fig. 21.

Original Definition.- Cortical shell small, ellipsoidal with small pentagonal and hexagonal pore frames more prevalent in area of median band. Bars of pore frames of medium thickness in Y direction; much thicker in Z direction (text-fig. 5). Four pore frames visible along AA' and BB'. Four (?) triradiate secondary spines broad proximally, long (for genus), sharply pointed distally (holotype: length 40 μm; width 30 μm) Polar spines long, slender; both triradiate in axial section with 3 narrow grooves alternating with 3 ridges of medium width.

Original Remarks.- *Zartus dickinsoni* n.sp. differs from *Z. imlayi* n.sp. in having much longer, and slender polar spines that are both completely triradiate in axial section and in having a proportionally smaller cortical shell. *Zartus dickinsoni* is compared to *Z. thayeri* n.sp. under the latter species.

Remarks.- Various morphotypes of *Zartus* with stout, long polar spines are included. The raised median band is well developed but may be of any length.

Etymology.- This species is named for Dr. William Dickinson, whose study of the geology of the Izee area offered a sound foundation for our investigations.

Measurements (in μm).-
Based on 8 specimens.

	HT	av.	max.	min.
Vertical diameter of shell	70	68	85	55
Length lower spine:	113	109	130	95
Length upper spine:	105	79	105	70
Horizontal diameter of shell:	65	72	82	65
Width atbase of upper spine:	25	24	30	20
Width at base of lower spine:	20	21	30	20

Type Locality.- OR 516 (Pessagno & Blome, 1980). Lower part of middle member Snowshoe Formation, eastern Oregon.

UAZones.- 3-4 , early-mid Baj. to late Baj.

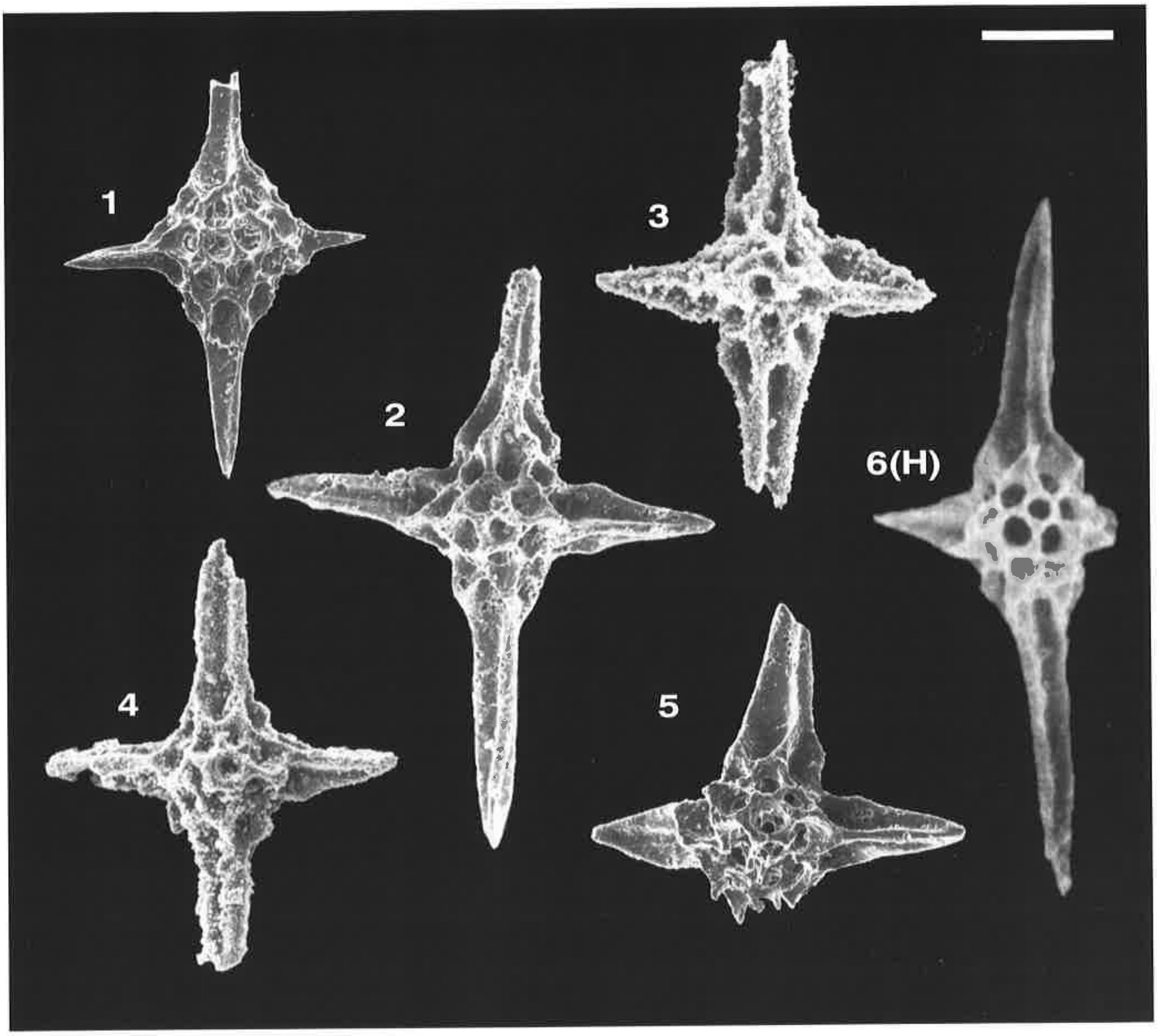


Plate 3041. ***Zartus dickinsoni*** **gr. PESSAGNO & BLOME.** Magnification x350. **Fig. 1.** POB81/3017, IN7. **Fig. 2.** POB81/3019, IN7. **Fig. 3.** GO890305, GL128. **Fig. 4.** GO890506, GL127. **Fig. 5.** POB81/3021, IN7. **Fig. 6(H).** PESSAGNO & BLOME 1980, pl. 8, fig. 1.

ZARTUS IMLAYI GR. 3040

Zartus imlayi gr. PESSAGNO & BLOME

Synonymy.-
Zartus imlayi PESSAGNO & BLOME
PESSAGNO & BLOME 1980, p. 250, pl. 9, figs. 1, 8, 14, 18.
Zartus sp. cf. *Z. dickinsoni* or *Z. imlayi* PESSAGNO & BLOME
BAUMGARTNER 1985, figs. 37. a-c.

Original Definition.- Cortical shell crudely ellipsoidal with large, massive, somewhat irregular, pore frames lacking nodes at their vertices; pentagonal pore frames predominating over hexagonal pore frames. Bars of pore frames thick in Z direction particularly in area of median band; of medium thickness in Y direction (text-fig. 5). Secondary spines short (7 μm on holotype), wide proximally (23 μm on holotype), triradiate in axial section. Polar spines both wide proximally; one spine shorter than the other. Proximal 1/3 of shorter polar spine triradiate in axial section, distal 2/3 circular in axial section. Longer spine completely triradiate in axial section; comprised of 3 wide longitudinal ridges alternating with 3 moderately wide longitudinal grooves; ridges broad proximally, then gradually decreasing in width distally; grooves wedge-shaped, decreasing in width in a distal direction.

Original Remarks.- *Zartus imlayi* n.sp. differs from *Z. jurassicus* n.sp. in having 1 polar spine which is partially circular in axial section and a more inflated cortical shell. In addition, the polar spines of *Z. imlayi* are shorter than those of *Z. jurassicus.*

Remarks.- Included are all forms with short and thin polar spines.

Etymology.- This species is named for Dr. Ralph Imlay in honor of his contributions to the study if the Jurassic ammonite biostratigraphy of eastern Oregon.

Measurements (in μm).-
Based on 5 specimens.

	HT	av.	max.	min.
Vertical diameter of shell:	80	57	80	50
Length lower spine:	60	61	70	50
Length upper spine:	45	47	55	40
Horizontal diameter of shell:	80	81	92	70
Width at base of upper spine:	20	21	30	20
Width at base of lower spine:	15	22	30	15

Type Locality.- OR 516 (Pessagno & Blome, 1980). Lower part of middle member Snowshoe Formation, eastern Oregon.

UAZones.- 1-4, early-mid Aal. to late Baj.

zealis >> TETRATRABS ZEALIS 3121

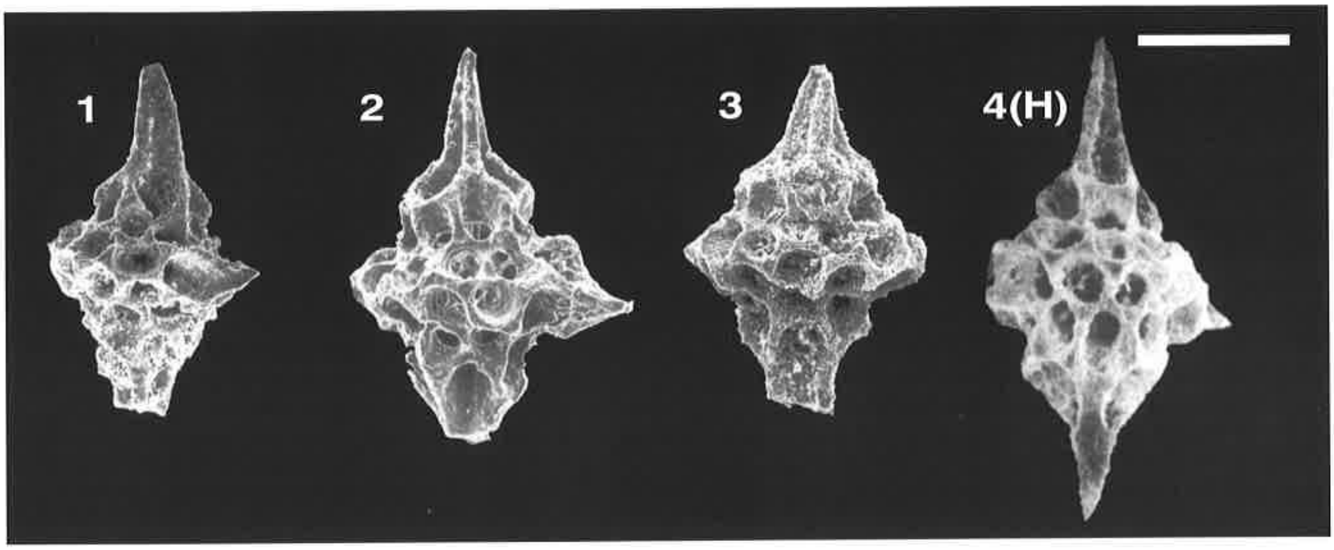


Plate 3040. ***Zartus imlayi* gr. PESSAGNO & BLOME.** Magnification x350. **Fig. 1.** POB80/3953, POB1262. **Fig. 2.** POB81/3020, IN7. **Fig. 3.** POB80/3960, POB1262. **Fig. 4(H).** PESSAGNO & BLOME 1980, pl. 9, fig. 1.

ZHAMOIDELLUM 3695

Genus: *Zhamoidellum* DUMITRICA

Synonymy.-
Zhamoidellum DUMITRICA
DUMITRICA 1970, p. 79.

Type Species.- *Zhamoidellum ventricosum* DUMITRICA 1970.

Original Definition.- Cryptothoracic tricyrtids with large inflated abdomen without aperture or sutural pore. Cephalis poreless, with four collar pores, with or without a short apical horn; thorax campanulate, porous, partly depressed into the abdominal cavity, its opening without descending spines.

Original Remarks.- This new genus is very similar to *Cryptamphorella* n.gen. from which it differs, firstly, by the porous structure of its thorax and, secondly, by its having no sutural pore. In fact neither *Cryptamphorella* seems to possess it always. The members of this genus are very frequent in the upper Jurassic. We described herein only two better preserved species.

Remarks.- Species are distinguished primarily on general test shape.

Etymology.- This genus is dedicated to Dr. A. I. Zhamoida, as a homage to his activity for disentangling the biostratigraphy of the Mesozoic radiolaritic series. Neuter gender.

Included Taxa.-
4079 *Zhamoidellum ovum* DUMITRICA
5511 *Zhamoidellum testatum* JUD
3308 *Zhamoidellum ventricosum* DUMITRICA

ZHAMOIDELLUM OVUM 4079

Zhamoidellum ovum DUMITRICA

Synonymy.-
Zhamoidellum ovum DUMITRICA
DUMITRICA 1970, p. 79, pl. 9, figs. 52a-b, 53-54.
DUMITRICA & MELLO 1982, pl. 3, fig. 13.
OZVOLDOVA 1988, pl. 7, fig. 3.
WIDZ 1991, p 257, pl. 4, fig. 19.
KIESSLING & ZEISS 1992, p. 191, pl. 2, fig. 7.
Zhamoidellum sp. A
AITA 1982, pl. 3, figs. 7-8b.
Zhamoidellum mikamense AITA
AITA 1985, figs. 7.10-11.
AITA 1987, p. 74, pl. 4, figs. 9a-b; pl. 10, figs. 10-11.
IWATA & TAJIKA 1989, pl. 5, fig. 2.
MATSUOKA 1992, pl. 3, fig. 3; pl. 4, fig. 8.
Tricolocapsa sp.
? WAKITA 1988, pl. 5, fig. 19.

Original Definition.- Shell oval, generally smooth, thick-walled. Cephalis poreless, smooth, without apical horn, partly encased in the thick thoracic wall. Collar stricture visible. Thorax porous, with lower part constricted and depressed into abdominal cavity; the upper, unencased part tronconical. Abdomen subspherical to oval, thick-walled, with circular pores, small and sparse proximally, gradually increasing in size to the distal end.

Original Remarks.- The characters of the species are rather constant, except those of the abdomen; the latter has usually globular forms, sometimes becoming more or less acute to the distal end.

Remarks.- *Z. mikamense* AITA is treated as a synonym of *Z. ovum* DUMITRICA. These two forms can be separated at the subspecies level.

Measurements (in μm).-
Based on 20 specimens. Height of the shell 115-150, of cephalo-thorax 45-55, of abdomen 85-110, diameter of cephalis 25-33, of thorax 50-70, of abdomen 100-120.

Type Locality.- Pojorita, Suceava district, Moldova valley, Romania.

UAZones.- 9-11, mid-late Oxf. to late Kimm.-early Tith.

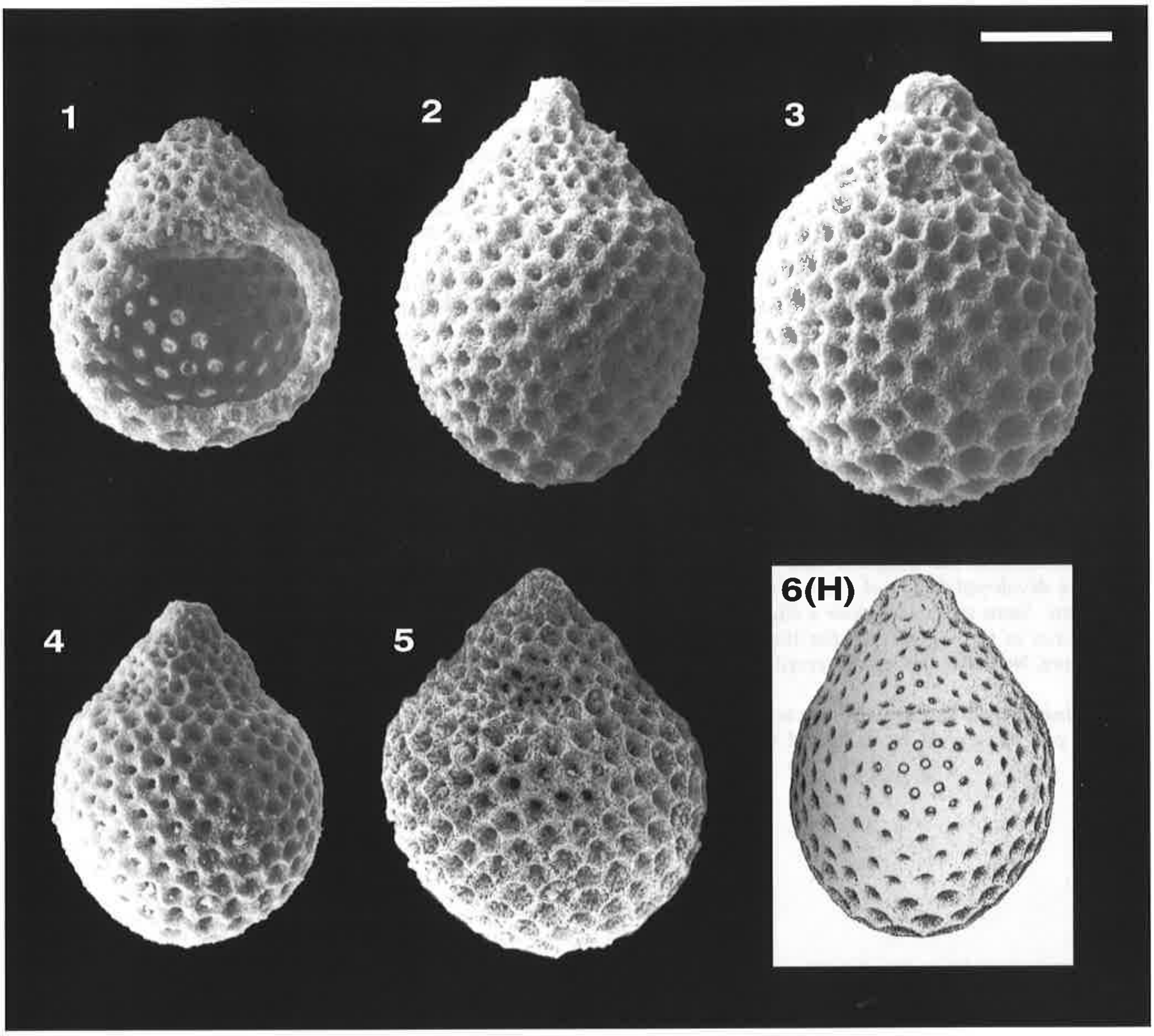


Plate 4079. *Zhamoidellum ovum* DUMITRICA. Magnification x400. **Fig. 1.** DU2581, PJ19. **Fig. 2.** DU2456, PJ25. **Fig. 3.** DU2462, PJ25. **Fig. 4.** DU2900, DR77. **Fig. 5.** GO.B3/1101, KRS6. **Fig. 6(H).** DUMITRICA 1970, pl. 9, fig. 52a.

ZHAMOIDELLUM TESTATUM 5511

Zhamoidellum testatum JUD

Synonymy.-
gen. et sp. indet.
THUROW 1988, pl. 8, fig. 17.
Sethocapsa testata JUD
AGUADO et al. 1991, text-fig. 1.19.
Zhamoidellum testatum JUD
JUD 1994, p. 119, pl. 24, figs. 12-15.

Original Definition.- Spherical test of 3 segments. Cephalo-thorax conical, smooth, with short, blunt horn on well preserved specimens. Thorax latticed, partly incased within abdominal cavity. Abdomen greatly inflated, spherical, with variably tuberculate surface and small and more or less regularly arranged pores. Several sturdy, conical spines are developed on the tubercles around the apical portion and a single short, conical spine is present on most specimens at the antapical end. Sometimes shorter spines are developed on top of other tubercles and near the distal spine. Some specimens show a slight depression with small pores in the vicinity of the thorax, reminding a sutural pore. No distal aperture observed.

Original Remarks.- By all structural characters this species can very well be assigned to *Zhamoidellum* DUMITRICA the species of which where so far known from the Oxfordian. *Zhamoidellum testatum* n.sp. differs from *Sethocapsa trachyostraca* FOREMAN, with which it could be confused, by having spines on most specimens only in apical and distal positions and by having a shorter apical part. A slight depression with small pores in the vicinity of the thorax, reminding a sutural pore, was found by P. Dumitrica on well preserved specimens of his Rumanian samples (personal communication).

Etymology.- From the Latin *testatus, -a, -um,* possessing a head.

Measurements (in μm).-
Based on 6 specimens.

	HT	av.	min.	max.
Heigh excl. spines:	215	228	214	280
Width of test:	204	218	197	275
Height of ap. part:	27	31	27	37
Length spines:	54	46	34	56

Type Locality.- Fiume Bosso, Umbria-Marche Italy.

UAZones.- 18-22, latest Val.-earliest Haut. to late Barr.-early Apt.

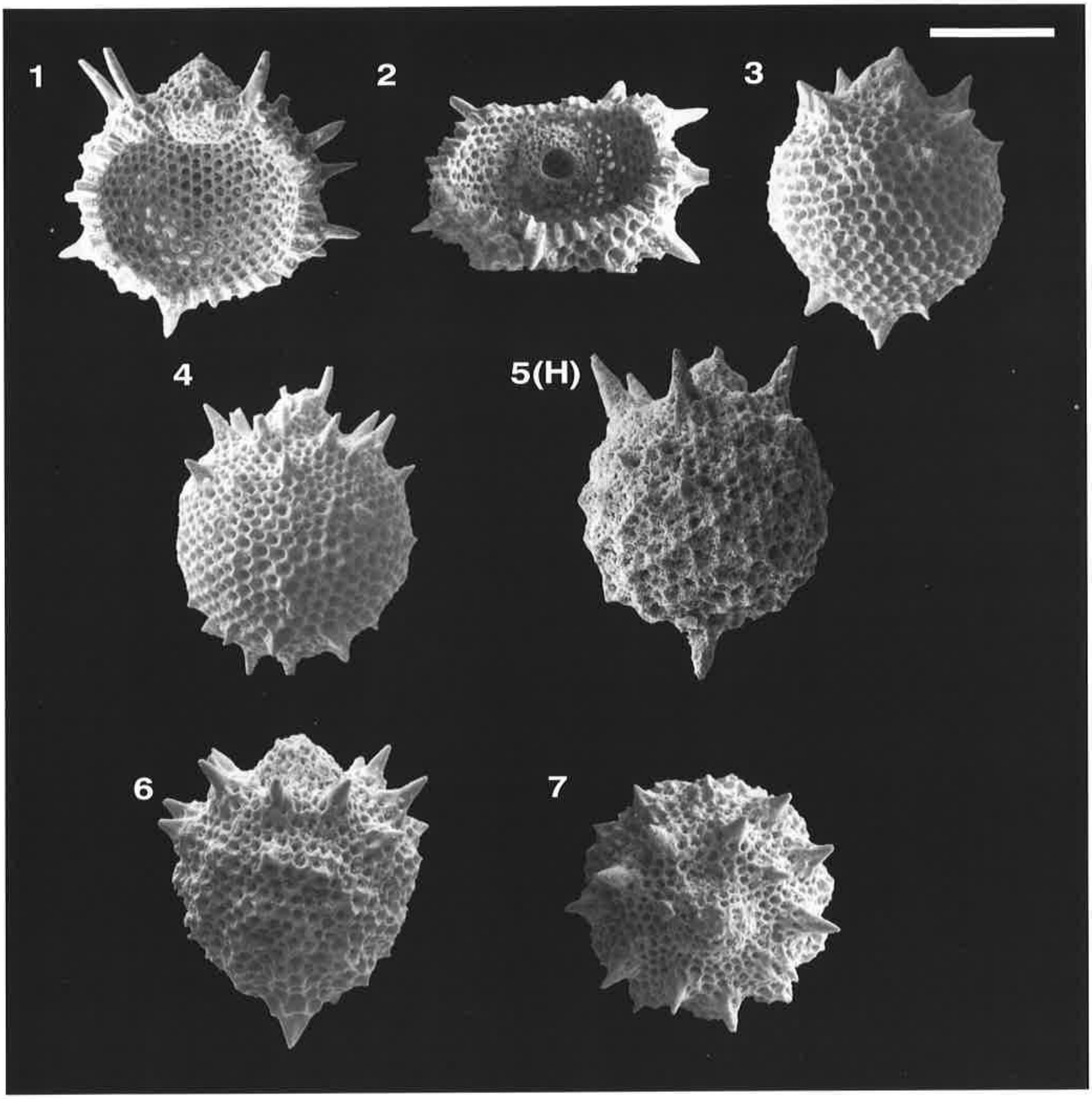


Plate 5511. *Zhamoidellum testatum* JUD. Magnification x200. **Fig. 1.** DU800, Mo46. **Fig. 2.** DU801, Mo46. **Fig. 3.** DU803, Mo46. **Fig. 4.** DU505, Mo46. **Fig. 5(H).** RJ40, Bo617.0. **Fig. 6.** DU678, Mo46. **Fig. 7.** DU679, Mo46.

ZHAMOIDELLUM VENTRICOSUM 3308

Zhamoidellum ventricosum DUMITRICA

Synonymy.-
Zhamoidellum ventricosum DUMITRICA
DUMITRICA 1970, p. 79, pl. 9, figs. 55a-b.
AITA 1982, pl. 3, fig. 5.

Original Definition.- Globose shell with poreless cephalis, without apical horn or with a very short one. Thorax campanulate, with small pores and less than half depressed into the abdominal cavity. Thoracic opening simple, circular. Abdomen large, globulous, slightly flattened at its upper part. Its wall rough, with circular pores set in polygonal frames; short, conical spines arise here and there from the angles of the frames. Lumbar stricture well-definite. Without sutural pore and aperture.

Measurements (in μm).-
Based on 2 specimens. Height of shell 140-145, of cephalis 27, of thorax 45, of cephalo-thorax 57-60, of abdomen 100-105, diameter of thorax 57, of abdomen 135.

Type Locality.- Pojorita, Eastern Carpathians, Romania.

UAZones.- 8-11, middle Call.-early Oxf. to late Kimm.-early Tith.

zweilii >> SETHOCAPSA (?) ZWEILII 5464

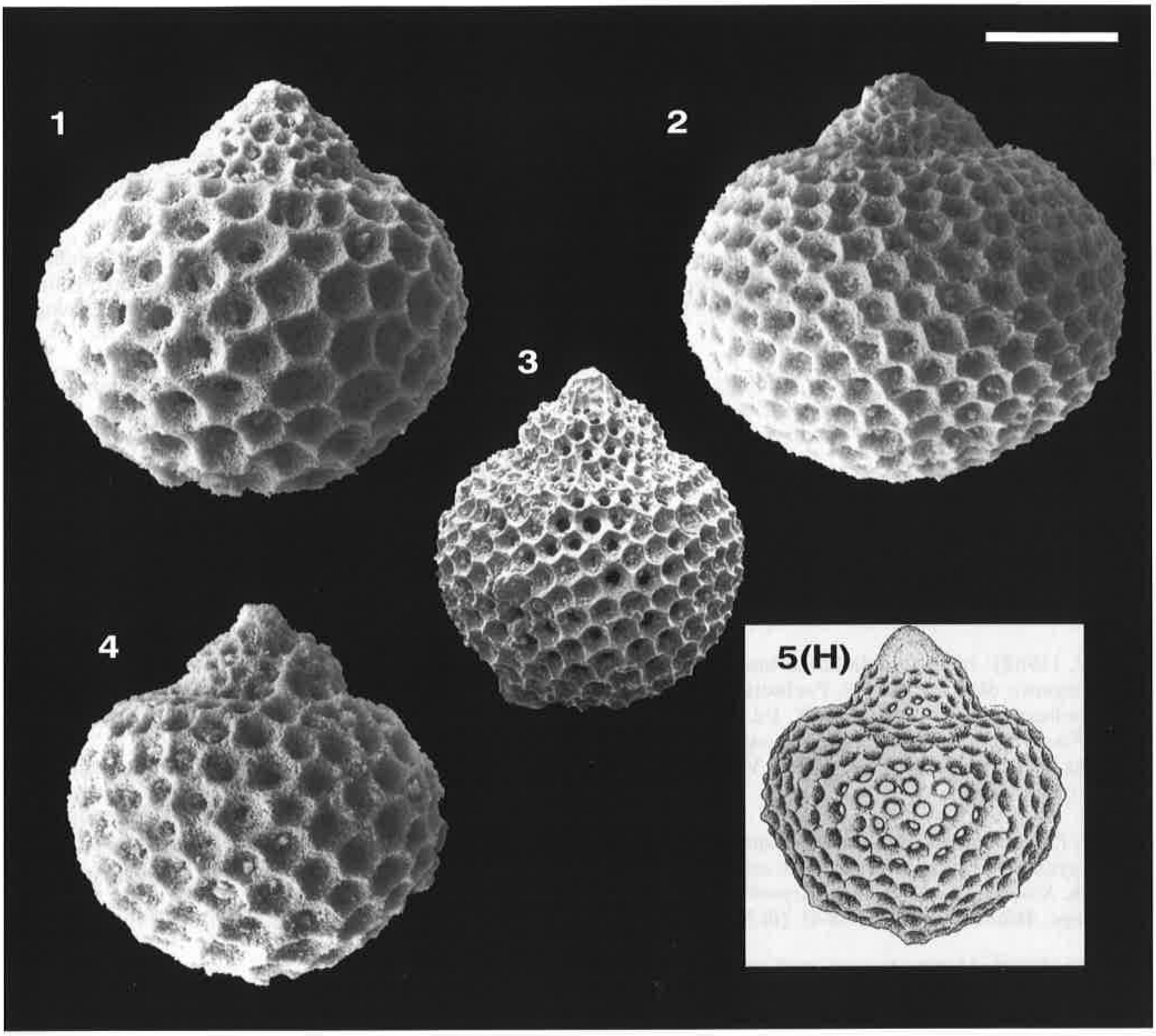


Plate 3308. ***Zhamoidellum ventricosum*** **DUMITRICA.** Magnification x350. **Fig. 1.** POB81/1473, 534A.125.2.36. **Fig. 2.** DU2708, PJ14. **Fig. 3.** DU3145, PJ8. **Fig. 4.** DU2958, PJ13. **Fig. 5(H).** DUMITRICA 1970, pl. 9, fig. 55b.

REFERENCES

ADACHI, M. (1982). Some considerations on the Mirifusus baileyi assemblage in the Mino terrain, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 211-225.

ADACHI, M. (1988). Permian radiolarian-bearing cherts from the Marble Bay area, North Island, New Zealand. *Japanese Journal of Geology and Geography*, **97** (6), 90-92. (*in Japanese*)

ADACHI, M. & KOJIMA, S. (1983). Geology of the Mt. Hikagedaira area, east of Takayama, Gifu Prefecture, central Japan. *Journal of Earth Sciences Nagoya University*, **31**, 37-67.

AGUADO, R., O'DOGHERTY, L., REY, J. & VERA, J.A. (1991). Turbiditas calcáreas del Cretácico al Norte de Vélez Blanco (Zona Subbética): bioestratigrafía y génesis. *Revista de la Sociedad Geológica de España*, **4** (3-4), 271-304.

AITA, Y. (1982). Jurassic radiolarian biostratigraphy in Irazuyama district, Kochi Prefecture, Japan - a preliminary report. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, special Volume, **5**, 255-270. (*in Japanese*)

AITA, Y. (1985). Jurassic radiolarian biostratigraphy of the Irazuyama Formation (Takano Section), Shikoku, Japan. *Scientific and Technical Reports of the Mining College, Akita University*, **6**, 33-41. (*in Japanese*)

AITA, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

AITA, Y. & OKADA, H. (1986). Radiolarians and calcareous nannofossils from the uppermost Jurassic and lower Cretaceous strata of Japan and Tethyan regions. *Micropaleontology*, **32** (2), 97-128.

ALIEV, K.S. (1961). New radiolarian species of the Lower Cretaceous deposits of northeastern Azerbaidzhan. *Izvestiya Akademiya Nauk Azerbaidzhanskoy SSR, Seriya Geologo-Geograficheskikh Nauk i Nefti*, **1**, 51-65. (*In Russian*)

ALIEV, K.S. (1965). *Radiolarians of the Lower Cretaceous deposits of northeastern Azerbaidzhan and their stratigraphic significance* - Izdatel'stvo Akademii Nauk, Azerbaidzhanskoi SSR, Baku. 124 p.

AOKI, T. (1982). Upper Jurassic to Lower Cretaceous radiolarians from the Tsukimiyama and Tei Melanges of the northern Shimanto Belt in Kochi Prefecture, Shikoku. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 339-351. (*in Japanese*)

AOKI, T. & TASHIRO, M. (1982). A stratigraphical study of the Cretaceous Shimanto Belt (The «Doganaro» and Uwagumi Formations) at Uwagumi, Kagami-machi, Kami-gun, Kochi Prefecture, Shikoku. *Research Reports of the Kochi University*, **31**, 1-39.

AUBRECHT, R. & OZVOLDOVA, L. (1994). Middle Jurassic-Lower Cretaceous development of the Pruské Units in the western part of the Pieniny Klippen Belt. *Geologica Carpathica*, **45** (4), 211-223.

BAUMGARTNER, P.O. (1980). Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peleponnesus, Greece). *Micropaleontology*, **26** (3), 274-322.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1985). Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). *Mémoires de la Société Helvétique des Sciences Naturelles*, **99**, 1-111.

BAUMGARTNER, P.O. (1992). Lower Cretaceous radiolarian biostratigraphy and biogeography off northwestern Australian (ODP sites 765 and 766 and DSDP site 261), Argo abyssal plain and lower Exmouth Plateau. *In* Gradstein, F.M., Ludden, J.N. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program). **123**, 299-342.

BAUMGARTNER, P.O. & BERNOULLI, D. (1976). Stratigraphy and radiolarian fauna in a Late Jurassic-Early Cretaceous section near Achladi (Evvoia, Eastern Greece). *Eclogae Geologicae Helvetiae*, **69** (3), 601-626.

BAUMGARTNER, P.O., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BLOME, C. (1984a). Upper Triassic Radiolaria and radiolarian zonation from western North America. *Bulletins of American Paleontology*, **85** (318), 1-88.

BLOME, C. (1984b). Middle Jurassic (Callovian) radiolarians from carbonate concretions, Alaska and Oregon. *Micropaleontology*, **30** (4), 343-389.

BOUYSSE, P., SCHMIDT-EFFING, R. & WESTERCAMP, D. (1983). La Désirade Island (Lesser Antilles) revisited: Lower Cretaceous radiolarian cherts and arguments against an ophiolitic origin for the basal complex. *Geology*, **11** (4), 244-247.

CAMPBELL, A.S. (1954). Radiolaria. *In* Moore, R.C. Ed. *Treatise on Invertebrate Paleontology* - Geological Society of America and University of Kansas Press, Lawrence/Kansas. Part. D, Protista **3**, 11-195.

CAMPBELL, A.S. & CLARK, B.L. (1944). Radiolaria from Upper Cretaceous of Middle California. *Geological Society of America, Special Papers*, **57**, 1-61.

CARAYON, V., DE WEVER, P. & RAOULT, J.-F. (1984). Etude des blocs calcaires contenus dans les séries franciscaines du Sud-Ouest de l'Oregon (U.S.A.): conséquences sur l'âge des mélanges franciscains. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **298** (16), 709-714.

CARNEVALE, P. (1908). Radiolarie e silicoflagellati di Bergonzano (Reggio Emilia). *Memorie del Reale Istituto Veneto di Scienze, Lettre ed Arti*, **28** (3), 1-46.

CARTER, E.S., CAMERON, B.E.B. & SMITH, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

CARTER, E.S. & JAKOBS, G.K. (1991). New Aalenian Radiolaria from the Queen Charlotte Islands, British Columbia: implications for biostratigraphic correlation. *Geological Survey of Canada, Current Research, Paper*, **91-1A**, 337-351.

CAYEUX, L. (1897). Contribution à l'étude micrographique des terrains sédimentaires. 1. Etude de quelques dépôts siliceux secondaires et tertiaires du Bassin de Paris et de la Belgique. 2. Craie du Bassin de Paris. *Mémoires de la Société Géologique du Nord, Lille*, **4** (2), 1-591.

CHEDIYA, D.M. (1959). Obzor Sistematiki Radiolyarii. *Tadzhikskii Gosudarstvennyi Universitet, Stalingrad*, 330 and corrigenda.

CIARAPICA, G. & ZANINETTI, L. (1982). Faune à Radiolaires dans la séquence triasique/liasique de Grotta Arpaia, Portovenere (la Spezia), Apennin septentrional. *Revue de Paléobiologie*, **1** (2), 165-179.

CITA, M.B. (1964). Ricerche micropaleontologiche e stratigrafiche sui sedimenti pelagici del Giurassico superiore e del Cretaceo inferiore nella catena del Monte Baldo. *Rivista italiana di Paleontologia e Stratigrafia, Memoria*, **10**, 1-182.

CITA, M.B. & PASQUARE, G. (1959). Studi stratigrafici sul sistema Cretaceo in Italia. Nota IV. Osservazioni micropaleontoligiche sul Cretaceo delle Dolomiti. *Rivista italiana di Paleontologia e Stratigrafia*, **65** (4), 385-443.

CONTI, M. (1986). New data on the biostratigraphy of the Tuscan cherts at Monte Cetona (Southern Tuscany, Italy). *Marine Micropaleontology*, **11**, 107-112.

CONTI, M. & MARCUCCI, M. (1986). The onset of radiolarian deposition in the ophiolite sequences of the Northern Apennine. *Marine Micropaleontology*, **11**, 129-138.

CONTI, M. & MARCUCCI, M. (1991). Radiolarian assemblage in the Monte Alpe cherts at Ponte di Lagoscuro, Val Graveglia (eastern Liguria, Italy). *Eclogae geologicae Helvetiae*, **84** (3), 791-817.

CSONTOS, L., DOSZTALY, L. & PELIKAN, P. (1991). Radiolarians from the Bükk Mts. *A Magyar Allami Földtani Intézet évi jelentése*, 357-381. (*in Hungarian*)

DANELIAN, T. (1989). *Radiolaires jurassiques de la zone Ionienne (Epire, Grèce). Paléontologie-Stratigraphie, implications paléogéographiques*. Unpublished Ph.D. Thesis (n° 89-25). Université Pierre & Marie Curie, Paris, 269 p.

DANELIAN, T. & BAUDIN, F. (1990). Découverte d'un horizon carbonaté, riche en matière organique, au sommet des radiolarites d'Epire (zone ionienne, Grèce): le Membre de Paliambela. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **311**, 421-428.

DAVIS, A.G. (1950). The Radiolaria of the Hawasina Series of Oman. *Proceedings of the Geologists Association*, **61**, 206-217.

DE WEVER, P. (1981a). Une nouvelle sous-famille, les Poulpinae, et quatre nouvelles espèces de *Saitoum* radiolaires mésozoïques tethysiens. *Geobios*, **14** (1), 5-15.

DE WEVER, P. (1981b). Hagiastridae, Patulibracchiidae et Spongodiscidae (Radiolaires polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (1), 27-50.

DE WEVER, P. (1982a). Nassellaria (Radiolaires Polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (4), 189-232.

DE WEVER, P. (1982b). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

DE WEVER, P. (1984). Révision des radiolaires mésozoïque de type Saturnalide, proposition d'une nouvelle classification. *Revue de Micropaléontologie*, **27** (1), 10-19.

DE WEVER, P. & CABY, R. (1981). Datation de la base des schistes lustrés postophiolitiques par des radiolaires (Oxfordien supérieur-Kimmeridgien moyen) dans les Alpes Cottiennes (Saint-Véran, France). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **292**, 467-472.

DE WEVER, P. & CORDEY, F. (1986). Datation par les Radiolaires de la Formation des Radiolarites s.s. de la Série du Pinde-Olonos (Grèce): Bajocien (?)-Tithonique. *Marine Micropaleontology*, **11**, 113-127.

DE WEVER, P., DANELIAN, T., DURAND-DELGA, M., CORDEY, F. & KITO, N. (1987). Datations des radiolarites post-ophiolitiques de Corse alpine à l'aide des Radiolaires. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **305**, 893-900.

DE WEVER, P., DUÉE, G. & EL KADIRI, K. (1985). Les séries stratigraphiques des klippes de Chrafate (Rif septentrional, Maroc). Témoins d'une marge continentale subsidente au cours du Jurassique-Crétacé. *Bulletin de la Société Géologique de France, Série 8*, **1** (3), 363-379.

De Wever, P., Geyssant, J.R., Azéma, J., Devos, I., Duée, G., Manivit, H. & Vrielynck, B. (1986). La coupe de Santa Anna (zone de Sciacca, Sicile): Une synthèse biostratigraphique des apports des macro-, micro- et nannofossiles du Jurassique supérieur et Crétacé inférieur. *Revue de Micropaléontologie*, **29** (5), 141-186.

De Wever, P. & Miconnet, P. (1985). Datations directes des radiolarites du bassin du Lagonero (Lucanie, Italie méridionale). Implications et conséquences. *Revista Española de Micropaleontología*, **17** (3), 373-402.

De Wever, P. & Origlia-Devos, I. (1982a). Datations nouvelles par les radiolaires de la série des radiolarites S.P. du Pinde-Olonos (Grèce). *Comptes Rendus de l'Académie des Sciences de Paris, Séries 2*, **294**, 399-404.

De Wever, P., Sanfilippo, A., Riedel, W.R. & Gruber, B. (1979). Triassic radiolarians from Greece, Sicily and Turkey. *Micropaleontology*, **25** (1), 75-110.

De Wever, P. & Thiébault, F. (1981). Les Radiolaires d'âge Jurassique supérieur à Crétacé supérieur dans les radiolarites du Pinde-Olonos (Presqu'île de Koroni; Péloponnèse méridional, Grèce). *Geobios*, **14**, 577-609.

Donofrio, D. & Mostler, H. (1978). Zur Verbreitung der Saturnalidae (Radiolaria) im Mesozoikum der Nördlichen Kalkalpan und Südalpen. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **7** (5), 1-55.

Dosztaly, L. (1988). A paleontological study of the «Oregszirt» radiolarites in the Pilis Mountains. *A Magyar Allami Földtani Intézet évi jelentése*, 229-239.

Dumitrica, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (série Géologie)*, **14** (1), 45-124.

Dumitrica, P. (1972). Cretaceous and Quaternary Radiolaria in deep sea sediments from the northeast Atlantic Ocean and Mediterranean Sea. *In* Ryan, W.B.F., Hsu, K.J. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **13** (2), 829-901.

Dumitrica, P. (1975). Cenomanian Radiolaria at Podul Dimbovitei. Micropaleontological guide to the Mesozoic and Tertiary of the Romanian Carpathians. *14th European Micropaleontological Colloquium, Romania* - Institute of Geology and Geophysics, Bucharest, 87-89.

Dumitrica, P. (1978). Family Eptingiidae n. fam., extinct Nassellaria (Radiolaria) with sagittal ring. *Dari de seama ale sedintelor, Institutul de Geologie si Geofizica, Bucuresti*, **64**, 27-38.

Dumitrica, P. & De Wever, P. (1991). Assignation to radiolaria of two Upper Jurassic species previously described as Foraminifera: systematic consequences. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **312**, 553-558.

Dumitrica, P., Kozur, H. & Mostler, H. (1980). Contribution to the radiolarian fauna of the Middle Triassic of the Southern Alps. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **10** (1), 1-46.

Dumitrica, P. & Mello, J. (1982). On the age of the Meliata Group and the Silica Nappe radiolarites (localities Drzkovce and Bohunovo, Slovak Karst, CSSR). *Geologicke prace,* **77**, 17-28.

Dunikowski, E. (1882). Die Spongien, Radiolarien und Foraminiferen der unterliassischen Schichten vom Schafberg bei Salzburg. *Denkschriften der Akademie der Wissenschaften. Wien, Mathematisch-Naturwissenschaftlichen Classe*, **45**, 163-194.

Ehrenberg, C.G. (1847a). Uber eine halibiolithische, von Herrn R. Schomburgk entdeckte, vorherrschend aus mikroskopischen Polycystinen gebildete, Gebirgsmasse von Barbados. *Bericht der konigliche preussichen Akademie der Wissenschaften zu Berlin*, 382-385.

Ehrenberg, C.G. (1847b). Uber die mikroskopischen kieselschaligen Polycystinen als mächtige Gebirgsmasse von Barbados und uber das Verhältniss deraus mehr als 300 neuen Arten bestehenden ganz eigenthumlichen Formengruppe jener Felsmasse zu den jetzt lebenden Thieren und zur Kreidebildung Eine neue Anregung zur Erforschung des Erdlebens. *Bericht der konigliche preussichen Akademie der Wissenschaften zu Berlin*, 40-60.

El Kadiri, K. (1984). *Les radiolarites Jurassiques des klippes de Chrafate (Rif Septentrional-Maroc): Stratigraphie, Taxonomie.* Thèse 3ème Cycle, Université de Pau (n°168). Unpublished, 459 p.

El Kadiri, K. (1992). Description de nouvelles espèces de radiolaires jurassiques de la Dorsale calcaire externe (Rif, Maroc). *Revista Española de Paleontología*, **Núm. Extra.**, 37-48.

Empson-Morin, K. (1981). Campanian Radiolaria from DSDP Site 313, Mid-Pacific Mountains. *Micropaleontology*, **27** (3), 249-292.

Empson-Morin, K. (1982). Reexamination of the late Cretaceous radiolarian genus *Amphipyndax* FOREMAN. *Journal of Paleontology*, **56** (2), 507-519.

Fischli, H. (1916). Beitrag zur Kenntnis der fossilen Radiolarien in der Riginagelfluh. *Mitteilungen der Naturwissenschaftlichen Gesellschaft in Winterthur, Jahrgang 1915-1916,* **11**, 44-47.

Foley, L.A., Korsch, R.J. & Orr, T.O.H. (1986). Radiolaria of Middle Jurassic to Early Cretaceous ages from the Torlesse Complex, eastern Tararua Range, New Zealand. *New Zealand Journal of Geology and Geophysics*, **29** (4), 481-490.

FOREMAN, H.P. (1966). Two Cretaceous radiolarian genera. *Micropaleontology*, **12** (3), 355-359.

FOREMAN, H.P. (1968). Upper Maestrichtian Radiolaria of California. *Special Papers in Palaeontology*, **3**, 1-82.

FOREMAN, H.P. (1971). Cretaceous Radiolaria, Leg 7, DSDP. *In* Winterer, E.L., Riedel, W.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **7**, 1673-1693.

FOREMAN, H.P. (1973a). Radiolaria of Leg 10 with systematics and ranges for the families Amphipyndacidae, Artostrobiidae and Theoperidae. *In* Worzel, J.L., Bryant, W. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **10**, 407-474.

FOREMAN, H.P. (1973b). Radiolaria from DSDP Leg 20. *In* Heezen, B.C., MacGregor, J.D. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **20**, 249-305.

FOREMAN, H.P. (1975). Radiolaria from the North Pacific, Deep Sea Drilling Project, Leg 32. *In* Larson, R.L., Moberly, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **32**, 579-676.

FOREMAN, H.P. (1978). Mesozoic Radiolaria in the Atlantic Ocean off the northwest coast of Africa, Deep Sea Drilling Project, Leg 41. *In* Lancelot, Y., Seibold, E. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **41**, 739-761.

FOREMAN, H.P. & RIEDEL, W.R. (1972). *Catalogue of Polycystine Radiolaria, Series 1 (1834-1900)*. (Meyen 1834-Bury 1862), Part 1 (Acanthodesmia- Haliomma) & Part 2 (Haliphormis-Gen. et sp. indet.), **1** - American Museum of Natural History, Special Publication, New York.

GORICAN, S. (1987). Jurassic and Cretaceous radiolarians from the Budva zone (Montenegro, Yugoslavia). *Revue de Micropaléontologie*, **30** (3), 177-196.

GORKA, H. (1989). Les Radiolaires du Campanien inférieur de Cracovie (Pologne). *Acta Palaeontologica Polonica*, **34** (4), 327-354.

GRILL, J. & KOZUR, H. (1986). The first evidence of the Unuma echinatus radiolarian zone in the Rudabanya Mts. (northern Hungary). *Geologisch Paläontlogische Mitteilungen Innsbruck*, **13** (11), 239-275.

HAECKEL, E. (1862). *Die Radiolarien (Rhizopoda Radiaria). Eine monographie* - Reimer, Berlin, 572 p.

HAECKEL, E. (1881). Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien (Basis for a radiolarian classification from the study of Radiolaria of the Challenger collection). *Jenaische Zeitschrift fur Naturwissenschaft*, **15**, 418-472.

HAECKEL, E. (1887). Report on the Radiolaria collected by H.M.S. Challenger during the years 1873-1876. *Report on the Scientific Results of the Voyage of the H.M.S. Challenger, Zoology*, **18**, clxxxviii + 1803.

HATTORI, I. (1987). Jurassic radiolarian fossils from the Nanjo Massif, Fukui Prefecture, Central Japan. *Bulletin of the Fukui Municipal Museum of Natural History*, **34**, 29-101.

HATTORI, I. (1988a). Radiolarian fossils from manganese nodules at the upper reach of the Turamigawa in the Nanjo Massif, Fukui Prefecture, central Japan, and the tectonic significance of the northwestern Mino Terrane. *Bulletin of the Fukui Municipal Museum of Natural History*, **55**, 55-101.

HATTORI, I. (1988b). Surface texture of radiolarians and extraction method of radiolarians. *Memoirs of the Faculty of Education, Fukui University*, **38** (3), 71-89. (*in Japanese*)

HATTORI, I. (1989). Jurassic radiolarians from manganese nodules at three sites in the western Nanjo Massif, Fukui Prefecture, Central Japan. *Memoirs of the Faculty of Education, Fukui University*, **2** (29), 47-134. (*in Japanese*)

HATTORI, I. & SAKAMOTO, N. (1989). Geology and Jurassic Radiolarians from manganese nodules of the Kanmuriyama-Kanakusadake Area in the Nanjo Massif, Fukui Prefecture, Central Japan. *Bulletin of the Fukui Municipal Museum of Natural History*, **36**, 25-79. (*in Japanese*)

HATTORI, I. & YOSHIMURA, M. (1982). Lithofacies distribution and radiolarian fossils in the Nanjo area in Fukui Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 103-116.

HATTORI, I. & YOSHIMURA, M. (1983). Late Triassic to Middle Jurassic ages for greenstones within the Mesozoic Nanjo Massif of the Mino terrane, central Japan. *Memoirs of the Faculty of Education, Fukui University, Series 2*, **32**, 67-80.

HEITZER, I. (1930). Die Radiolarienfauna der mitteljurassischen Kieselmergel im Sonnwendgebirge. *Jahrbuch der Geologischen Bundesanstalt (Wien)*, **80**, 381-406.

HINDE, G.J. (1900). Description of fossil Radiolaria from the rocks of Central Borneo. *In* Molengraaff, G.A.F. Ed. *Borneo-Expeditie: Geologische verkenningstochten in Centraal Borneo (1893-94)* - Brill, E. J & Gerlings, D., Leiden/Amsterdam, 1-56.

HINDE, G.J. (1908). Radiolaria from the Triassic and other rocks of the Dutch East Indian Archipelago. *In* Verbeek, R.D.M. Ed. *Molukken-verslagen Geologische verkenningstochten in hetoostelijke gedeelte van den Nederlandsch Oost-Indischen Archipelago, Jaarboek van het mijnwezen in Nederlandsch Oost-Indie*. **37**, 694-736.

HOJNOS, R. (1916). Beitrage zur Kenntnis der ungarischen fossilen Radiolarien. *Földtany Közlöny*, **46**, 340-364.

HOLZER, H.L. (1980). Radiolaria aus Atzrückstanden des Malm und der Unterkreide der Nördlichen Kalkalpen (Osterreich). *Annalen des Naturhistorischen Museums in Wien*, **83**, 153-167.

HORI, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 562-586.

HORI, R. & OTSUKA, T. (1989). Early Jurassic radiolarians from the Mt. Norikuradake area, Mino Terrane, central Japan. *Journal of Geosciences, Osaka City University*, **32**, 175-198.

HORI, R. & YAO, A. (1988). *Parahsuum* (Radiolaria) from the Lower Jurassic of the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **31**, 47-61.

ICHIKAWA, K. & YAO, A. (1973). Scanning electron microscope studies of pores of some cyrtoid radiolarians. *Journal of Geosciences, Osaka City University*, **16**, 125-144.

ICHIKAWA, K. & YAO, A. (1976). Two new genera of Mesozoic cyrtoid radiolarians from Japan. *In* Takayanagi, Y. & Saito, T. Eds. *Progress in Micropaleontology, special Publication* - Micropaleontology Press, The American Museum of Natural History, New York, 110-117.

IGO, H., SASHIDA, K. & UENO, H. (1987). Early Cretaceous radiolarians from the Esashi Mountains, northern Hokkaido. *Annual Report of the Institute of Geosciences, the University of Tsukuba*, **13**, 105-109.

IMOTO, N., TAMAKI, A., TANABE, T. & ISHIGA, H. (1982). An age determination on the basis of radiolarian biostratigraphy of a bedded manganese deposit at the Yumiyama Mine in the Tamba District, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 227-235.

ISHIDA, K. (1983). Stratigraphy and radiolarian assemblages of the Triassic and Jurassic siliceous sedimentary rocks in Konose Valley, Tokushima Prefecture, Southwest Japan. *Journal of Science, University of Tokushima*, **16**, 111-141.

ISHIDA, K. (1985). Discovery of Permian radiolarians from the pelitic rocks in the Middle Zone of the Chichibu Belt in eastern part of Tokushima Prefecture, Shikoku. *Journal of the Geological Society of Japan*, **91** (2), 155-156.

ISHIDA, K. (1986). Geology and radiolarian ages of the Mesozoic formations in the South Zone of the Chichibu Belt in Eastern Shikoku. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 235-243.

ISOZAKI, Y. & MATSUDA, T. (1985). Early Jurassic radiolarians from bedded chert in Kamiaso, Mino Belt, central Japan. *Earth Science, Journal of the Association for the geological Collaboration in Japan*, **39** (6), 429-442.

IWASAKI, T., SASHIDA, K. & IGO, H. (1984). Discovery of Cretaceous radiolarians from the Chichibu Belt near the Mt. Ogura in Minamiaiki Village, Minamisku County, Nagano Prefecture, Central Japan. *Journal of the Geological Society of Japan*, **90** (5), 349-352. (*in Japanese*)

IWATA, K., HARIYA, Y., CHOI, J.H., YAGI, E. & MIURA, T. (1990). Radiolarian age of the manganese deposits of the tokoro belt, northeast Hokkaido. *Journal of the Faculty of Science, Hokkaido University, Series 4: Geology and Mineralogy*, **22** (4), 565-576.

IWATA, K. & KATO, Y. (1986). Upper Cretaceous radiolarians of the Yubetsu Group and the Hidaka Supergroup in the northern Hidaka Belt. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 75-86.

IWATA, K. & TAJIKA, J. (1989). Jurassic and Cretaceous radiolarians from the pre-Tertiary system in the Hidaka Belt, Maruseppu region, Northeast Hokkaido. *Journal of the Faculty of Science, Hokkaido University, Series 4: Geology and Mineralogy*, **22** (3), 453-466.

JUD, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

KANIE, Y., TAKETANI, Y., SAKAI, A. & MIYATA, Y. (1981). Lower Cretaceous deposits beneath the Yezo group in the Urakawa area, Hokkaido. *Journal of the Geological Society of Japan*, **87**, 527-533. (*in Japanese*)

KARRER, F. (1867). Über einige Foraminiferen aus dem weissen Jura von St. Veit bei Wien. *Sitzungsberichte der Keiserlichte Akademie der Wissenschaften in Wien, mathematisch-naturwissenschaftlichen Classe* **55** (1), 364-368.

KASHIMA, N. (1983). Geology of the aqueduct tunnel no. 6 at «the Chichibu Belt», western Shikoku. *Ehime Chigaku (Geology of Ehime)*, (Memorial volume of Professor Miyashida Michitoshi), 169-176.

KATO, Y. & IWATA, K. (1989). Radiolarian biostratigraphic study of the pre-Tertiary system around the Kamikawa Basin, central Hokkaido, Japan. *Journal of the Faculty of Science, Hokkaido University, Series 4: Geology and Mineralogy*, **22** (3), 425-452.

KAWABATA, K. (1988). New species of Latest Jurassic and Earliest Cretaceous radiolarians from the Sorachi Group in Hokkaido, Japan. *Bulletin of the Osaka Museum of natural History*, **43**, 1-13.

KEMKIN, I.V. & RUDENKO, V.S. (1993). New representants of the genus *Cinguloturris* (Radiolaria) in Mesozoic deposits of Sikhote-Alin. *Tikhookeanskaya Geologiya*, 110-121. (*in Russian*)

KIDO, S. (1982). Occurrence of Triassic chert and Jurassic siliceous shale at Kamiaso, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 135-151. (*in Japanese*)

KIDO, S., KAWAGUCHI, I., ADACHI, M. & MIZUTANI, S. (1982). On the *Dictyomitrella* (?) *kamoensis-Pantanellium foveatum* assemblage in the Mino area, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 195-210. (*in Japanese*)

KIESSLING, W. & ZEISS, A. (1991/92). New palaeontological data from the Hochstegen Marble (Tauern window, eastern Alps). *Geologisch Paläontlogische Mitteilungen Innsbruck*, **18**, 187-202.

KIESSLING, W. (1992). Paleontological and facial features of the Upper Jurassic Hochstegen Marble (Tauern Window, Eastern Alps). *Terra Nova*, **4** (2), 184-197.

KIMINAMI, K., KONTANI, Y. & MIYASHITA, S. (1985). Lower Cretaceous strata covering the abyssal tholeiite (the Hidaka Western Greenstone Belt) in the Chiroro area, central Hokkaido, Japan. *Journal of the Geological Society of Japan*, **91**, 27-42.

KISHIDA, Y. & HISADA, K. (1986). Radiolarian assemblages of the Sambosan Belt in the western part of the Kanto Mountains, central Japan. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 25-34.

KISHIDA, Y. & SUGANO, K. (1982). Radiolarian zonation of Triassic and Jurassic in outer side of southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 271-300. (*in Japanese*)

KITO, N. (1987). Stratigraphic relation between greenstones and clastic sedimentary rocks in the Kamuikotan Belt, Hokkaido, Japan. *Journal of the Geological Society of Japan*, **93** (1), 21-35. (*in Japanese*)

KITO, N. (1989). *Radiolaires du Jurassiques Moyen et Supérieur de Sicile (Italie): Biostratigraphie et Taxonomie*. Unpublished Ph.D. Thesis (n° 89-7). Université Pierre & Marie Curie, Paris, 239 p.

KITO, N. & DE WEVER, P. (1992). Nouvelles espèces d'Hagiastridae (radiolaires) du Jurassique Moyen de Sicile (Italie). *Revue de Micropaléontologie*, **35** (2), 127-141.

KITO, N. & DE WEVER, P. (1994). New species of Middle Jurassic Actinommidae (Radiolaria) from Sicily (Italy). *Revue de Micropaléontologie*, **37** (2), 123-134.

KITO, N., DE WEVER, P., DANELIAN, T. & CORDEY, F. (1990). Middle to Late Jurassic radiolarians from Sicily (Italy). *Marine Micropaleontology*, **15** (3-4), 329-349.

KLUZINGER, C.B. (1877). *Die Korallthierre des rothen Meeres*, **1**, Berlin.

KOCHER, R.N. (1981). Biochronostratigraphische Untersuchungen oberjurassischer radiolarien führender Gesteine, insbesondere der Südalpen. *Mitteilungen aus dem geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge*, **234**, 1-184.

KOJIMA, S. (1982). Some Jurassic, Triassic and Permian radiolarians from the eastern part of Takayama City, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 81-91.

KOJIMA, S. (1989). Mesozoic terrane accretion in Northeast China, Sikhote-Alin and Japan regions. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **69**, 213-232.

KOJIMA, S. & MIZUTANI, S. (1987). Triassic and Jurassic Radiolaria from the Nadanhada Range, Northeast China. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **148**, 256-275.

KOZUR, H. (1984). New radiolarian taxa from the Triassic and Jurassic. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **13** (2), 49-88.

KOZUR, H. (1985). The radiolarian genus *Eoxitus* n. gen. from the *Unuma echinatus* Zone (Bajocian) of northern Hungary. *Proceedings of the koninklijke nederlandse Akademie van Wetenschappen. Series B: Palaeontology, Geology, Physics, Chemistry, Anthropology*, **88** (2), 211-220.

KOZUR, H. (1991). The evolution of the Meliata-Hallstatt ocean and its significance for the early evolution of the Eastern Alps and Western Carpathians. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **87** (1-4), 109-135.

KOZUR, H. & MOSTLER, H. (1972). Beiträge zur Erforschung der mesozoischen Radiolarien. Teil I: Revision der Oberfamilie Coccodiscacea Haeckel 1862 emend. und Beschreibung ihrer triassischen Vertreter. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **2**, 60.

KOZUR, H. & MOSTLER, H. (1979). Beiträge zur Erforschung der mesozoischen Radiolarien. Teil III: Die Oberfamilien Actinommacea Haeckel 1862 emend., Artiscacea Haeckel 1882, Multiarcusellacea nov. der Spumellaria und triassische Nassellaria. *Geologisch Paläontlogische Mitteilungen Innsbruck*, **9** (1-2), 1-132.

KOZUR, H. & MOSTLER, H. (1983). The polyphyletic origin and the classification of the Mesozoic saturnalids (Radiolaria). *Geologisch Paläontlogische Mitteilungen Innsbruck*, **13** (1), 1-47.

KOZUR, H. & MOSTLER, H. (1989). Radiolarien und schwammskleren aus dem Unterperm des Vorurals.

Geologisch Paläontlogische Mitteilungen Innsbruck, **2**, 147-275.

Kurimoto, C. (1989). Microfossil from the Gozaishoyama district in the southwestern part of the Mino Terrane, cental Japan. *Bulletin of the Geological Survey of Japan*, **40** (2), 55-64. (*in Japanase*)

Li, H.S. (1986). Upper Jurassic (early Tithonian) radiolarians from southern Bangong Lake, Xizang. *Acta Micropalaeontologica Sinica*, **3** (3), 297-316. (*in Chinese*)

Li, H.S.. & Wu, H.R. (1985). Radiolaria from the Cretaceous Congdu Formation in southern Xizang (Tibet). *Acta Micropalaeontologica Sinica*, **2** (1), 61-76. (*in Chinese*)

Lozyniak, P.Y. (1969). The radiolarians of the Lower Cretaceous deposits of the Ukranian Carpathians. *In* Vialov, O.S. Ed. *Fossil and Recent Radiolarians: Materials of the Second All Union Seminar on Radiolaria* - Lvov University, Lvov, USSR, 29-41. *(in Russian)*

Marcucci, M., Conti, M. & Spadea, P. (1987). Radiolarian association in cherts from Timpa delle Murge (Lucanian Appennine, Italy). *Ofioliti*, **12** (2), 411-414.

Matsuda, T. & Isozaki, Y. (1982). Radiolarians around the Triassic-Jurassic boundary from the bedded chert in the Kamiaso Area, Southwest Japan. Appendix: «Anisian radiolarians». *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 93-101. (*in Japanese*)

Matsuoka, A. (1982a). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and the Niyodo areas, Kochi Prefecture, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 237-253. (*in Japanese*)

Matsuoka, A. (1982b). Jurassic two-segmented Nassellarians (Radiolaria) from Shikoku, Japan. *Journal of Geosciences, Osaka City University*, **25**, 71-86.

Matsuoka, A. (1983a). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and adjacent areas, Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **26** (1), 1-48. (*in Japanese*)

Matsuoka, A. (1983b). The conformable relationship between chert beds and clastic beds in the Triassic-Jurassic sequence of the southern subbelt of the Chichibu belt, Kochi prefecture. *Journal of the Geological Society of Japan*, **89**, 407-410. (*in Japanese*)

Matsuoka, A. (1984). Late Jurassic four-segmented nassellarians (Radiolaria) from Shikoku, Japan. *Journal of Geosciences, Osaka City University*, **27**, 143-153.

Matsuoka, A. (1985). Middle Jurassic Keta formation of the southern part of the Middle Chichibu Terrane in the Sakawa area, Kochi Prefecture, Southwest Japan. *Journal of the Geological Society of Japan*, **91** (6), 411-420. (*in Japanese*)

Matsuoka, A. (1986a). Faunal change of radiolarians around the Jurassic-Cretaceous boundary - with special reference to some multi-segmented nassellarians. *Fossils*, **40**, 1-15. (*in Japanese*)

Matsuoka, A. (1986b). Stratigraphic distribution of two species of *Tricolocapsa* in the Hisuikyo Section of the Kamiaso area, Mino Terrane. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 59-62.

Matsuoka, A. (1986c). *Tricolocapsa yaoi* Assemblage (Late Jurassic radiolarians) from the Togano Group in Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **29**, 101-115.

Matsuoka, A. (1988). First appearance biohorizon of *Tricolocapsa conexa* within Jurassic siliceous mudstone sequences of the Kamiaso area in the Mino Terrane, central Japan; a correlation of radiolarian zones of the Middle Jurassic. *Journal of the Geological Society of Japan*, **94** (8), 583-590.

Matsuoka, A. (1989). A key to connecting Jurassic terranes in Japan chert clastic sequence. *Structural Geology, Journal of the Tectonic Research Group of Japan*, **34**, 135-144.

Matsuoka, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

Matsuoka, A. & Oji, T. (1990). Middle Jurassic radiolaria fossils from the Magisawa Formation in the Taro Belt, North Kitakami Mountains. *Journal of the Geological Society of Japan*, **96** (3), 239-241. (*in Japanese*)

Matsuoka, A. & Yao, A. (1985). Latest Jurassic radiolarians from the Torinosu Group in Southeast Japan. *Journal of Geosciences, Osaka City University*, **28**, 125-145.

Matsuoka, A. & Yao, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

Matsuyama, H., Kumon, F. & Nakajo, K. (1982). Cretaceous radiolarian fossils from the Hidakagawa Group in the Shimanto Belt, Kii Peninsula, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 371-382. (*in Japanese*)

MIZUTANI, S. (1981). A Jurassic formation in the Hida-Kanayama Area, Central Japan. *Bulletin of the Mizunami Fossil Museum*, **8**, 147-190.

MIZUTANI, S., HATTORI, I., ADACHI, M., WAKITA, K., OKAMURA, Y., KIDO, S., KAWAGUCHI, I. & KOJIMA, S. (1981). Jurassic formations in the Mino Area, Central Japan. *Proceedings of the Japan Academy, series B*, **57**, 194-199.

MIZUTANI, S. & KIDO, S. (1983). Radiolarians in Middle Jurassic siliceous shale from Kamiaso, Gifu Prefecture, Central Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **132**, 253-262.

MIZUTANI, S. & KOIKE, T. (1982). Radiolarians in the Jurassic siliceous shale and the Triassic bedded chert of Unuma, Kagamigahara City, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 117-134. (*in Japanese*)

MIZUTANI, S., KOJIMA, S., SHAO, J.A. & ZHANG, Q.L. (1986). Mesozoic radiolarians from the Nadanhada area, Northwest China. *Proceedings of the Japan Academy, Series B: Physical and Biological Sciences*, **62** (9), 337-340.

MIZUTANI, S., NISHIYAMA, H. & ITO, T. (1982). Radiolarian biostratigraphic study of the Shimanto Group in the Nanto-Nansei area, Mie Prefecture, Kii Peninsula, central Japan. *Journal of Earth Sciences Nagoya University*, **30**, 31-107.

MIZUTANI, S., UEMURA, T. & YAMAMOTO, H. (1984). Jurassic radiolarians from the Tsugawa Area, Niigata Prefecture, Japan. *Earth Science, Journal of the Association for the Geological Collaboration in Japan*, **38** (5), 352-358.

MOORE, T.C. (1973). Radiolaria from Leg 17 of the Deep Sea Drilling Project. *In* Winterer, E.L., Ewing, J.I. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **17**, 797-869.

MURATA, M., OHISHI, A., NISHIZONO, Y., SATO, T. & TAKEHARA, T. (1982). Late Mesozoic radiolarian fauna from the Sakaguchi Formation. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 327-337.

MURCHEY, B. (1984). Biostratigraphy and lithostratigraphy of cherts in the Franciscan Complex, Marin Headlands, California. *In* Blake, M. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles, **43**, 51-70.

MUZAVOR, S.N.X. (1977). *Die oberjurassische Radiolarienfauna von Oberaudorf am Inn.*. Inaugural-Dissertation zur Erlangung des Doktorgrades des Fachbereiches Geowissenschaften der Ludwig-Maximilians-Universität zur München, 163 p.

NAGAI, H. (1985). Ray cross-section of middle Jurassic Hagiastridae and Patulibracchiidae (Radiolaria). *Bulletin of the Nagoya University, Furukawa Museum*, **1**, 1-13.

NAGAI, H. (1986). Jurassic *Eucyrtidiellum* (Radiolaria) from Central Japan. *Bulletin of the Nagoya University, Furukawa Museum*, **2**, 1-21.

NAGAI, H. (1987). Middle Jurassic *Eucyrtidiellum* (Radiolaria) from Kutsuwano, Gifu Prefecture, Central Japan. *Bulletin of the Nagoya University, Furukawa Museum*, **3**, 1-11.

NAGAI, H. (1988). Early Jurassic *Eucyrtidiellum* (Radiolaria) from Kamiaso, Gifu Prefecture, Central Japan. *Bulletin of the Nagoya University, Furukawa Museum*, **4**, 1-9.

NAGAI, H. & MIZUTANI, S. (1990). Jurassic *Eucyrtidiellum* (Radiolaria) in the Mino Terrane. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 587-602.

NAKAGAWA, C., NAKASEKO, K., KAWAGUCHI, K. & YOSHIMURA, R. (1980). Radiolarian fossils from the upper Jurassic and Cretaceous formations of the Shimanto belt in the eastern part of Shikoku - a study of the Shimanto belt in the eastern part of Shikoku (no. 4). *Journal of Gakugei Tokushima University. Natural Science and Mathematics*, **31**, 1-27.

NAKASEKO, K., MIZUTANI, S. & YAO, A. (1983). Radiolarian fossils and Mesozoic geology of the Japanese Islands. *Kagaku (Science)*, **53** (2), 177-183.

NAKASEKO, K. & NISHIMURA, A. (1981). Upper Jurassic and Cretaceous Radiolaria from the Shimanto Group in Southwest Japan. *Science Reports, College of General Education, Osaka University*, **30** (2), 133-203.

NAKASEKO, K., NISHIMURA, A. & SUGANO, K. (1979). Cretaceous Radiolaria in the Shimanto Belt, Japan. *News of Osaka Micropaleontologists, Special Volume*, **2**, 1-49.

NEVIANI, A. (1900). Supplemento alla fauna a Radiolari delle rocce mesozoiche del Bolognese. *Bollettino della Societa Geologica Italiana*, **19**, 645-671.

NISHIZONO, Y. & MURATA, M. (1983). Preliminary studies on the sedimentary facies and radiolarian biostratigraphy of Paleozoic and Mesozoic sediments, exposed along the mid-stream of the Kuma River, Kyushu, Japan. *Kumanto Journal of Science, Geology*, **12**, 1-40. (*in Japanese*)

NISHIZONO, Y., OHISHI, A., SATO, T. & MURATA, M. (1982). Radiolarian fauna from the Paleozoic and Mesozoic formations, distributed along the mid-stream of Kuma River, Kyushu, Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 311-326. (*in Japanese*)

OKADA, H., HATAKENAKA, A. & NAKASEKO, K. (1982). Age of the Sorachi Group in its type area in Hokkaido. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 353-357.

OKAMURA, M. (1980). Radiolarian fossils from the northern Shimanto Belt (Cretaceous) in Kochi Prefecture, Shikoku. *Geology and Paleontology of the Shimanto Belt*, 153-178.

OKAMURA, M. & MATSUGI, H. (1986). Cretaceous radiolarians from the time equivalent formations of the arc-trench system, Shikoku. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 117-129.

OKAMURA, M., NAKASEKO, K. & NAKANO, K. (1982). Radiolarians from the Kajisako Formation, Monobe area, Shikoku. Multidisciplinary Research of the Upper Cretaceous Monobe Area - *Paleontological Society of Japan, Special Papers.* **25**, 93-102.

OKAMURA, M. & UTO, H. (1982). Notes on stratigraphic distributions of radiolarians from the Lower Cretaceous sequence of chert in the Yokonami Melange of Shimanto Belt, Kochi Prefecture, Shikoku. *Research Report of the Kochi University, Natural Sciences*, **31**, 87-94.

ORIGLIA-DEVOS, I. (1983). *Radiolaires du Jurassique supérieur-Crétacé inferieur: Taxonomie et révision stratigraphique (zone du Pinde-Olonos, Grèce, zone de Sciacca, Italie, Complexe de Nicoya, Costa Rica et forages du DSDP.* Unpublished Thèse de 3ième cycle, Université Pierre et Marie Curie, Paris. 328 p.

OWADA, K. & SAKA, Y. (1982). Preliminary note on the Paleozoic and the Mesozoic formations in the Chichibu Belt, Okutama District, Kwanto Mountains, Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 67-80.

OZVOLDOVA, L. (1975). Upper Jurassic radiolarians from the Kisuca Series in the Klippen Belt. *Západné Karpaty, Séria Paleontológia*, **1**, 73-86.

OZVOLDOVA, L. (1979). Radiolarian assemblage of radiolarian cherts of Podbiel locality (Slovakia). *Casopis pro Mineralogii a Geologii*, **24** (3), 249-261.

OZVOLDOVA, L. (1987). Investigations of Mesozoic Radiolarians from West Carpathians, Brief review. *Miscellanea Micropaleontologica*, **2** (1), 191-202. (*in Czech*)

OZVOLDOVA, L. (1988). Radiolarian associations from radiolarites of the Kysuca succession of the Klippen Belt in the Vicinity of Myjava - Turá Lúka (West Carpathians). *Geologicky Sborník (Bratislava)*, **39** (3), 369-392.

OZVOLDOVA, L. (1990). Occurrence of Albian radiolaria in the underlier of the Vienna Basin. *Geologicky Sborník (Bratislava)*, **41** (2), 137-154.

OZVOLDOVA, L. (1992). The discovery of a Callovian radiolarian association in the Upper Posidonia Beds of the Pieniny succession of the Klippen Belt (Western Carpathians). *Geologica Carpathica*, **43** (2), 111-122.

OZVOLDOVA, L. & PETERCAKOVA, M. (1987). Biostratigraphic research of upper Jurassic limestones of the Cachtice Carpathians (locality Bzince pod Javorinou). *Západné Karpaty, Séria Paleontológia*, **12**, 115-124.

OZVOLDOVA, L. & PETERCAKOVA, M. (1992). Hauterivian radiolarian association from the Luckovska Formation, Manin Unit (Mt. Butkov, western Carpathians). *Geologica Carpathica*, **43** (5), 313-324.

OZVOLDOVA, L. & SYKORA, M. (1984). The radiolarian assemblage from Cachticke Karpaty Mts. limestones (the locality Sipkovsky Haj). *Geologicky Sborník (Bratislava)*, **35** (2), 259-290.

PANTANELLI, D. (1880). I diaspri della Toscana e i loro fossili. *Atti della reale Accademia nazionale dei Lincei, Memorie della Classe di Scienze fisiche, matematiche e naturali*, **8**, 35-66.

PARONA, C.F. (1890). Radiolarie nei noduli selciosi del calcare giurese di Cittiglio presso Laverno (Radiolarians from siliceous nodules of the Jurassic limestones of Cittiglio near Laverno). *Bollettino della Societa Geologica Italiana*, **9**, 132-175.

PAVSIC, J. & GORICAN, S. (1987). Lower Cretaceous Nannoplankton and Radiolaria from Vrsnik (western Slovenia). *Razprave IV, Razreda Sazu*, **26** (2), 15-36.

PESSAGNO, E.A. (1963). Upper Cretaceous Radiolaria from Puerto Rico. *Micropaleontology*, **9** (2), 197-214.

PESSAGNO, E.A. (1969). Mesozoic planktonic Foraminifera and Radiolaria. *In* Ewing, M.W., Worzel, J.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **1**, 607-621.

PESSAGNO, E.A. (1971a). Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg 1) and the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology*, **60** (264), 5-83.

PESSAGNO, E.A. (1971b). A new radiolarian from the Upper Cretaceous of the California Coast Ranges. *Micropaleontology*, **17** (3), 361-364.

PESSAGNO, E.A. (1972). Cretaceous Radiolaria. Part I: The Phaseliformidae, new family, and other Spongodiscacea from the Upper Cretaceous portion of the Great Valley Sequence, part II; Pseudoaulophacidae Riedel from the Cretaceous of California and the Blake-Bahama Basin (JOIDES leg 1). *Bulletins of American Paleontology*, **61** (270), 269-328.

PESSAGNO, E.A. (1973). Upper Cretaceous Spumellariina from the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology*, **63** (276), 49-102.

PESSAGNO, E.A. (1975). Upper Cretaceous Radiolaria from DSDP Site 275. *In* Kennett, J., Houtz, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **29**, 1011-1029.

PESSAGNO, E.A. (1976). Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley Sequence, California Coast Ranges. *Micropaleontology Special Publication*, **2**, 1-95.

PESSAGNO, E.A. (1977a). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. (1977b). Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. *Contribution Cushman Foundation for Foraminiferal Research, Special Publication*, **15**, 1-87.

PESSAGNO, E.A. & BLOME, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26** (3), 225-273.

PESSAGNO, E.A. & BLOME, C. (1982). Bizarre Nassellariina (Radiolaria) from the Middle and Upper Jurassic of North America. *Micropaleontology*, **28** (3), 289-318.

PESSAGNO, E.A., BLOME, C. & LONGORIA, J. (1984). A revised radiolarian zonation from Upper Jurassic of western North America. *Bulletins of American Paleontology*, **87** (320), 1-51.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

PESSAGNO, E.A., FINCH, W. & ABBOTT, P.L. (1979). Upper Triassic Radiolaria from the San Hipolito Formation, Baja California. *Micropaleontology*, **25** (2), 160-197.

PESSAGNO, E.A., LONGORIA, J., MACLEOD, N. & SIX, W. (1987). Studies of North American Jurassic Radiolaria; Part I, Upper Jurassic (Kimmeridgian-upper Tithonian) Pantanelliidae from the Taman Formation, east-central Mexico; tectonostratigraphic, chronostratigraphic, and phylogenetic implications. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-51.

PESSAGNO, E.A. & POISSON, A. (1979). Lower Jurassic Radiolaria from the Gumuslu Allochton of southwest Turkey (Taurides Occidentales). *Bulletin of the Mineral Research and Exploration Institute of Turkey*, **92**, 47-69.

PESSAGNO, E.A., SIX, W.M. & YANG, Q. (1989). The Xiphostylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. *Micropaleontology*, **35** (3), 193-255.

PESSAGNO, E.A. & WHALEN, P. (1982). Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, **28** (2), 111-169.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

PETRUSHEVSKAYA, M.G. (1981). Nassellarian radiolarians from the world oceans. *In Description of the Fauna of the USSR*. Publications of the Zoological Institute, Academy of Sciences of the USSR - Nauka, Leningradskoe Otdelenie, Leningrad, USSR, **128**, 405 p. *(in Russian)*

POLUZZI, A., PADOVANI, M. & ZAMPI, M. (1983). Early Cretaceous Radiolaria from the Montagna dei Fiori Section (Marche region, central Italy). *Giornale di Geologia*, **45** (1), 33-56.

PRINCIPI, P. (1909). Contributo allo studio dei Radiolari Miocenici Italiani. *Bollettino della Società Geologica Italiana*, **28**, 1-22.

RENZ, G.W. (1974). Radiolaria from Leg 27 of the Deep Sea Drilling Project. *In* Veevers, J.J., Heirtzler, J.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **27**, 769-841.

RIEDEL, W.R. & SANFILIPPO, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **26**, 771-814.

RIEDEL, W.R. & SCHLOCKER, J. (1956). Radiolaria from the Franciscan Group, Belmont, California. *Micropaleontology*, **2** (4), 357-360.

RIEGRAF, W. (1986). Callovian (Middle Jurassic) Radiolaria and sponge spicules from southwest Germany. *Stuttgarter Beiträge zur Naturkunde. Serie B: Geologie und Paläontologie*, **5** (123), 31.

RÜST, D. (1885). Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura. *Palaeontographica*, **31**, 269-321.

RÜST, D. (1888). Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen der Kreide. *Palaeontographica*, **34**, 181-213.

RÜST, D. (1898). Neue Beiträge zur Kenntniss der Fossilen Radiolarien aus Gesteinen des Jura und der Kreide. *Palaeontographica*, **45**, 1-67.

SAITO, M. (1989). Jurassic melanges in the Taniguni area, Gifu Prefecture, Mino terrane. *Journal of the Geological Society of Japan*, **95** (8), 579-594. (*in Japanese*)

SAKA, Y. (1983). Preliminary note on the Jurassic strata in the Chichibu terrane,western Shima Peninsula, southwest Japan. *Gakujutsu Kenkyu, School of Education, Waseda University*, **32**, 29-34.

SANFILIPPO, A. & RIEDEL, W.R. (1985). Cretaceous Radiolaria. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne/Sidney, 573-630.

SASHIDA, K. (1988). Lower Jurassic multisegmented Nassellaria from the Itsukaichi area, western part of Tokyo Prefecture, central Japan. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences*, **9**, 1-27.

SASHIDA, K., IGO, H., IGO, H., TAKIZAWA, S., HISADA, K., SHIBATA, T., TSUKADA, K. & NISHIMURA, H. (1982). On the Jurassic radiolarian assemblages in the Kanto district. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 51-66.

SATO, T., MURATA, M. & YOSHIDA, H. (1986). Triassic to Jurassic radiolarian biostratigraphy in the southern part of Chichibu terrain of Kyushu, Japan. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 9-23. (*in Japanese*)

SATO, T., NISHIZONO, Y. & MURATA, M. (1982). Paleozoic and Mesozoic radiolarian faunas from the Shakumasan Formation. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 301-310. (*in Japanese*)

SCHAAF, A. (1981). Late Early Cretaceous Radiolaria from Deep Sea Drilling Project Leg 62. *In* Thiede, J., Vallier, T.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **62**, 419-470.

SCHAAF, A. (1984). Les radiolaires du Crétacé inférieur et moyen: biologie et systématique. *Science Géologiques (Strasbourg) Mémoire*, **75**, 1-189.

SCHAAF, A. (1985). Un nouveau canevas biochronologique du Crétacé inférieur et moyen: les biozones à radiolaires. *Sciences géologique (Strasbourg) Bulletin*, **38** (3), 227-269.

SCHAAF, A., POLINO, R. & LAGABRIELLE, Y. (1985). Nouvelle découverte de Radiolaires d'âge Oxfordien supérieur-Kimmeridgien inférieur, à la base d'une série supra-ophiolitique des Schistes Lustrés piémontais (Massif de Traversiera, Haut val Maira, Italie). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **301** (14), 1079-1084.

SCHMIDT-EFFING, R. (1980). Radiolarien der Mittel-Kreide aus dem Santa Elena-Massiv von Costa Rica. *Neue Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **160** (2), 241-257.

SQUINABOL, S. (1903). Le Radiolarie dei noduli selciosi nella Scaglia degli Euganei. Contribuzione I. *Rivista Italiana di Paleontologia*, **9**, 105-151.

SQUINABOL, S. (1904). Radiolarie cretacee degli Euganei. *Atti e Memorie della reale Accademia di Scienze, Lettere ed Arti in Padova, Nuova Serie*, **20**, 171-244.

SQUINABOL, S. (1914). Contributo alla conoscenza dei Radiolarii fossili del Veneto. Appendice - Di un genera di Radiolari caratteristico del Secondario. *Memorie dell'Istituto Geologico della Reale Universita di Padova*, **2**, 249-306.

STEIGER, T. (1981). Kalkturbidite im Oberjura der Nördlichen Kalkalpen (Barmsteinkalke, Salzburg, Osterreich). *Facies*, **4**, 215-348.

STEIGER, T. (1992). Systematik, stratigraphie und Palökologie der Radiolarien des Oberjura-Unterkreiden-Grenzbereiches im Osterhorn-Tirolikum (Nördliche Kalkalpen, Salzburg und Bayern). *Zitteliana*, **19**, 3-188.

STOLL, N.R., DOLLFUS, R.P., FOREST, J., RILEY, N.D., SABROSKY, C.W., WRIGHT, C.W. & MELVILLE, R.V. (1964). *International Code of Zoological Nomenclature* - By the International Trust for Zoological Nomenclature, (2nd. edition), London, 176 p.

SUNOUCHI, H., SUGANO, K. & OGAWA, Y. (1982). Occurrence of Jurassic radiolarian from siliceous claystone in the northern belt of the Chichibu terrane, north of Ino town, Kochi prefecture and its significance. *Journal of the Geological Society of Japan*, **88** (12), 975-978. (*in Japanese*)

SUYARI, K. (1986a). Restudy of the Northern Shimanto Subbelt in eastern Shikoku. *Journal of Science, University of Tokushima*, **19**, 45-54.

SUYARI, K. (1986b). Radiolarian assemblages from the Torinosu Group and the cherts of the North Subbelt of the Shimanto Belt. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 245-254. (*in Japanese*)

SUYARI, K. & HASHIMOTO, H. (1985). A radiolarian assemblage from the Izumi Group of Eastern Shikoku. *Journal of Science, University of Tokushima*, **18**, 103-127.

SUYARI, K. & ISHIDA, K. (1985). Radiolarian age of the Torinosu Group, Shikoku, Japan. *Journal of Science, University of Tokushima*, **18**, 83-101. (*in Japanese*)

SUYARI, K. & KUWANO, Y. (1986). Radiolarian age of the Torinosu group, Shikoku, Japan, Part 2. *Journal of Science, University of Tokushima*, **19**, 37-43. (*in Japanese*)

TAJIKA, J. & IWATA, K. (1983). Ocurrence of Cretaceous radiolarians from the Hidaka Supergroup around Maruseppu, northeast Hokkaido. *Journal of the Geological Society of Japan*, **89** (3), 535-538. (*in Japanese*)

TAKAHASHI, K. (1984). Radiolaria: sinking population, standing stock, and production rate. *Marine Micropaleontology*, **8** (3), 171-181.

TAKEMURA, A. (1986). Classification of Jurassic Nassellarians (Radiolaria). *Palaeontographica. Abteilung A: Paläozoologie-Stratigraphie*, **195** (1-3), 29-74.

TAKEMURA, A. & NAKASEKO, K. (1982a). Jurassic Palaeoscenidiids from manganese ore deposits in the Mino Belt and their significance on evolution and classification of Nassellaria. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 173-182.

TAKEMURA, A. & NAKASEKO, K. (1982b). Two new Jurassic genera of family Palaeoscenidiidae (Radiolaria). *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **128**, 452-464.

TAKEMURA, A. & NAKASEKO, K. (1986). The cephalic skeletal structure of Jurassic «*Eucyrtidium*» (Radiolaria). *Journal of Paleontology*, **60** (5), 1016-1024.

TAKETANI, Y. (1982a). Cretaceous radiolarian biostratigraphy of the Urakawa and Obira areas, Hokkaido. *Science Reports of the Tohoku University*, **52** (1-2), 1-75.

TAKETANI, Y. (1982b). Cretaceous Radiolaria from Hokkaido. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 361-369.

TAKETANI, Y. & KANIE, Y. (1992). Radiolarian age of the Lower Yezo Group and the upper part of the Sorachi Group in Hokkaido. *In* Ishizaki, K. & Saito, T. Eds. *Centenary of Japanese Micropaleontology* - Terra Scientific Publishing Company, Tokyo, Japan, 365-373.

TAN, S.H. (1927). Over de samenstelling en het onstaan van krijt- en mergel-gesteenten van de Molukken. *Jaarboek van het mijnwezen in Nederlandsch Oost-Indie, jaargang 55, 1926, verhandelingen, 3rd gedeelte*, 5-165.

TANAKA, H., FUJITA, H., MIYAMOTO, T. & HASE, A. (1985). Late Jurassic radiolarian fossils from the Shinkai Formation developed to the south of Mt. Haidate, Oita Prefecture, Kyushu. *Journal of the Geological Society of Japan*, **91** (8), 569-571. (*in Japanese*)

TERAOKA, Y. & KURIMOTO, C. (1986). Cretaceous stratigraphy of the Shimanto Terrane in the Uwajima area, West Shikoku, Southwest Japan, with reference to the stratigraphic distribution of mega- and radiolarian fossils. *Bulletin of the Geological Survey of Japan*, **37**, (8), 417-453. (*in Japanese*)

THUROW, J. (1987). *Die kretazischen Turbiditserien im Gibraltarbogen: Bindeglied zwischen atlantischer und tethyaler Entwickung*. Unpublished Ph. Dissertation, Universität Tübingen. 500 p.

THUROW, J. (1988). Cretaceous radiolarians of the North Atlantic Ocean: ODP Leg 103 (Sites 638, 640 and 641) and DSDP Legs 93 (Site 603) and 47B (Site 398). *In* Boillot, G., Winterer, E.L. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program), **103**, 379-418.

TIPPER, H.W., SMITH, P.L., CAMERON, B.E.B., CARTER, E.S., JAKOBS, G.K. & JOHNS, M.J. (1991). Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. *In* Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia - *Geological Survey of Canada, Paper,* **90-10**, 203-235.

TONIELLI, R. (1991). Associazioni a radiolari dei «Calcari e Marne a Posidonia» del Monte Terminilletto (RI). *Paleopelagos*, **1**, 18-37.

TUMANDA, F. (1989). Cretaceous radiolarian biostratigraphy in the Eashi Mountain area, Northern Hokkaido, Japan. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences*, **10**, 1-44.

VELLEDITS, F., HIVES, T. & BARSONY, E. (1986). A Jurassic-Lower Cretaceous Profile in Obanya Valley (Mecsek Mts., Hungary). *Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominate. Sectio Geologica*, **26**, 159-175.

VINASSA DE REGNY, P.E. (1899). I radiolari delle ftaniti titoniane di Carpena (Spezia). *Paleontographia Italica*, **4**, 217-238.

VINASSA DE REGNY, P.E. (1901). Radiolari Cretacei dell'Isola di Karpathos. *Memorie della reale Accademia delle Scienze dell'Istituto di Bologna*, **9**, 497-512.

VISHNEVSKAYA, V. (1993). Jurassic and Cretaceous radiolarian biostratigraphy in Russia. *In* Blueford, J.R. & Murchey, B.L. Eds. *Micropaleontology, special Publication*, Radiolaria of giant and subgiant fields in Asia. Nazarov Memorial Volume - Micropaleontology Press, American Museum of Natural History, New York, **6**, 175-200.

VISHNEVSKAYA, V.S. (1984). *Radiolarites as analogues of contemporary oozes* - Nauka, Moscow, USSR, 118 p. (*in Russian*)

VISHNEVSKAYA, V.S. (1988). On the possibility of subdividing the USSR siliceous volcanic formations surrounding the northwest Pacific. *In* Puscharovskii, Y.M. Ed. *Reports on the geology of the Kamchatka and the Koryak Plateau* - Nauka, Moscow, USSR, 8-15. *(in Russian)*

VISHNEVSKAYA, V.S., CHEJOVICH, V. & DE ALBEAR, J. (1982). Edad y condiciones de formación de las silicitas de la zona de Camajuani (Cuba). *Comunicaciones breves, Ciencias de la Tierra y del Espacio*, **5**, 113-117.

VISHNEVSKAYA, V.S. & CHEKHOVICH, V. (1985). A new assemblage of Mesozoic radiolarians in Cuba. *Problems of Micropaleontology*, **27**, 201-203. (*in Russian*)

WAKITA, K. (1982). Jurassic radiolarians from Kuzuryo-ko-Gujo-hachiman area. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 153-171. (*in Japanese*)

WAKITA, K. (1987). The occurrence of Latest Jurassic-Earliest Cretaceous radiolarians at the Hida-Kanayama area in the Mino Terrane, central Japan. *Journal of the Geological Society of Japan*, **93** (6), 441-443. (*in Japanese*)

WAKITA, K. (1988). Early Çretaceous melange in the Hida-Kanayama area, central Japan. *Bulletin of the geological Survey of Japan*, **39** (6), 367-421.

WAKITA, K. & OKAMURA, Y. (1982). Mesozoic sedimentary rocks containing allochthonous blocks, Gujo-hachiman, Gifu Prefecture, central Japan. *Bulletin of the Geological Survey of Japan*, **33** (4), 161-185. (*in Japanese*)

WIDZ, D. (1991). Les Radiolaires du Jurassique supérieur des radiolarites de la zone des Klippes de Pieniny (Carpathes occidentales, Pologne). *Revue de Micropaléontologie*, **34** (3), 231-260.

WIDZ, D. & DE WEVER, P. (1993). Nouveaux Nassellaires (Radiolaria) des radiolarites jurassiques de la coupe de Szeligowy Potok (Zones de Klippes de Pieniny, Carpathes Occidentales, Pologne). *Revue de Micropaléontologie*, **36** (1), 77-91.

WISNIOWSKI, T. (1888). Beitrag zur Kenntniss der Mikrofauna aus den oberjurassischen Feuersteinknollen der Umgegend von Krakau. *Jahrbuch der Kaiserlich-Koniglichen Geologischen Reichsanstalt*, **38** (4), 657-702.

WU, H. (1986). Some new genera and species of Cenomanian Radiolaria from southern Xizang (Tibet). *Acta Micropalaeontologica Sinica*, **3** (4), 347-360.

WU, H. & LI, H. (1982). The Radiolaria of the olistostrome of Zongzhuo Formation, Gyangze, South Xizang, Tibet. *Acta Palaeontologica Sinica*, **21** (1), 64-71.

YAMAGATA, T. (1989). Mesozoic chaotic formations of Mino Terrane, northwestern Mino Mountains, central Japan. *Journal of the Geological Society of Japan*, **95** (6), 447-461.

YAMAMOTO, H. (1983). Occurrence of late Jurassic radiolarians of the Mirifusus baileyi assemblage from Neo village, Gifu prefecture, central Japan. *Journal of the Geological Society of Japan*, **89**, 595-596. (*in Japanese*)

YAMAMOTO, H., MIZUTANI, S. & KAGAMI, H. (1985). Middle Jurassic radiolarians from Blake Bahama Basin, West Atlantic Ocean. *Bulletin of the Nagoya University, Furukawa Museum*, **1**, 25-49.

YAMAUCHI, M. (1982). Upper Cretaceous radiolarians from Northern Shimanto Belt along the course of Shimanto River, Kochi Prefecture, Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 383-397.

YANG, Q. & WANG, Y.J. (1990). A taxonomic study of Upper Jurassic radiolarian from Rutog county, Xizang (Tibet). *Acta micropalaeontologica sinica*, **7** (3), 195-218.

YAO, A. (1972). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part I: Spongosaturnalids. *Journal of Geosciences, Osaka City University*, **15**, 21-65.

YAO, A. (1979). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part II: Nassellaria I. *Journal of Geosciences, Osaka City University*, **22**, 21-72.

YAO, A. (1982). Middle Triassic to Early Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53-70.

YAO, A. (1983). Late Paleozoic and Mesozoic radiolarians from southwest Japan. *In* Iijima, A., Hein, J.R. & Siever, R. Eds. *Developments in Sedimentology*, Siliceous Deposits in the Pacific Region - Elsevier, Amsterdam, The Netherlands, **36**, 361-375.

YAO, A. (1984). Subdivision of the Mesozoic complex in Kii-Yura area, southwest Japan and its bearing on the Mesozoic basin development in the southern Chichibu terrane. *Journal of Geosciences, Osaka City University*, **27**, 41-103.

YAO, A. (1991). Prospects in biochronology: A comment from the viewpoint of Mesozoic radiolarian chronology. In Problems and prospects of paleontology in 21st century; reports on 1991 annual meeting of the Paleontological Society of Japan - *Fossils*, **50**, 8-9. *(in Japanese)*

YAO, A., MATSUDA, T. & ISOZAKI, Y. (1980). Triassic and Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **23**, 135-154.

YAO, A., MATSUOKA, A. & NAKATANI, T. (1982). Triassic and Jurassic radiolarian assemblages in southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, Osaka, **5**, 27-43. (*in Japanese*)

YASUDA, M. (1989). Equivalents to the Torinosu Group of the Chichibu Belt in the southeastern part of the Kanto Mountans, central Japan; lithology and radiolarian biostratigraphy. *Journal of the Geological Society of Japan*, **95** (6), 463-478. (*in Japanese*)

YEH, K. (1987a). Taxonomic studies of lower Jurassic Radiolaria from east-central Oregon. *National Museum of Natural Science, Special Publication*, **2**, 1-169.

YEH, K. (1987b). A revised classification for the family Canoptidae (Radiolaria). *Memoirs of the Geological Society of China*, **8**, 63-72.

YOKOTA, S. & SANO, H. (1986). Radiolarian fossils from the Middle Jurassic Ammonites-bearing formation of Bisho, Yatsushiro district, Kumamoto Prefecture. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, Osaka, **7**, 53-58.

ZHAMOIDA, A.I. (1968). Subclass Radiolaria. *New species of ancient plants and invertebrates from the USSR* - VSEGEI, Moscow, USSR, 162-177. *(in Russian)*

ZITTEL, K.A. (1876). Ueber einige fossile Radiolarien aus der norddeutschen Kreiden. *Zeitschrift der deutschen geologischen Gesellschaft*, **28**, 75-87.

Alphabetic listing of all genera, species and subspecies

3

Biostratigraphy of radiolarian bearing sections and regional radiolarian biochronology

5. Towards a Mesozoic radiolarian database - Updates of work 1984 - 1990

by Peter O. Baumgartner

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

ABSTRACT

The Zonation presented by Baumgartner (1984a,b) had a limitation to 110 species, because the program used for its calculation (Guex & Davaud 1982) was limited to 110 species. The BioGraph program (Savary & Guex, 1991) allows to run "SAMPLE" files in which the number of species can be up to 500 and the number of sections is unlimited. Sample files keep the faunal information of each sample and do not generalise local ranges as do the DATUM files presented in Baumgartner (1984b).The prime data collected from the majority of sections discussed in Baumgartner (1984) included already 300 morphotypes. This database was the basis for an update of a large number of sections.This chapter comments on the update of those sections of the 1984 database, that are not discussed in other chapters. The procedures of updating are discussed and comments are made for all sections of the 1984 database. Radiolarian data by El Kadiri (1992) was included with this data base to determine the age of two samples from the Rif (Morocco).

1. Introduction

In the last 10 years a great amount of new data on Jurassic-Lower Cretaceous radiolarians was collected. Many of the sections that were discussed in the papers by Baumgartner (1984b, 1987, 1990) have been entirely restudied and are presented in other biostratigraphic chapters of this book. This chapter is dedicated to an update of those sections of the 1984 database that are not discussed in other chapters.

The zonation presented by Baumgartner (1984a,b) included only 110 species, because the program used for its calculation (Guex & Davaud 1982) was limited to 110 species. Consequently, only 110 species were listed in the 1984 database with "data"-codes 1-110, and described in the systematic part of that paper. However, the prime data collected from the majority of sections in the years 1981-1984 included already 300 morphotypes (Codes "pob" 1-300), which were defined for internal use by a set of illustrations. When the INTERRAD Jurassic-Cretaceous Working Group ("Working Group") started its work in 1989, this database, consisting of illustrations with codes and sample lists with corresponding codes was used as a basis for updating a large number of sections.

Meanwhile, many species were described by a number of authors and those not yet described were going to be introduced in the catalogue presented in this book. Initially, all pob-codes of taxa first appearing in the Jurassic were converted into MRD-codes by adding 3000, eg. pob 113 became MRD 3113. Species that had their first appearance in the Lower Cretaceous were converted by adding 5000, e.g. pob 229 became MRD 5229. All samples of the 1984 database were converted in this way to form an initial database.

During the years of activity of the Working Group, many of these initial taxa became split and others merged, and still others were discarded. As a consequence, new codes were created and we had to revise the entire data to eliminate erroneous codes. The example of the species *Tetratrabs zealis* and *T. izeensis* may illustrate the procedure: *T. izeensis* is an older form, characterized by shorter rays but otherwise close to the slender forms of *T. zealis*. In 1984 *T. izeensis* was not yet described and both species were coded together as "pob 121", which became "MRD 3121". When we introduced *T. izeensis* (MRD 3302) we had to reexamine all critical samples, by going back to the residues and SEM images to know if MRD 3121 was correct, or had to be replaced by MRD 3302, or if the two species were found together. There were many cases like this, that made the revision of many residues necessary. Where we had no access to the actual residue, the doubtful species codes were simply erased. This resulted in impoverished data sets for some of the sections taken from Baumgartner *et al.* (1980) and Kocher (1981). As a consequence, these sections have not been used for the construction of the new zonation (indicated by * in front of the section name), but have been compared to it by running the sections with the numerical ranges of the UAZones95 range chart (for procedures see *Chapter* 32).

In the following, we list all sections treated in Baumgartner (1984b) which will be mentioned in the original numerical order. Reference will be made to other chapters that describe the same section or the same locality. Composite sections will be discussed following the original sections. The zonal and age assignments that resulted from the new zonation is often apparently less precise than the assignments made in 1984, because of the relatively poorer quality of the data as compared to entirely revised data, and because of longer ranges of some species in the present zonation. However, the assignments are certainly more conservative, in the sense that the given age range covers the actual age of the samples with certainty.

Comments on the sections 1 to 51 of Baumgartner 1984b

Notation

The numbers in front of each paragraph correspond to the section numbers of Baumgartner (1984b). These

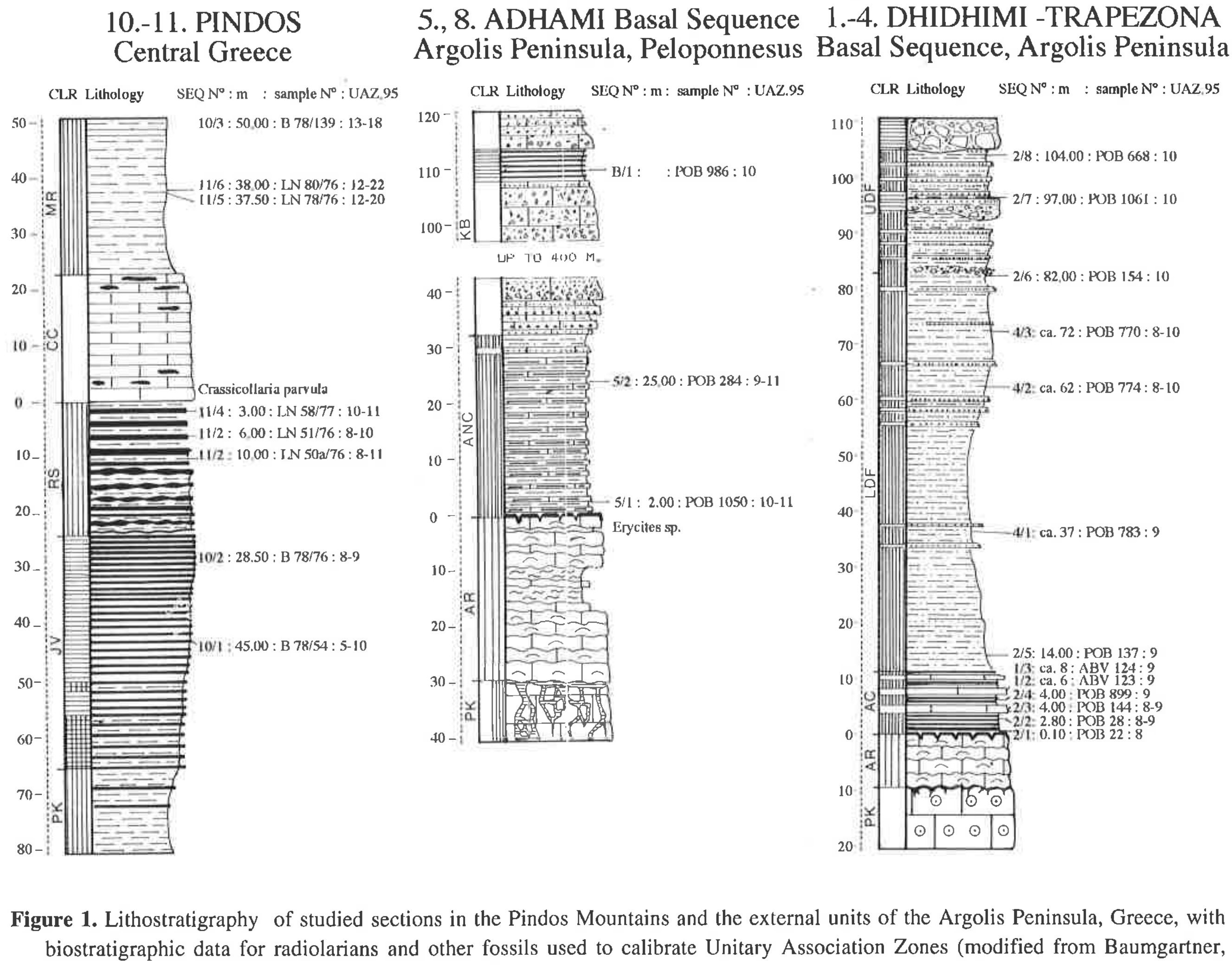


Figure 1. Lithostratigraphy of studied sections in the Pindos Mountains and the external units of the Argolis Peninsula, Greece, with biostratigraphic data for radiolarians and other fossils used to calibrate Unitary Association Zones (modified from Baumgartner, 1984). See text for further information on the sections.

numbers are followed by the name of the section in the present database (see *Chapters* 37-38.). reference is made to other chapters or to previous literature dealing with the section, the radiolarian data or the local geology.

1. *POB1 DHIMAINA, Argolis Peninsula, Peloponnesus, Greece: 9 samples.
References.- De Wever (in Vrielynck, 1978) p. 39, loc. T-l 3. Baumgartner *et al.* (1980) p. 64, loc. a. Coll. B. Vrielynck.
Lithology and sample location.- Vrielynck 1978, Baumgartner *et al.* 1980, Baumgartner (1985) pl. 4. Section C. See composite section, Figure 1.
Biostratigraphy.- Baumgartner et al 1980, p. 28. Baumgartner 1985
Radiolarian data.- De Wever (in Vrielynck, 1978). Baumgartner *et al.* (1980), De Wever (in Kocher, 1981), and own examination of De Wever's residues. Baumgartner 1984b-data converted to MRD-codes, checked and doubtful data deleted.

2. Angelokastron, Argolis Peninsula, Peloponnesus, Greece: 8 samples. Included in COMPOSITE ARGOLIS PENINSULA, see below
References. Baumgartner (1980), p. 314-316, loc.A-B. Baumgartner *et al.* (1980), p. 65, loc.C0-C2.
Lithology and sample location.- Baumgartner *et al.* (1980), Baumgartner (1985), pl. 4. Section E. See composite section, Figure 1.
Radiolarian data.- Own observations: Baumgartner 1980, Baumgartner *et al.*, 1980 (in Kocher, 1981). Baumgartner 1984b-data converted to MRD-codes, checked in residues and SEM and updated.

3. *POB3_PROSIMNI, Argolis Peninsula, Peloponnesus, Greece: 3 samples.
References.- De Wever (in Vrielynck, 1978), p. 36, loc. T-l 1. Baumgartner *et al.* (1980), p. 66, loc. d. Coll. B. Vrielynck.
Lithology and sample location.- Baumgartner (1985), pl. 4. Section A.
Biostratigraphy.- Baumgartner 1985
Radiolarian data.- De Wever (in Vrielynck, 1978). Baumgartner *et al.* (1980), De Wever (in Kocher, 1981), own examination of De Wever's residues. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

4. Taxiarchis, Argolis Peninsula, Peloponnesus, Greece: 3 samples. Included in COMPOSITE ARGOLIS PENINSULA, see below
References.- Baumgartner (1980), p.316, loc.C. Baumgartner *et al.* (1980), p.64, loc.b. Baumgartner (1985), pl. 5, Section D.
Radiolarian data.- Own data: Baumgartner 1980, Baumgartner *et al.*, 1980 (in Kocher 1981). Baumgartner 1984b-data converted to MRD-codes, checked in residues and SEM and updated.

1, 2, 4. COMPOSITE_ARGOLIS_PENINSULA: 13 samples. This a composite of sections 1, 2 and 4. Samples 1-4 are taken from Section 2 (levels 1-4). Angelokaston. Samples 5-6 are taken from Section 1(levels 2-3). Samples 7 is again taken from Section 2(level 5). Samples 6-10 are taken from Section 4 (levels 1-3). samples 11-13 are taken again from Section 2

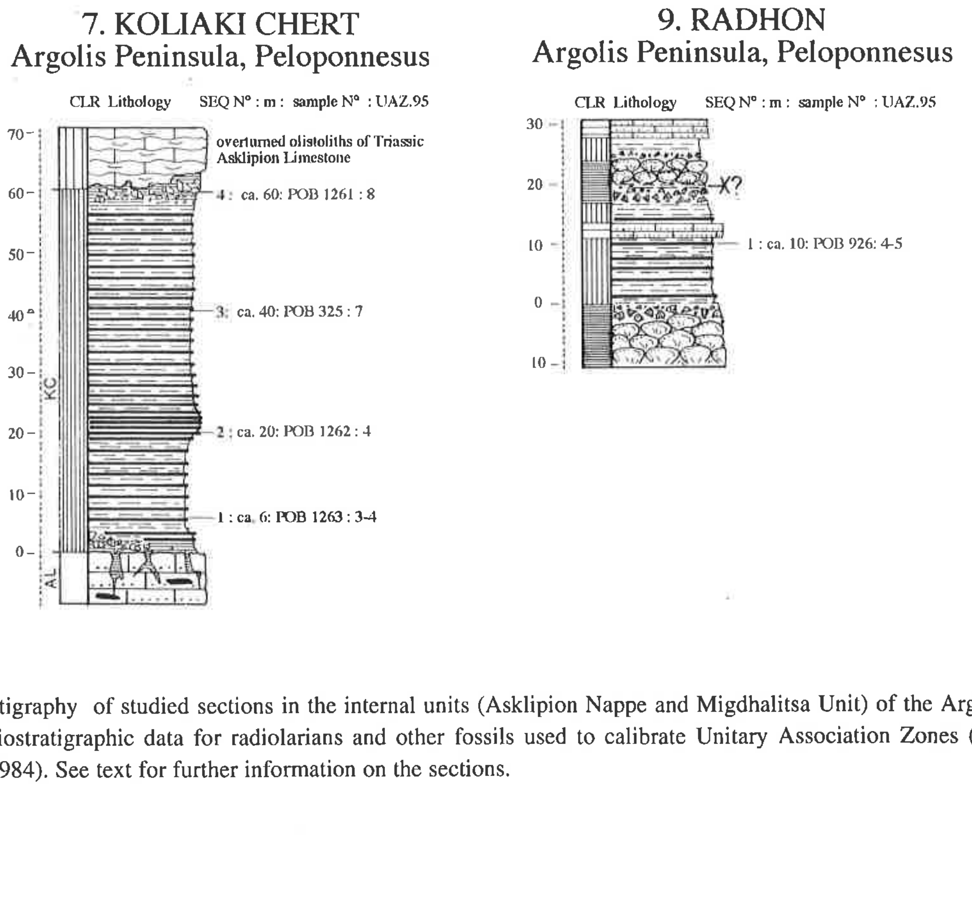


Figure 2. Lithostratigraphy of studied sections in the internal units (Asklipion Nappe and Migdhalitsa Unit) of the Argolis Peninsula, Greece, with biostratigraphic data for radiolarians and other fossils used to calibrate Unitary Association Zones (modified from Baumgartner, 1984). See text for further information on the sections.

(levels 11-13). The construction of this composite is based on lithologic correlation over a few km distance in adjacent outcrops of the same stratigraphic sequence (Baumgartner, 1985, pl. 4).

5. *POB5_KANDHIA, Argolis Peninsula, Peloponnesus, Greece: 2 samples.

References.- Baumgartner et al 1980, p.66, loc.e. Baumgartner 1985, pl. 1, Section A

Radiolarian data.- Own data: Baumgartner *et al.,* 1980 (in Kocher, 1981). Baumgartner 1984b-data converted to MRD-codes, checked in residues and SEM and updated.

6. *POB6 SERRADA Trento Province, northern Italy: 1sample.

Locality data.- The section was measured along the Serrada-Terragnolo-Rovereto road in the first hairpin curve at the entrance of Serrada (opposite to the road sign "Serrada"), about 300 m uproad from the section measured by D. Bernoulli & C. Sturani (unpubl. manuscnpt).

Lithology and sample location.- The section is floored by cream colored massive oolitic grainstones (San Vigilio Oolites), overlain by about 3 m of pelagic, Bositra-rich pink limestones (Lumachella a *Posidonia alpina*) topped by a Fe-Mn-hardground. This hardground is overlain by a 3.7 m thick spnge spicule- and radiolarian-rich unit consisting of 3-6 cm-bedded, pink cherty limestones with thin greenish marly partings. Four soft, pale green bentonite layers are found at 1.30, 1.40, 1.60 and 1.70 m above the hardground. The radiolarian sample cited here, POB 1403, is located 3.50 m above hardground or 1.80 m above the highest bentonite. This unit is overlain by 30 cm of flat bedded beige pelagic limestone, then about 10 m of nodular marly limestone (Rosso Ammonitico Superiore) and then white *Calpionella*-bearing nannofossil limestones.

Biostratigraphy.- Based on regional data presented in Chapter 11, the cherty limestones between the top of the bentonites and the base of The Rosso Ammonitico superiore is of middle Oxfordian to early Kimmeridian age.

Radiolarian data.- Own data. Baumgartner 1984b-data converted to MRD-codes, checked in residues and SEM and updated.

7-8. POB7-8 THEOKAFTA KOLIAKI COMPOSITE Is a composite section of localites 7 and 8

7. Koliaki Chert, Argolis Peninsula, Peloponnesus, Greece: 4 samples.

References.- Baumgartner 1985, p.73-75, Fig. 38, Pl. 6, section A and E. See Figure. 2.

Lithology and sample location.- The samples included under this locality are a composite of the cited section A, Koliaki Chert, Theokafta Subunit and one sample (POB 325) from the Koliaki Chert of the Main Asklipion Unit. Sample 1, POB 1263 was collected a few m above the brecciated top of the Adhami Limestone (Upper Liassic-? lower Middle Jurassic) in red, thinbedded siliceous mudstones and chert. Locality: 1.5 km north of Asklipion, along dirt road linking Asklipion limestone quarries with new national road, 30 m from entrance to new road, on east side of dirt road (x: 06.83.13; y: 41.63.75, topographic map of Greece 1:50,000, sheet Ligourion). Sample 2, POB 1262 was collected 100 m south of sample 1, 30 m north of last outcrops of Asklipion limestone olistoliths (x: 06.83.16; y: 41.63.55). Sample 3, POB 325 was collected in the Main Asklipion Unit, within a sequence of red siliceous mudstones and chert of at least 100 m thickness in the little valley below Koutroumbeika, between Trakhia and Bafi (Aj. Eleni) (x: 06.91.20; y: 41.59.00). Sample 4, POB 1261 was collected from the chert matrix of a breccia with conodont-beanng Triassic Asklipion Limestone fragments (Baumgartner, 1985, Fig. 36a) which borders the main body of Asklipion Limestone, just below the contact with the tectonically overlying keratophyric tuffs at the little col of the forementioned dirt road (x: 06.83.18; y: 41.63.40).

Radiolarian data.- Own data. Baumgartner 1984b-1985-data converted to MRD-codes, checked in residues and SEM and updated.

8. Theokafta, Argolis Peninsula, Peloponnesus, Greece: 1 sample.

References.- Baumgartner (1980), p. 316, loc. D. Baumgartner *et al.* (1980), p. 66, loc. f.

Lithology and location.- Baumgartner (1985), Pl.2, 3, section F.

Radiolarian data.- Own data, see also Kocher (1981). Baumgartner 1984b-1985-data converted to MRD-codes, checked in residues and SEM and updated.

9. *POB9_RHADON, Argolis Peninsula, Peloponnesus, Greece: 1 sample.

References.- Baumgartner (1985, p. 82, Figs. 40, 42,43).

Lithology and Sample location.- The main road Trakhia-Kranidhi cuts across the Migdhalitsa Ophiolite Unit and has a culmination approximately 3.5 km west of Radhon, where the road cut exposes nice pillow lavas with ocean floor characteristics (Baumgartner, 1985, samples POB 300, 301, Figs. 40-42). 100 m south of the pass the road cuts through small outcrops of pillows, pillow breccias and overlying red radiolarian chert, siliceous mudstones and siliceous limestones (redeposited). Sample POB 926 was collected about 10 m above pillow breccias. See Figure 2.

Radiolarian data.- Own data. Baumgartner 1984b-1985-data converted to MRD-codes, checked in residues and SEM and updated.

10. *POB10_PINDOS, Central Greece: 3 samples.

References.- Baumgartner *et al.* (1980) p. 66, loc. g, coll. M. Baltuck.

Lithology and sample location.- Baltuck (1982). See Figure 1.

Radiolarian data.- Own data: Baumgartner *et al.* (1980); in Kocher 1981. Baumgartner1984b-data converted to MRD-codes, checked and doubful data deleted.

11. *POB11_MARATHOS, Central Greece: 6.
References.- Baumgartner *et al.* (1980), p.66, loc.h, coll. N. Lyberis, preparation: E.A. Pessagno. Lithology and sample location. Lyberis (1978).
Radiolarian data.- Own data based on observations in Pessagno's residues: Baumgartner *et al.* 1980, in Kocher 1981. Baumgartner1984b-data converted to MRD-codes, checked and doubful data deleted.

12. *DU2_POJORITA, Rarau Mountains, Romania: 2 samples. This section has been restudied by Dumitrica (Chapter 24).

13. *POB13_LACU_ROSU, Haghimas Mountains, Romania: 1 sample.
14. *POB14_PIATRA_SOIMULUI, Rarau Mountains, Romania: 1 sample.
15. *POB15_GOMIELOR_VALLEY, Drocea Mountains, Romania: 1 sample.
References.- Dumitrica (1970, p.45 for locality 12.), Baumgartner *et al.* (1980), p.67, loc.i, coll. P. Dumitrica.
Biostratigraphy.- Discussed in Baumgartner *et al.* 1980. Radiolarian data. Own data based on examination of Dumitrica's residues. Kocher (1981). Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

16. *DU1_SVINITA,This section has been restudied by Dumitrica *(Chapter* 23).

17. *POB17_BESOZZO_II, Prov. Varese, Lombardy, northern Italy: 3 samples.
References.- Baumgartner *et al.* (1980) p.67, loc. 1, Kocher 1981, p.38, loc. 1, coll. R. Kocher.
Radiolarian data.- Kocher 1981. Baumgartner1984b-data converted to MRD-codes, checked and doubful data deleted.

18. *POB18_MONTE_GENEROSO, Ticino, southern Switzerland: 3 samples.
References.- Kocher (1981) p.40, loc.t.
Radiolarian data.- Kocher (1981) and own revision of Kocher's residues. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

19. POB19_TORRE_DI_BUSI, Prov. Como, Lombardy, see Chapter 11.

20. *POB20_VALMAGGIORE, Brenta, Prov. Varese, northern Italy: 4 samples.
References.- Baumgartner *et al.* (1980), p.67, loc.o. Kocher (1981), p.39, loc.o. Coll. R. Kocher.
Radiolarian data.- Kocher (1981). Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

21. *POB21_Besozzo_I, Besozzo Sup., Prov. Varese, northern Italy: 5 samples.
References.- Baumgartner *et al.* (1980) p. 67, loc. p. ; Kocher (1981) p. 39, loc. p. Coll. R. Kocher.
Radiolarian data.- Kocher (1981). Baumgartner 1984b-data converted to MRD-codes, checked, updated and doubtful data deleted.

22-23. POB22-23-RJ9_SANGIANO_RUSCONI, Prov. Varese, northern Italy. This is a composite section based on data from locality 22, locality 23, and 10 samples of the Lower Cretaceous section studied by Jud (see Chapter 12). the Sangiano section is clearly located stratigraphically below the Cava Rusconi Section in the same syncline.

22. Sangiano, Prov. Varese, northern Italy: 7 samples.
References.- Baumgartner *et al.* (1980), p. 68, loc.q. Kocher (1981), p. 39, loc. q. Coll. R. Kocher. See Figure 3.
Radiolarian data.- Kocher (1981). Baumgartner 1984b-data converted to MRD-codes, checked, updated, and doubful data deleted.

23. Cava Rusconi, Cittiglio, Prov. Varese, northern Italy: 1 sample.
References.- Baumgartner *et al.* 1980, p.68, loc. s. POB 1205. See Figure 3
Radiolarian data.- Own data: Baumgartner *et al.* 1980, and Kocher (1981). Baumgartner 1984b-data restudied by Jud (1994, and *Chapter* 12, this volume).

24. POB24-RJ10_BREGGIA_JUR_CRET, Breggia Gorge,Ticino, southern Switzerland. Is a composite section that includes 24 samples.of Baumgartner 1984b and 12 samples studied recently by Jud (1994 and Chapter 12, this volume). The following annotaions concern mainly the Jurassic part of the section.

References.- Baumgartner *et al.* (1980), p.68, 10 c. Kocher 1981, p. 40, 10c. coll. R. Kocher. Topmost sample 24: POB 1330: own collection.
Lithology and sample location.- Kocher (1981) includes the entire outcrop back to the waterfall in the lower Breggia gorge with the basal radiolarites. The lower 20 m of his section (samples B 61 and B 100) are however, marly and contain abundant *Bositra.* We include this part of the section with the Marne a Posidonia, an equivalent of the Sogno Formation. Sample 24: POB 1330 was collected in the quarry of Maiolica Lombarda, 10.50 m above the top of the Rosso ad Aptici (steeply dipping bedding plane at entrance of narrow gorge), at the base of the second slump unit. See Figure 3.
Radiolarian data.- Baumgartner *et al.* (1980), Kocher (1981), Baumgartner (1984b) reexamination of Kocher's residues. Baumgartner 1984b-data converted to MRD-codes, checked, updated by reexamination of Kocher's residues and doubtful data deleted.

25. POB25_SALTRIO, Prov. Varese, northern Italy: 12 samples.

References.- Baumgartner *et al.* 1980, p.67, loc. m. Kocher 1981, p.38, loc. m. Coll. R. Kocher. See Figure 3.

Radiolarian data.- Baumgartner *et al.* 1980, Kocher 1981, Baumgartner 1984b reexamination of Kocher's residues. Baumgartner1984b-data converted to MRD-codes, checked, updated by reexamination of Kocher's residues.

26. POB26_RJ_1_BOSSO_JUR_CRET, Fiume Bosso, near Pianello, Umbria, Central Italy, is a composite section composed of 23 samples discussed in Baumgartner (1984b, 1990) and 58 lower Cretaceous samples studied by Jud (1994, Chapter 12, this volume). The following annotaions concern mainly the Jurassic part of the section.

References.- Kocher 1981, p.41, loc.n (samples RK). Samples W79: Coll. E.L. Winterer. Sample POB BO230.8: own collection. See Figure 4. Earlier lithologic and biostratigraphic work includes Centamore *et al.* 1971, Micarelli *et al.* 1977 (Maiolica), McBride & Folk 1979 (Radiolarites), Bernoulli *et al.* 1979. and references cited in Chapter 12).

Radiolarian data.- Kocher (1981), revision of Kocher's residues and own data. Baumgartner1984b-data converted to MRD-codes, checked, updated by reexamination of Kocher's residues.

27. *POB27_MONTE CETONA, Tuscany, Central Italy: 9 samples. This section has been restudied by Marcucchi and Conti *(Chapter* 13, this volume)

References.- Kocher (1981), p. 41, loc. v.

Lithology and sample location.- Bernoulli *et al. 1979.*

Radiolarian data.- Kocher (1981). Baumgartner1984b-data converted to MRD-codes, checked, and doubtful data deleted.

28. *POB28_SANTA ANNA, near Caltabellotta, Sicily, Italy: 4 samples. This section has been restudied by DeWever et al. (1986, and *Chapter* 17, this volume) The 4 samples represented here are form the lower siliceous unit undelying nodular limestones of the Kimmeridgian-

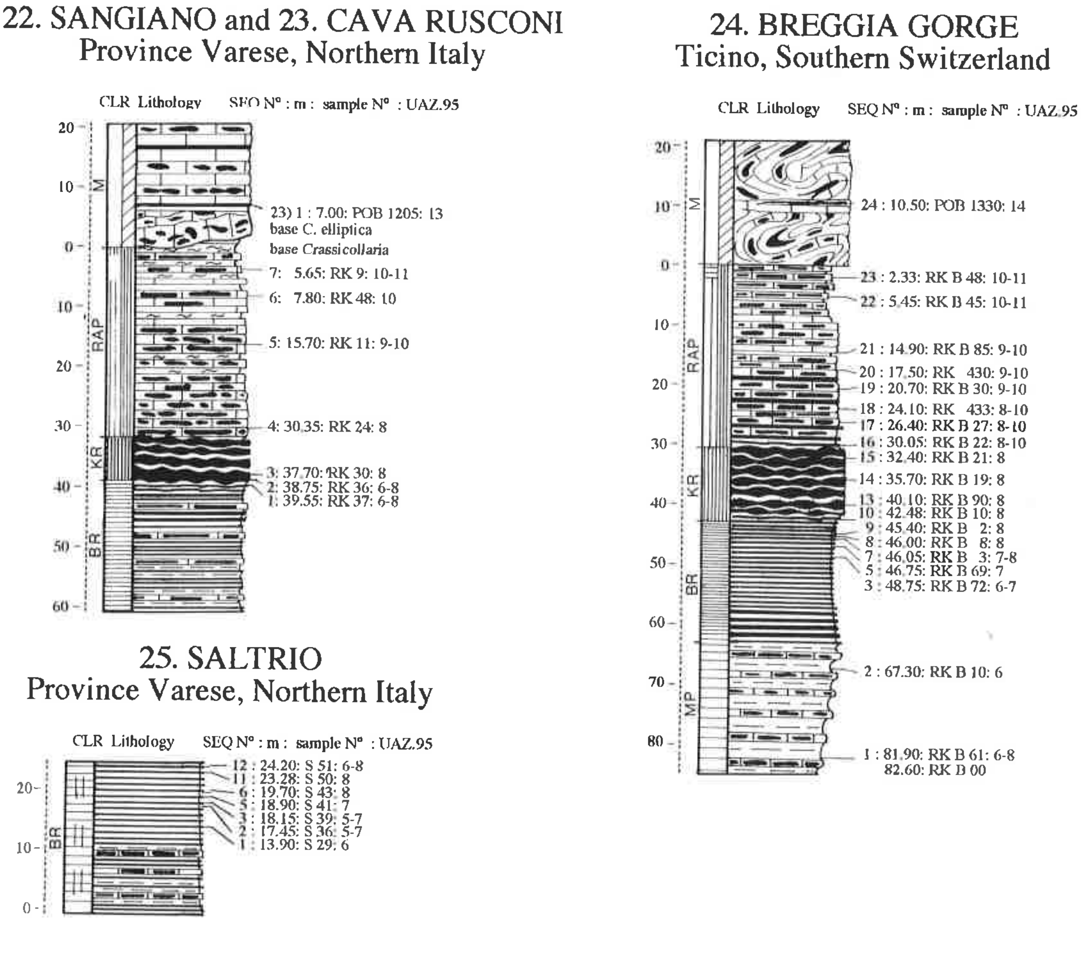


Figure 3. Lithostratigraphy of studied sections in theWestern Lombardy Basin (Generoso Basin), Northern Italy, with biostratigraphic data for radiolarians and other fossils used to calibrate Unitary Association Zones (modified from Baumgartner 1984). See text for further information on the sections, and *Chapter* 11 for further sections of this area.

Tithonian.

References. - Riedel & Sanfilippo 1974, p. 774, WRE 67-74. Baumgartner 1980, p.68, loc.tl-t2. Samples I-3: Sl-S4: Coll. B. McCill.

Radiolarian data.- Riedel & Sanfilippo (1974), Baumgartner *et al.* (1980) Kocher (1981) and own revisions of Sl-S4 and WRE 67-74. Baumgartner 1984b-data converted to MRD-codes, checked, and doubtful data deleted.

29. *POB29_DSDP_LEG_41_SITE_367, Cape Verde Basin, East Atlantic: 7 samples.

References.- Foreman 1978, p. 739.

Biostratigraphy.- Summarized in Baumgartner *et al.* 1980.

Radiolarian data.- Foreman (1978) Baumgartner *et al.* (1980) and own revisions of Foreman's residues. Baumgartner1984b-data converted to MRD-codes, checked, and doubtful data deleted.

30. POBMA30_DSDP_LEG_76_Site_34, Blake Bahama Basin, see *Chapter* 7.

31. *POB31_LEG_17, Site 167, Magellan Rise, Central Pacific: 6 samples.

References.- Riedel & Sanfilippo 1974, p.773.

Radiolarian data.- Riedel & Sanfilippo 1974, Baumgartner *et al.* 1980, in Kocher 1981, own observations in Riedel & Sanfilippo's residues. Baumgartner1984b-data converted to MRD-codes, checked, and doubtful data deleted.

32-33. *POB32/33_DSDP_LEG_32/33, Northwest Pacific, Site 306: 7 samples, Site 307: 6 samples.

References.- Foreman 1975, p. 579.

Radiolarian data.- Foreman 1975, Baumgartner *et al.* 1980, and own revision of Foreman's residues. Baumgartner 1984b-data converted to MRD-codes, checked, and doubtful data deleted.

34-35. *POB34/35_DSDP_LEG_20, Southeast Japan Abyssal Plain, Northwest Pacific, Site 195: 4 samples, Site 196: 3 samples.

References.- Foreman (1973) p.249.

Radiolarian data.- Foreman (1973), Baumgartner *et al.* (1980), in Kocher (1981), and own revision of Foreman's residues. Baumgartner1984b-data converted to MRD-codes, checked, and doubtful data deleted.

36. *POB36_GLASENBACH Gorge, near Salzburg, Austria: 2 samples.

References.- Kocher (1981) p. 42.

Lithology.- Bernoulli & Jenkyns (1970).

Radiolarian data.- Own data. Baumgartner 1984b-data converted to MRD-codes, checked, and doubtful data deleted.

37. *POB37_POINT_SALI, Santa Barbara County, California, USA: 3 samples.

References.- Riedel & Sanfilippo 1974, p.773: Pt. Sal, coll. C.A. Hopson and D.E. Karig, WR 73-4. Pessagno 1977, p. 102: samples NSF 900F-NSF 911.5 and own collection.

Radiolarian data.- Idem and own revisions of the above residues and raw samples.Baumgartner1984b-data converted to MRD-codes, checked, and doubtful data deleted.

38. *POB38_VEVEYSE_DE_CH_ST_DENIS, Cant. Vaud, Switzerland: 1 sample.

Locality data.- New radiolarian locality. Earlier work includes Charollais & Rigassi 1961 (calpionellids, nannoconids and other microfossils), Busnardo *et al.* (in preparation, ammonite high resolution stratigraphy). Locality: 2.5 km southeast of the town Châtel-St-Denis, gorge of Veveyse river several 100 m upriver from motorway and road bridges in river bed.

Lithology and sample location.- The sequence spans the Kimmeridgian to Barremian with siliceous limestones, marly, partly turbiditic limestones and marls. The studied sample comes from the middle part of the æction, and corresponds to bed 67-4 of Busnardo *et al.* (in preparation). Lithology: dark gray, mottled, clayey limestone, with abundant burrows in which radiolarians and other microfossil fragments are preserved as pyrite.

Biostratigraphy.- Bed 67-4 belongs to the Callidiscus Ammonite-zone of the terminal Valanginian (R. Busnardo, personal communication).

Radiolarian data.- Own data. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

39. POB39_DSDP_LEG_1_SITE_5, Blake Bahama Basin, Western Atlantic: 1 sample.

References.- Pessagno 1971. Sample 5A-7-1-top.

Radiolarian data.- Own examination of Pessagno's residue. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

40. POB40_IN_UNUMA, see *Chapter* 28.

41. *POB41_GUATEMALA_NICOYA, near Santa Rosa, Nicoya Peninsula, Costa Rica: 1 sample.

References.- New radiolarian locality. See KUYPERS 1979, Fig.21. Locality: Lower part of Quebrada Triste, near Guatemala, 2.75 km east of Santa Rosa. Coll. E. Kuypers.

Lithology and sample location.- Dark brown Mn-rich chert sampled a few meters above contact with basalt.

Radiolarian data.- Own data, many other samples from Nicoya Peninsula are in preparation.Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

42. *POB42_SUR_OMAN, OM 191, OM 200, near Sur, Hawasina Complex, southeastern Oman: 2 samples.

References. - Tipitt 1981. Coll. R.G. Coleman.

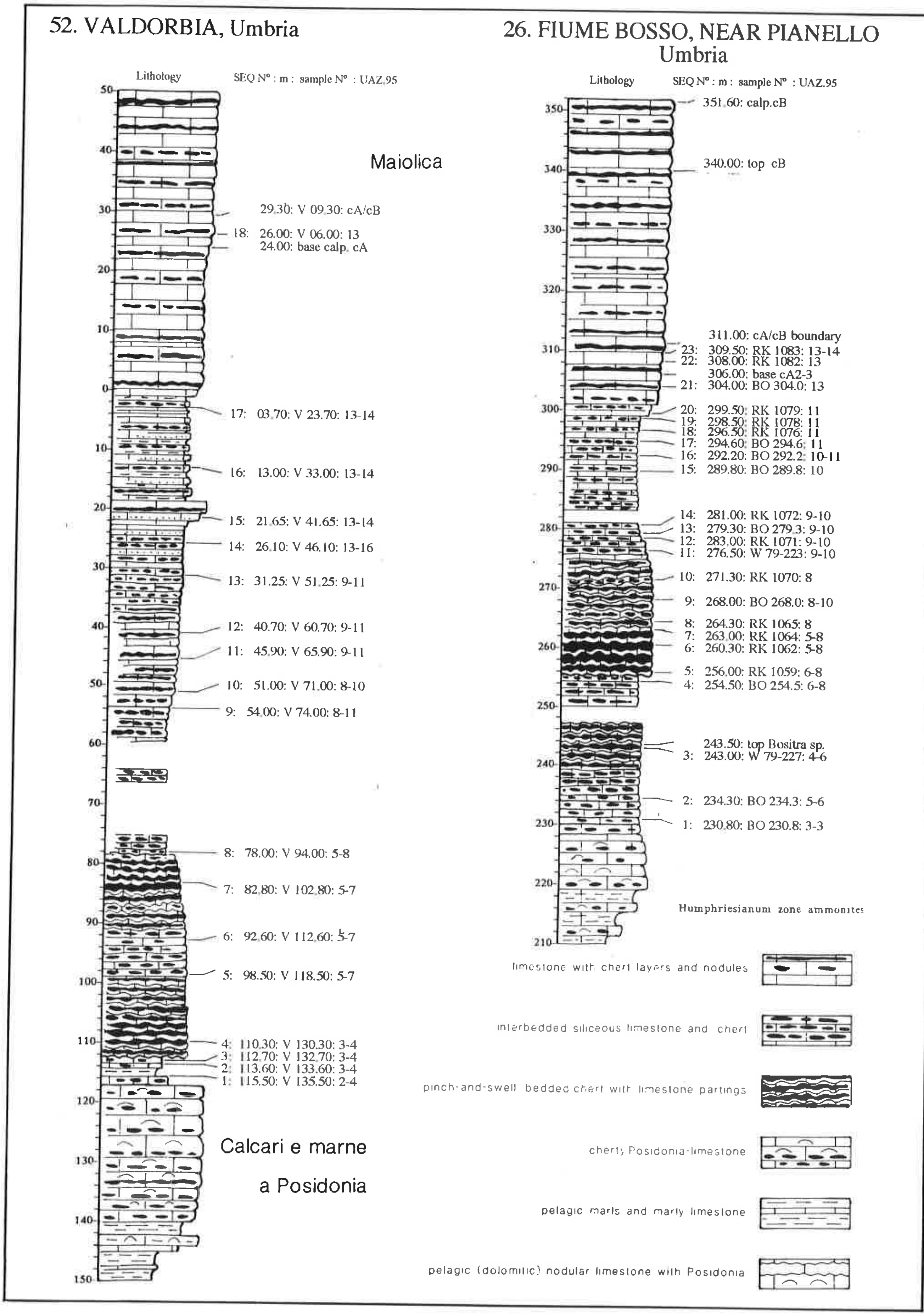


Figure 4. Lithostratigraphy of studied basinal sections in theUmbria-Marche Apennines, Central Italy, with biostratigraphic data for radiolarians and other fossils used to calibrate Unitary Association Zones (modified from Baumgartner, 1990).

Radiolarian data. - Own observations in Tipitt's residues. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

43. *POB43_TRATTBERG, Salzburg, Austria: 2 samples.
Locality data.- For geology: Steiger 1981. Localities: Along road Hallein-Trattberg. Sample 1: above "Gletscherschliff' Natural Monument, sample 2: Quarry below Trattbergalp. Coll. P.O. B. and T. Steiger.
Lithology.- Light gray, clayey nannofossil limestones with gray replacement chert nodules and layers, "Aptychenschichten".
Radiolarian data.- Own data. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

44. CENIGA see *Chapter* 11.

45. SECTION POB45_LO_SIERRA_DE_RICOTE, see Chapter 8.

46. *POB46_MONTE_CAMPANELLO_ELBA, near Volterraio, Elba, Italy: 2 samples.
Locality data.- New radiolarian locality. Lithologic description by Barret, 1979, 1982. The base of tl section collected lies 300 m west of Le Panche, the col of the Rio nell'Elba-Magazzini road, at about 300 altitude. Variolitic pillow lavas are overlain by Mn Fe crusts and dark red ferrugineous siliceous mud stones. The lowest sample with determinable radiolarians was collected in the first cm-thick white radiola rian sands 80 cm above basement. Coll. P.O.B. and E.L. Winterer.
Radiolarian data.-.Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

47. *POB__FELO_NAMIA_ELBA, Italy: 1.
Locality data.- Previous illustration of section in FOLK & McBRIDE 1978 and BERNOULLI *et al.* 1979. The extremely reduced section of radiolarites is exposed in a small quarry located at the Porto Azzurro-Rio Marina road between the localities Namia and San Felo, on the north side of th road. Along the road on the east side of the quarry the base of the section is exposed: Sheared but free serpentinite is overlain by

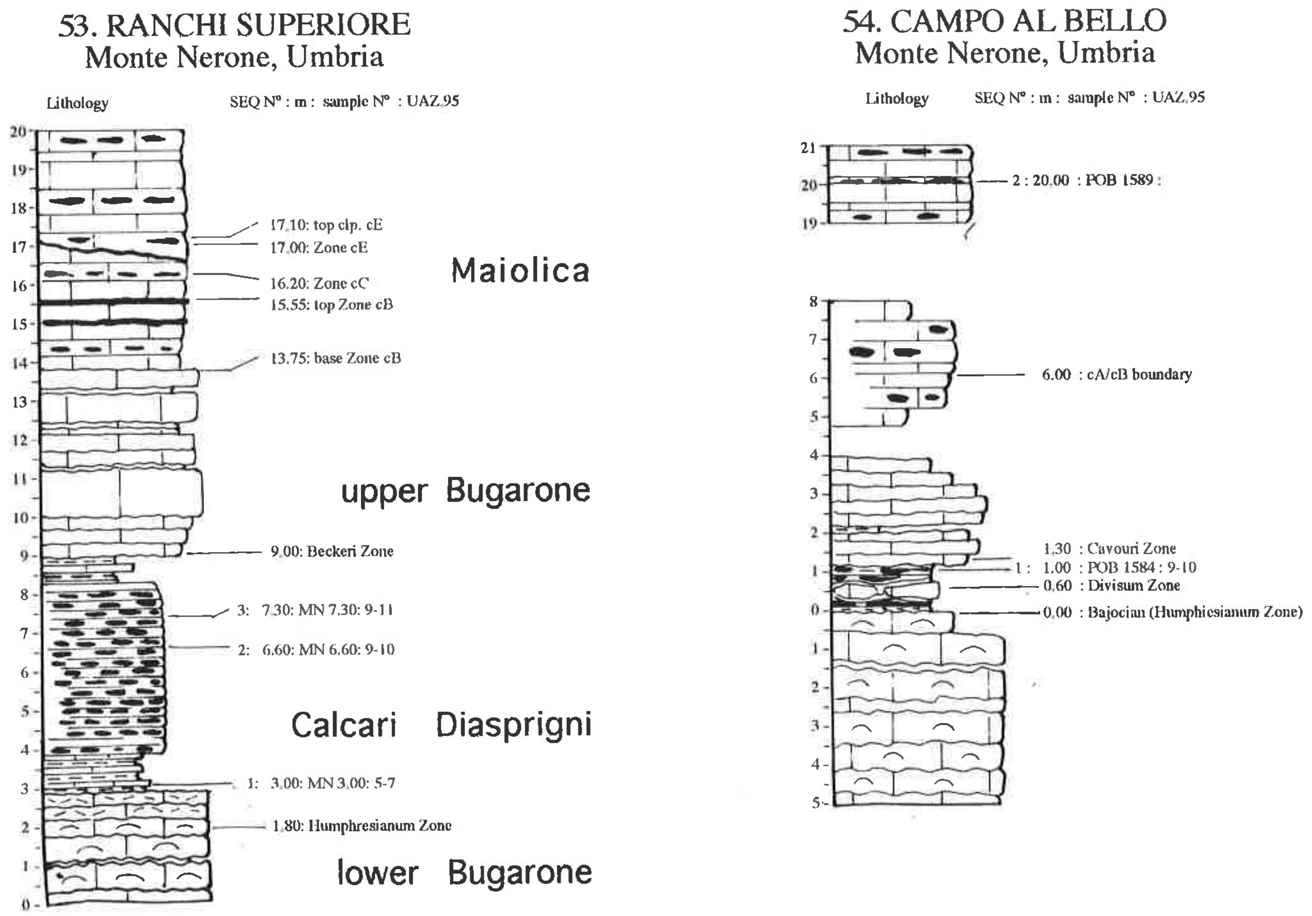


Figure 5. Lithostratigraphy of studied «seamount» sections in the Umbria-Marche Apennines, Central Italy, with biostratigraphic data for radiolarians and other fossils used to calibrate Unitary Association Zones (modified from Baumgartner 1990). See text for further information on the sections, and *Chapter* 15 for further sections of this area.

about 8 m of weathered serpentinite including large boulder-like bodies of free serpentinite. The following 16 m thickness to the entrance of the quarry include very altered serpentini penetrated by abundant calcite veins and in the upper 10 m dikes of red to pink siliceous muddy sediment On the east wall of quarry this is overlain along a very irregular contact by an ophiolite breccia containi basalt fragments of dominantly 2-10 cm size but also entire pillows, basaltic sandstone-clasts and ra gabbro fragments embedded in a shaly matrix of siliceous mudstone and overlain by mainly thinbedd siliceous mudstone. The sample POB 1615 is the lowest sample containing determinable radiolarians, 1. m above basalt breccia. Coll. P.O.B. and E. L. Winterer.

Radiolarian data.- Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted.

48. *POB48_ROCCETTE_DI_VARA, Liguria, Italy: 2 samples.

Locality data.- New radiolarian locality. Earlier descriptions of the locality include Abbate, 1969 and Folk & McBride 1978. The section is along the Brugnato-Roccetta di Vara road, the overturned base of tl section is exposed east of the first river bridge and on a gravel road (our lowest sample POB 1661) just wes of the big radiolarite quarry (sample POB 1662) on the south side of the road. The lowest sample wi determinable radiolanans (POB 1661) was collected 1.40 m above the graded top of the underlying gabb breccia and 60 cm below a graded gabbroic sandstone poorly exposed on the east side of gravel road. PC 1662 was sampled 29.20 m above the gabbro breccia in the southeast corner of quarry. Coll P.O.B. and E.L.Winterer.

Radiolarian data.- Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted

49. *POB49_C_31_SIMANTOV, northern Evvoia, eastern Greece: 1 sample.

Sample data.- Residue provided by J. Simantov, Geneva, described as interpillow sediment of the Pelagonian (s.l.) ophiolites of northern Evvoia.

Radiolarian data.- Own data: Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted

50. *POB50_JEBEL_AL_HASI_OMAN, DB 6214, Al Aridh Formation, Jebel al Hasi, Hawasina Nappes, Central Oman: 1 sample.

References.- Bernoulli et al.(1990). The sample comes from bedded lime-free radiolarites and shales in the type area of the Al Aridh Formation (Glennie *et al.* 1974). Coll. D. Bernoulli.

Radiolarian data.- Own data. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted

51. *POB51_ACHLADI_GREECE, DB 4575, near Achladi, northern Evvoia, eastern Greece: 1 sample.

Reference.- Baumgartner & Bernoulli, 1976.

Radiolarian data.- Own data: DB 4575, not early Neocomian as supposed in the reference. Baumgartner 1984b-data converted to MRD-codes, checked and doubful data deleted

52. POB56_RJ7_VALDORBIA_JUR_CRET, Umbria-Marche Apennines, Central Italy. 25 samples. See also *Chapter* 12

Reference.- Baumgartner 1990

Radiolarian data.- Own data:. Baumgartner 1990-data converted to MRD-codes, checked and doubful data deleted

53. POB53_RJ5_RANCHI_SUP, Monte Nerone high, Umbria- Marche Apennines, Central Italy. 10 samples. Cretaceous samples are discussed in *Chapter* 12.

Reference.- Baumgartner 1990

Radiolarian data.- Own data:. Baumgartner 1990-data converted to MRD-codes, checked and doubful data deleted

54. POBRJ6_CAMPO_AL_BELLO, Monte Nerone high, Umbria- Marche Apennines, Central Italy. 4 samples. Cretaceous samples are discussed in *Chapter* 12.

Reference.- Baumgartner 1990

Radiolarian data.- Own data:. Baumgartner 1990-data converted to MRD-codes, checked and doubful data deleted

3. Comments on data by El Kadiri 1992

El Kadiri (1984, 1992) described early Middle Jurassic radiolarians from two sections of the Dorsale Calcaire Externe (Rif, Morocco). We included El Kadiri's data with our data base, because we hoped to obtain calibration by the ammonites reported from beds immediately below the described radiolarian levels. In the section Oued El Haika El Kadiri (1992) reported a specimen of *Phymatoceratinae* characteristic of the middle-late Toarcian from beds immediately below sample ks412. In the section Oued Beniderkoul, he reported late Toarcian *Pseudogrammoceras* sp. from red nodular limestones underlying radiolarian level ks302. We have produced a data set of these two samples by including illustrated taxa only (either in El Kadiri 1984 or 1992). Preliminary runs of the data (see *Chapter* 32) confirmed the younger age of ks312, suspected by El Kadiri (1992). Sample ks412 is actually assigned to UAZ 2-3 (late Alenian to early-middle Bajocian), whereas sample ks302 is assigned to UAZ 3 (early-middle Bajocian), as indicated in *Chapters* 32 and 38. These ages are, however younger than the middle to late Toarcian ages assigned to the radiolarian faunas by El Kadiri (1992) on the basis of the ammonites. The sections of the Dorsale Calcaire Externe are, in general, condensed and we suspect a significant hiatus between the ammonite-bearing red nodular limestones and the radiolarite levels studied by El Kadiri.

References

ABBATE, E. (1969). Geologia delle Cinque Terre e dell'entoroterra di Levanto (Liguria orientale). *Memorie della Società Geologica Italiana*, **8**, 923-1014.

BALTUCK, M. (1982). Provenance and distribution of Tethyan pelagic and hemipelagic siliceous sediments, Pindos Mountains, Greece. *Sedimentary Geology*, **31**, 63-88.

BARRET, T.J. (1979). *Origin of bedded cherts overlying ophiolitic rocks in the Italian North Apennines, and implication of the ophiolitic-pelagic sediment sequences for seafloor processes.* Ph.D. Thesis (unpublished). Oxford University, 419 p.

BARRET, T.J. (1982). Stratigraphy and sedimentology of Jurassic bedded chert overlyingophiolites in the Northern Apennines, Italy. *Sedimentology*, **29**, 353-373.

BAUMGARTNER, P.O. (1980). Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peleponnesus, Greece). *Micropaleontology*, **26** (3), 274-322.

BAUMGARTNER, P.O. (1984a). Comparison of unitary associations and probabilistic ranking and scaling as applied to Mesozoic radiolarians. *Computers and Geosciences*, **10** (1), 167-183.

BAUMGARTNER, P.O. (1984b). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1985). Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). *Mémoires de la Société helvétique des Sciences Naturelles*, **99**, 1-111.

BAUMGARTNER, P.O. (1987a). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BAUMGARTNER, P.O. (1990). Genesis of Jurassic Tethyan radiolarites - The example of Monte Nerone (Umbria-Marche Apennines). *In* Pallini, G.*et al.* Eds. *Atti del II convegno internazionale Fossili Evoluzione Ambiente, Pergola 1987*, 19-32.

BAUMGARTNER, P.O. & BERNOULLI, D. (1976). Stratigraphy and radiolarian fauna in a Late Jurassic-Early Cretaceous section near Achladi (Evvoia, Eastern Greece). *Eclogae Geologicae Helvetiae*, **69** (3), 601-626.

BAUMGARTNER, P.O., BJØRKLUND, K.R., CAULET, J.-P., DE WEVER, P., KELLOGG, D., LABRACHERIE, M., NAKASEKO, K., NISHIMURA, A., SCHAAF, A., SCHMIDT-EFFING, R. & YAO, A. (1981). Eurorad II, 1980 - Second European meeting of radiolarian paleontologists: current research on Cenozoic and Mesozoic radiolarians. *Eclogae Geologicae Helvetiae*, **74** (3), 1027-1061.

BAUMGARTNER, P.O., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, part **2**, 23-86.

BERNOULLI, D. & JENKYNS, H.C. (1970). A Jurassic basin: the Glasenbach Gorge, Salzburg, Austria. *Verhandelingen Geologisch Bundesanstalt in Wien*, **4**, 504-531.

BERNOULLI, D., KÄLIN, O. & PATACCA, E. (1979). A sunken continental margin of the Mesozoic Tethys: The Northern and Central Apennines. *Symposium "Sédimentation jurassique W-européen* - Publication Spécial de l'Association Sédimentologique Française, **1**, 197-210.

BERNOULLI, D., WEISSERT, H. & BLOME, C.D. (1990). Evolution of the Triassic Hawasina Basin, Central Oman Mountains. *In* Robertson, A.H.F., Searle, M.P. & Ries, A.C. Eds. *The geology and tectonics of the Oman Region* - Special Publications of the Geological Society of London, **49**, 189-202.

BUSNARDO, R., CHAROLLAIS, J. & WIEDMANN, M. (in prep.). Le Crétacé inférieur de la Vevèyse de Châtel-St-Denis (Fribourg): stratigraphie et ammonites.

CENTAMORE, E., CHIOCCHINI, M., DEIANA, G., MICARELLI, A. & PIERUCCINI, U. (1971). Contributo a la conoscenza del Giurassico dell'Appennino Umbro-Marchigiano. *Studi Geologico Camerti*, **1**, 7-89.

CHAROLLAIS, J. & RIGASSI, D. (1961). Répartition de quelques microfossiles dans le Jurassique supérieur et le Crétacé de Châtel-St-Denis. *Archives des Sciences, Genève*, **14** (2), 265-279.

DE WEVER, P., GEYSSANT, J.R., AZÉMA, J., DEVOS, I., DUÉE, G., MANIVIT, H. & VRIELYNCK, B. (1986). La coupe de Santa Anna (zone de Sciacca, Sicile): Une synthèse biostratigraphique des apports des macro-, micro- et nannofossiles du Jurassique supérieur et Crétacé inférieur. *Revue de Micropaléontologie*, **29**, (5), 141-186.

DUMITRICA, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue roumaine de Géologie, Géophysique et Géographie (série Géologie)*, **14** (1), 45-124.

EL KADIRI, K. (1984). *Les radiolarites Jurassiques des klippes de Chrafate (Rif Septentrional-Maroc):*

Stratigraphie, Taxonomie. Thèse 3ème Cycle, Université de Pau (n°168). Unpublished, 459 p.

El Kadiri, K. (1992). Description de nouvelles espèces de radiolaires jurassiques de la Dorsale calcaire externe (Rif, Maroc). *Revista Española de Paleontología*, **Núm. Extra.**, 37-48.

Folk, R.L. & McBride, E. (1978). Radiolarites and their relation to subjacent "Oceanic Crust" in Liguria, Italy. *Journal of Sedimentary Petrology*, **48** (4), 1069-1102.

Foreman, H.P. (1973). Radiolaria from DSDP Leg 20. *In* Heezen, B.C., MacGregor, J.D. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C. **20**, 249-305.

Foreman, H.P. (1975). Radiolaria from the North Pacific, Deep Sea Drilling Project, Leg 32. *In* Larson, R.L., Moberly, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **32**, 579-676.

Foreman, H.P. (1978). Cretaceous Radiolaria in the eastern South Atlantic, Deep Sea Drilling Project, Leg 40. *In* Bolli, H.M., Ryan, W.B.F. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **40**, 839-843.

Glennie, K.W., Boeuff, M.G.A., Hughes-Clarke, M.W., Moody-Stuart, M., Pilaar, W.F.H. & Reihhardt, B.M. (1974). Geology of the Oman Mountains. *Verhandlungen Koniglische Nederlands Geologisch Mijnbouwkundig Genootschaap*, **31**, 1-423.

Guex, J. & Davaud, E. (1982). Recherche automatique des associations unitaires: option nouvelle et exemple d'application. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **78** (2), 195-205.

Jud, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

Kocher, R.N. (1981). Biochronostratigraphische Untersuchungen oberjurassischer radiolarien fuhrender Gesteine, insbesondere der Südalpen. *Mitteilungen aus dem Geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge*, **234**, 1-184.

Kuypers, E. (1979). La geología del Complejo Ofiolítico de Nicoya, Costa Rica. *Informe Seminario del Instituto Geográfico Nacional*, (Julio-Diciembre), 15-76.

Liberys, N. (1978). *Etude géologique de la partie méridionale des montagnes d'Agrapha (Euritanie, Grèce).* Thèse de 3ème cycle. Université Pierre et Marie Curie, Paris, 1-145 p.

McBride, E.F. & Folk, R.L. (1979). Features and Origin of Italian Jurassic Radiolarites deposited on continental crust. *Journal of Sedimentary Petrology*, **49** (3), 837-868.

Micarelli, A., Potetti, M. & Chiocchini, M. (1977). Ricerche microbiostratigraphiche sulla Maiolica della regione Umbro-Marchigiana. *Studi Geologico Camerti*, **3**, 57-86.

Pessagno, E.A. (1971). Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg 1) and the Great Valley Sequence, California Coast Ranges. *Bulletins of American Paleontology*, **60** (264), 5-83.

Pessagno, E.A. (1977). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

Riedel, W.R. & Sanfilippo, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Steiger, T. (1981). Kalkturbidite im Oberjura der Nördlichen Kalkalpen (Barmsteinkalke, Salzburg, Osterreich). *Facies*, **4**, 215-348.

Tippit, P.R. (1981). *Radiolarian biostratigraphy of the Hawasina Complex.* Ph.D. Thesis (n° 200). Program of Geoscience. UNiversity of Texas, Dallas, 339 p.

Vrienlynck, B. (1978). *Données nouvelles sur les zones internes du Péloponnèse. Grèce. Les massifs à l'est de la plaine d'Argos.* Thèse 3éme cycle (unpublished). Université des Sciences Techniques, Lille, 115 p.

6. Jurassic and Cretaceous Radiolarians from the Lesser Caucasus (Zod Pass, Mount Karawul and Site 22 in the Koshuni River Basin)

by Valentina S. Vishnevskaya

Institute of Litosphaera, Staromonethyiper. 22, Moskova, 109017, Russia

ABSTRACT

Rich radiolarian faunas of Jurassic-Cretaceous age have been recovered from radiolarites and radiolarian-bearing limestones in sequences from Eastern Tethys (Fig. 1) from localities in the Caucuses (Russia, Armenia, Georgia, Azerbaijan and in the Crimea (Ukraine). Independent dating is provided by ammonoids in some Jurassic and Lower Cretaceous samples and by rare inoceramids and foraminifers that co-occur in many Cretaceous samples at several intervals. The age of the red radiolarites located at the branches of the Lesser Caucasus ophiolite belt can be refined on the basis of the radiolarian faunas alone. Within the sequences of Eastern Tethys a change in the faunas can be observed. In samples analysed from the flanks of Tethys towards Peri-Tethys a decline in taxonomical and morphological diversity has been established. The Boreal type of radiolarian fauna of northern Peri-Tethys (Russia, Norway) is quite different from the Tethyan assemblage described here.

1. Geographical and geological frameworks

The richest radiolarian-bearing sections are widespread in the ophiolite zones of the Lesser Caucasus (Vishnevskaya, 1975, 1984). There are only fragmentary Triassic or Cretaceous sections in these tectonic zones where other fossils have been found (Vishnevskaya, 1990) e.g. the Zod section (Fig. 2). Radiolarian faunas from samples outside the ophiolite zones are less rich but well-dated by co-occurring or associated fossil groups (Vishnevskaya & Sedaeva, 1987, 1989; Vishnevskaya *et al.*, 1990). These faunas provide the most complete record of radiolarian evolution throughout the Eastern Tethys Jurassic-Cretaceous sequences. Studied sequences include the Lower-Middle Jurassic section of Site 22 (Armenia), the Middle Jurassic-Lower Cretaceous section of Mount Karawul (Azerbaijan, to the north of the Lesser Caucasus Sevan-Akera ophiolite zone), the Upper Jurassic section of Dagomis River (Russia, on the western slopes of the Greater Caucasus), the Lower Cretaceous section of Mt. Susuzlukh (Azerbaijan, to the north-east of the Lesser Caucasus Sevan-Akera ophiolite zone) and the Upper Cretaceous section of Surami Ridge (Georgia, Chiature, Middle Caucasus) (Fig. 3). Only the Jurassic sections are considered here.

Over the past few years, geological studies have resulted in the recognition of several distinct geochemical and petrological affinities of ophiolitic rocks associated with the Lesser Caucasus radiolarites (Zakaridze *et al.*, 1986). Volcanic rocks have been formed in different geodynamic environments: tholeitic basalts with intraplate affinity (Upper Triassic-Jurassic), alkaline and subalkaline differentiated basaltic-andesite of a seamount (Neocomian), and basaltic-andesite and boninites of immature ensimatic island arcs (Albian-Cenomanian).

In addition, radiolarites were subjected to regional metamorphism to the chlorite facies. The Caucasus radiolarian-bearing volcano-sedimentary rocks are structurally imbricated by numerous east-vergent thrust faults (Vishnevskaya, 1984).

In a general palaeogeographical framework these sections belong to the northern margin of Tethys and the section from the western slope of the Greater Caucasus probably belongs to the transitional zone between the folded belt and the Scythian plate.

According to the ideas of Knipper (1991) some evidence of Late Triassic destruction of the northern side of Gondwana seem to be recorded by the ophiolite sequence in the Lesser Caucasus. This process, which was related to the opening of the Mesotethys ocean basin, was accompanied by the detachment of continental blocks from the African-Arabian craton. Faunal data indicate that the break-up of the continent had already occurred by late Carnian time, Later, the Gondwana fragment began its northward journey, during which it entered various palaeogeodynamic environments, reconstructed from geochemical affinities of the volcanic rocks. This fragment of Gondwana reached the northern Tethys margin at the beginning of Coniacian times, when it was obducted.

2. Section 1 - Zod Pass

2.1. Access

The Zod Pass section (Figs. 2, 3) is located on the boundary of Armenia and Azerbaijan (Knipper, 1991) in the north-eastern roadcut of the road to Vardenis (Armenia).

2.2. Description of the outcrop

The section comprises Intervals 1 - 3. The following succession is visible up the section (Fig. 3):

Interval 1. Comprises 10m. of upper Carnian, volcano-sedimentary strata consisting of contourites and distal turbidites of graywacke composition with interbedded layers of basalts, andesites, pelites and radiolarites;

Interval 2. Comprises 5m. of Toarcian sediments with indistinct bedding and sorting, pelites and radiolarites within which is located the Level 0;

Interval 3. Comprises 100m. of a Jurassic volcano-sedimentary member containing blocks of nodular limestone with middle Norian bivalves and conodonts.

2.3. Previous dating

Unfortunately no previous age determinations have been published for this section.

2.4. Radiolarians

Radiolarians were extracted using standard HF methods (Dumitrica, 1970; Pessagno & Newport, 1972; De Wever, 1982)

Interval 2:

Sample 0

Bernoullius sp.

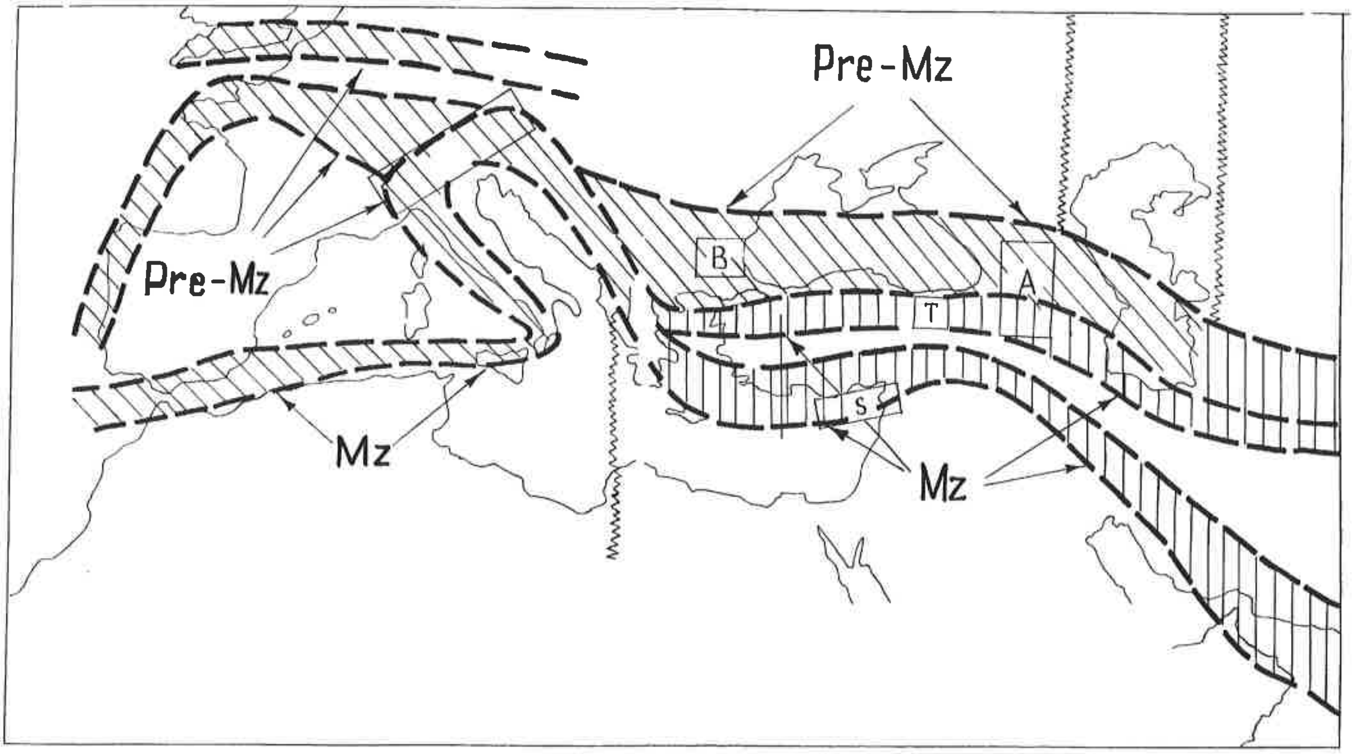


Figure 1. Locations of studied radiolarian bearing rocks in eastern Tethys. **A.** Armenia and Azerbaijan areas, **S.** Syria, **T.** Turkey, **B.** Bulgaria.

Paronaella variabilis CARTER
Trillus elkhornensis PESSAGNO & BLOME
Crubus wilsonensis CARTER
Hsuum minoratus SASHIDA
Parvicingula gigantocornis KISHIDA & HISADA.

2.5. Syntheses of ages as indicated by the various fossils

This Sample (number 0) is dated as Toarcian by radiolarians alone, but it is underlain by rocks which contain Upper Triassic (Carnian) radiolarians including
Canoptum cf. *verrucosum* BRAGIN,
Capnuchosphaera tricornis DE WEVER,
Capnuchosphaera lea DE WEVER,
Capnuchosphaera cf. *triassica* DE WEVER,
Pentaspongodiscus cf. *dercourti* DE WEVER,
Triassocampe nova YAO,
together with Norian bivalves
Halobia norica MJS.,
Halobia ex gr. *salinarum* BRÖNNIMAN
and conodonts (Knipper, 1991)
Neogondolella navicula (HUCKRIEDE)
Epigondolella cf. *postera* (KOZUR & MOSTLER)

This assemblages is also recognized in Site 22 in the Koshuni River basin. Ammonites *Aegoceras henley* SOWERBY and *Dactyloceras commune* SOWERBY from contemporaneous tuffs confirm the Pliensbachian-Toarcian age (Zone 0 of Vishnevskaya, 1993). The assemblage of this sample belonging to the Zone 0 is conformably overlain by tuffaceous argillite beds containing Aalenian-Middle Bajocian radiolarians of Zone 1 of Vishnevskaya (1993) and the ammonite *Parkinsonia parkinsoni* SOWERBY in time-equivalent tuffs.

3. Section 2 - Mt. Karawul

3.1. Access (Fig. 1)

Section 2 is located on the south-eastern hill of Mt. Karawul (Kamyshly Village, Azerbaijan) near the road leading to Chapli Post Office. It is located 0.5 km SW of the bridge, along the valley of the Levchay River.

3.2. Description of the outcrop

The section comprises Intervals, 1 to 7.

Interval 1. Comprises 15 m of jaspers rhythmically (4-7 cm), interbedded with siltstone, greenish to pink in colour, overlying andesite-basalts;

Interval 2. Comprises 120 m of rhythmically (from 90-10 up to 50-30 cm) interbedded volcanic sandstone and andesite-basalt tuff which is massive to well-bedded, coarse to medium, and rarely fine-grained; then 30 m rhythmically (from 10-15 to 3-5 cm upwards) interbedded siliceous siltstone and shale, rare sandstone;

Interval 3. Comprises 47 m of two rhythms represented by poorly-sorted graywacke sandstone, containing angular

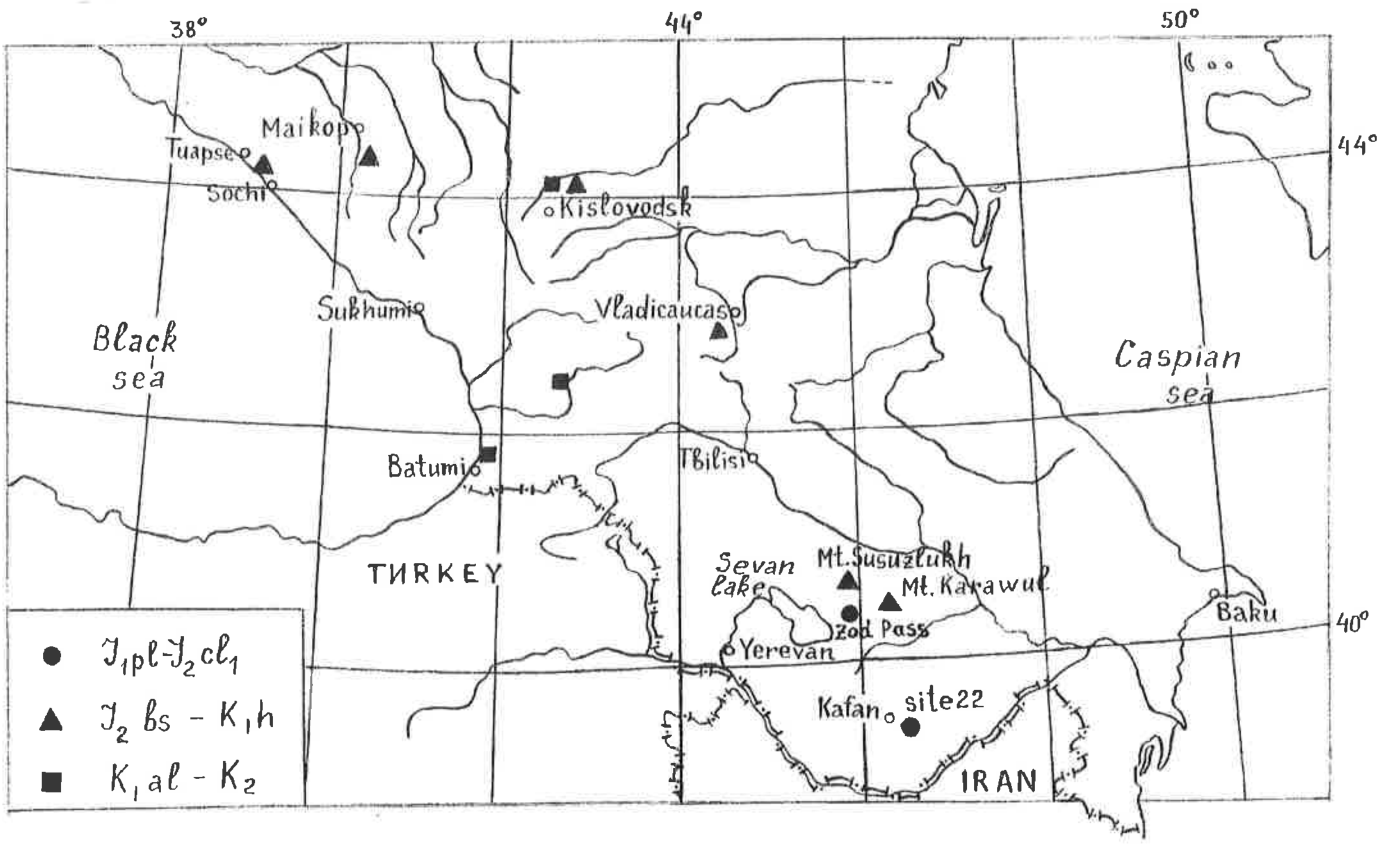


Figure 2. Location of described sections in the Caucasus.

grains of chert, in the lower part (1.5-2 m) and thin-bedded, well-graded, fine-grained graywacke alternating with shale and chert in the upper part (2-3 m). The sequences pass upwards into massive thin-bedded tuffaceous chert of white to pink or greenish or very rarely red colour (15-20 m); the contact between rhythms is sharp; it should be noted that the layers of sandstone contourites in the lower part contain numerous very fine clasts of chert and andesite-basalt, and the siltstone turbidites of the upper part contain abundant fragments of radiolarians and sponge spicules;

Interval 4. Comprises 250m. of light coloured siltstone alternating with dark-grey shale; siltstone contains minor amounts of sandstone and angular fragments of chert in the lower part; limestones with corals occur here;

Interval 5. Comprises 150m. of thick-bedded, graded graywacke sandstone and siliceous siltstone with evidence of submarine slumping prior to lithification of the beds;

Interval 6. Comprises 90m. of light-grey limestone with interbedded siltstone layers and an horizon of limestone breccia with clasts of chert at the base where the stratigraphic contact marks the change from terrigenous to carbonate sedimentation;

Interval 7. Comprises 100m. of rhythmically thin-bedded light-pink radiolarian and spicularian chert and grey siliceous limestone with submarine slumping, overlain by Albian-Cenomanian terrigenous rocks with conglomerate.

3.3. Previous dating

Interval 1. No ammonites or foraminifers have been found at this locality but several well-preserved radiolarian assemblages recorded are assigned to Zone 1 of Vishnevskaya, 1993.

Interval 2. Abdulkasumzade (1963) and Shikhalibeili (1964) reported macrofauna including the ammonite *Parkinsonia parkinsoni* SOWERBY, a zonal species of Late Bajocian age from a sandstone.

Interval 3. In the lower part of this interval Panov (1972, pers. comm.) collected ammonites from a shale: *Perisphinctes* sp., which is restricted to a Bajocian-Early Oxfordian age range. The Callovian-Oxfordian belemnite *Hibolites semihastetus* BL. (identified by A. Alizade) was also found in this shale.

Interval 5. Aptychi: *Punctaphychus cinctus* TROUTH., *Lametaphychus lamellosus* (PARKINSON), *L. mortilleti* (PICTET & LORIOL), *L. angulocostatus angulocostatus* TROUTH., *L. angulocostatus sumphysocostatus* TROUTH. and ammonites *Virgatosphinctes* were collected at this interval.

Interval 6. The limestone of this interval includes Aptychi: *Punctaptychus punctatus punctatus* (VOLLZ.), *Lamellaptychus beyrichi beyrichi* (OPPEL). The ammonites *Beriasella paunnei* (POM.), have been recovered in the time-equivalent radiolarian-bearing

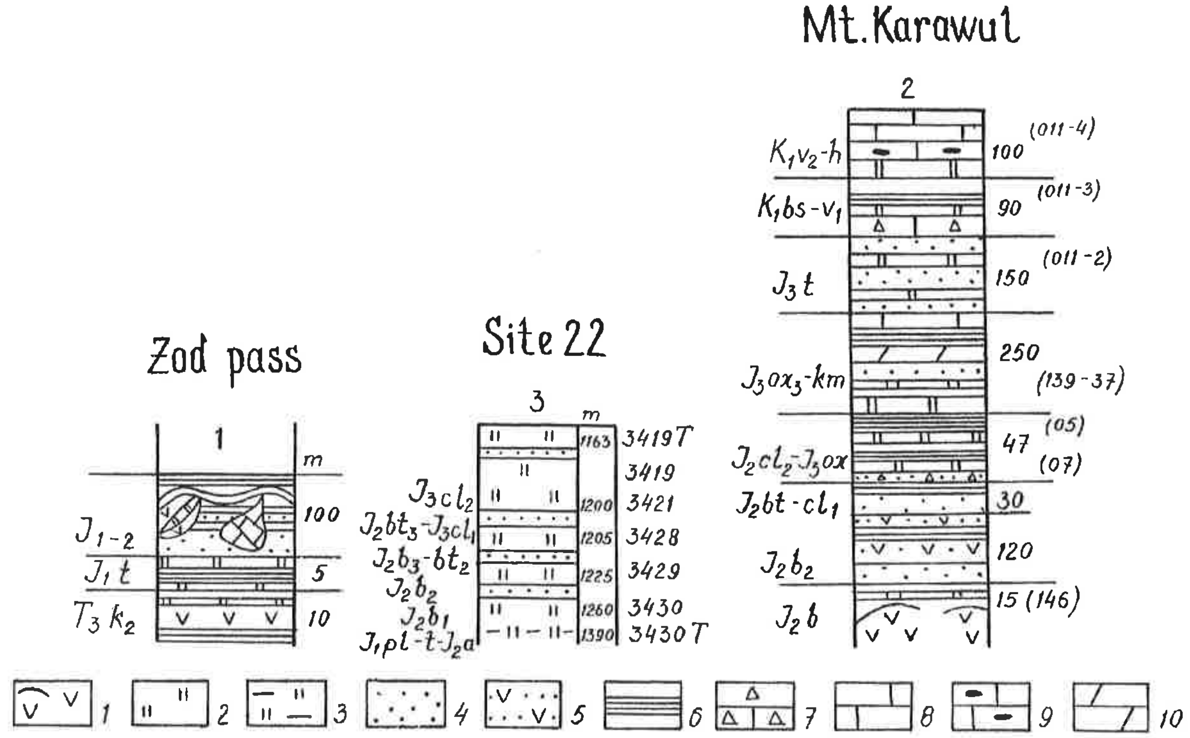


Figure 3. Lithostratigraphical sections. **1.** Basalt, **2.** Chert and jasper, **3.** Clay chert, **4.** Siltstone and sandstone, **5.** Tuff, **6.** Shale, **7.** Limestone with clasts, **8.** Limestone, **9.** Limestone with nodules, **10.** Marl.

interval 6 of Susuzlukh Mountain.

Interval 7. Dr. Maslakova (1973, pers. comm.) identified the foraminifera *Hedbergella hoterivica* (SUBBOTINA), *Hedbergella* sp. and *Gavelinella* sp.

3.4. Radiolarians

Radiolarians were extracted with Hydrofluoric acid (10%) following standard methods (Dumitrica, 1970; Pessagno & Newport, 1972; De Wever, 1982) Among them the following species were identified:

Interval 1:
Sample 146
Transhsuum maxwelli gr. (PESSAGNO)
Transhsuum medium TAKEMURA
Unuma echinatus ICHIKAWA & YAO
Unuma latusicostatus (AITA).

Interval 2: Unfortunately radiolarians were not recovered in any sample from this interval.

Interval 3:
Sample 05
Acanthocircus trizonalis s.l. (RÜST)
Archaeodictyomitra apiarium (RÜST)
Gorgansium spp
Homoeoparonaella elegans (PESSAGNO)
Mirifusus petzholdti (RÜST)
Podobursa helvetica (RÜST)
Ristola altissima altissima (RÜST)
Transhsuum maxwelli gr. (PESSAGNO)
Tritrabs exotica (PESSAGNO).

Interval 3:
Sample 07
Cinguloturris carpatica DUMITRICA.
Emiluvia premyogii BAUMGARTNER
Homoeoparonaella (?) *giganthea* BAUMGARTNER
Mirifusus dianae s.l. (KARRER)
Mirifusus fragilis s.l. BAUMGARTNER
Obesacapsula morroensis PESSAGNO
Perispyridium ordinarium gr. (PESSAGNO)
Podobursa helvetica (RÜST)
Ristola altissima altissima (RÜST)
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma jonesi (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)
Tritrabs exotica (PESSAGNO)

Interval 4:
Sample 139-37
Bernoullius dicera (BAUMGARTNER)
Dibolachras chandrika KOCHER
Emiluvia orea orea BAUMGARTNER
Homoeoparonaella (?) *pseudoewingi* BAUMGARTNER
Mirifusus dianae s.l. (KARRER)
Mirifusus fragilis s.l. BAUMGARTNER
Mirifusus guadalupensis PESSAGNO
Napora deweveri BAUMGARTNER
Napora lospensis PESSAGNO
Obesacapsula cetia (FOREMAN)
Obesacapsula morroensis PESSAGNO
Paronaella mulleri PESSAGNO
Parvicingula boesii gr. (PARONA)
Parvicingula dhimenaensis s.l. BAUMGARTNER
Podobursa helvetica (RÜST)
Podobursa spinosa (OZVOLDOVA).
Ristola altissima altissima (RÜST)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma jonesi (PESSAGNO)

Interval 5:
Sample 011-2
Archaeodictyomitra excellens (TAN)
Emiluvia sedecimporata (RÜST).
Ristola altissima s.l. (RÜST)
Suna echiodes (FOREMAN)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Triactoma tithonianum RÜST

Interval 6:
Sample 011-3
Ditrabs sansalvadorensis (PESSAGNO)
Mirifusus dianae minor BAUMGARTNER
Pantanellium berriasianum BAUMGARTNER
Parvicingula cosmoconica (FOREMAN)
Podobursa polyacantha (FISCHLI)
Ristola cretacea (BAUMGARTNER)
Xitus (?) *alievi* (FOREMAN).

Interval 7:
Sample 011-4
Dibolachras tytthopora FOREMAN
Mirifusus dianae minor BAUMGARTNER
Mirifusus dianae s.l. (KARRER)
Pseudodictyomitra carpatica (LOZYNIAK)
Sethocapsa trachyostraca FOREMAN
Sethocapsa uterculus (PARONA)
Thanarla elegantissima (CITA)

3.5. Syntheses of ages as indicated by the various fossils

Interval 1 Dated by radiolarians alone. Some are marker species of the late Bajocian.

Interval 2 Dated as late Bajocian by the zonal ammonite *P. parkinsoni* SOWERBY.

Interval 3. From the presence of *Perisphinctes* sp. the lower limit is dated as late Bajocian and the upper limit is determined as early Oxfordian. The radiolarian assemblages confirm the upper limit. Both samples 05 and 07 are assigned to the mid Callovian-early Oxfordian age interval.

Interval 4. This interval is dated by radiolarians as late Oxfordian-Kimmeridgian.

Interval 5. This interval begins directly where the strata contains numerous Tithonian aptychi. The radiolarians recorded correspond with Tithonian Zone 5 (Vishnevskaya, 1993).

Interval 6. Aptychi of Berriasian-early Valanginian ammonites were recorded in association with Berriasian-Valanginian radiolarians.

Interval 7. A late Valanginian-Hauterivian age has been well-established by the co-occurrence of the radiolarians *Cecrops septemporatus* (PARONA), *Sethocapsa uterculus* (PARONA) and planktonic foraminifers *Hedbergella hoterivica* (SUBBOTINA).

4. Section 3 - Site 22

4.1. Access (Fig. 2)

Site 22 is situated in the Koshuni River basin about 15 km to the east of Kafan town (Fig. 3).

4.2. Description of the section

The site is a drilled interval from 1390 to 1163 metres which comprises Interval Zones 0-4.

The section consists of an upward sequence of:

Interval 0*:* Comprises 0.120m. of dark-grey chert interbedded with siliceous argillite.

Interval 1*:* Comprises 35m. of dark-red chert inter-layered with siliceous and tuffaceous aleurolite.

Interval 2*:* Comprises 20m. of brown chert argillite interbedded with siliceous siltstone and sandstone.

Interval 3*:* Comprises 5m. of grey chert argillite.

Interval 4*:* Comprises 37m. of dark-grey argillite alternating with siliceous siltstone and sandstone.

Interval 5*:* Comprises 163m. of a volcanic sequence, which consists of andesite, dacite, rhyodacite (Zakariadze *et al.*, in press).

4.3. Previous dating

There is no previous data for this section apart from radiolarian data.

4.4. Radiolarians

Radiolarians were extracted from chert samples using standard HF methods (Dumitrica, 1970; Pessagno & Newport, 1972; De Wever, 1982).

Interval 0:

Sample 3430:

Hsuum PESSAGNO

Sample 3430 T

Acanthosphaera sp.nov.
Bipedis sp.
Crubus wilsonensis Carter
Hsuum minoratum SASHIDA
Katroma bicornis DE WEVER
Lupherium sp. A PESSAGNO & WHALEN
Parahsuum cruciferum TAKEMURA
Protopsium sp.
Trillus cf. *elkhornensis* PESSAGNO & BLOME
Trillus spp.

Interval 1*:*

Sample 3429

Acanthocircus suboblongus s.l. (YAO)
Angulobracchia purisimaensis (PESSAGNO)
Cyrtocapsa mastoidea YAO
Napora pyramidalis BAUMGARTNER
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma jonesi (PESSAGNO)
Tritrabs hayi (PESSAGNO)

Interval 1*:*

Sample 3429 T

Acanthosphaera cf. *mochi* KOZUR & MOSTLER
Archaeospongoprunum imlayi PESSAGNO
Cyrtocapsa japonica YAO
Emiluvia cf. *antiqua* (RÜST)
Emiluvia splendida CARTER
Eoxitus hungaricum KOZUR.
Hsuum rosebudense PESSAGNO & WHALEN
Kafanella (?) sp.
Lupherium officerense PESSAGNO & WHALEN
Napora pyramidalis BAUMGARTNER
Paronaella cf. *paenorbis* (RÜST)
Spongotripus incompus CARTER
Trillus elkhornensis PESSAGNO & BLOME
Tripocyclia trigonum RÜST
Tritrabs hayi (PESSAGNO)
Turanta ? *unica* PESSAGNO

Interval 2*:*

Sample 3428

Acanthocircus carinatus FOREMAN
Hsuum rosebudense PESSAGNO & WHALEN
Lupherium nitidum PESSAGNO & WHALEN
Napora deweveri BAUMGARTNER
P. aff. *ultrasincerum* PESSAGNO & BLOME
Pantanellium sanrafaelense PESSAGNO & BLOME
Parvicingula aculeata CARTER
Tetraditryma corralitosensis s.l. (PESSAGNO)
Transhsuum medium TAKEMURA
Tritrabs hayi (PESSAGNO)

Interval 3*:*

Sample 3421

Eoxitus hungaricum KOZUR
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
Eusyringium anglisi NEVIANI
H. obispoensis PESSAGNO
Hsuum lupheri PESSAGNO & WHALEN
Hsuum sp. aff. *H. cuestaense* PESSAGNO
Napora ? *bukryi* PESSAGNO.
Napora lospensis PESSAGNO
Paronaella mulleri PESSAGNO
Parvicingula dhimenaensis s.l. BAUMGARTNER
Parvicingula profunda PESSAGNO & WHALEN

Parvicingula schoolhousensis gr. Pessagno & Whalen
Parvicingula cf. *aculeata* Carter

Interval 4:
Sample 3419
Eucyrtidiellum ptyctum (Riedel & Sanfilippo)

Interval 5:
Sample 3419 T:
Tricolocapsa yaoi (Kozur)

4.5. Syntheses of ages as indicated by the various fossils

Interval 0: Based on radiolarians these sediments can be assigned a Pliensbachian-Toarcian age (sample 3430 T). Similar sediments containing radiolarian assemblages of the same age are widespread in the Alaverdi area of Armenia where they are overlain by chert argillites bearing rare Toarcian-Aalenian ammonites including *Aegoceras henley* Sowerby and *Dactylioceras commune* Sowerby.

Interval 1: From radiolarian evidence this level is dated as Aalenian-early Bajocian (samples 3429, 3429T).

Interval 2: Based on radiolarians the age is determined as late Bajocian. In the Alaverdi area (Vascepar River section) of Armenia (Vishnevskaya, 1993) these sediments are represented by interbedded chert argillites and tuffs, which contain an abundant, well-preserved ammonite fauna: *Parkinsonia parkinsoni* Sowerby, *Oppelia subradiata* Sowerby, *Posidonia buchi* Roem. The ammonite *Parkinsonia parkinsoni* Sowerby is a zonal marker for the late Bajocian interval. Ammonites belonging to the *Parkinsonia parkinsoni* Zone (late Bajocian-early Bathonian age) were determined by Tikhomirova (1981). These include *Pseudophylloceras kudernatschi* (Hauer), *Holcophylloceras zignodianum* D'Orbigny, *Calliphyloceras heterophylloides* (Oppel), *Ebrayiceras rursum* Buckman, and *E. problematicum* (Gemmellaro).

Interval 3: The co-occurrence of *Ristola turpicula* Pessagno & Whalen and *Eoxitus hungaricum* Kozur with numerous parvicingulids (*P. profunda* Pessagno & Whalen, *P. dhimenaensis* Baumgartner, *P. schoolhousensis* Pessagno & Whalen) allows a Bathonian age-determination. This interpretation is confirmed by the occurrence of similar radiolarian assemblages in tuffs containing *Oppelia fallax* (Geuraner), *Partschiceras* gr. *subobtusum* Kudrn. within the argillites of the *Zigzagiceras zigzag* Zone of Mt. Schachtacht (Armenia) (Tikhomirova, 1981).

Intervals 4 and 5: The samples 3419, 3419 T assigned to thess chronological intervals contain a well-preserved and diverse early Callovian radiolarian fauna: *Orbiculiforma lowreyensis* Pessagno, *Eucyrtidiellum ptyctum* Riedel & Sanfilippo, *Hsuum directipora* Rüst.

5. Conclusion

Sedimentation of the Lesser Caucasus radiolarite probably began in Carnian times (Zod Pass section). In the Mt. Karawul section the oldest discovery of radiolarite can be precisely dated as Bajocian in age.

Levels synchronous with the above have been identified in Syria, Turkey and Bulgaria. Some of these levels have been also found in Albania and Cuba.

References

Abdulkasumzade, M.R. (1963). Stratigraphy and fauna from Upper Jurassic of north-east Lesser Caucasus. *Doklady Akademii Nauk Azerbajdzanskoj SSR*, 1-53. (*in Russian*)

De Wever, P. (1982). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

Dumitrica, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14** (1), 45-124.

Knipper, A.L. (1991). Upper Triassic - Early Jurassic sedimentary breccias in the Ophiolitic suite of the Lesser Caucasus. *In* Peters, T. *et al.* Eds. *Ophiolite Genesis and Evolution of the Oceanic Lithosphere* - Ministry of Petroleum and Minerals. Sultanate of Oman, 705-713.

Pessagno, E.A. & Newport, R.L. (1972). A technique for extracting Radiolaria from radiolarian cherts. *Micropaleontology*, **18** (2), 231-234.

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Shikhalibeili, E.S. (1964). Geological structure and tectonic evolution of east Lesser Caucasus. *Doklady Akademii Nauk Azerbajdzanskoj SSR*, **1**, 307 p. (*in Russian*)

Tikhomirova, L. (1981). First results of the study of Jurassic radiolarians from the sub Caucauses. *Systematics, evolution and stratigraphic significance of Radiolaria* - Nauka, Moscow, USSR, 83-88. *(in Russian)*

Vishnevskaya, V. (1993). Jurassic and Cretaceous radiolarian biostratigraphy in Russia. *In* Blueford, J.R. & Murchey, B.L. Eds. *Micropaleontology, Special Publication*, Radiolaria of giant and subgiant fields in Asia. Nazarov Memorial Volume - Micropaleontology Press, American Museum of Natural History, New York, **6**, 175-200.

VISHNEVSKAYA, V.S. (1975). About age of Sevan-Akera Lesser Caucasus radiolarites. *Doklady Akademii Nauk SSSR*, **224** (6), 1381-1383. (*in Russian*)

VISHNEVSKAYA, V.S. (1984). *Radiolarites as analogues of contemporary oozes* - Nauka, Moscow, USSR, 118 p. *(in Russian)*

VISHNEVSKAYA, V.S. (1990). *Late Mesozoic volcano-chert sequences: stratigraphy and paleoenvironments on base radiolarian analysis*. Ph.D. Thesis. (Unpublished), Moscow, 47 p. *(in Russian)*

VISHNEVSKAYA, V.S., AGARKOV, Y.V., ZAKARIADZE, G.S. & SEDAEVA, K.M. (1990). Late Jurassic-Cretaceous radiolarians of the Greater Caucasus as a key for determination of age and paleoenvironment of the ophiolites from the Lesser Caucasus. *Doklady Akademii Nauk SSSR*, **310** (6), 1417.

VISHNEVSKAYA, V.S. & SEDAEVA, K.M. (1987). About biolithostratigraphic correlation of Mesozoic polyfacies sequences from South USSR. *Radiolaria and biostratigraphy* - Sverdlovsk, 31-33. *(in Russian)*

VISHNEVSKAYA, V.S. & SEDAEVA, K.M. (1989). Silicic formations in the carbonate and terrigenous-carbonate rocks of the Mesozoic in the Greater Caucasus. *Lithology-and-Mineral-Resources-(USSR)* - Plenum Publishing Corporation, Moscow, **23** (5), 443-453.

ZAKARIADZE, G.S., BOGDANOVSKI, O.G., KARPENKO, S.F., KNIPPER, A.L., JAGOUTZ, E., VISHNEVSKAYA, V.S. & SOLOV'EVA, N.V. (in press). Accretionary structure of the Lesser Caucasus ophiolite zones in light of geochronological and geochemical data.

ZAKARIADZE, G.S., KNIPPER, A.L., SOBOLEV, A.V., TSAMERIAN, O.P., DMITRIEV, L.V., VISHNEVSKAYA, V.S. & KOLESOV, V.G. (1986). The main features of structure and composition of volcanic series of Lesser Caucasus. *In* Bogatikov, O.A. Ed. *Oceanic magmatism* - Nauka, Moscow, 218-241. *(in Russian)*

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION 1_ZOD PASS: bottom 1 - top 1
< 1 {Sample 0}: 3614, 3659

SECTION 2_MT. KARAWUL: bottom 1 - top 7
< 7 {Sample 011-4}: 3161, 3286, 5462, 5422, 3293, 5296, 3063
< 6 {Sample 011-3}: 3165, 3174, 3255, 3227, 3280, 3286, 5674
< 5 {Sample 011-2}: 3094, 3097, 3164, 3181, 3287, 3216
< 4 {Sample 139-37}: 3185, 3150, 3181, 3180, 3161, 3159, 3169, 3139, 3197, 3096, 3160, 3036, 3035, 3203, 3265, 3266, 3241, 3224, 3223, 3230
< 3 {Sample 07}: 3100, 3210, 3105, 3113, 3119, 3159, 3161, 3169, 3180, 3266, 3096, 3241, 3193
< 2 {Sample 05}: 3065, 3076, 3263, 3241, 3104, 3169, 5703, 3180, 3119
< 1 {Sample 146}: 3180, 3278, 3231, 4058

SECTION 3_SITE 22: bottom 1 - top 7
< 7 {Sample 3419}: 3017
< 6 {Sample 3421}: 3017, 3036, 3182, 3184, 3139, 3197
< 5 {Sample 3428}: 3035, 3116, 3273, 3278, 5012
< 4 {Sample 3429 T}: 3116, 3033, 2002, 3039, 2011
< 3 {Sample 3429}: 3033, 3064, 3096, 3116, 3144, 3180, 3307
< 2 {Sample 3430 T}: 3039, 2010
< 1 {Sample 3430}: 3649

7. New Radiolarian Data from DSDP Site 534A, Blake Bahama Basin, Central Northern Atlantic

by Peter O. Baumgartner[1] and Atsushi Matsuoka[2]

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Department of Geology, Faculty of Science, Niigata University, Niigata 950-21, Japan

ABSTRACT

This chapter discusses the age assignment of radiolarian samples from DSDP Leg 76, Site 534A, Cores 127 through 81, assigned to UAZones 6 to 14 (middle Bathonian to late Berriasian-earliest Valanginian. The discovery of a radiolarian sample in the lowest sediment core above basement assignable to a middle Bathonian radiolarian age is discussed in the light of existing biostratigraphy based on dinoflagellates and nannofossils. In the light of the presently known ranges of the nannofossils, the lowest Core 127 may well be of middle Bathonian age, while Cores 126 through 111 are probably of early Callovian age according to radiolarians. These ages are approximately one stage older that previously stated, but correlate well with earlier extrapolations based on magnetic anomalies.

1. Introduction

IPOD/DSDP LEG 76 Site 534 was drilled in 1980 to unravel the early history of the Atlantic opening and its deep water sedimentation. The cores of Site 534A contain the oldest sediments recovered from *in situ* oceanic crust of the Atlantic. The Site is located in the Blake Bahama Basin (Fig. 1) between the Marine Magnetic anomaly M25 and the Blake Spur Anomaly (Fig. 2), presumably on M28 on a relatively low-relief oceanic crust (Fig. 3). The age of the oldest sediments is critical to the opening history of the Central Atlantic and the concomitant opening of the Western Tethys seaway (Bernoulli & Lemoine 1980, Fourcarde *et al.* 1991).

Well-preserved, mostly pyritized radiolarians were observed by the shipboard party in the Middle and Upper Jurassic cores and studied by Baumgartner (1983, 1984). He correlated the radiolarian faunas of the lowest cores with assemblages recovered from the basal, green radiolarites of the Southern Alps and Umbria (Baumgartner, 1983). The middle Callovian to Kimmeridgian ages stated in the Initial Reports of DSDP Leg 76 (Sherida, Gradstein *et al.*, 1983) were used in the following studies to calibrate Zones A1 and A2, Baumgartner (1984, 1987).

Yamamoto *et al.* (1985) published a report on Sample 534A-126-1, 119.5-130 cm, and compared it with the upper part of the *Guexella nudata* Assemblage Zone and with either the upper part of the *Tricolocapsa conexa* or the lower part of the *Stylocapsa* (?) *spiralis* Zone of Matsuoka (1983) and Matsuoka & Yao (1986).

Matsuoka collected a set of samples that were treated by us in 1992. One sample, 534A-127-1, 13-15 cm was selected and added to the Baumgartner (1984) data base, because it is the lowest radiolarian sample described so far.

2. New data and zonation

Sample 127-1,13-15 cm (Fig. 4) is characterised by the presence of *Ares cylindricus flexuosus*: UAZones 4-6, *Stylocapsa oblongula* : UAZones 6-8, and many other species typical of the upper Middle Jurassic. The sample is assigned to UAZone 6, calibrated to the middle Bathonian (see *Chapter 32*). Samples 126-4, 14 cm to 111-1, 12 cm are assigned to UAZone 7 calibrated to the late Bathonian-early Callovian (see *Chapter 32*). These ages are compared to other biostratigraphic data and discussed below.

Sample 106-1, 29 cm (Fig. 4) is assigned to UAZone. 11 calibrated as late Kimmeridgian to early Tithonian. This level is Kimmeridgian according to dinoflagellate biostratigraphy (Habib & Drugg, 1983) mainly based on the FO of *Occisucysta balia* in Core 111-1, 29 cm. It is just below the Kimmeridgian/Tithonian boundary which according to these authors is placed between samples 105-

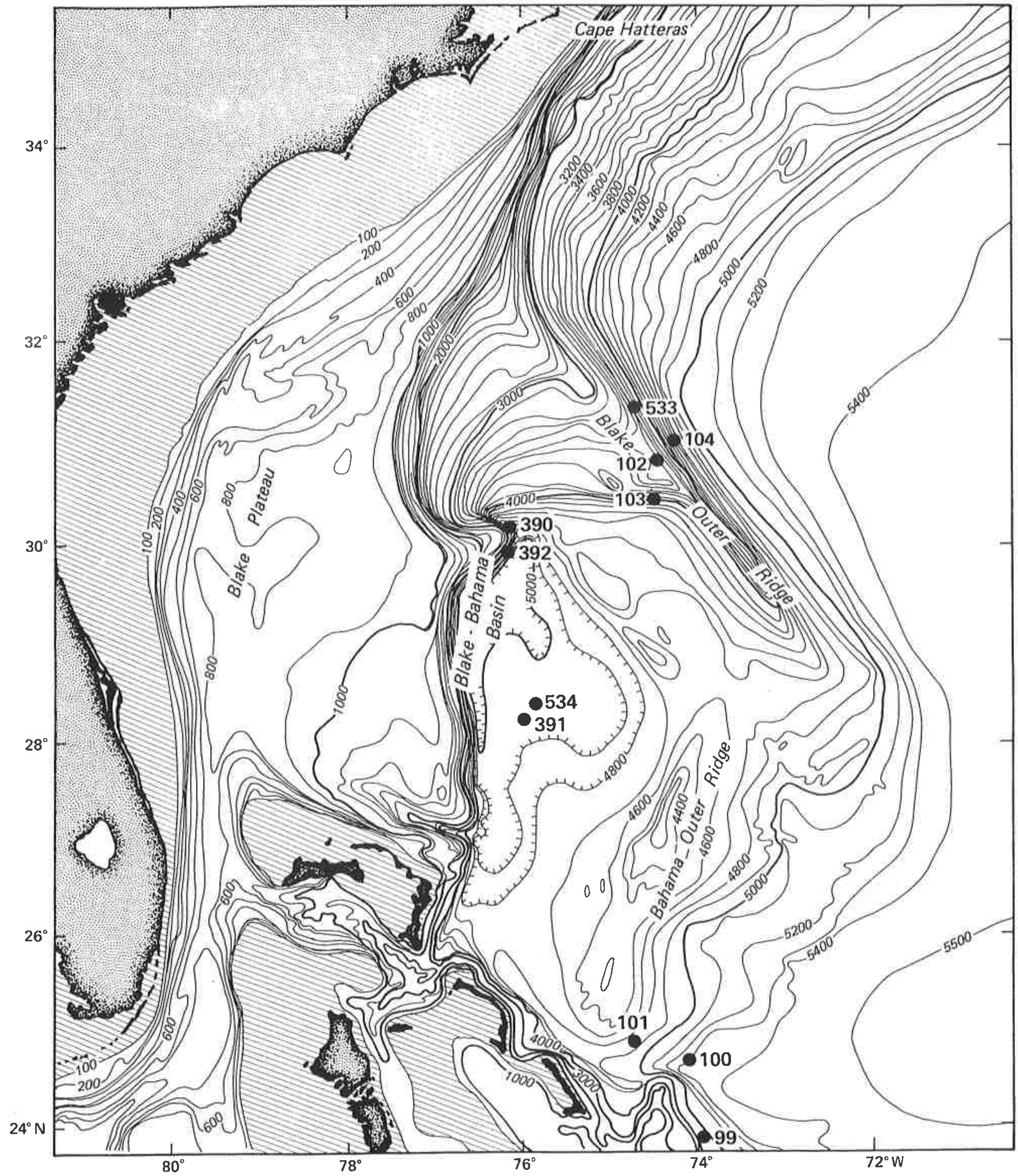


Figure 1. Location of Site 534 relative to previous DSDP Sites and the general physiography of the North-western Central Atlantic (from Shipboard Scientific Party 1983)

1, 17-18 cm and 104-2. 59-61 cm, based on the FO of *Cometodinium whitei* in the latter sample. Roth (1983) states that Cores 113 to 101 appear to be Kimmeridgian in age, based on nannofossils.

Sample 89-2. 47 cm is assigned to UAZone 14 (early-early late Berriasian). After Remane (1983) this sample is just one core above the top of *Calpionella* Zone A (earliest Berriasian), It is certainly Berriasian since the LO of *Calpionella alpina*, that is usually found near the Berriasian/Valanginian boundary was found in Core 88-1, 148-150 cm. Roth (1983) recovered the Berriasian *Nannoconus colomi* Zone in Cores 91 to 87. Also Habib & Drugg (1983) considered the interval of Cores 91-2, 57-58 cm to 87-6, 7-8 cm as early Berriasian, based on rare dinoflagellates.

Samples 81-2, 64 cm and 81-2, 3 cm (Fig. 4) are assigned to UAZone 15 (late Berriasian-earliest Valanginian). Habib & Drugg (1983) determined the FO of *Druggidium apicopaucicum*, indicating the earliest Valanginian immediately above in Sample 81-1, 61-62 cm. After Roth (1983) Cores 86 to 79 are assignable to the late Berriasian to early Valanginian *Retecapsa neocomiana* (NC2) Zone.

3. Discussion of the age of the oldest sediments resting on basalt.

The radiolarian data presented in this chapter supports an older age of the basal sediments overlying basalt at Site 534A than previously stated: Sample 127-1, 13 cm, about 467 cm above basalt, is assigned to UAZone 6 (middle Bathonian) and the interval 126-4, 14 cm to 111-1, 12 cm is assigned to UAZone 7 (late Bathonain-early Callovian).

The scientific party of Leg 76 (Sheridan, Gradstein *et al.* 1983) assigned a middle Callovian age to the basal sediments overlying basalt at Site 534A. This age was based primarily on dinoflagellate (Habib & Drugg 1983) and nannofossil (Roth, 1983) biostratigraphy. Habib & Drugg (1983) used unpublished reports on ammonite-dated stratigraphies from European stratotypes to date the basal sediments. Roth (1983) reported the first occurrence (FO) of *Stephanolithion bigotii* in Sample 126-4,70 cm, a datum that is now placed in the early Callovian *Calloviense* ammonite Zone (Bown *et al.* in press). The last occurrence (LO) of *Stehanolithion hexum* was observed in Sample 123-3,131 cm, a datum now placed in the late Callovian (Bown *et al.* in press).

This middle Callovian age of the basal sediments was recently questioned on the basis of new nannofossil data by Reale & Monechi (1994) who found the FO of *Cyclagelosphaera wiedmanni* in Sample 127-2, 30 cm, a datum that they found in the basal Callovian *macrocephalus* ammonite Zone of the Quissac section in SE France. Recently, the FO of this species was also found in the Terminilleto section (Bartolini *et al.* this volume) at TM165.22 m. This level is about one metre above the lowest radiolarian sample assigned to UAZone 7 (TM164.06, late Bathonian - early Callovian) and about 2 metres above the last sample assigned to UAZone 6 (TM163.05 middle Bathonian). Therefore, it appears that the FO of *Cyclagelosphaera wiedmanni* may be around the middle/late Bathonian boundary, which is confirmed by radiolarian correlation to Site 534A, where this FO was found 167 cm below the only sample assigned to UAZone 6 and 616 cm below the first sample assigned to UAZone. 7.

In conclusion, we have provided evidence for an age as old as middle Bathonian for Core 127, i.e. the first 4.5

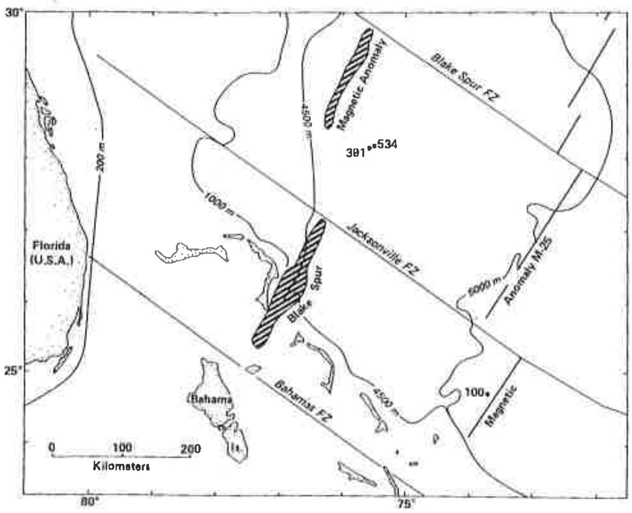


Figure 2. Location of Site 534 on the landward side of the marine "Jurassic Magnetic Quiet Zone", between M25 and the Blake Spur Anomaly (After Gradstein 1983).

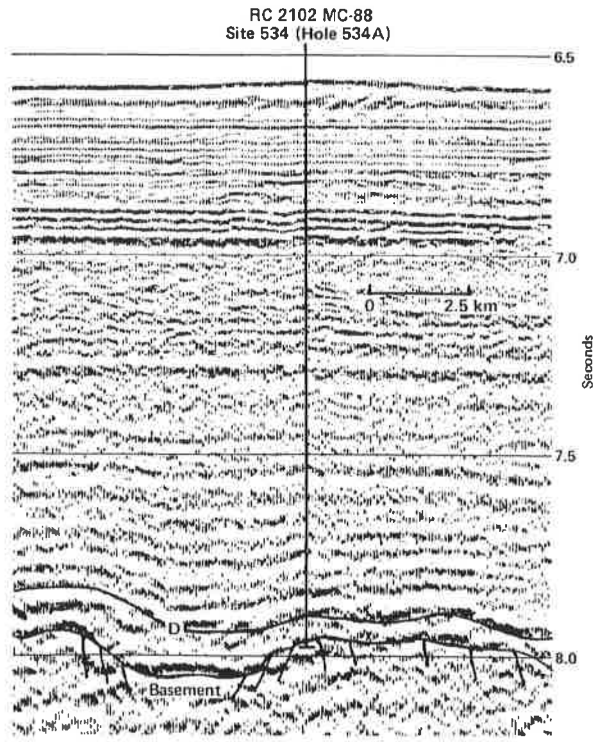


Figure 3. Seismic reflection profile of the *Robert Conrad* with inferred basement topography and the best estimate of the location of Site 534 (from Shipboard Scientific Party 1983).

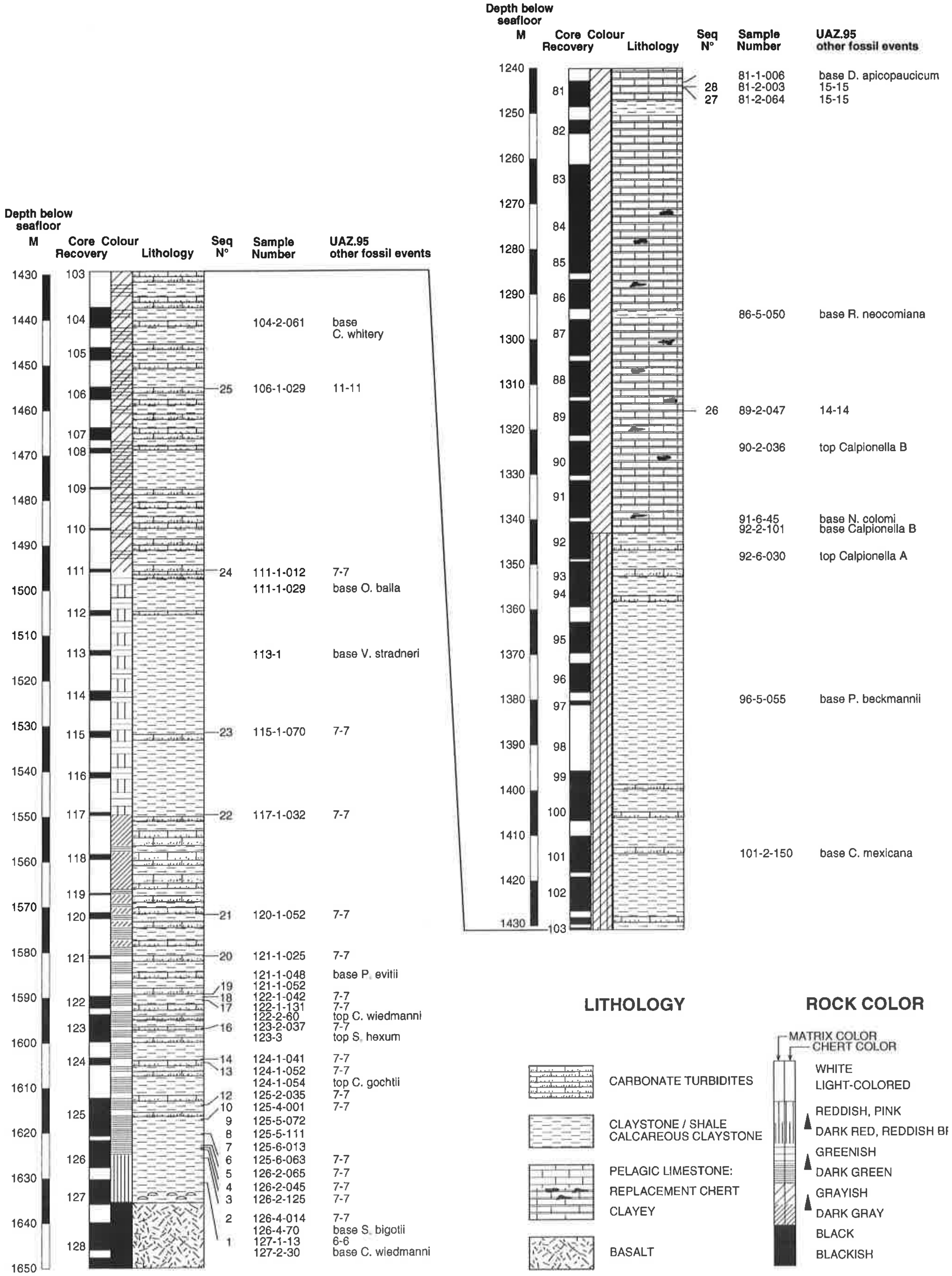


Figure 4. Log of Leg 76, Site 534A, Cores 127-81, redrawn from Baumgartner (1984) with studied radiolarian samples (1-28) assigned to UAZones, and other important biostratigraphic markers.

metres of sediment resting on basalt.

Cores 126-4 to 111-1 could be as old as late Bathonian, but may as well be early Callovian in age based on radiolarians, while nannofossil evidence (the LO of *S. hexum)* points to a late Callovian age starting in Core 123-3. However, the LO of *S. hexum* may be preservational, since nannofossils become rare and poorly-preserved starting from Core 123-2 up-section. The FO of *Valagapilla stradneri* was observed by Roth (1983) in Sample 113-1. 47 cm and was considered as lower-middle Oxfordian in age. This FO is now questionably placed in the lower Pliensbachian by Bown *et al.* (in press). The only evidence for ages younger than Callovian of these cores may come from the dinoflagellate stratigraphy that, needs to be reviewed in the light of the present knowledge of ranges.

4. Correlations

UAZone 6 has been found at the base of the green radiolarites in the Southern Alps (See *Chapters 5, 32*), at Terminilletto (see *Chapter 15.*) and most importantly near the base of Site 801B, westernPacific, Samples 35R-CC to 33R-CC (see *Chapter 27*, by Matsuoka, this volume) It appears that the oldest recovered sediments on the Pacific oceanic crust are about the same age (middle Bathonian) as those on oceanic crust of the Central Atlantic.

5. Implications for the early history of the Atlantic

Since 1983, the age of the Blake Spur Anomaly was though to be of early Callovian age, i.e. 20 my younger than assumed by extrapolation of magnetic anomalies by previous authors (Bryan *et al.* 1980). Site 534 is presumably located on magnetic anomaly M28, predicted by Bryan et al (1980) as of 160 my (middle Bathonian on the Van Hinte, 1976, time scale used by the author) This extrapolation fits remarkably well with our radiolarian ages of the oldest sediments at Site 534.

This means that the spreading ridge "jump" inferred to explain the gap between the East Coast and the Blake Spur Magnetic Anomalies must have occurred during the Bathonian rather than the Callovian.

Only slightly younger (UAZone 7, late Bathonian-early Callovian) ages are documented in the oldest sediments on Tethyan oceanic crust at several localities (see *Chapters 9, 10*, and *13*, this volume).

References

BAUMGARTNER, P.O. (1983). Summary of middle Jurassic-early Cretaceous radiolarian biostratigraphy of Site 534 (Blake-Bahama Basin) and correlation to Tethyan sections. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 569-571.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BERNOULLI, D. & LEMOINE, M. (1980). Birth and early evolution of the Tethys: the overall situation. *International Geological Congress 26th, Paris*, **C5**, 169-179.

BOWN, P.R. *et al.* (in press). Recent advances in Jurassic calcareous nannofossil research. .

BRYAN, G.M., MARKL, R.G. & SHERIDAN, R.E. (1980). IPOD Site Surveys in the Blake-Bahama Basin. *Marine Geology*, **35**, 43-63.

FOURCADE, E., AZEMA, J., CECCA, F., BONNEAU, M., PEYBERNES, B. & DERCOURT, J. (1991). Essai de reconstitution cartographique de la paléogéographie et des paléoenvironnements de la Tethys au Tithonique supérieur (138 a 135 Ma). *Bulletin de la Société Géologique de France, Série 8*, **162** (6), 1197-1208.

GRADSTEIN, F.M. (1983). Paleoecology and stratigraphy of Jurassic abyssal Foraminifera in the Blake-Bahama Basin (Western North Atlantic), Deep Sea Drilling Porject Site 534. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 537-559.

HABIB, D. & DRUGG, W.S. (1983). Dinoflagellate age of Middle Jurassic-Early Cretaceous sediments in the Blake-Bahama Basin. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 623-638.

MATSUOKA, A. (1983). Middle and Latest Jurassic Radiolarian Biostratigraphy in the Sakawa and Adjacent Areas, Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **26**, 1-48.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelle*, **80** (3), 317-340.

Sheridan, R.E., Gradstein, F.M. *et al.* (1983). Site 534: Blake-Bahama Basin. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 141-340.

Reale, V. & Monechi, S. (1994). *Cyclagelosphaera wiedmannii* new species, a marker for the Callovian. *Journal of Nannoplankton Research*, **16** (3), 117-119.

Remane, J. (1983). Calpionellids and the Jurassic/Cretaceous Boundary at the Deep Sea Drilling Project Site 534, Western North Atlantic Ocean. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 561-567.

Roth, P.H. (1983). Jurassic and Lower Cretaceous Calcareous nannofossils in the Western North Atlantic (Site 534): biostratigraphy, preservation, and some observation on biogeography and paleoceanography. *In* Sheridan, R.E., Gradstein, F.M. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **76**, 587-621.

Van Hinte, J.E. (1976). A Cretaceous Time scale. *The American Association of Petroleum Geologists Bulletin*, **60** (4), 498-516.

Yamamoto, H., Mizutani, S. & Kagami, H. (1985). Middle Jurassic radiolarians from Blake Bahama Basin, West Atlantic Ocean. *Bulletin of the Nagoya University, Furukawa Museum*, **1**, 25-49.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION POBMA30_DSDP_LEG_76_S_534: bottom 1-top 28
{sample 12 did not exist in BG84 > only 27 samples}
< 28 {081-2-003}: 3062, 3063, 3065, 3087, 3092, 3245, 3263, 3281, 3284, 3287, 3289, 3291, 3293, 3294, 3295
< 27 {081-2-064}: 3062, 3063, 3065, 3087, 3090, 3092, 3255, 3263, 3284, 3287, 3289, 3291, 3293, 3294, 3295, 5073
< 26 {089-2-047}: 3062, 3065, 3087, 3094, 3112, 3171, 3225, 3227, 3255, 3263, 3280, 3281, 3282, 3283, 3284, 3285, 3288, 3289, 3290, 3291, 4073, 6121, 6129
< 25 {106-1-029}: 3020, 3037, 3063, 3066, 3078, 3081, 3090, 3091, 3092, 3094, 3095, 3096, 3097, 3100, 3113, 3131, 3138, 3161, 3164, 3167, 3168, 3170, 3171, 3177, 3182, 3188, 3193, 3197, 3213, 3215, 3216, 3217, 3218, 3224, 3226, 3230, 3240, 3243, 3245, 3258, 3263, 3265, 3290, 4069
< 24 {111-1-012}: 3002, 3012, 3013, 3015, 3021, 3023, 3031, 3047, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3109, 3121, 3124, 3150, 3164, 3169, 3180, 3181, 3213, 3220, 3223, 3235, 3240, 3244, 3273, 3276, 3277, 3279,3290, 3292
< 23 {115-1-070}: 3013, 3047, 3051, 3052, 3059, 3061, 3062, 3063, 3064, 3085, 3096, 3110, 3118, 3150, 3277, 3279, 3290
< 22 {117-1-032}: 3013, 3017, 3044, 3046, 3051, 3052, 3064, 3078, 3085, 3096, 3124, 3169, 3189, 3204, 3210, 3236, 3239, 3244, 3273, 3276, 3279
< 21 {120-1-052}: 3008, 3012, 3017, 3049, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3085, 3096, 3103, 3110, 3113, 3121, 3139, 3140, 3147, 3150, 3152, 3160, 3163, 3167, 3169, 3176, 3180, 3181, 3193, 3199, 3266, 3267, 3413
< 20 {121-1-025}: 3013, 3033, 3044, 3052, 3064, 3085, 3096, 3113, 3117, 3118, 3119, 3121, 3124, 3131, 3135, 3150, 3152, 3160, 3180, 3199, 3205, 3210, 3215, 3216, 3223, 3235, 3244, 3254, 3273, 3276
< 19 {121-1-052}: 3031, 3044, 3051, 3062, 3064, 3065, 3076, 3082, 3085, 3090, 3096, 3103, 3113, 3116, 3117, 3118, 3121, 3123, 3124, 3131, 3133, 3135, 3137, 3140, 3150, 3152, 3159, 3160, 3167, 3169, 3197, 3204, 3210, 3213, 3215, 3220, 3222, 3244, 3254, 3267, 3269, 3273, 3278, 3290, 3292, 4010
< 18 {122-1-042}: 3003, 3013, 3014, 3016, 3017, 3020, 3024, 3031, 3033, 3044, 3045, 3046, 3051, 3052, 3055, 3061, 3062, 3063, 3064, 3078, 3085, 3116, 3117, 3118, 3121, 3139, 3147, 3150, 3152, 3169, 3180, 3181, 3189, 3192, 3193, 3210, 3212, 3216, 3222, 3235, 3236, 3240, 3244, 3276, 3279, 3292, 4010
< 17 {122-1-131}: 3008, 3012, 3013, 3052, 3055, 3064, 3085, 3103, 3113, 3124, 3137, 3140, 3150, 3163, 3169, 3176, 3181, 3216, 3217, 3236, 3240, 3243, 3265, 3273, 3290, 3413
< 16 {123-2-037}: 3008, 3013, 3044, 3049, 3052, 3061, 3064, 3085, 3106, 3121, 3150, 3169, 3176, 3181, 3277
< 15 {124-2-097}: 3031, 3033, 3044, 3055, 3061, 3076, 3078, 3103, 3121, 3124, 3147, 3150, 3152, 3160, 3161, 3169, 3176, 3181, 3210, 3213, 3244, 3273, 3274, 3292, 3413

< 14 {124-1-041}: 3012, 3031, 3044, 3045, 3051, 3052, 3055, 3059{2}, 3061, 3076, 3078, 3124, 3160, 3181, 3210, 3240, 3244, 3268, 3273, 3276, 3277, 3279, 3290, 3292, 3413, 4044

< 13 {124-1-052}: 3002, 3003, 3012, 3013, 3028, 3031, 3033, 3043, 3044, 3045, 3046, 3051, 3052, 3059{2}, 3061, 3076, 3078, 3097, 3104, 3118, 3124, 3152, 3159, 3169, 3187, 3189, 3210, 3215, 3221, 3222, 3239, 3240, 3244, 3254, 3271, 3273, 3276, 3279{1}, 3292, 3413, 4010

< 12 {125-2-035}: 3003, 3012, 3015, 3020, 3023, 3031, 3033, 3043, 3047, 3051, 3052, 3059, 3062, 3064, 3076, 3078, 3085, 3110, 3118, 3121, 3124, 3150, 3160, 3169, 3180, 3181, 3189, 3204, 3210, 3213, 3215, 3221, 3222, 3239, 3244, 3273, 3276, 3290, 3292, 3413, 4005, 4010

< 11 {125-2-115}: 3003, 3008, 3012, 3013, 3015, 3020, 3024, 3031, 3033, 3043, 3051, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3085, 3096, 3118, 3121, 3124, 3150, 3159, 3160, 3169, 3180, 3189, 3197, 3204, 3210, 3212, 3213, 3215, 3223, 3235, 3236, 3240, 3244, 3267, 3269, 3270, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4063

< 10 {125-4-001}: 3008, 3012, 3013, 3020, 3021, 3031, 3043, 3047, 3051, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3078, 3085, 3110, 3118, 3124, 3150, 3164, 3180, 3181, 3187, 3189, 3197, 3210, 3215, 3221, 3223, 3235, 3244, 3269, 3273, 3276, 3277, 3278, 3292, 3413

< 9 {125-5-072}: 3012, 3013, 3031, 3047, 3051, 3052, 3054, 3055, 3059, 3061, 3063, 3064, 3070, 3076, 3078, 3085, 3096, 3100, 3110, 3118, 3121, 3124, 3150, 3174, 3180, 3181, 3189, 3193, 3197, 3204, 3205, 3210, 3215, 3216, 3220, 3221, 3222, 3223, 3235, 3240, 3244, 3267, 3268, 3269, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4010, 4044, 4071

< 8 {125-5-111}: 3002, 3008, 3012, 3013, 3015, 3020, 3023, 3024, 3031, 3033, 3045, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3063, 3064, 3069, 3070, 3076, 3078, 3085, 3096, 3118, 3139, 3150, 3159, 3169, 3180, 3181, 3187, 3192, 3197, 3204, 3235, 3239, 3240, 3244, 3261, 3270, 3271, 3277, 3292, 3413, 4063

< 7 {125-6-013}: 3008, 3012, 3051, 3052, 3061, 3110, 3150, 3160, 3161, 3164, 3167, 3169, 3181, 3197, 3244, 3274, 4044

< 6 {125-6-063}: 3002, 3008, 3012, 3013, 3020, 3021, 3024, 3031, 3033, 3047, 3049, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3063, 3064, 3078, 3085, 3096, 3110, 3121, 3124, 3150, 3164, 3169, 3180, 3181, 3187, 3197, 3213, 3215, 3222, 3223, 3235, 3240, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4010, 4044, 4063

< 5 {126-2-045}: 3002, 3008, 3012, 3021, 3031, 3047, 3051, 3052, 3055, 3061, 3064, 3065, 3082, 3085, 3096, 3110, 3117, 3118, 3121, 3124, 3133, 3140, 3150, 3159, 3164, 3180, 3181, 3215, 3220, 3221, 3235, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3290, 3413, 4005, 4063

< 4 {126-2-065}: 3008, 3012, 3013, 3015, 3020, 3021, 3031, 3032, 3047, 3052, 3054, 3055, 3061, 3064, 3074, 3076, 3078, 3085, 3096, 3100, 3110, 3118, 3121, 3124, 3150, 3180, 3181, 3187, 3197, 3210, 3213, 3216, 3220, 3221, 3223, 3235, 3239, 3244, 3268, 3270, 3271, 3273, 3277, 3279, 3290, 3413, 4063

< 3 {126-2-125}: 3003, 3007, 3008, 3012, 3013, 3015, 3020, 3023, 3024, 3031, 3032, 3033, 3043, 3047, 3049, 3051, 3052, 3055, 3061, 3062, 3063, 3064, 3065, 3076, 3078, 3082, 3085, 3096, 3097, 3100, 3109, 3110, 3117, 3118, 3124, 3125, 3133, 3150, 3159, 3164, 3167, 3169, 3180, 3181, 3187, 3197, 3210, 3213, 3215, 3220, 3235, 3236, 3240, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3292, 3413, 4005, 4044, 4063

< 2 {126-4-140}: 3031, 3043, 3045, 3047, 3051, 3055, 3061, 3064, 3078, 3085, 3125, 3180, 3197, 3235, 3244, 3268, 3276, 3290, 3413, 4005

< 1 {76-534A-127-1-13-15}: 3276, 3012, 3047, 3052, 3055, 3061, 3064, 3065, 3082, 3085, 3088, 3096, 3097, 3113, 3124, 3140, 3164, 3169, 3197, 3215, 3221, 3223, 3235, 3238, 3244, 3270, 3273, 3277, 3412, 3413, 4032, 4061, 4063, 4072

8. Middle and Upper Jurassic radiolarian assemblages co-occurring with ammonites from the Subbetic Realm (Southern Spain)

by Luis O'Dogherty [1, 2], Peter O. Baumgartner [2], José Sandoval [3] Agustín Martín-Algarra [3] and Alain Pillevuit [2]

[1]Present address: Departamento de Geología Marina, Facultad de Ciencias del Mar, Universidad de Cádiz, 11510, Puerto Real, Spain

[2] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

[3] Departamento de Estratigrafía y Paleontología, Universidad de Granada, 18002 Spain.

ABSTRACT

Radiolarian-rich siliceous facies of the Middle-Upper Jurassic have been analyzed in different areas of the Subbetic realm (mediam and inner subbetic). This siliceous deposits occur within two stratigraphic units: (1) a lower siliceous unit (greenish calcareous radiolarites) Bathonian to Callovian in age and, (2) an upper siliceous unit (redish pelitic radiolarites) Oxfordian in age. Ammonites faunas recovered from interbedded and occasionally from the same layers allow a direct correlation to stages.

1 Geological and paleogeographical setting

1.1 Introduction

The present-day western Mediterranean Alpine chains form a mountain belt which almost completely surrounds the area occupied by the sea (Fig. 1). In this western Mediterranean region, three main realms are distinguished: the southern realm is related to the North African Rif and Tell chains; the eastern realm is made up of the Apennines; and the northwestern realm corresponds to the Betic Cordillera and the Balearic range. There are other neighbouring Alpine chains that must be considered separately: Middle Atlas, Saharian Atlas and Tunisian Atlas in the African margin, and Iberian chain, Catalonian coastal range, Pyrinees and Provence chains in the European margin.

It is classically considered that the Alpine Peri-mediterranean chains have been formed by collision between the Eurasian and the African plate, in the region where a great sea, the Tethys, was formerly located.

At the beginning of the Triassic, all these elements were part of a single continent Pangea, that extended from Eurasia to Africa. The Triassic distension was marked by both volcanism and transgression of shallow-water seas which initiated the separation of Iberia from both Europe and Africa. After the Triassic, a major break existed also along the eastern flank of Apulia, and separated this continental mass from Europe (Ricou *et al.*, 1986).

The installation of a carbonate platform over the Triassic sediments accompanied the beginning of the Jurassic. The prevailing facies in the Betic Cordillera are shallow-marine carbonate platform with episodes of tidal-flat and supratidal deposition (García-Hernández *et al.*, 1980). During the Jurassic, the change from shallow water to pelagic facies occurred. This event coincides with the breakdown of the main carbonate platforms all over the Mediterranean domain and with early stages of opening of the Central Atlantic (Bernoulli & Jenkins, 1974). Since this episode, deposition of radiolarites and siliceous sediments were common througouth the Middle-Upper Jurassic

This distensional stage established another major break between the Western Mediterranean blocks and both Africa and Apulia and gave rise to the creation of important basins and the individualisation of some continental blocks. Between the Alboran block and Iberia, the Jurassic distension created the Subbetic basin in which siliceous shales were deposited (García-Hernández et al., 1980). In the Upper Jurassic, Apulia was separated from Eurasia by an oceanic basin and the northern side of Apulia was divided into swells and troughs (Ricou et al., 1986).

1.2 Betic External Zones (Southern Iberian Margin)

The Betic Cordillera, the westernmost of the European Alpine Chains (Fig. 1), originated during the late Tertiary as a consequence of the drift of the African plate toward Iberia. This convergence caused the deformation of materials previously accumulated in two opposite continental margins, separated by a narrow fringe of oceanic or semioceanic character. Finally, an oblique collision of both took place as a consequence of the compressive orogenic activity (García-Hernández *et al.*, 1980; Martín-Algarra, 1987; Sanz de Galdeano, 1990). These continental margins had become separated throughout the Jurassic as a consequence of distensive tectonics, which were determined by the Central Atlantic opening and, in the Mediterranean regions, by the opening of the Ligurian-Thetys ocean.

This process brought about the appearance of more or less deep basins and subbasins in both margins. From a palaeogeographical point of view, the geological realms that

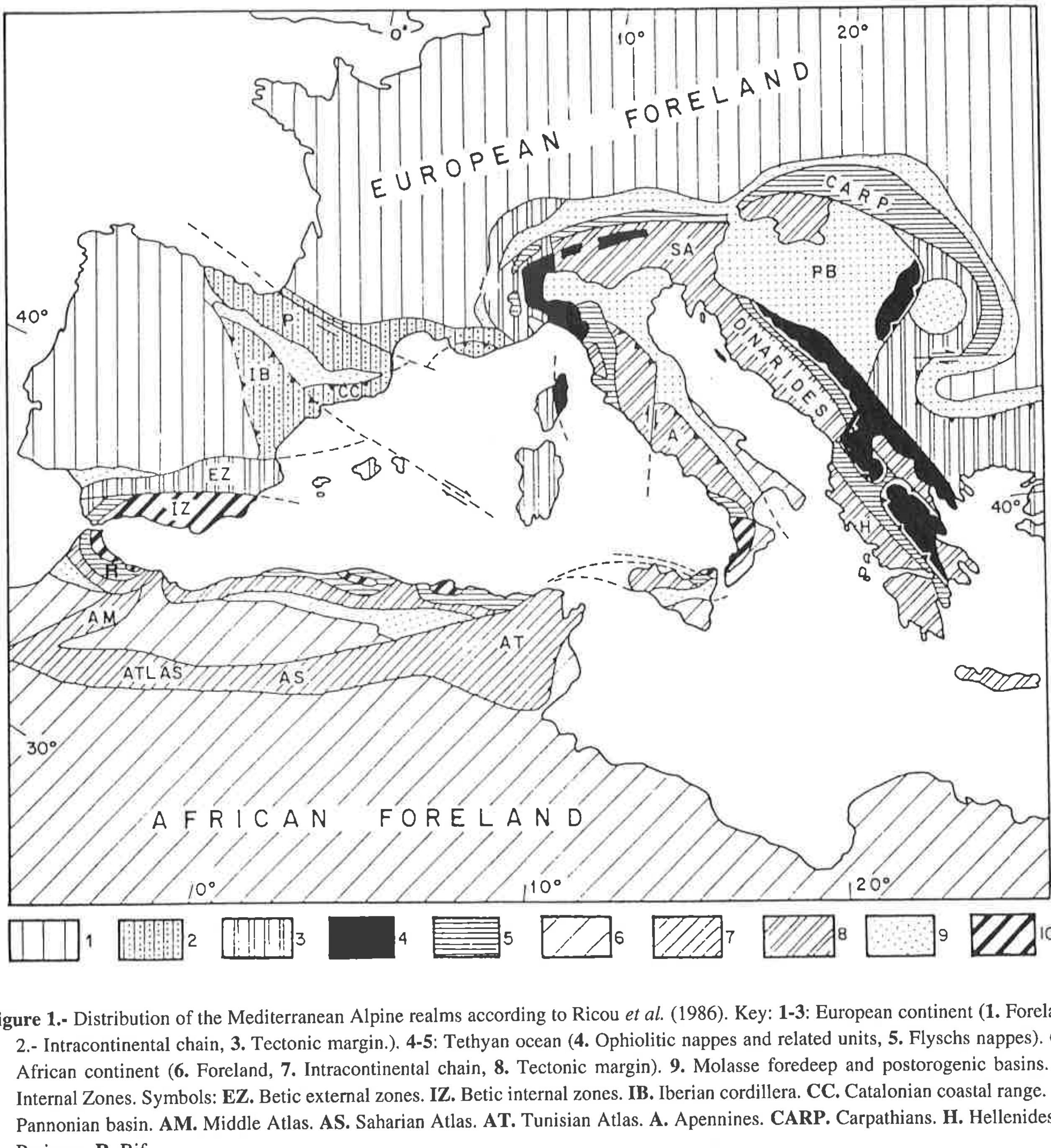


Figure 1.- Distribution of the Mediterranean Alpine realms according to Ricou *et al.* (1986). Key: **1-3**: European continent (**1.** Foreland, 2.- Intracontinental chain, **3.** Tectonic margin.). **4-5**: Tethyan ocean (**4.** Ophiolitic nappes and related units, **5.** Flyschs nappes). **6-8**: African continent (**6.** Foreland, **7.** Intracontinental chain, **8.** Tectonic margin). **9.** Molasse foredeep and postorogenic basins. **10.** Internal Zones. Symbols: **EZ.** Betic external zones. **IZ.** Betic internal zones. **IB.** Iberian cordillera. **CC.** Catalonian coastal range. **PB.** Pannonian basin. **AM.** Middle Atlas. **AS.** Saharian Atlas. **AT.** Tunisian Atlas. **A.** Apennines. **CARP.** Carpathians. **H.** Hellenides. **P.** Pyrinees. **R.** Rif.

make up the present Betic Cordillera were the western extreme of the tethyan regions. Through them and also the north African domains, Rif and Atlas, must have existed the biogeographic connections between these regions and peri-pacific regions.

Palinspastic and palaeogeographical reconstructions of the western end of the European Alpine chains during the Cretaceous recognise various major tectonic-palaeogeographic domains (plates or subplates). To the north there was the Southern Iberian Paleomargin (Fig. 2), now structured into tectonic units corresponding to the External Zones of the Betic Cordillera (García-Hernández *et al.*, 1980; Vera, 1988). To the south, lay the margin adjacent to the African plate, corresponding to the External Zones of the Rif. Between these plates to the east, where they tend to come together, there was a domain which Durand-Delga & Fontboté (1980) named the "Mesomediterranean subplate". The tectonic deformation of this subplate gave rise to the formation of the Internal Zones of both the Betic and Rif chains.

As mentioned above, two great geological realms can be recognised in the Betic Cordillera: the External and Internal Zones (cf. Figs. 1 and 2). Between them and their westernmost point, the Campo de Gibraltar Complex crops out. The latter is comprised of a suite of mainly Tertiary rocks (with some Mesozoic at the base). These were deposited in a depression with an oceanic or semioceanic substrate (North African Flysch Trough) lying between the African and Iberian plates and the Mesomediterranean subplate, the structure of which is today a complex of thrust nappes. During the Cretaceous, the North African Flysch Trough was situated in an oceanic or semi-oceanic seaway between the Tethys and North Atlantic.

Jurassic carbonate and siliceous pelagic sediments crop out in the southern Iberian paleomargin which forms part of various different tectonics units that make up the Betic Cordillera. They are found in a subsiding realm which lay adjacent and parallel to the edge of the continental platform: the External Zones.

The external zones are made up of Triassic to early Miocene rocks which were deposited along the Southern Iberian Palaeomargin. The tectonic style of the external Zones of the Betic Cordillera is typical of a sheared-off sedimentary cover (García-Hernández *et al.*, 1980). From the earliest studies of the External Zones (Blumenthal, 1927; Fallot, 1948), two major tectonic and paleogeographical domains have been recognised: the Prebetic and Subbetic (Fig. 2). The Subbetic, with an

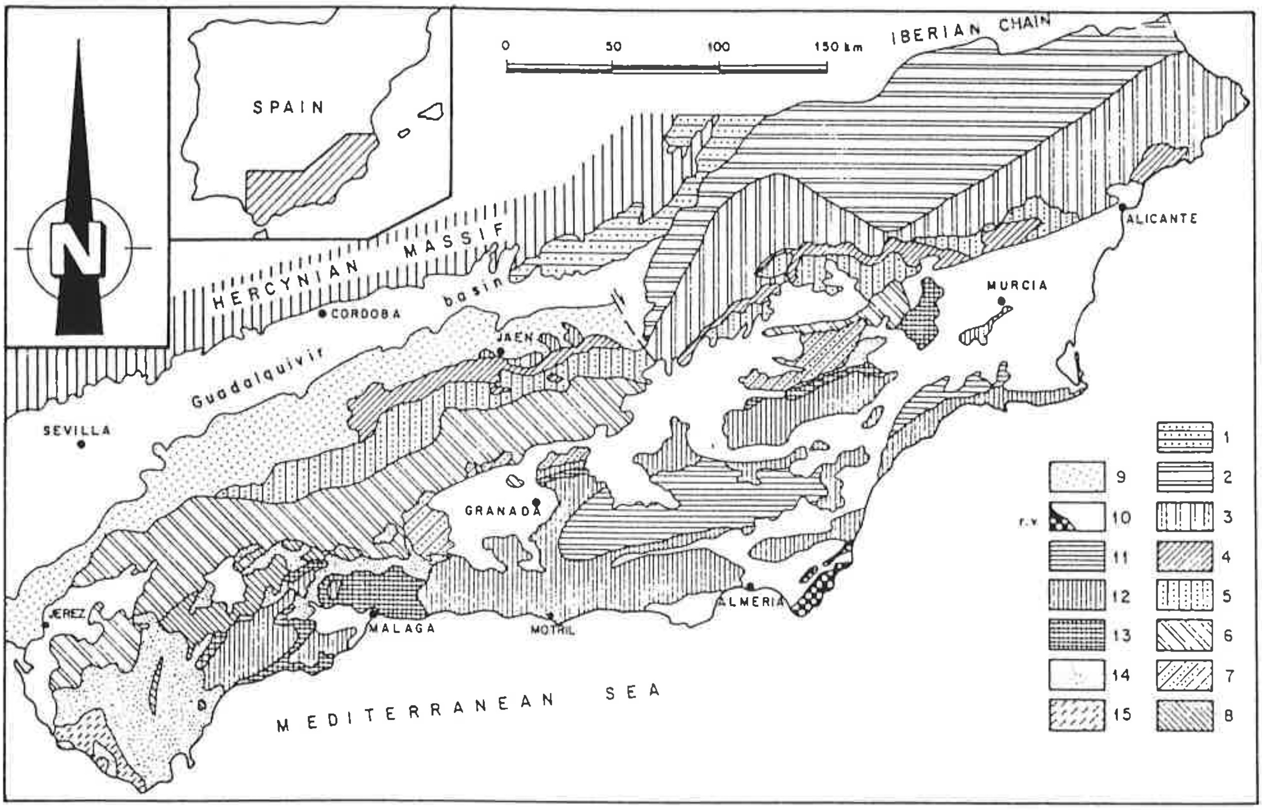


Figure 2. Geological sketch map of the Betic Cordillera showing the different geological units, equivalent to palaeogeographic domains (after Martín-Algarra *et al.*, 1992). *Key*: **1.** Non-folded cover (Mesozoic-Tertiary) of the Iberian Massif. **2-3**: Prebetic (**2.** External Prebetic, **3.** Internal Prebetic). **4.** Intermediate domain. **5-8**: Subbetic (**5.** External Subbetic, **6.** Median Subbetic, **7.** Internal Subbetic, **8.** Penibetic). **9.** Miocene Syntectonic deposits. **10.** Upper Miocene to Quaternary postorogenic deposits; **r.v.** volcanic rocks). **11-13**: Internal Zones (**11.** Nevado-Filábride, **12.** Alpujárride, including Rondaide, **13.** Maláguide). **14.** Flysch units of the Campo de Gibraltar Complex. **15.** Almarchal unit of the campo de Gibraltar Complex.

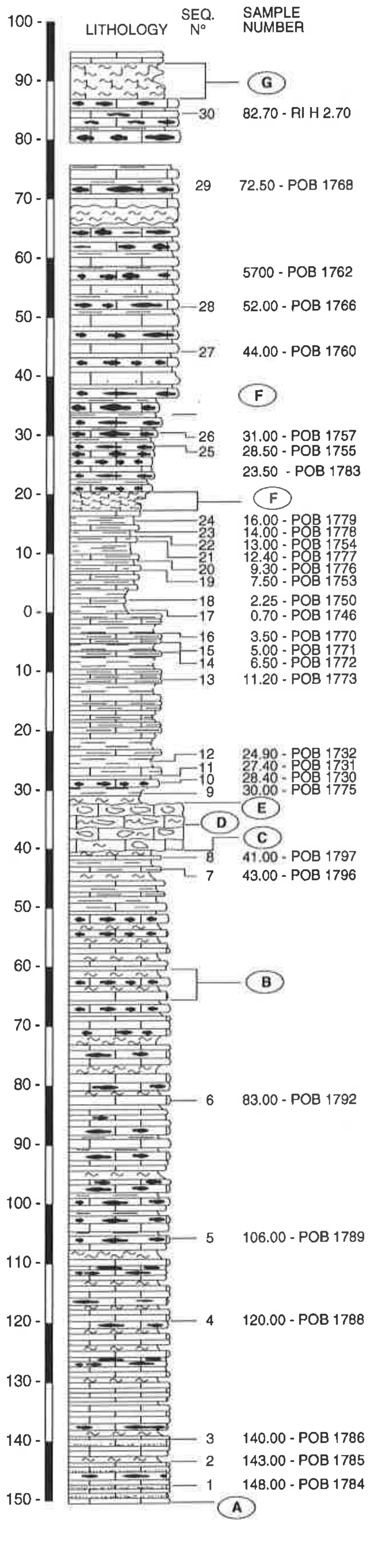


Figure 3. Lithostratigraphic log of the Sierra de Ricote section and position of samples and biostratigraphic ammonites data. (see text for ammonites position).

internal nappe structure, is allochtonous, in contrast to the para-autochtonous character of the Prebetic (García-Hernández *et al.*, 1980). There are also considerable differences between the Subbetic and Prebetic zones, both from a stratigraphic and palaeogeographical point of view.

During the Jurasic and Cretaceous times the Prebetic formed a pericontinental platform bordering the southwest of the old Iberian continent, where shallow-water environments prevailed. It was the site of thick, mainly carbonate, sedimentation interrupted from time to time by the influx of terrigenous sediments (Azema *et al.*, 1979; Vera, 1988). Basinwards, between the Prebetic and Subbetic, there existed a smaller, individual, palaeogeographical domain (cf. Fig. 2), which has been called the Intermediate Domain (Foucalt, 1960; Ruiz-Ortiz, 1980). In the innermost area of the basin was the Subbetic. Throughout the Cretaceous this was a pelagic zone with mainly marly and marly-calcareous sedimentation, punctuated locally by calciturbidites (Martín-Algarra *et al.*, 1992).

These larger domains can be subdivided into smaller subdomains. Specifically, the morphology of the Subbetic basin was very irregular due to severe Jurassic intracontinental rifting along the Southern Iberian Paleomargin (García-Hernández *et al.*, 1989), which gave rise to high swells and deep troughs. These subdomains were the External Subbetic, the Median Subbetic and the Internal Subbetic. The sedimentary patterns of these subdomains were very different during the Jurassic and Lower Cretaceous (Martín-Algarra, 1987).

The External Subbetic subdomain was a high swell throughout the Middle and Upper Jurassic (Azema *et al.*, 1979; García-Hernández *et al.*, 1980; Vera, 1986, 1988) and was locally emergent during the Lower Cretaceous (Molina, 1987). This swell separated the subsiding basin of the Intermediate Domain from another trough further from the continent: the Median Subbetic (Fig. 2). The internal edge of the margin was made up of yet another swell, the Internal Subbetic, which, far from being a homogeneous domain, comprised a chain of humps (Martín-Algarra, 1987) with relatively different stratigraphic characteristics from one site to another. The westernmost of these domains, named Penibetic, tended to subside the least and even became emerged and largely karsted during the Lower Cretaceous (Company *et al.*, 1982; González-Donoso *et al.*, 1983; Martín-Algarra, 1987). The boundaries between the Subbetic troughs and swells were specially suitable sites for gravity resedimentation processes and they often contain considerable quantities of turbidites and other reworked sediments. These deposits are practically all carbonates because the siliciclastic sediments from the Iberian continent rarely reached as far as the outermost sectors of the Subbetic.

2 Stratigraphic framework

The Middle Subbetic Zone, was a deep basinal marine environment, that has undergone the greatest subsidence in Subbetic region. Its thicker sediments are predominantly limestone, marl and radiolaritic and calcareous turbidite lithologies (Azema *et al.*, 1979; Vera, 1988).

In this study we present datas from sections belonging to the meadiam and inner Subbetic.

2.1 Studied section

We have selected only those sections (four sections) where ammonites have been found in the same stratigraphic level or close to the radiolarian level. The most part of these data are preliminary. A complete list of radiolarian fauna is given in the appendix.

Inner Subbetic

One section has been studied (Sierra Harana), refereces to stratigraphy and biostratigraphic data are found in Sequeiros (1974) and Sandoval (1983). The sample JA4-2, yielded a rich radiolarian fauna together with ammonites of middle Oxfordian age.

Middle Subbetic

Three sections have been studied: Sierra de Ricote, Casa Blanca and La Martina.

Sierra de Ricote: Refereces to stratigraphy and biostratigraphic data are found in Seyfried (1978), Sandoval (1983), Baumgartner (1987), O'Dogherty *et al.* (1989) In Figure 3 are indicated ammonites belonging to the following ammonite zones:

A Subfurcatum and Garantiana Zone late Bajocian
B Parkinsoni Zone late Bajocian
C Zigzag Zone early Bathonian
D Costatus Zone middle Bathonian
E Patina Zone early-middle? Callovian
F Divisum and/or Strombecki Zone early Kimmeridgian
G Buckhardticeras Zone early Tithonian

Camino de Casa Balnca: Refereces to stratigraphy and biostratigraphic data are found in Olóriz (1978), Olóriz *et al.*, (1979) and Sandoval (1983). One sample CB-7, yielded a rich radiolarian fauna together with ammonites of early Bathonian age.

Cerro de la Martina: Refereces to stratigraphy and biostratigraphic data are found in Sanz de Galdeano (1973) Sandoval (1983), O'Dogherty *et al.* 1989 one sample 89L-LM-16 yielded a rich radiolarian fauna together with ammonites of latest Bathonian age.

References

AZEMA, J., FOUCAULT, A., FOURCADE, E., GARCÍA-HERNÁNDEZ, M., GONZÁLEZ-DONOSO, J.M., LINARES, A., LINARES, D., LÓPEZ-GARRIDO, A.C., RIVAS, P. & VERA, J.A. (1979). *Las Microfacies del Jurásico y Cretácico de las zonas externas de las Cordilleras Béticas* - Servicio de Publicaciones, Universidad de Granada. 83 p.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BERNOULLI, D. & JENKYNS, H. (1974). Alpine, Mediterranean, and central Atlantic Mesozoic facies in relation to the early evolution of the Tethys. *In* Dott Jr., R.H. & Shaver, R.H. Eds. *Modern and ancient geosynclinal sedimentation* - Special Publication of the Society of Economic Paleontologists and Mineralogists, **19**, 129-160.

BLUMENTHAL, M. (1927). Versuch einer tektonischen Gliederung der Betischen Cordilleren von Central und Südwest Andalusien. *Eclogae Geologicae Helvetiae*, **20**, 487-592.

COMPANY, M., GONZÁLEZ-DONOSO, J.M., LINARES, D., MARTÍN-ALGARRA, A., REBOLLO, M., SERRANO, F., TAVERA, J.M. & VERA, J.A. (1982). Diques neptúnicos en el Cretácico del Penibético aspectos genéticos y etapas de relleno. *Cuadernos de Geología Ibérica*, **8**, 545-562.

DURAND-DELGA, M. & FONTBOTÉ, J.M. (1980). Le cadre structural de la Méditerranée occidentale. *In* Auboin, J., Debelmas, J. & Latreille, M. Eds. *Géologie des Chaînes alpines issues de la Tethys* - Mémoires du Bureau de Recherches Géologiques et Minières, Orleans, **15**, 67-85.

FALLOT, P. (1948). Les Cordilléres Bétiques. *Estudios Geológicos*, **4**, 259-279.

FOUCAULT, A. (1960-62). Problèmes paléogéographiques et tectoniques dans le Prébétique et le Subbétique dans la transversale de la Sierra Sagra (Province de Grenade, Espagne). *Société Géologique de France, Livre Mém. Prof. P. Fallot.* **1**, 175-182.

GARCÍA-HERNÁNDEZ, M., LÓPEZ-GARRIDO, A.C., RIVAS, P., SANZ DE GALDEANO, C. & VERA, J.A. (1980). Mesozoic paleogeographic evolution of the external zones of the Betic Cordillera. *Geologie en Mijnbouw*, **59** (2), 155-168.

GONZÁLEZ-DONOSO, J.M., LINARES, D., MARTIN-ALGARRA, A., REBOLLO, M., SERRANO, F. & VERA, J.A. (1983). Discontinuidades estratigráficas durante el Cretácico en el Penibético (Cordillera Bética). *Estudios Geológicos*, **39**, 71-116.

LINARES, A. & SANDOVAL, J. (1979). Contribución al estudio del Bajociense de la Sierra de Ricote (Murcia).

Cuadernos de Geología, Universidad de Granada, **8-9**, 275-307.

MARTÍN-ALGARRA, A. (1987).*Evolución geológica Alpina del Contacto entre las Zonas Internas y las Zonas Externas de la Cordillera Bética*. Ph.D. Thesis. University of Granada, 1171 p.

MARTÍN-ALGARRA, A., RUIZ-ORTIZ, P.A. & VERA, J.A. (1992). Factors controlling Cretaceous Turbidite deposition in the Betic Cordillera. *Revista de la Sociedad Geológica de España*, **5** (1-2), 53-80.

MOLINA, J.M. (1987).*Análisis de facies del Mesozoico en el Subbético externo (Provincia de Córdoba y Sur de Jaén)*. Ph.D. Thesis. University of Granada, 518 p.

O'DOGHERTY, L., SANDOVAL, J., MARTIN-ALGARRA, A. & BAUMGARTNER, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

OLÓRIZ, F. (1978). *Kimmeridgiense-Tithónico inferior en el sector central de las Cordilleras Béticas. Zona Subbética. Paleontología. Bioestratigrafía*. Ph.D. Thesis. University of Granada, 758 p.

OLÓRIZ, F., RIVAS, P. & TAVERA, J.M. (1979). La serie jurásica de la Unidad de Casa Blanca-Puerto de las Palomas (prov. de Jaén, Zona Subbética). *Cuadernos de Geología, Universidad de Granada*, **10**, 605-616.

RICOU, L.E., DERCOURT, J., GEYSSANT, J., GANDJACQUET, C., LEPVRIER, C. & BIJU-DUVAL, B. (1986). Geological constrains on the Alpine evolution of the Mediterranean Tethys. *Tectonophysics*, **123**, 83-122.

RUÍZ-ORTIZ, P.A. (1980).*Análisis de facies del Mesozoico de las unidades intermedias (entre Castril-Prov. de Granada y Jaén)*. Ph.D. Thesis. University of Granada, 272 p.

RUIZ-ORTIZ, P.A., BUSTILLO, M.A. & MOLINA, J.M. (1989). Radiolarite sequences of the Subbetic, Betic Cordillera, southern Spain. *In* Hein, J.R. & Obradovic, J. Eds. *Siliceous Deposits of the Tethys and Pacific Regions* - Springer-Verlag, New York, 107-127.

SANDOVAL, J. (1983). *Bioestratigrafía y Paleontología (Stephanoceratacea y Perisphinctacea) del Bajocense y Bathonense en las Cordilleras Béticas*. Ph.D. Thesis. University of Granada, 613 p.

SANDOVAL, J. (1990). A revision of Bajocian zones division in the Subbetic (Southern Spain). *In* Cresta, S. & Pavia, G. Eds. *Meeting on Bajocian stratigraphy.* Memorie Descrittive della Carta Geologica d'Italia, **40**, 141-162

SANZ DE GALDEANO, C. (1973). *Geología de la transversal Jaén-Frailes, Provincia de Jaén*. Ph.D. Thesis. University of Granada, 274 p.

SANZ DE GALDEANO, C. (1990). Geologic evolution of the Betic Cordilleras in the Western Mediterranean, Miocene to the present. *Tectonophysics*, **172**, 107-119.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SEQUEIROS, L. (1974). *Paleobiogeografía del Calloviense y Oxfordiense en el Sector Central de la Zona Subbetica.* Ph.D. Thesis (n° 65). University of Granada, 636 p.

SEYFRIED, H. (1978a). Der subbetische Jura von Murcia (Südost Spanien). *Geologisches Jahrbuch, Reihe B, Regionale Geologie Ausland*, **29**, 1-204.

SEYFRIED, H. (1978b). Ensayo sobre el significado paleogeográfico de los sedimentos del Jurásico de las Cordilleras Béticas orientales. *Cuadernos de Geología, Universidad de Granada*, **10**, 317-348.

VERA, J.A. (1986). Las Zonas Externas de la Cordillera Bética. *Libro Jubilar J. M. Rios: Geología de España* - Instituto Geológico Minero de España, Madrid. **2**, 218-251.

VERA, J.A. (1988). Evolución de los sistemas depósitos en el margen ibérico de la Cordillera Bética. *Revista de la Sociedad Geológica de España*, **1** (3-4), 373-391.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991). Sample numbers are given in parenthesis (see Fig. 3 for the stratigraphic position of the samples in different sections).

SECTION CASA_BLANCA: bottom 1 - top 1
< 1{89cb7}: 3051, 3064, 3192, 3197, 3231, 3297, 4044, 4054, 4058

SECTION 59_LO_S_HARANA: bottom 1 - top 1
< 1{JA4-2}: 3017, 3064, 3065, 3069, 3082, 3104, 3122, 3161, 3162, 3163, 3164, 3193, 3230, 3241, 3263, 3274, 3305, 3171, 3176, 4055,4069, 4073

SECTION 60A_CERRO_LA_MARTINA: BOTTOM 1 - TOP 2
< 1{89L-M-6}: 3122, 3006, 3064, 3085, 3095, 3096, 3121, 3159, 3160, 3163, 3164, 3167, 3169, 3181, 3241, 3266
< 2{89N-M-16. 0.5m below 16}: 3241, 3161, 3164, 3167, 3171, 3181, 3185, 3224, 3230, 3265, 3274, 4069

SECTION 58_LO__CB_7: bottom 1 - top 1
< 1: 3051, {3084,} 3192, 3197, 3231, 3297, 4044, 4054, 4058

SECTION 45_POBLO_SIERRA_DE_RICOTE: bottom 1 - top 30
< 30: 3171, 3161, 3203, 3286, 4069
< 29: 3094, 3097, 3161, 3171, 3286, 4069
< 28: 3094, 3097, 3100, 3161, 3171, 3177, 3218, 3243, 4069
< 27: 3094, 3097, 3100, 3113, 3161, 3171, 3177, 3218, 3243, 4069
< 26: 3094, 3097, 3100, 3103, 3113, 3122, 3161, 3171, 3177, 3218, 3243, 4069
< 25: 3094, 3097, 3100, 3103, 3113, 3122, 3161, 3171, 3177, 3218, 3243, 3263, 4069
< 24: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3218, 3230, 3243, 3263, 4069
< 23: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 22: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 21: 3069, 3095, 3097, 3100, 3103, 3113, 3122, 3160, 3161, 3162, 3164, 3176, 3181, 3193, 3197, 3199, 3215, 3218, 3230, 3241, 3243, 3263, 3295, 4055, 4069
< 20: 3095, 3097, 3100, 3103, 3113, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 19: 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3121, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3215, 3218, 3230, 3243, 3244, 3263, 4069
< 18: 3017, 3064, 3069, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3121, 3122, 3160, 3161, 3162, 3164, 3176, 3181, 3193, 3197, 3199, 3210, 3215, 3223, 3241, 3244, 3263, 3292, 4010, 4055, 4069
< 17: 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 16: 3012, 3052, 3064, 3065, 3082, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3164, 3176, 3181, 3197, 3199, 3210, 3215, 3230, 3244, 4069
< 15: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 14: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 13: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3160, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 12: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3160, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 11: 3008, 3012, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3121, 3160, 3164, 3166, 3169, 3181, 3197, 3199, 3210, 3215, 3244
< 10: 3008, 3012, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3121, 3160, 3164, 3166, 3169, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 9 {POB1775}: 3008, 3012, 3051, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3110, 3121, 3124, 3160, 3162, 3164, 3166, 3169, 3176, 3181, 3193, 3197, 3199, 3210, 3215, 3230, 3244, 3273, 4010, 4060, 4069
< 8 {POB1797}: 3007, 3008, 3012, 3052, 3055, 3064, 3085, 3095, 3096, 3103, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 7 {POB1796}: 3006, 3012, 3051, 3052, 3055, 3061, 3064, 3095, 3096, 3103, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273, 3297, 4044, 4053, 4054, 4058
< 6: 3012, 3051, 3052, 3055, 3061, 3064, 3095, 3096, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 5: 3051, 3055, 3061, 3064, 3095, 3096, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 4: 3051, 3055, 3061, 3064, 3096, 3110, 3124, 3159, 3169, 3181, 3197, 3210, 3231, 3244, 3273
< 3: 3051, 3064, 3096, 3124, 3159, 3169, 3181, 3197, 3210, 3231, 3244, 3273
< 2: 3051, 3064, 3096, 3124, 3159, 3169, 3181, 3197, 3210, 3244, 3273

< 1{POB1784}: 3005, 3011, 3051, 3064, 3089, 3096, 3124, 3149, 3159, 3169, 3181, 3192, 3197, 3231, 3244, 3273, 3307, 3309, 4058

9. Radiolarians from the Base of the Supra-ophiolitic Schistes Lustrés Formation in the Alps (Saint-Véran, France and Traversiera Massif, Italy)

by Patrick De Wever[1] and Peter O. Baumgartner[2]

[1] CNRS-Université Pierre et Marie Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France

[2] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

ABSTRACT

The re-examination of a radiolarian fauna from the basal strata of the metamorphosed sedimentary cover of an ophiolitic series (Schistes Lustrés Sequence) indicates a Bathonian-Callovian age. This age is different from that previously given for this fauna. It is older than the age determined nearby for equivalent strata (Saint-Véran, Queyras, France). A diachronism is thus proved for these radiolarites of the western alps. It leads us to reject this strata as a chronostratigraphic level.

1. Introduction

The Chabrière Series (Lemoine, 1971) belongs to the "Schistes Lustrés" s.l. of the French Alps and it represents the sedimentary cover of an ophiolite. This series begins with red and green siliceous beds thought to be the metamorphosed equivalent of radiolarite. The radiolarite is less recrystallised in the Mont Genèvre area where it yields radiolarians (Squinabol, 1913; Cayeux, 1929). This facies is usually overlain by light coloured marble thought to be the equivalent of the calpionellid limestone of the Apennines (Val Lavagna Formation) (Lemoine, 1971), which themselves are overlain by alternating schists and limestone and then by black clayey schists (Middle Cretaceous?)

Radiolarian also exist in the basal strata of the metamorphosed sedimentary cover of an ophiolitic series (Schistes Lustrés Sequence, high Maira Val, Italy) and permit the determination of a Callovian age (De Wever *et al.*, 1987). This age is therefore older than that obtained nearby for equivalent strata (Saint-Véran, Queyras, France) and demonstrates diachroneity for these western Alpine radiolarites.

Ligurian ophiolites exist at the base of the large overthrust of the inner Ligurides over the African Plate (Vara Supergroups, Abbate *et al.*, 1980). The lower part of the ophiolitic nappe (which is highly serpentinised) is generally composed of gabbros, diorites and plagiogranites, and is radiochronologically dated as:

(1) 185-162 Ma (Bigazzi *et al.*, 1973), = Sinemurian to Bathonian according the Van Hinte's scale (1976) but Mid Aalenian to Early Oxfordian according to the scale of Harland *et al.* (1982), and

(2) 193-163 Ma (Fontignie *et al.*, 1982) = Toarcian to Oxfordian according to Kent & Gradstein's scale (1985) but Mid Bathonian to Hettangian according Van Hinte (1976), and also

(3) 212-192 Ma (Carpena & Caby, 1984) = Norian to Sinemurian according to the scale of Odin & Odin (1990).

The Ligurian ophiolites were transformed by a high metamorphic grade (high pressure-low temperature) to a greenschist facies in an oceanic environment. The lower part of this nappe is overlain by pillow basalts or sedimentary rocks (radiolarite and micritic limestone).

2. Locations

2.1. Description of the Saint-Véran section

The section is located on the north-east flank of Pic Cascavelier (sheet Aiguilles, 1/25'000, altitude 2'530 m). Structurally, the sequence corresponds to the reverse flank of the Pic Marcel syncline-like fold (Lemoine, 1971 and Tricard, 1974).

The metacherts form a regular horizon in sedimentary contact, although slightly tectonised, with an ultramafic formation made of either ophicalcites or breccias. Further to the south-east this horizon is in contact with metabasalts and breccias with granitoid elements (Caby et al., 1971).

The metamorphosed cherts are exposed as ribbon cherts 15m thick (fig. 1). The rocks are highly deformed in isoclinal folds (Caby, 1973, cf. figs. 1-5). Their geometry reveals high pressure/low temperature deformation (see below). The stratification remains visible in this formation.

A. The basal schistose formation is composed of (in depositional order):
- **A1:** thin ribbon-like basic schists (= 2 m); chloritites to magnesian chlorite; schists with tremolite and talc; carbonaceous glaucophanites with white mica;
- **A2:** ankeritic marble horizon, previously used as ornamental stone (0 to 2.50 m); laterally enriched in garnet (grossularite);
- **A3:** slightly siliceous chloritoschists (1.50 m) rich in needles of blue amphibole, and showing millimetric layers of white micas, quartz, serpentine and chlorites. The overall composition is basic to ultrabasic (fragments of pyroxene, sphene, altered chromite, serpentine; talc and garnet, copper impregnations and phosphatic ribbons).

B. Ribbon metaradiolarite (10 m), green near the base, strongly folded and with several lithologies:
- **B1:** white microquartzite with red-purple and green ribbons of iron micas;
- **B2:** red haematitic chert;
- **B3:** red iron pelitic schists with quartz, albite, and white mica, chlorite, apatite, metallic oxides and carbonates. Tiny needles of lawsonite, blue amphibole and aegerine are spread in the rock.

The section is a vertical cliff and the radiolarian sample was collected at its base. It corresponds to an isoclinal fold as thick as 10 cm in the fold axis but as thin as 2 cm on the flanks.

2.2. Description of the Traversiera section

The Traversiera Massif contains an outcrop of green rocks among the Schistes Lustrés (calcschistes) of the Piedmont Zone. This massif is located on the Italian side of Cottian Alps, north of Acceglio village (high Val Maira). It merges with a north-south strip of Schistes Lustrés, between the Acceglio Zone and the Roure Zone (Internal Briançonnais), in continuation with the massifs of Roche Noire, Pelvat de Chabrière and Mont Gabel.

The ophiolites are composed of serpentinites and metamorphosed pillow basalts (blue schist facies). A multimetric thick bed of light coloured marble stratigraphically covers serpentinites (to the west) and basalts (to the east) and is thought to be of Mid Jurassic (Malm) age, as in the Chabrière Series (Lemoine et al., 1986). Radiolarian lenses (up to 3-4 m thick and 10-20m long) occur between the marble and the ophiolite. Radiolarite also occurs as thin horizons within basaltic breccias.

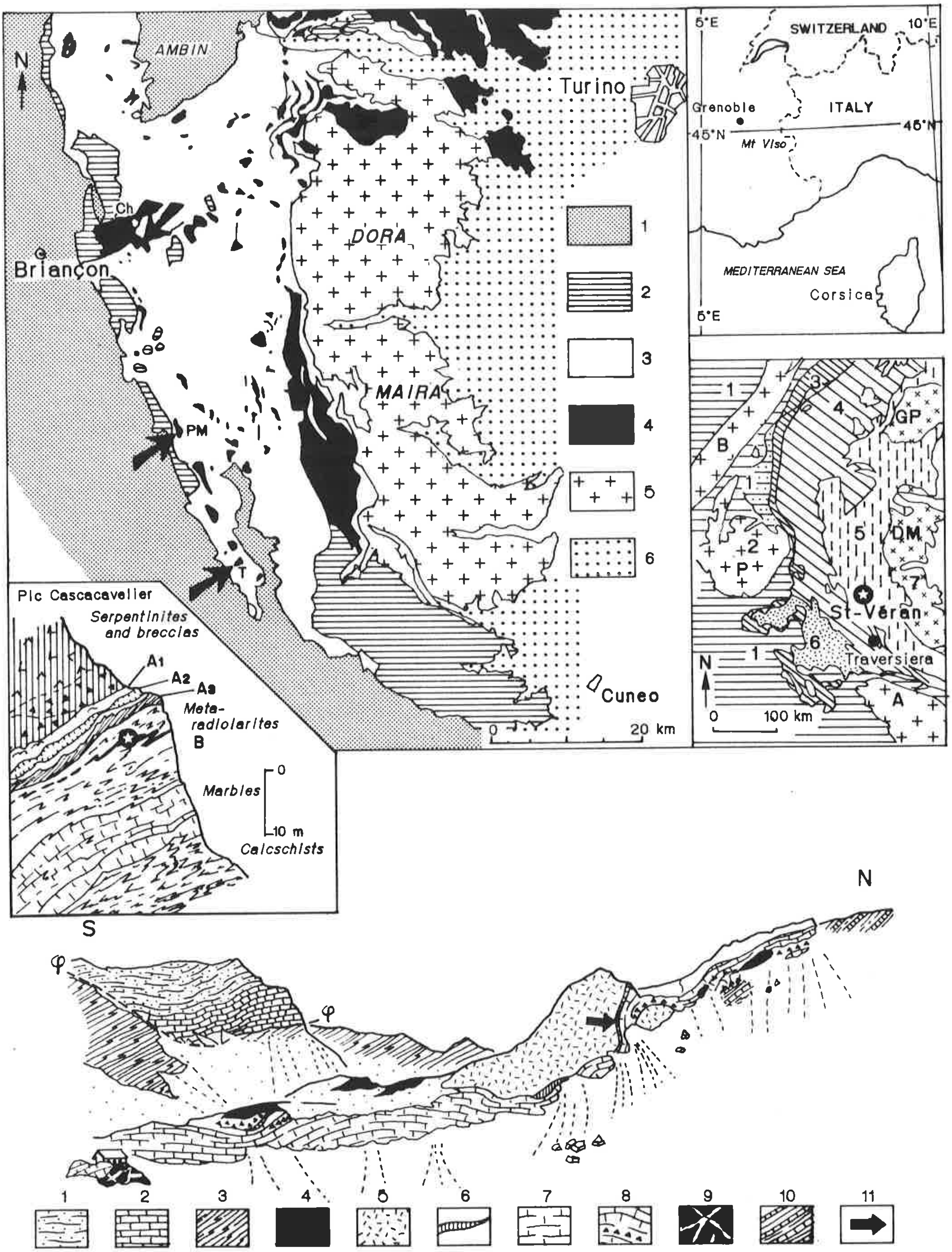
Figure 1. Upper right: Geographic location of sections from Queyras and Traversiera.

Centre right: Location map of the studied sections (indicated by stars):
1. External zones, **2.** External crystalline massifs, **B.** Belledonne, **P.** Pelvous, **A.** Argenteras; **3.** Valaisan and Subbriançonnais zones, **4.** Briançonnais zone, **5.** Piedmont zone, **6.** Allochthonous flysch, **7.** Internal crystalline massifs, **GP.** Grand Paradis, **DM.** Dora Maira

Upper left corner: Geological sketch map of the sections from the Alps (indicated by arrows):
1. Briançonnais zone, **2.** External Piedmont, **3.** Undifferentiated Schistes Lustrés, **4.** Ophiolites, **5.** Dora Maira Massif, **6.** Pô plain, **PM.** Pic Marcel (Queyras section), **T.** Traversiera

Centre left: Section of the supra-ophiolitic sequence (in reverse order) on the north-east flank of Pic Cascavelier.
A. Basal schistose formation, **A1.** Ribbon basic schists, **A2.** Ankeritic marble, **A3.** Chlorito-schists; **B.** Metamorphosed ribbon radiolarite with white microquartzite, hematitic chert, and red pelitic schists. ✪**.** marks the radiolarian layer.

Bottom centre: View of the Traversiera massif.
1. Triassic quartzite from Roure (background), **2.** Triassic dolomites from Roure (background); **3.** Calcschists; **4.** Serpentinites; **5.** Metamorphosed pillow-basalts; **6.** Radiolarian cherts; **7.** Marbles; **8.** Ophiolitic breccias within marbles; **9.** Ophicalcites; **10.** Schists and limestones; **11.** Position of samples.


AMBIN
N
Turino
Ch
Briançon
DORA
MAIRA
PM
T
Cuneo
0
20 km
1
2
3
4
5
6
5°E
SWITZERLAND
10°E
Grenoble
ITALY
45°N
45°N
Mt Viso
MEDITERRANEAN SEA
Corsica
5°E
1
3
4
GP
B
1
5
DM
2
P
7
St-Véran
6
Traversiera
N
1
A
0
100 km
Pic Cascacaveller
Serpentinites
and breccias
A1
A2
A3
Meta-
radiolarites
B
Marbles
0
10 m
Calcschists
S
N
1
2
3
4
5
6
7
8
9
10
11

3. Radiolarians

3.1. Radiolarian preservation of the Saint-Véran radiolarians.

The analysed sample consists of 50% quartz crystals which isolate angular carbonaceous fragments (1 to 2 mm in size). The later are spherolites (entire or broken) made of rhodocrosite (MnCO3) with a margin made of kutnahorite (Ca (Mn, MgFe) (CO3)2). Undeformed radiolarians are embedded in rhodocrosite.

Observation of the various petrographic structures reveals that the original rock was a radiolarian chert rather than a calcarenite (see De Wever & Caby, 1981). Radiolaria are exclusively preserved in kutnahorite spherulites. Their exceptional state of preservation is the result of early diagenetic fossilisation within a rhodocrosite medium, which is inert under these metamorphic conditions.

3.2. Radiolaria from Saint-Véran section

Radiolarian were extracted from the rock with Hydrochloric acid by standard techniques (De Wever 1979, 1982). The following radiolarians were recognized (De Wever & Caby, 1981) :

Acaeniotyle diaphorogona gr. FOREMAN sensu BAUMGARTNER
Bernoullius dicera (BAUMGARTNER)
Crucella theokaftensis BAUMGARTNER
Emiluvia salensis PESSAGNO
Mirifusus guadalupensis PESSAGNO
Pantanellium riedeli PESSAGNO
Paronaella pygmaea BAUMGARTNER
Parvicingula boesii gr. (PARONA)
Perispyridium ordinarium gr. (PESSAGNO)
Podobursa helvetica (RÜST)
Podobursa spinosa (OZVOLDOVA)
Podocapsa amphitreptera FOREMAN
Pseudocrucella adriani BAUMGARTNER
Pseudocrucella sanfilippoae (PESSAGNO)
Saitoum elegans DE WEVER
Saitoum pagei PESSAGNO
Tetraditryma corralitosensis s.l. (PESSAGNO)
Tetraditryma pseudoplena BAUMGARTNER
Tritrabs casmaliaensis (PESSAGNO)

3.3. Radiolaria from Traversiera.

Phosphatic nodules (hydroxyl-apatite, Lagabrielle, 1987) exist within folded and schistose radiolarite. 10 nodules (2 to 20 cm in size) were etched with hydrochloric acid (5 to 15% during 2 to 48 h) (De Wever *et al.*, 1987). The following radiolarians were identified:

Angulobracchia purisimaensis (PESSAGNO)
Emiluvia hopsoni PESSAGNO
Emiluvia premyogii BAUMGARTNER
Emiluvia salensis PESSAGNO
Higumastra imbricata (OZVOLDOVA)
Homoeoparonaella argolidensis BAUMGARTNER
Monotrabs plenoides gr. BAUMGARTNER
Palinandromeda depressa (DE WEVER & MICONNET)
Paronaella kotura BAUMGARTNER
Podobursa helvetica (RÜST)
Tetraditryma corralitosensis s.l. (PESSAGNO).
Tetraditryma pseudoplena BAUMGARTNER
Transhsuum brevicostatum gr. (OZVOLDOVA)
Triactoma jonesi (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)

4. Conclusions

The Radiolarian association identified from Saint-Véran dates the sample now as middle-late Oxfordian (UAZ. 9-9).

Radiolarians from phosphatic nodules from Traversiera are now dated as UAZ. 7-7 (late Bathonian-early Callovian) by the zonation proposed in this book.

Radiolarians from Saint-Véran nodules and those from Traversiaera are thus not of the same age despite the close geographical proximity (Cottian Alps). The age difference may range from 7 to 15 Ma.

A mid-late Callovian age was also indicated by radiolarians overlying Ligurian ophiolites (Rocchetta di Vara - Baumgartner, 1984; now dated UAZ. 6 - 8, middle Bathonian to middle Callovian-early Oxfordian, this volume) whereas southwards and in Elba, the base of the radiolarite has been dated as Mid Oxfordian-Early Kimmeridgian (Conti & Marcucci, 1986). Samples from Monte Campanello and from S. Felo-Namia (Baumgartner, 1984) now date the base of the radiolarites in Elba as UAZ. 8-10 (middle Callovian-early Oxfordian to late Oxfordian-early Kimmeridgian, see *Chapter 5*) The diachronism thus appears consistent in both areas (Cottian Alps and Liguria, Elba). The absolute ages assigned by various authors to these stages clearly indicate an important diachronism of the ocean floor formed in the Liguria-Piemont Ocean.

References

ABBATE, E., BORTOLOTTI, V. & PASSERINI, P. (1980). Apennines ophiolites: a peculiar oceanic crust. *In* Rocci, G. Ed. *Tethyan ophiolites* - Ofioliti, Special Issue, Firenze, **1**, 59-93.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BIGAZZI, G., BONADONNA, F.P., FERRERA, G. & INNOCENTI, F. (1973). Fission track ages of zircons and apatites from Northern Apennine ophiolites. *Fortschritte der Mineralogie,* **50** (3), 51-53.

CABY, R. (1973). Les plis transversaux dans les Alpes occidentales: implications pour la genèse de la chaîne alpine. *Bulletin de la Société Géologique de France, Série VII,* **15** (5-6), 624-634.

CABY, R., MICHARD, A. & TRICART, P. (1971). Découverte d'une brèche polygénique à éléments granitoïdes dans les ophiolithes métamorphiques piémontaises (schistes lustrés du Queyras, Alpes françaises). *Comptes Rendus de l'Académie des Sciences de Paris, Série II,* **273**, 999-1002.

CARPENA, J. & CABY, R. (1984). Fission-track evidence for late Triassic oceanic crust in the french occidental Alps. *Geology,* **12**, 108-111.

CAYEUX, L. (1929). *Les roches sédimentaires de France* - Imprimerie Nationale, Paris. 454 p.

CONTI, M. & MARCUCCI, M. (1986). The onset of radiolarian deposition in the ophiolite sequences of the Northern Apennine. *Marine Micropaleontology,* **11**, 129-138.

DE WEVER, P. (1982). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication,* **7**, 1-599.

DE WEVER, P., BAUMGARTNER, P.O. & POLINO, R. (1987). Précision sur les datations de la base des Schistes Lustrés postophiolitiques dans les Alpes Cottiennes. *Comptes Rendus de l'Académie des Sciences de Paris, Série II,* **305**, 487-491.

DE WEVER, P. & CABY, R. (1981). Datation de la base des schistes lustrés postophiolitiques par des radiolaires (Oxfordien supérieur-Kimmeridgien moyen) dans les Alpes Cottiennes (Saint-Véran, France). *Comptes Rendus de l'Académie des Sciences de Paris, Série II,* **292**, 467-472.

DE WEVER, P., RIEDEL, W.R., BAUMGARTNER, P., DUMITRICA, P., BJØRKLUND, K.R., CAULET, J.P., DROBNE, K., GRANLUND, A. & KOCHER, A.R. (1979). Recherches actuelles sur les Radiolaires en Europe. *Annales de la Société Géologique du Nord, Lille,* **96**, 205-222.

FONTIGNIE, D., DELALOYE, M. & BERTRAND, J. (1982). Ages radiométriques K/Ar des éléments ophiolitiques de la Nappe des Gets (Haute-Savoie, France). *Eclogae Geologicae Helvetiae,* **75** (11), 117-126.

HARLAND, H.B., ARMSTRONG, R.L., COX, A.V., CRAIG, L.E., SMITH, A.G. & SMITH, D.G. (1989). *A geologic time scale* - Cambridge University Press, Cambridge/New York/Port Chester. 263 p.

KENT, D.V. & GRADSTEIN, F.M. (1985). A Cretaceous and Jurassic geochronology. *Geological Society of America, Bulletin,* **96** (11), 1419-1427.

LAGABRIELLE, Y. (1987). *Les ophiolites: marqueurs de l'histoire tectonique des domaines océaniques. Le cas des Alpes franco-italiennes (Queyras, Piémont), comparaison avec les ophiolites d'Antalya (Turquie) et du Coast Range de Californie.* Thèse de Doctorat d'Etat. Université de Bretagne Occidentale, Bretagne, 350 p.

LEMOINE, M. (1971). Données nouvelles sur la série du Gondran près de Briançon (Alpes Cottiennes). Réflexions sur les problèmes stratigraphique et paléogéographique de la zone piémontaise. *Géologie Alpine,* **47**, 181-201.

LEMOINE, M., BAS, T., ARNAUD-VANNEAU, A., ARNAUD, H., DUMONT, T., GIDON, M., BOURBON, M., DE GRACIANSKI, P.C., RUDKIEWICZ, J.L., MEGARD-GALLI, J. & TRICART, P. (1986). The continental margin of the Mesozoic Tethys in the Western Alps. Marine and Petroleum *Geology,* **3**, 179-199.

ODIN, G.-S. & ODIN, C. (1990). Echelle numérique des temps géologiques. *Géochronique,* **35**, 12-22.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles,* **80** (3), 317-340.

SQUINABOL, S. (1913). Radiolari della strada nazionale al Monginervo. *Bollettino del Reale Comitato Geologico d'Italia,* **43** (2-3), 281-289.

TRICARD, P. (1974). Les schistes lustrés du Haut-Cristallin (Alpes Cottiennes, France): lithostratigraphie, architecture et tectogenèse. *Géologie Alpine,* **50**, 131-152.

VAN HINTE, J.E. (1976). A Cretaceous Time scale. The American Association of Petroleum *Geologists Bulletin,* **60** (4), 498-516.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION
DW2_ALPES_QUEYRAS_DW81:
bottom 1 - top 1
< 1 {DW2_ALPES_QUEYRAS_DW81}: 3020, 3022, 3078, 3090, 3100, 3117, 3123, 3126, 3129, 3131, 3133, 3160, 3169, 3171, 3185, 3215, 3223, 3230, 3273

SECTION
DW3_ALPES_ITALIE_TRAVERSIERA_DWPOB:
bottom 1- top 1
< 1 {DW3_ALPES_ITALIE_TRAVERSI}: 3005, 3096, 3103, 3110, 3113, 3117, 3123, 3140, 3144, 3152, 3169, 3181, 3210, 3063,3215, 3225, 3273

10. Supra-ophiolitic Radiolarites from Alpine Corsica (France)

by Patrick De Wever[1] and Taniel Danelian[2]

[1] CNRS-Université Pierre et Marie Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France

[2] Department of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Road, Edinburgh EH9 3JW, UK

ABSTRACT

Radiolarians from Alpine radiolarites in the Balagne Nappe (Corsica) provided the means of dating various levels of the overlying ophiolites as Mid-Late Jurassic: Callovian-Early Kimmeridgian to the South of Novella, Middle Callovian-Early Kimmeridgian beneath the San Colombano Grand Rocher; Mid Oxfordian-Tithonian to the east of this site. These ages are in agreement with those established from the overlying limestones as well as with radiometric data from underlying ophiolites (De Wever *et al.*, 1987).

1. Geological framework

In Corsica, units with ophiolites belong to the Ligurian domain which opened during Jurassic time. Ligurian nappes in Corsica show the usual components of an ophiolite sequence: serpentinized peridotite, gabbros, sheeted dykes and pillow-lava flows. These eruptive rocks are overlain by sedimentary rocks, usually represented by radiolarites. This pile of eruptive and sedimentary rocks is metamorphosed. The metamorphic grade is higher in lower structural units. It is usually possible to distinguish three main units: (Fig.1A)

1- Bastian units (Durand-Delga, 1984) are visible in the core of a large anticline which runs from Castagniccia to Cape Corse. They are marked by a high pressure metamorphism (blueschist facies with glaucophane) with a strong stretching and flattening (gabbros and basalts are transformed to prasinite, colourless cherts are transformed to quartzite).

2- Ligurian units, Inzecca type, overthrust the previous ones. Their metamorphism is also of a high pressure grade but transformations are not as strong as the first type; cherts are still green and red along the 15-20 m thick type section of Inzecca and yielded identifiable radiolarians; the calcschist Erbajolo Formation overlies this pile (sometimes separated from it by few metamorphosed limestones).

3- the Balagne Nappe (Bonnal *et al.*, 1973; Nardi *et al.*, 1978; Durand-Delga *et al.*, 1978) is directly superposed over units 1 & 2 or with intermediate transgressive levels on the autochthonous basement of western Corsica. This nappe is made of pillow lavas (the thickness is of a kilometric order) with radiolarian cherts and a sedimentary cover (Malm to Eocene) enriched with debris of crystalline rocks. These characteristics distinguish this Balagno-Ligurian domain which is affected by low grade Alpine metamorphism.

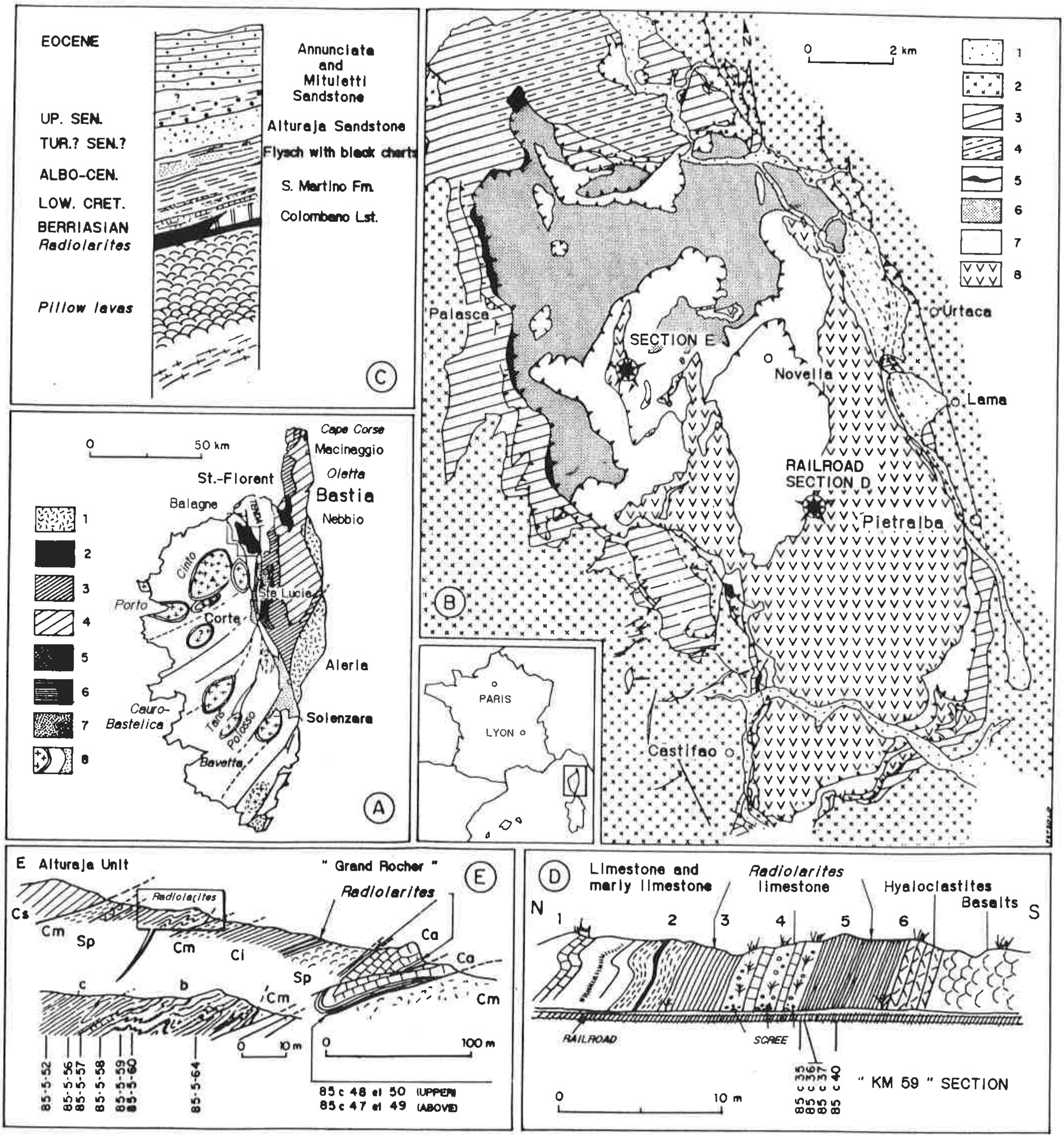


Figure 1.

1A. Stuctural sketch-map of Corsica (centre left). **1.** Neogene and Quaternary; **2.** Upper tectonic units (unmetamorphosed); **3.** Ligurian Units (metamorphosed); **4.** Bastian units; **5.** Bagliacone-Riventosa Units; **6.** Corte Slices; **7.** Caporalino Unit; **8.** Autochthonous: with pre-Permian basement, Permian annular structures and post-Palaeozoic cover.

1B. Sketch-map of the Balagne Nappe area (upper right). The two localities which were sampled are indicated with stars. **1.** Quaternary; **2.** Autochthonous basement; **3.** Eocene; **4.** Nappe of Bas Ostriconi; **5.** Imbricate zone; **6.** Annunciata Formation (nappe); **7.** Cretaceous (nappe); **8.** Ophiolites, radiolarites and limestones (nappe).

1C. Lithostratigraphic section of Balagne Nappe (upper left corner). The ages are indicated on the left of the column, the formation names are on the right.

1D. Section at "Km 59" along the railway, near the Calvi-Ponte Leccia road (lower right corner). The numbers correspond to those used in the text. Positions of productive samples are given (level 5).

1E. Section of the San Colombano pass zone (down left corner). **Sp.** pillow-basalts; **Ci.** Lower Cretaceous; **Cm.** Middle Cretaceous; **Cs.** Upper Cretaceous; **Ca.** San Colombano limestones; a, b, c, subdivision within radiolarite formation. Positions of productive samples are given.

2. Ages of Corsican ophiolites

Two radiometric ages have been reported:

1. Beccaluva *et al.* (1981) dated as 181,4 ± 6 M.a. (K-Ar method) a brown-green amphibole from a gabbro collected in Balagne. According to various radiochronologic scales, this corresponds to a Middle Jurassic (Dogger) age.

2. Ohnenstetter *et al.* (1981) dated as 161 ± 3 M.a. (U-Pb method) zircons extracted from plagiogranites (albitites) intruded within gabbros of the Inzecca region. This result corresponds to a late Mid to early Late Jurassic age (late Dogger-early Malm).

Biostratigraphic study of calpionellids in Balagne (as in the Apennines) has shown that calpionellid limestones are resting on radiolarites overlying the ophiolites.

3. Description of sections

3.1. Railroad section

Section along the railroad Ponte Leccia-Calvi, at the "Km 59" marker (De Wever et al., 1987):

The section is located 4 km south of Novella, (Durand-Delga *et al.*, 1978; Routhier, 1956; Bosma, 1956) just before the bridge where the railroad crosses the N197 road and the River Lagani (= Navaccia), north-east of la Cima di Urtaca (or Termine).

The succession, shows from base to top (Figs. 1B ,1D):

a. Pillow lavas overlain by pillow breccias (8 m), and black hyaloclastites (2m.).

b. Radiolarite (7m.) in beds less than 10 cms. thick; they are mainly green in the lower part where they show layers of hyaloclastites (level 6), and they become red-violet in the upper half (level 5).

c. Covered zone (around 5m.) where some limestone beds crop out with red chert ribbons (level 4) either micritic or oolitic with resedimented foraminifera (Trocholins) with pelitic interlayers.

d. Radiolarites: 5m of regularly alternating shales and cherts, orange-red near the base (level 3), green and richer in shales near the top (level 2). The orange-red base yielded *Lamellaptychus* gr. *beyrichi*, which ranges from Kimmeridgian to early Berriasian.

e. 3m of alternating grey or pink fine limestone and siliceous purplish-blue shales (level 1), overlain by light marly limestones (2 m thick) thought to be Early Cretaceous in age. Calpionellids from the base of level 1 (Routhier, 1956; Parsy-Vincent, 1974): *Calpionella elliptica* Cadish and *Calpionellopsis oblonga* (Cadish), non Colom date the boundary between middle and late Berriasian.

Samples were collected in levels 1,3,5,6 and in the upper hyaloclastites which capped the pillow-lavas. Among 23 samples (19 cherts and 4 limestones), 6 yielded radiolarians (from levels 1,5,6), however, the only identifiable specimens are from level 5

3.2. San Colombano Sections

The San Colombano tectonic zone is located east of the pass of the same name, 3km east-south-east of Palasca. It is intercalated between the Toccone and Alturaja sub-units which belong to the Balagne Nappe (Durand-Delga *et al.*, 1978, p. 149) (figs. 1B,1E).

a) Grand Rocher section (altitude: 738m).

This radiolarite is overthrust onto a sequence of black cherts and shales (Albian-Cenomanian in age and belonging to the Toccone sub-unit). It shows from base to top :

a. grey-greenish radiolarite (2m are visible);
b. massive biodetrital calcarenites, with ribbon cherts (around 20 m thick);
c. massive calcarenites with millimetric to sub-metric fragments of Permian rhyolites, granites, micaschists, etc. (around 10 m);
d. light fine grained platey limestones (visible for 1.5 m at the minimum).

Grand Rocher limestones extend to the NNE in a folded bed in a syncline which opens westwards. In its normal flank, *Everticyclammina virguliana, Conicospirillina basiliensis, Trocholina alpina* were found, in the base of the calcarenite (level b and c) indicating a late Kimmeridgian age (Peybernes, *in* Guérin, 1984) .

Two chert samples were collected 0.8m below the limestone bed.

b) Section along the San Colombano-Novella track

The Grand Rocher tectonic element is overthrust by a complex element which is well-exposed along the Novella road (fig. 1E). The radiolarite section shows decimetric beds, seems to be monoclinal but is in fact, folded. The section is exposed from base to top (NB: the sequence is probably overturned) :

a. few metres of green cherts, with limestone layers in the upper part;
b. around 20m of red cherts, alternating with cm to multi-dm (maximum 1 m) of grey limestone beds partly silicified, oobioclastic, with *Protopeneroplis trochangulata, Trocholina alpina, Nautiloculina oolithica* (Peybernès, in Guérin, 1984) with small fragments of the "basement";
c. around 10m of grey to black cherts with shaly (hyaloclastites?) interlayers.

20 samples were collected from cherts in the level "b", 13 yielded identifiable radiolarians

4. Biostratigraphic results

4.1. Railroad Section

Section along the railroad Ponte Leccia-Calvi, at the "Km 59" marker (De Wever et al., 1987):

In this section, the base and the top of the ribbon cherts were dated (level "5"). This succession (4 m of sedimentary rocks) was probably deposited during Callovian-early

Kimmeridgian times. This result agrees well with the calpionellid limestones (level "1") which are mid-late Berriasian in age.

The holo-radiolaritic sedimentation ends at latest in early Kimmeridgian time. During the late Kimmeridgian-Tithonian a limey and clayey sedimentation was progressively added to the pure radiolaritic sediments. In Berriasian times (mainly mid and late), sedimentation was restricted to calpionellid limestones.

Section KM 59:

85c35: *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)
Transhsuum maxwelli gr. (PESSAGNO)
Transhsuum brevicostatum gr. (OZVOLDOVA)
85c36: *Transhsuum maxwelli* gr. (PESSAGNO)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Stichocapsa robusta MATSUOKA
85c37: *Transhsuum maxwelli* gr. (PESSAGNO)
Stichocapsa robusta MATSUOKA
85c40: *Palinandromeda podbielensis* (OZVOLDOVA)
Transhsuum brevicostatum gr. (OZVOLDOVA)

4.2. San Colombano sections (fig. 1E).

In the western element of the San Colombano Grand Rocher (section IIB), radiolarians from samples 85C-47 and 85C-49 (same horizon) are now dated as late Bathonian-early Callovian. Radiolarians from sample 85 C-48, slightly above, indicate the same age. The San Colombano Limestone was dated as late Kimmeridgian at its base, there is a good correlation between these two age interpretations.

In the eastern element of the Grand Rocher (section IIA), dates provided by samples 85C-56, 85C-57, 85C-58, 85C-59, 85C-60, and 85C-64 show that the overall red radiolarite sedimentation occurred during the mid Callovian-early Oxfordian to late Kimmeridgian-early Tithonian.

Section IIB:

85c48-50 : *Triactoma jonesi* (PESSAGNO)
Homoeoparonaella argolidensis BAUMGARTNER
Tritrabs ewingi s.l. (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs exotica (PESSAGNO)
Transhsuum maxwelli gr. (PESSAGNO)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Stichocapsa robusta MATSUOKA
85c47-49 : *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)
Tritrabs ewingi s.l. (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tetratrabs zealis (OZVOLDOVA)
Crucella theokaftensis BAUMGARTNER
Paronaella mulleri PESSAGNO
Paronaella kotura BAUMGARTNER
Transhsuum maxwelli gr. (PESSAGNO)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Spongocapsula palmerae PESSAGNO
Emiluvia premyogii BAUMGARTNER
Tetraditryma corralitosensis s.l. (PESSAGNO)
Stichocapsa robusta MATSUOKA

Section IIA:

85-5-56: *Tetratrabs bulbosa* BAUMGARTNER
Transhsuum brevicostatum gr. (OZVOLDOVA)
Emiluvia salensis PESSAGNO
Podobursa spinosa (OZVOLDOVA)
Archaeodictyomitra apiarium (RÜST)
Emiluvia orea s.l. BAUMGARTNER
85-5-57: *Mirifusus dianae* s.l. (KARRER)
Emiluvia orea s.l. BAUMGARTNER
85-5-58: *Mirifusus dianae* s.l. (KARRER)
Mirifusus chenodes (RENZ)
Spongocapsula palmerae PESSAGNO
Spongocapsula perampla (RÜST)
Emiluvia orea s.l. BAUMGARTNER
85-5-59: *Podobursa spinosa* (OZVOLDOVA)
Emiluvia orea s.l. BAUMGARTNER
85-5-60: *Triactoma jonesi* (PESSAGNO)
Mirifusus dianae s.l. (KARRER)
Ristola altissima s.l. (RÜST)
Spongocapsula perampla (RÜST)
Emiluvia orea s.l. BAUMGARTNER
85-5-64: *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)
Archaeodictyomitra apiarium (RÜST)

5. Comparisons

A Callovian-early Kimmeridgian age has been assigned to a level 4m above the pillow-lavas by using radiolarian data. The younger radiolarite of this section was probably deposited during Kimmeridgian and Tithonian times and this agrees well with the mid-late Berriasian age indicated by calpionellids found in beds a little higher up. Conti *et al.* (1985) reported radiolarians from a late Oxfordian-middle Tithonian interval (UA 8-10 from Baumgartner 1984) at the "Bocca di U Sorbello", in a level 6m. above pillow-basalts. Their dated level corresponds well to the "level 5" of the "Km. 59" Railroad Section.

The age interpreted from radiolarians from the western section of the San Colombano Grand Rocher for the upper part of the radiolarite (mid Callovian to late Kimmeridgian-early Tithonian), correlates perfectly with the late Kimmeridgian age indicated by foraminifera from the base of calcarenites which overlie them. This level is probably stratigraphically close to the level dated by Conti *et al.* (1985) as "late Oxfordian-middle Tithonian interval (UA 8-10)" for the upper part of radiolarites, near their boundary with the limestone.

References

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BECCALUVA, L., CHIESA, S. & DELALOYE, M. (1981). K/Ar age determination on some tethyan ophiolites. *Rendiconti della Società Italiana di Mineralogia e Petrologia*, **37** (2), 869-880.

BONNAL, M., PARSY, A., PRIOU-LACAZEDIEU, A. & DURAND-DELGA, M. (1973). Sur la structure de la Balagne sédimentaire (Corse). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **276**, 1949-1952.

BOSMA, W. (1956). *Contribution à la géologie de la Balagne (Corse)*. Amsterdam University, 128 p.

CONTI, M., MARCUCCI, M. & PASSERINI, P. (1985). Radiolarian cherts and ophiolites in the Northern Apennine and Corsica: Age, correlation and tectonic frame of siliceous deposition. *Ofioliti*, **10**, 203-224.

DE WEVER, P., DANELIAN, T., DURAND-DELGA, M., CORDEY, F. & KITO, N. (1987). Datations des radiolarites post-ophiolitiques de Corse alpine à l'aide des Radiolaires. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **305**, 893-900.

DURAND-DELGA, M. (1984). Principaux traits de la Corse alpine et corrélations avec les Alpes ligures. *Memorie della Società Geologica Italiana*, **28**, 285-329.

DURAND-DELGA, M., AMAUDRIC DU CHAFFAUT, S., BONIN, B., BONNAL, M., CARON, J.M., CONCHON, O., DELCEY, R., ORSINI, J., ORSZAG-SPERBER, F., PILOT, M.D. & VELLUTINI, P. (1978). *Corse*. Guides Géologiques Régionaux - Masson, Paris. 208 p.

GUÉRIN, G. (1984). *Secteur du Col de San Colombano, approche stratigraphique et structurale*. Diplôme d'Etat Appliqué (Unpublished). Laboratoire de Géologie Méditerranée. Université de Toulouse III.

NARDI, R., PUCCINELLI, A. & VERANI, M. (1978). Carta geologica della Balagne "sedimentaria" (Corsica) alla scala 1:25.000 e note illustrative. *Bollettino della Società Geologica Italiana*, **97**, 11-30.

OHNENSTETTER, M., OHNENSTETTER, D., VIDAL, P., CORNICHET, J., HERMITTE, D. & MACE, J. (1981). Crystallization and age of zircon from Corsica ophiolitic albitites: consequences for oceanic expansion in Jurassic times. *Earth and Planetary Science Letters*, **54**, 397-408.

PARSY-VINCENT, A. (1974). *Contribution à l'étude de la Balagne sédimentaire*. Thèse Doct. 3ème cycle (Unpublished). Laboratoire de Géologie Méditerranée. Université de Toulouse III.

ROUTHIER, P. (1956). Etude géologique de la Balagne sédimentaire (Corse septentrionale). *Bulletin du Service de la Carte Géologique de la France*, **54** (249), 265-293.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION DW4_CORSE_KM59: bottom 1 - top 4
< 4 {85c35}: 3017, 3180, 3181
< 3 {85c36}: 3180, 3181, 3298
< 2 {85c37}: 3180, 3298
< 1 {85c40}: 3008, 3181

SECTION DW5_CORSE_SAN_COLOMBANO_IIB_LATER bottom 1 - top 2
< 2 {85c48 - 50}: {85c48&50} 3096, 3103, 3113, 3117, 3119, 3180, 3181, 3298
< 1 {85c47 - 49}: {85c47&49} 3017, 3113, 3117, 3121, 3131, 3139, 3140, 3180, 3181, 3199, 3210, 3273, 3298

SECTION DW6_CORSE_SAN_COLOMBANO_IIA: bottom 1- top 6
< 6 {85-5-56}: {85C56} 3122, 3181, 3215, 3230, 3263, 4069
< 5 {85-5-57}: {85C57} 3161, 4069
< 4 {85-5-58}: {85c58} 3161, 3162, 3199, 3267, 4069
< 3 {85-5-59}: {85c59} 3230, 4069
< 2 {85-5-60}: {85c60} 3096, 3161, 3164, 3267, 4069
< 1 {85-5-64}: {85c64} 3017, 3263

11. New Middle and Upper Jurassic radiolarian assemblages co-occurring with ammonites and nannofossils from the Southern Alps (Northern Italy)

by Peter O. Baumgartner[1], Luca Martire[2], Spela Gorican[3], Luis O'Dogherty[4], Elisabetta Erba[5] and Alain Pillevuit[1]

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Dipartimento di Scienze della Terra, Università di Torino, Via Accademie delle Scienze 5 , 10123 Torino, Italy
[3] Paleontoloski Institut Ivana Rakovca ZRC SAZU, Gosposka 13, 61000 Ljubljana, Slovenia
[4] Departamento de Geología Marina, Facultad de Ciencias del Mar, Universidad de Cádiz, 11510, Puerto Real, Spain
[5] Dipartimento di Scienze della Terra, Università di Milano, Via Mangiagalli 34, 20133 Milano, Italy

ABSTRACT

Radiolarian assemblages recovered from the Sogno and the Radiolarite Formations in the Western Lombardy Basin are discussed in the context of new nannofossil data, indicating an early Bajocian age for the onset of lime-free radiolarite sedimentation in the Torre de Busi area. Radiolarian assemblages recovered from the middle, siliceous member of the Rosso Ammonitico Veronse of the Trento Plateau are discussed in the context of ammonite data and regional correlation based on the occurrence of a characteristic sequence of bentonites. These data allow for calibration of UAZones 8-10 and indicate, yet unresoilved, possible facies heteropies over short distances on the Trento Plateau. Radiolarian assemblages recovered from the top of the Vajont Limestone in the Belluno Trough range from late Bathonian-early Callovian to middle-late Oxfordian in age and suggest a more complex facies relationship than a simple onset of the Fonzaso Formation on the Vajont Limestone.

1. INTRODUCTION

The Southern Alps are a part of the Alpine chain and extend from W to E for about 500 km in northern Italy (Fig. 1). They are delimited to the west and to the north by a major tectonic line - the Iinsubric Line. The Southern Alps consist of a Hercinian crystalline basement overlain by a thick sedimentary cover which ranges an age from Permian to Cenozoic. The Southern Alps represent a relatively undisturbed slice of a palaeoafrican structural and palaeogeographic domain classically known as "Apulian Promontory" or "Apulian Microplate" (Channel *et al.*, 1979).

During Late Triassic and Jurassic times, extensional tectonics provoked the break-up of continental areas of equatorial Pangea and the birth of a "Ligurian Ocean" (Winterer & Bosellini, 1981). The Southern Alps represent one of the best preserved cross-section of a Jurassic passive margin of the whole Mediterranean area, where the original relationships between different palaeogeographic domains are still preserved (Winterer & Bosellini, 1981). In fact, one can see, in the details of the stratigraphy, the history of progressive foundering and drowning of the margin as a small oceanic basin was being created to the west, between the Southern Alps (Apulian Plate) and the French Alps (European Plate) (Winterer & Bosellini, 1981; Sarti *et al.*, 1992; Bertotti *et al.* 1993).

An important stage in the tectono-sedimentary evolution of the Southern Alps is represented by the Upper Triassic (Norian) formations with a high environmental uniformity throughout the whole region and with the deposition of tidal-flat dolostones (Dolomia Principale). Such event permits to follow the successive palaeogeographic evolution of the different units.

During the upper Triassic and Lower Liassic, a rifting phase caused the break up of the preexisting carbonate platform into a series of horst and grabens. These were bounded by synsedimentary faults which were active throughout the Jurassic as structures controlling facies distribution (Fig. 2). Four main palaeogeographic domains can be recognised in the Southern Alps, from east to west: the Friuli Platform, the Belluno Trough, the Trento Plateau and the Lombardian Basin. Carbonate sedimentation became very diversified. On structural highs fertile carbonate platforms developed and gave origin to thick sedimentary piles. In the intervening basins because of higher subsidence rates and abundant platform-derived sediments, greater sediment thicknesses were attained through the deposition of periplatform ooze and carbonate turbidites. The correlation between .the Jurassic formations of the Trento Plateau and adjacent basins is shown in Figures 3, 4.

During the Upper Liassic, probably related to the beginning of oceanic spreading, the drowning of structural highs and platforms began. Such events resulted in a sudden and overall reduction of sedimentation rates and in the genesis of "condensed" sequences (Rosso Ammonitico facies) and related sedimentary gaps typical of the Middle and Upper Jurassic.

By the end of the Jurassic and the beginning of the Cretaceous most of Southern Alps were in a basinal environment with a more or less uniform deposition of pelagic carbonate oozes, locally replaced by turbiditic sedimentation. Only the Friuli Platform, the most external part of the margin, maintained shallow carbonate conditions throughout the Cretaceous.

2. Lombardy Basin

2.1. Geological Framework

The Lombardy Basin makes up a large part of the Southern Alps and extends from the Garda Escarpment to the Canavese zone (Gaetani, 1975). The Late Triassic - Early Liassic extensional phase caused the drowning of the Triassic platforms and the articulation of the basin into a series of ridges and troughs. This complex morphology of the sea floor determined the depositional patterns leading to marked differences in facies and/or thicknesses among the stratigraphic successions of adjacent sectors (Gaetani, 1975; Winterer & Bosellini, 1981; Bertotti *et al.* 1993). Only the stratigraphic succession of the Albenza Plateau, will be to which the Torre de Busi section pertains discussed here. It comprises, from bottom to top, the following units:

PRESENT DAY PLATE CONFIGURATION

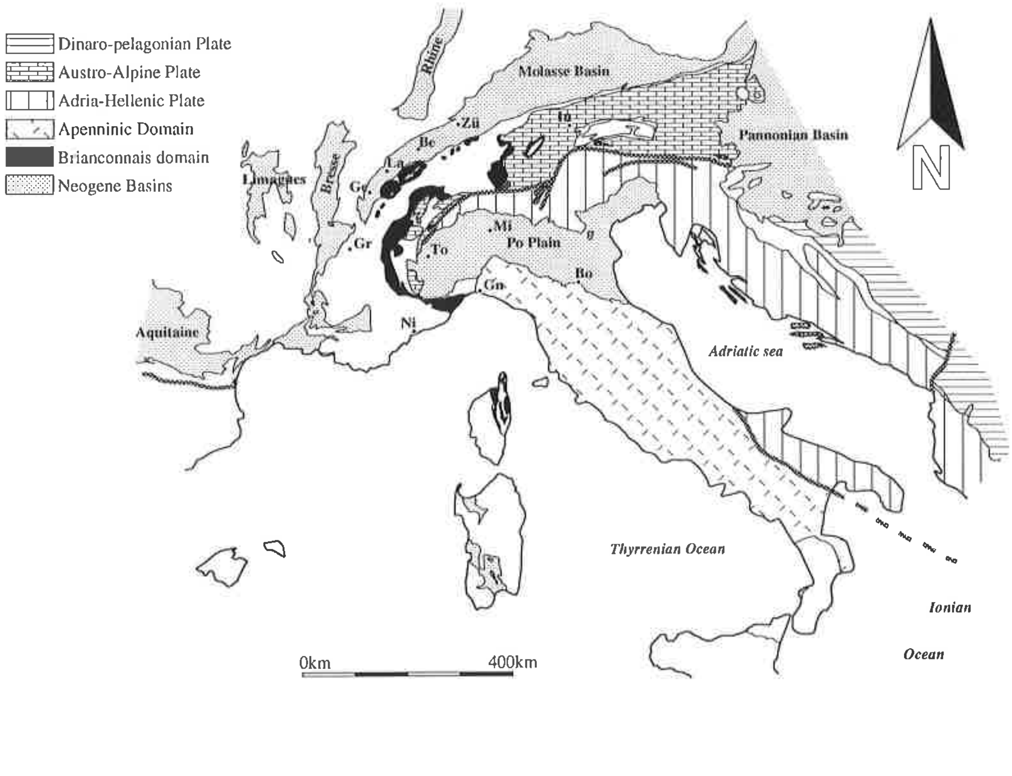


Figure 1. Principal tectonic provinces in the Alps, with location of the Insubric Line (modified from Winterer & Bosellini, 1981 and from Stampfli & Marchant, in press).

Medolo Group

Moltrasio Limestone. An extremely thick sequence (represents about 70% of the total thickness of Jurassic strata) consisting of dark grey marly limestones, in 20-40 cm beds, well defined by cm-thick marly-clayey interbeds (Fig 3, 4). They are mostly mudstones and wackestones. Dark cherts may be locally abundant, forming stratoidal lenses or irregular nodules. In the lower part of the unit, beds are thicker and, especially near the palaeohigh, they show graded bedding, with c-e, rarely b-e, Bouma sequences. The Moltrasio Limestone attains a thickness of 3000 m in the Generoso Trough depocenter, whereas it is represented only by a few meters of very cherty limestones on the palaeohighs. Synsedimentaryslides and slumps are widespread and of considerable size. Ammonite recoveries are rare because of the very high sedimentation rate, which may reach as high as 300 m/my. Ages indicated by fossils are late Hettangian (*Angulata* Zone) and Sinemurian (*Semicostatum* Zone). The Lotharingian is poorly documented.

Domaro Limestone.- It consists of grey limestones, becoming lighter coloured upwards, with marly-clayey joints and interbeds. Cherts are randomly distributed. The boundary between the Moltrasio and the Domaro Limestones is gradational. The thickness of the Domaro Limestone is of about 200 m in the Generoso Trough. Ammonites are rare in the lower part where some Carixian species have been found. In the upper part *Fuciniceras* is present, indicating the basal part of the *Stokesi* Zone (Early Domerian). The top of the Domaro is dated as upper Domerian.

Sogno Formation.- At the top of the Domaro or of the red nodular limestone called Rosso Ammonitico Lombardo (Fig. 3, 4) , a sharp lithological change to dark grey marls, silty shales, and laminated cherts (livello a pesci) occurs, that marks the base of the Sogno Formation. This lithofacies may be followed around the adjacent palaeohigh from Val Varea to Canzo, where it attains amaximum thickness of 24 m. In the Torre de Busi area it measures 5-10 m, while in the Alpe Turanti sequence only 25 cm of grey-blue silty shales rich in muscovite are documented. This unit, deposited in anoxic environment, is correlative of the early Toarcian Anoxic Event . Evidence of this anoxic episode is missing on the adjacent palaeohigh.

The Sogno Formation consists of a rythmic alternation of grey to pink limestones and marlstones of Toarcian, Aalenian and earliest Bajocain age. In the upper half of the formation (Aalenian - lowermost Bajocian) chert nodules become increasingly common in the limestone beds.These cherts contain the first determinable radiolarians near the top of the formation (see below)

Argille Rosse e Brune.- In the Sogno area carbonate sedimentation ends in the lower Bajocian (Fig 3, 4) with a

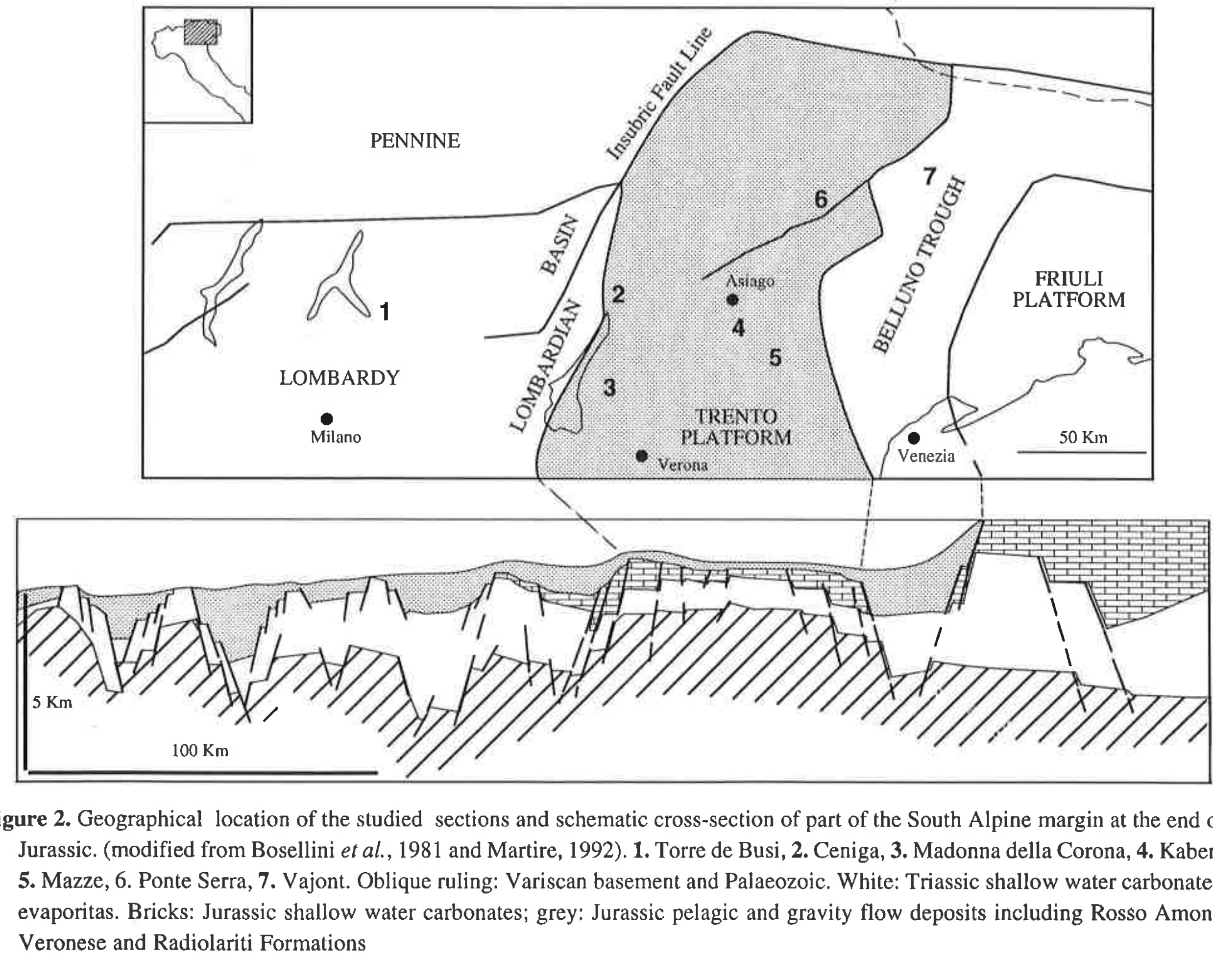


Figure 2. Geographical location of the studied sections and schematic cross-section of part of the South Alpine margin at the end of the Jurassic. (modified from Bosellini *et al.*, 1981 and Martire, 1992). **1.** Torre de Busi, **2.** Ceniga, **3.** Madonna della Corona, **4.** Kaberlaba, **5.** Mazze, 6. Ponte Serra, **7.** Vajont. Oblique ruling: Variscan basement and Palaeozoic. White: Triassic shallow water carbonates and evaporitas. Bricks: Jurassic shallow water carbonates; grey: Jurassic pelagic and gravity flow deposits including Rosso Amonittico Veronese and Radiolariti Formations

few dm. of brick-red or brown shales, sometimes containing ferromanganesiferous nodules, that represent the top of the Sogno Formation. The shales contain a rich nannoflora of early Bajocian age (see below) In the Torre de Busi Section these shales reach a thickness of 50-60 cm. They can be interpreted as bathyal condensed clays.

Selcifero Group

Radiolariti Formation. The lower member, called Basal or Green Radiolarites, of the Radiolariti Formation consists of ribbon-bedded mostly green cherts, with 5-15 cm thick chert beds and cm thick shale partings. The upper Member consists of dark red, knobby radiolarites in very irregular beds. The thickness of the formation may range from the 40 m to only a few m on basin slopes. When reduced, it is usually represented only by the knobby radiolarites. The base of the formation is very sharp. The top grades upwards into the Rosso ad Aptici Formatiuon by the progressive appearance of limestone and marlstone beds. The age of the Radiolariti Formation was classically considered to range

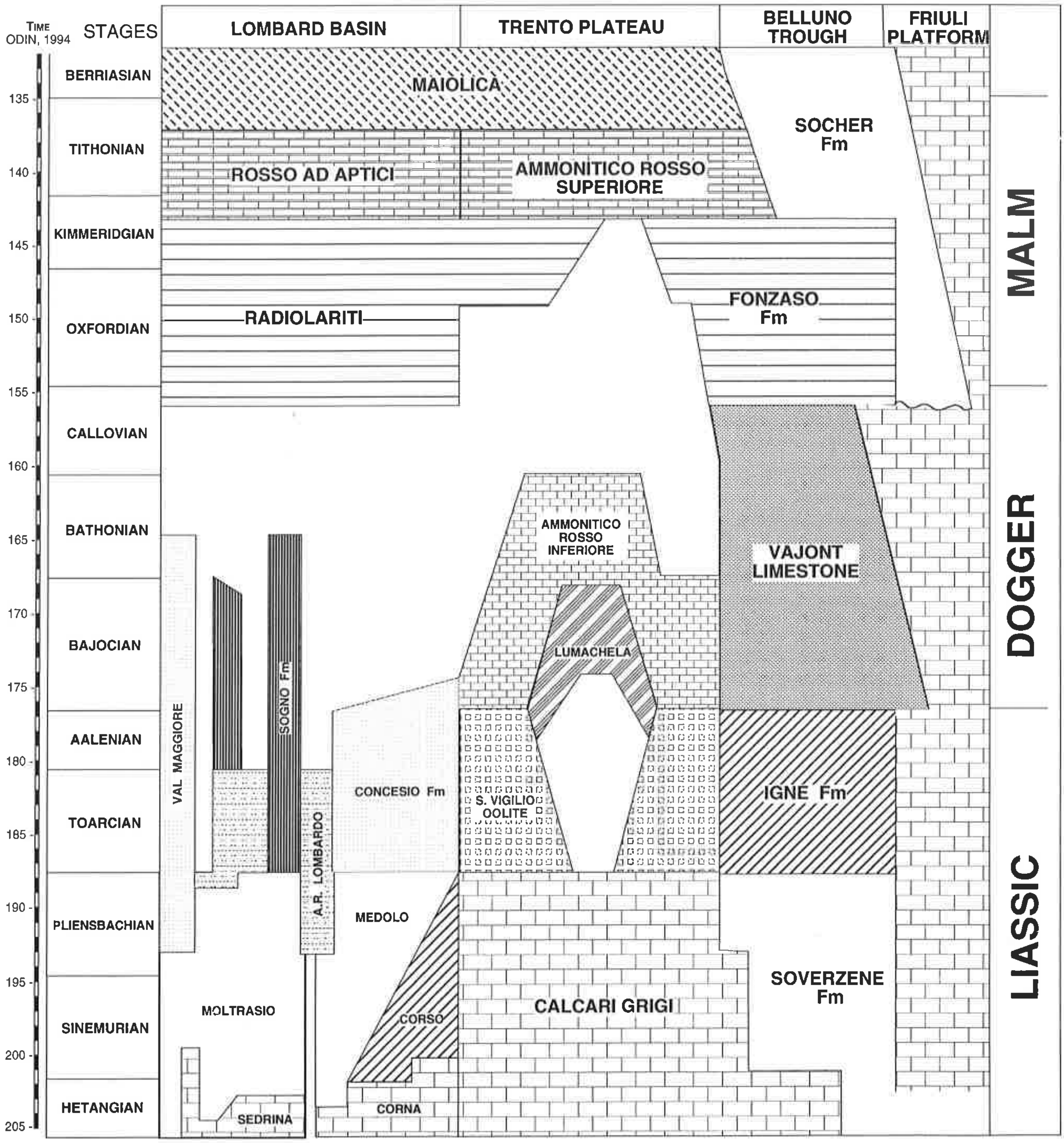


Figure 3. State of knowledge in 1980 of ages of Jurassic formations of the Southern Alps. (after Winterer & Bosellini, 1981).

from late Callovian to early Kimmeridgian (Fig. 3), both on the Plateaus and in basins. The diachroneity of the base of this Formation was demonstrated by Baumgartner (1984, 1987). Actually, the base of the green radiolarites is dated by nannofossils and radiolarians as late Bajocian, and the base of the knobby radiolarites as late Callovian. The passage to the Rosso ad Aptici Formation is dated as early to middle Oxfordian.

Rosso ad Aptici Formation..- The Radiolariti Formation is succeeded by brick-red to pink cherty limestones and interbedde marlstones, with a maximum thickness of 20-30 m. The Rosso ad Aptici is usually present both on palaeohighs and in the basins. Apthychi may be locally abundant, whereas ammonites are absent. The age based on aptychi and nannofossils ranges from middle Oxfordian to middle Tithonian.

Maiolica Lombarda Formation. The sequence grades up to whitish calcilutites, in 20-50 cm thick beds, representing a lithified nannofossil-ooze, which is locally rich in calpionellids. Calpionellids, nannofossils, radiolarians and magneostratigraphy provide an age range

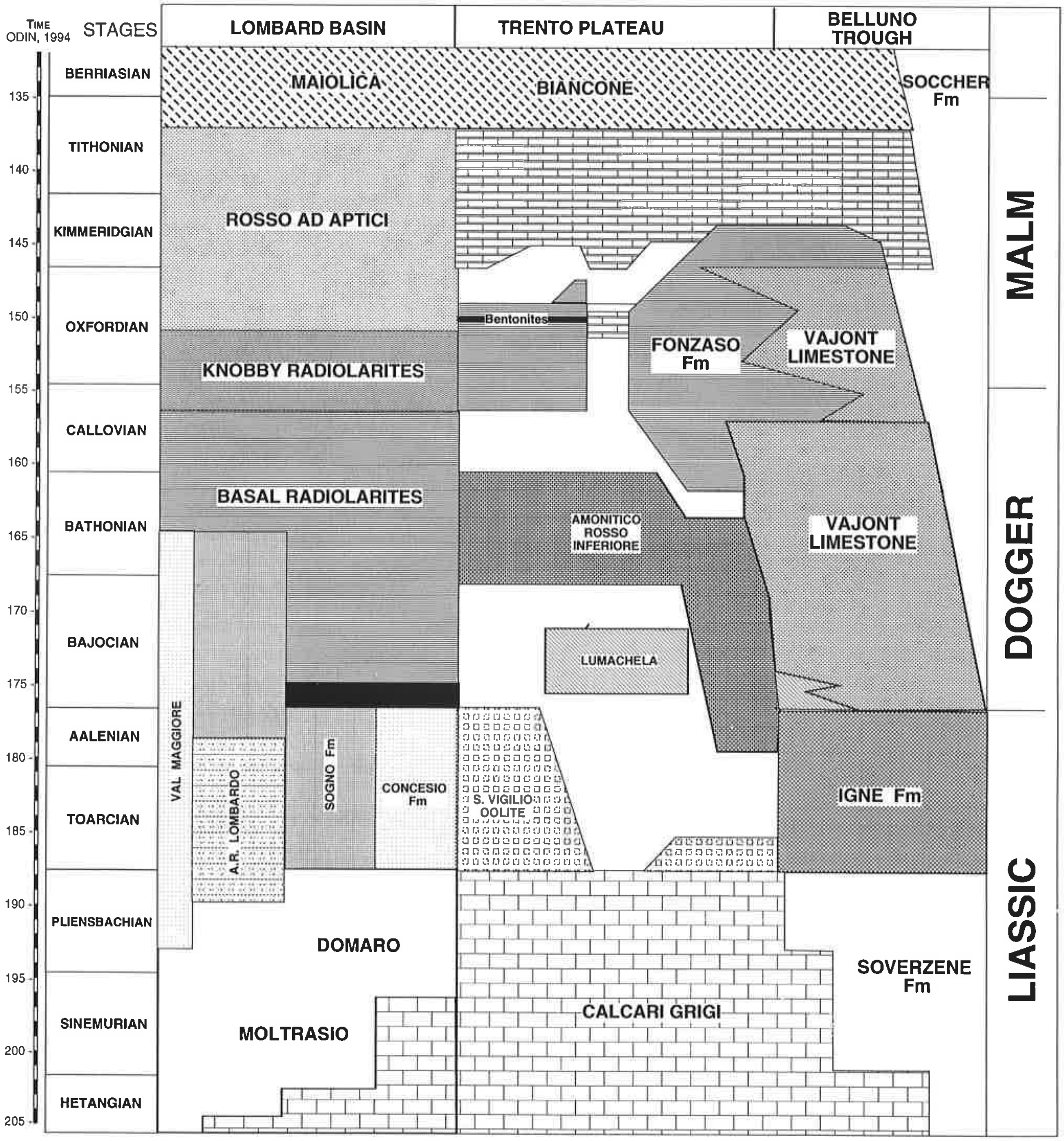


Figure 4. Present state of knowledge of biostratigraphic ages of the Jurassic formations in the Southern Alps mainly based on new ammonite, radiolarian and nannofossil data from the Lombardian Basin, Trento High Plateau and Belluno Trough.

of late Tithonian to early Aptian for the basinal sequences. The thickness may range from 180 m in the Generoso Trough depocenter, to 0.90 m in the truncated Colma Section. The resedimented bodies outcropping along the palaeohigh scarps are very spectacular. They may be responsible for the absence of the early Cretaceous on the palaeohigh itself.

2.2. Data on the studied section

Torre de Busi Section (Fig. 5).

This section crops out along the Torre de Busi-Sogno road, several 100 m below Colle di Sogno, where the road cuts down again into the Sogno Formation. This section has been previously studied for ammonites and radiolarian biostratigraphy (Gaetani & Poliani, 1978, Baumgartner *et al.* 1980, Kocher 1981, Baumgartner 1984). Sample POB 1341 (see Baumgartner, 1984) was collected 4.10 m below the sharp base of the basal radiolarites in the top part of the Sogno Formation in cherty, Bositra-rich limestone.

Nannofossil biostratigraphy of the Torre de Busi - Colle di Sogno Section

Calcareous nannofossils were studied in the uppermost portion of the Sogno Formation. A very detailed sampling was applied in order to precisely locate the sequence of nannofossil events and their spacing. Calcareous nannofloras are common, moderately preserved, relatively diversified, and consist of *Watznaueria britannica*, *Watznaueria communis*, *Watznaueria contracta*, *Watznaueria* sp., small *Watznaueria manivitae*, *Cyclagelosphaera margerelii*, *Hexalithus magharensis*, *Lotharingius velatus*, *Biscutum* aff. *finchii*. This assemblage is correlative of the Lower Bajocian. In fact, similar nannofloras were correlated to the *Discites* to lowermost part of the *Laeviuscola* zones in ammonite-dated sections of the Digne area - SE France (Erba, 1990). The latest Aalenian to early Bajocian interval records a turnover in calcareous nannofossils that is marked by the rapid speciation of nannoplankton, especially within the *Watznaueria* group. The appearance of new taxa has been verified in several sections outcropping in Northern (Gaetani & Erba, 1990; Cobianchi et al. 1992; Cobianchi 1992) and Central Italy (Baldanza et al. 1990; Reale et al. 1991) and partly verified also in other Tethyan sections (Berger, pers. comm. 1993).The closely spaced sequences of nannofossil events resulted in a high-resolution biostratigraphy for the Late Aalenian-Bajocian interval (Mattioli and Erba, in preparation).

The Upper Aalenian-Lower Bajocian interval was investigated for calcareous nannofossils also at the Alpe Turati section, where the Radiolarites overlie the Rosso Ammonitico Formation. The lithologic boundary is marked by a 70 cm thick interval consisting of dark brown clay (base), green clay, and black shales (top). Cm-spaced samples were collected through this interval and in the basal 40 cm of the Green Radiolarites where thin shaly joints are intercalated within the cherts. The common and moderately preserved nannofloras of this interval are very similar to the assemblages encountered at the Colle di sogno section just below the base of the Radiolarites and indicate an early Bajocian age. In particular, the occurrence of *W. britannica*, *W. communis*, *W. contracta*, small *Watznaueria manivitae*, *Watznaueria* sp., *C. margerelii* and the absence of *W. manivitae* s.s. allows the correlation of the base of the Radiolarites with the *Discites* to lowermost part of the *Laeviuscola* zones.

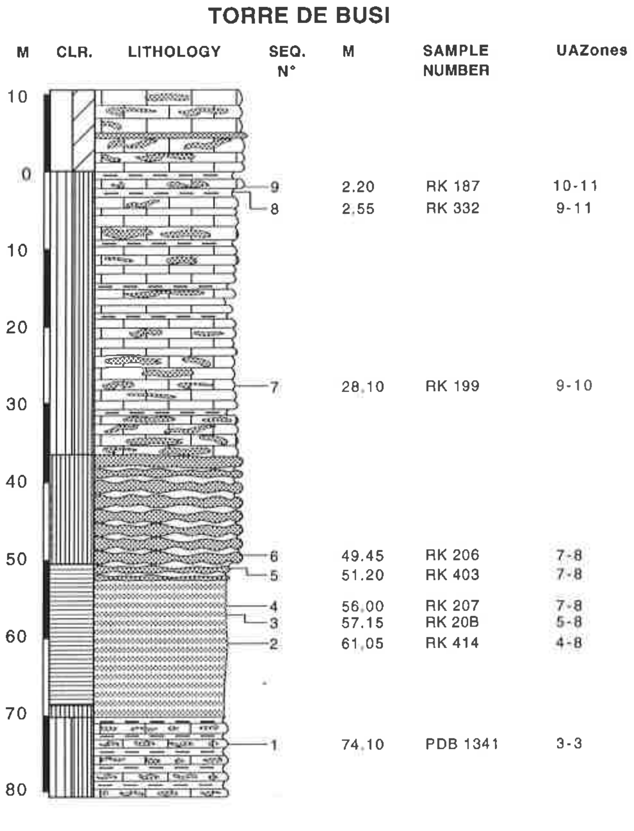


Figure 5. Lithostratigraphy of the Torre de Busi Section in the Lombardy Basin with location of radiolarian samples and zonal assignments.

3. Trento Plateau

3.1. Geological Framework

The Trento Plateau represents a wide area in NE Italy, extending in a N-S direction from Verona to Bolzano and Cortina d'Ampezzo (Fig. 2). Towards the east it passes into the Belluno Trough now corresponding to the Piave Valley. To the west, the "Garda Escarpment" fault system, active during Jurassic and Cretaceous, separates the Trento Plateau from the Lombardy Basin.

The stratigraphic and palaeogeographic evolution of Trento Plateau during the Jurassic reflects the oceanisation process of the Western Tethys . A phase of rifting, linked to crustal extension, is followed by a phase of drifting in which crustal cooling causes subsidence and overall drowning of the margin. These two phases are recorded by two typical formations ubiquitous on the whole Trento Plateau: the Calcari Grigi di Noriglio (platform facies, lower and middle Liassic) and the Rosso Ammonitico Veronese (pelagic plateau facies, upper Bajocian-Tithonian). In the central part of the Plateau (Altopiano di Asiago) these two formations are in direct contact, separated only by a mineralized surface which marks a gap ranging from Toarcian to Lower Bajocian (Sturani, 1964). In contrast, in the marginal part and especially on the western plateau, a complex of formations is present between Calcari Grigi and Rosso Ammonitico. It locally exceeds 200 m in thickness and has been defined as the San Vigilio Group (Barbujani *et al.* 1986).

Calcari Grigi di Noriglio. This sequence contains facies associations comparable to the "Bahamian" carbonate platform, virtually devoid of terrigenous input. Thicknesses locally are greater than 500 m. Peritidal carbonate deposits occur in the lower part, whereas lagoonal facies prevail in the upper part. Facies may be organized in small cyclothems beginning with subtidal calcareous massive beds grading to marsh facies or subaerial coal-rich layers (Bosellini & Broglio Loriga, 1971; Clari, 1975). This formation is referable to the lower and middle Lias owing to rare discoveries of ammonite faunas (e.g. Sarti, 1981).

San Vigilio Group.

On the whole, this group corresponds to the facies generally known in the literature under the formational name "Calcari Oolitici di San Vigilio" or "Oolite di San Vigilio" attributed to the Toarcian-Aalenian interval (Sturani, 1964). This complex is well-developed in the Monte Baldo area and consists of three formations (Barbujani *et al.*,1986). From bottom to top we may distinguish:

Calcare di Misone. This sequence is composed of yellowish mudstones and wackestones with sponge spicules, radiolarians, echinoid plates, peloids and big, scattered chert nodules. Some remains of hydrozoans and calcareous sponges are present. These facies represent relatively deep environments with strong pelagic influences. The parts richest in sponge remains have been interpreted as "mud mounds" (Beccarelli-Bauck, 1988). The thickness of this formation varies from 0 to 150 meters.

Tenno Formation. These sediments consist of biomicrites with sponge spicules, radiolarians and abundant chert nodules, in thin and even layers. Oolitic-peloidal calcarenite and peloidal calcsiltite beds are widespread in the upper part. These rocks also represent relatively deep facies with a marked pelagic input. Calcarenites and calcsiltites however show sediment contributions from shallow areas and a shoaling upward trend. Large thickness variations are present, up to a maximum of 150 metres.

Calcari Oolitici di San Vigilio. Sediments comprise oolitic and encrinitic grainstones with clear trough cross lamination and poorly-developed stratification, interlayered with thin biomicritic beds. Coral and sponges reefs, giving origin to lenticular bodies, are locally developed beside oolitic facies. This formation too is subject to wide thickness variation, up to 200 metres.

Lumachella a Posidonia alpina. (Figs. 3, 4). Under this name are indicated peculiar sediments consisting of white or red biomicrites to grainstones with thin-shelled bivalves, small ammonites and crinoids. These skeletal limestones are especially well represented in the central part of the Trento Plateau (Altopiano di Asiago) and show a patchy distribution as they are commonly preserved as fillings of dm-sized neptunian dykes present at the top of the Liassic Calcari Grigi. Detailed studies of the well preserved ammonite faunas (Sturani, 1964, 1971) have allowed precise biostratigraphic attributions of the Lumachella a Posidonia alpina. It ranges, as a whole, from Aalenian to Upper Bajocian (*Garantiana* Zone) but each fissure filling may show a different age, probably because of episodic sedimentation.

Rosso Ammonitico Veronese Formation. The Rosso Ammonitico Veronese is made up of red, nodular limestones characterised by the presence of ammonite moulds. The Rosso Ammonitico Veronese rarely exceeds 30 m in thickness and spans an age from Late Bajocian to Tithonian i.e. more than 30 m.y. Several discontinuities, corresponding to flat or irregular but always clear-cut

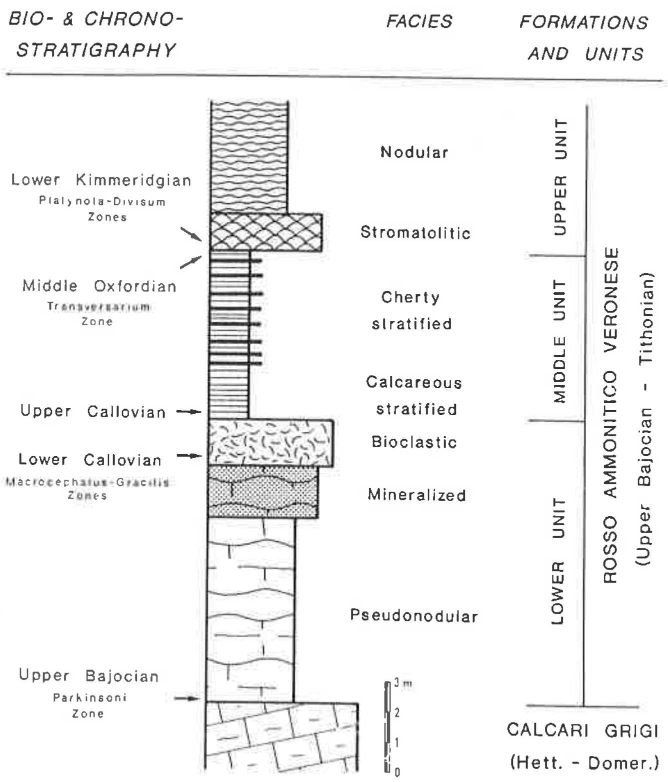


Figure 6. Rosso Ammonitico Veronese. General sketch of the stratigraphic column in the Altopiano of Asiago with the subdivision in informal units and facies. Arrows point to the levels where paleontological data (mainly based on ammonites) allow detailed biostratigraphic age assignments (from Martire, 1992).

surfaces, are present. They are occasionally emphasised by Fe and Mn oxides incrustations and correspond to sedimentary breaks spanning up to several ammonite biozones (Sturani, 1964; Jenkyns, 1971; Clari *et al.*, 1984, 1990; Pavia *et al.*, 1987; Martire, l989, 1992).

In the central part of the Trento Plateau (Altopiano of Asiago) three units have been recognised on the basis of macroscopic features such as bedding and gross lithology (Fig. 6): the lower unit is massive and hard (and therefore still actively quarried), the middle is thinly bedded and cherty, and the upper is typically nodular and marly. Detailed petrographic analysis has then distinguished seven lithofacies resulting from different depositional and diagenetic environnments (Martire, 1989, 1992). From bottom to top of the formation these are as follows:

Lower unit: Rosso Ammonitico Inferiore

(I) Pseudonodular facies: massively bedded red limestones composed of "predepositional nodules", i.e. intraclasts and oncolites, and "early diagenetic nodules" (Clari *et al.*, 1984), separated by a matrix of packstone filling firm-ground burrows. The lithological features show the alternation of stages of deposition and early cementation with hydrodynamic and biogenic reworking resulting in the formation of a sort of intraformational conglomerate (Kennedy & Garrison, 1975; Clari *et al.*, 1984; Martire, 1989).

(2) The mineralised facies differs from the preceding facies by a brownish colour due to a high content of mineralised grains, such as mm to cm-sized intraclasts the are bored and coated by Fe and Mn oxides.

(3) The bioclastic facies represents more or less pervasively early cemented grainstones, mainly consisting of thin-shelled bivalves (*Bositra*) and crinoid debris. A dense network of firm-ground burrows (*Thalassinoides*), filled by similar but darker sediment, crosses the beds.

Middle unit (equivalent of the Fonzaso Formation, see below)

(4) The calcareous stratified facies contains pink to red wackestones and mudstones in thin and even layers, with thin-shelled bivalves, spar-filled radiolarian molds, and tiny crinoid debris. The absence of intraclasts and of nodular structure and the flattening of bivalve shells show that these sediments have not experienced early cementation.

(5) The Cherty stratified facies is characterised by the abundance of nodules and lenses of red chert resulting in an irregular bedding style. In the upper part of this facies several red or green, up to 15 cm thick bentonite layers are present (Bernoulli & Peters, 1970; Clari *et al.*, 1990).

Upper unit: Rosso Ammonitico Superiore

(6) The stromatolitic facies forms massive, 50 cm-thick beds, displaying a biogenic millimetric lamination with domed morphologies (Massari, 1979, 1981; Clari *et al.*, 1984).

(7) The Nodular facies of the Rosso Ammonitico

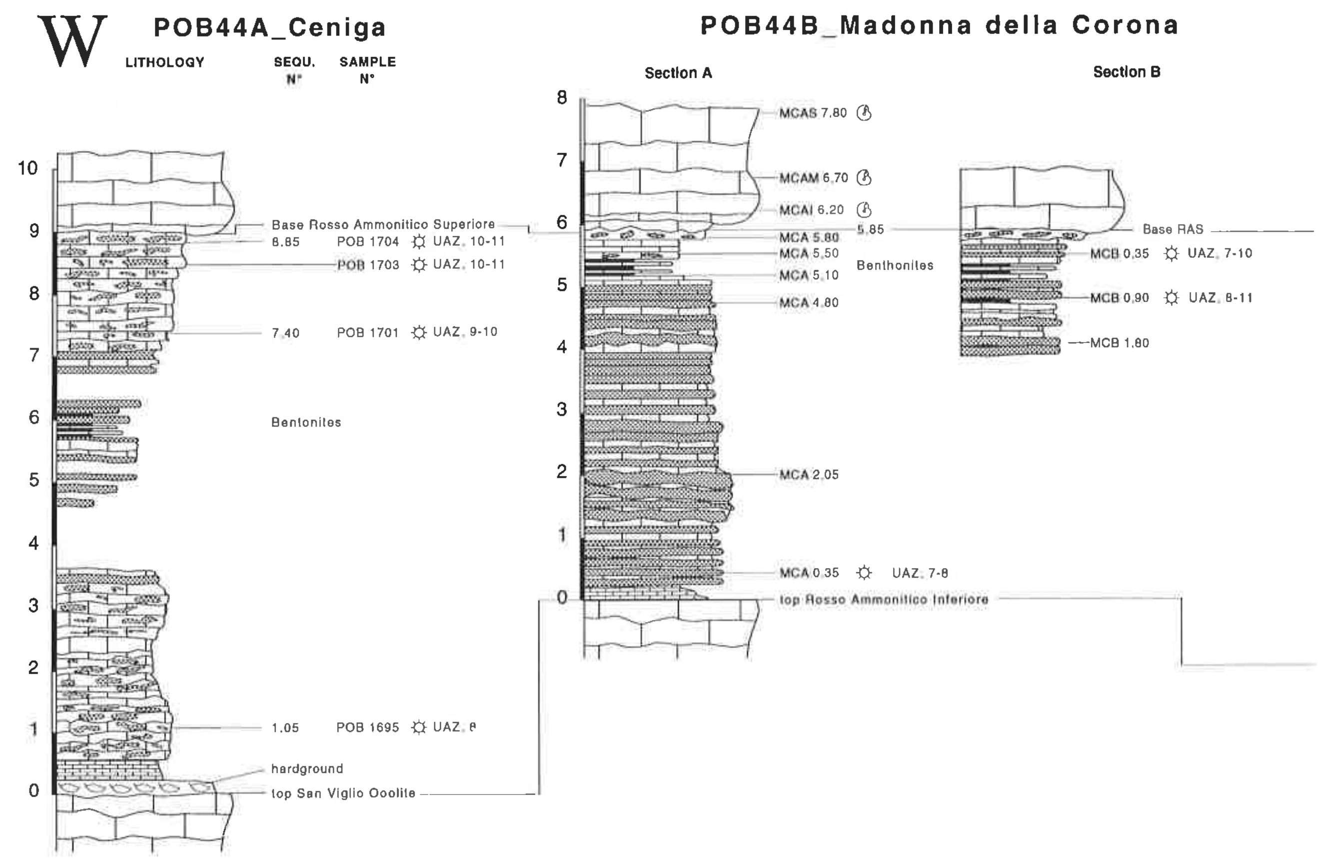


Figure 7. Lithostratigraphy of studied sections on the Trento Plateau with location of radiolarian samples, zonal assignments and other biostratigraphic data used for dating and correlation.

Veronese is characterised in outcrop by the differential weathering of pink, cm-sized, early lithified nodules and of the clay-rich, brick red matrix. The latter always displays fitted-fabric and dissolution-seams indicative of pervasive pressure-dissolution (Buxton & Sibley, 1981; Bathurst, 1987; Clari & Martire, in press). The scarcity of intraclasts shows that only minor reworking has taken place.

Fonzaso Formation. This formation is well represented in the easternmost part of the Trento Plateau where it reaches a thickness of several tens of meters, and replaces the middle member of the Rosso Ammonitico separating the lower and the upper members (Bosellini & Dal Cin, 1968; Della Bruna & Martire, 1985). It consists of thin- and plane-bedded, grey, greenish and reddish limestones regularly interlayered with chert beds. The limestones are mudstones to marly packstones containing abundant radiolarians. In addition to these pelagic facies, bioclastic-peloidal grainstones beds are present which are interpreted as distal, platform-derived resediments coming from the highly productive Friuli Platform (Bosellini *et al.*, 1981). No direct biostratigraphic data are available for this formation which is referred to the Callovian-Oxfordian interval on the basis of the age of under- and overlying formations.

Biancone. Whitish calcilutites, in 20-50 cm thick beds, representing a lithified nannofossil-ooze. Calcareous nannofossils, calpionellids and radiolarians suggest an age ranging from the late Tithonian to the early Aptian for the basinal sequences.

3.2 Data of the studied sections

Ceniga (Fig. 7).

This section was described by Fogelgesang 1975 (p. 29). From Arco one follows small road on right side of Sarca river about 3.5 km northwards to a little hill south of Ceniga. The outcrops are in teh road cut and on the slope of the little hill west of the road. We observed 9 m of thinly bedded pink siliceous limestones with lenses of red to reddish brown replacement chert. The bentonites observed in other sections of the Trento Plateau have all been found under a little overhang behind dense vegetation. Fogelgesang (1975) reports a late Oxfordian chaetetid species from a comparable section at Colme di Vignola, recovered from the Aptychus limestones, and concludes from his regional study on a late Oxfordian early Kimmeridgian age for the siliceous limestone. Rich and well preserved radiolarian faunas were recovered both from below and above the bentonites (Fig. 7). This section has yielded the most diverse faunas of the Trento Plateau, a fact which is explained by the immediate vicinity of theis locality to the Garda escarpment and the open Lombardy Basin.

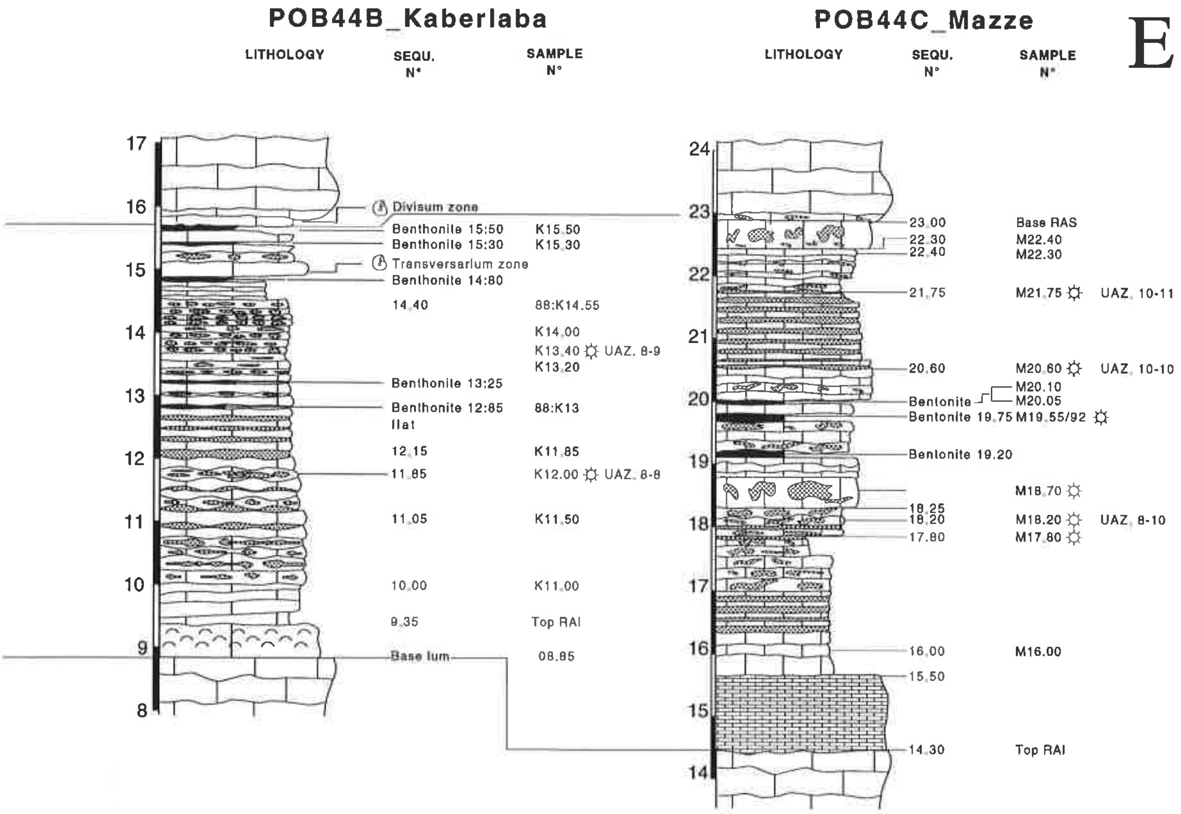


Figure 7. Continued

Madonna della Corona (Fig. 7)

This section has been described for the first time by Cita *et al.* (1959). The Rosso Ammonitico Veronese is well exposed in large outcrops along the road leading to the sanctuary. All the three units of this formation are here present:

- the lower unit, calcareous, more massive and devoid of ammonites, is only accessbible in its upper part. The basal sharp contact between the Rosso Ammonitico Veronese and the oolitic grainstones of the underlying Oolite di San Vigilio is, however, beautifully exposed on the other side of the small valley.

- the siliceous and well bedded middle unit is 6 m thick. The red chert nodules and layers are well develloped and can reach the thickness of several tens of centimetres. In the upper part of this member several thin layers of bentonitic clays are present which allows regional correlations.

- the upper unit is poorly bedded, quite rich in internal moulds of ammonites, and has a thickness of about 10 m.

Another section, located in an abandoned quarry a few hundred meters to the south of Madonna della Corona has been recently studied (Papa, 1994). In the first limestone bed of the Rosso Ammonitico Superiore overlying the bentonite at the top of the middle, cherty, unit, some ammonites have been found, pointing to a middle Oxfordian (*Transversarium* Zone) age.

Radiolarian samples recovered from below and above the bentonites are rich and moderaltely diverse. The residues are dominated by sponge spicules.

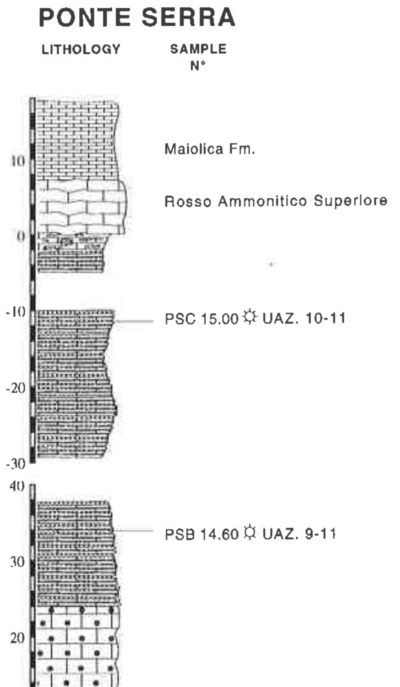


Figure 8. Lithostratigraphy of the Ponte Serra Section in the Belluno Trough with with location of radiolarian samples and zonal assignments.

Kaberlaba (Fig. 7)

This section is located in an active quarry on the Altopiano di Asiago, 4 km SW of Asiago. It has been described by Martire (1989) and Clari *et al.* (1990). It is very similar to Madonna della Corona section in that the three units of the Rosso Ammonitico Veronese are present. Quite rich, though not well preserved, ammonite associations allow to date directly the top of the lower unit (lower Callovian, *Gracilis* Zone), the top of the middle unit, marked by the thickest of five bentonite layers (middle Oxfordian, *Transversarium* Zone), and the base of the upper unit (Lower Kimmeridgian, *Strombecki-Divisum* Zones). A long gap, encompassing the upper Oxfordian and part of the lower Kimmeridgian, is therefore documented between the middle and the upper units.

Radiolarian samples recovered from this section are well preserved but of very low diversity. The residues are totally dominanted by sponge spicules, characteristic of all localities inside the Trento Plateau.

Mazze (Fig. 7)

This section is located in an abandoned quarry on the Altopiano di Asiago, 9 km SE of Asiago. It has been described by Martire (1989). It differs from the Kaberlaba section by 3 meters of cherty limestones of the middle unit above the last bentonite. Unfortunately no biostratigraphic data other than radiolarians are available for this section owing to the very poor preservation of ammonites.

Radiolarian samples recovered from this locality are of very low diversity and the resididues are totally dominated by sponge spicules.

Summary of correlation between ammonites and radiolarian UAZones on the Trento Plateau

The studied sections of the Rosso Ammonitico Veronese can be correlated on the basis of detailed facies correlation, ammonite dating (Martire, 1989, 1992) and the regional occurrence of a sequence of characteristic bentonite layers (Bernoulli & Peters, 1970, Martire 1989).

Transversarium Zone (middle Oxfordian) ammonites were recovered both from below (Kaberlaba) and above (near Madonna della Corona) the upper two bentonite layers, restricting their age to this ammonite zone. On the other hand, *Divisum* Zone ammonites (lower Kimmeridgian) were recovered directly above the topmost bentonite at Kaberlaba. Radiolarian samples below the bentonites are assigned to UAzone 8, whereas one sample recovered between the lower and the upper bentonites at Kaberlaba is assigned to UAZones 8-9. Samples above the bentonites are assigned to UAZ. 9-10 (Ceniga), 7-10 (M. della Corona),or 10-10 (Mazze). This data has contributed to the calibration of the UAZones (see *Chapter* 32). It also indicates that the condensed limestone section that exists between the middle Oxfordian and the lower Kimmeridgian at Kaberaba may be laterally replaced by radiolarian-bearing cherty limestones at Mazze and Ceniga. We will assess these possible facies heteropies in a forthcoming publication.

4. Belluno Trough

4.1 Geological Framework

The Belluno Trough is a narrow and elongate basin on the northwestern corner of the Apulian Plate continental margin. It acquired topographic identity in Early Liassic time, during the break-up of a wide Upper Triassic carbonate shelf (Winterer & Bosellini, 1981). in the beginning (Liassic), the Belluno Trough was a starved depression accumulating euxinic mudstones that bounded by two shallow-water carbonate banks (Trento and Friuli Platforms). When, during the Bajocian, the shallow-water Trento Platform was drowned, the western edge of the Friuli Platform, turned into a prolific oolite "factory" (Bosellini *et al.*, 1981). The oolite sands of the Friuli margin were transported downslope and gradually built a complex of coalescent deep-sea fans, which, prograding westward, infilled the Belluno Trough (Bosellini *et al.*, 1981). The fans terminated westward against the faulted edge of the Trento Plateau and in some places, where the topographic relief decreased, the oolite fans could spill over the escarpment onto the edge of the plateau. By the end of Middle Jurassic time, the Belluno Trough was no longer a submarine depression but a gentle slope connecting the Friuli Platform to the Trento Plateau.

Igne Formation

The Igne Formation is a 80-150 m thick succession of thin-bedded cherty and marly limestones which commonly show a nodular structure and contain ammonite molds. Limestones consist mainly of wackestones with thin-shelled bivalves, radiolarians and crinoid ossicles. Slumps, slide scars and breccias are widespread. The Igne Formation is referred to the Toarcian - Aalenian interval (Casati & Tomai, 1968). radiolarian samples are under study.

The Vajont Limestone.

It is a wedge-shaped lithosome constituted for the most part of graded calcarenites (oolitic grainstone and packstone) showing ripple and parallel lamination in the upper part of the beds. Graded breccia horizons consisting of micritic clasts (mud chips) occur with blocks up to 1 m in diameter. The base of the Vajont Limestone is channelled into the underlying Igne Formation.

The Vajont Limestones are interpreted as resedimented deep water deposits (Bosellini *et al.*, 1981). Maximum thicknesses (800-1000 meters) occur in the eastern parts of the Belluno Trough, close to the Friuli Platform. In the more distal sections, beds are laterally continuous and tabular and display thickening-upward sequences. Palaeocurrents indicate a common southeast provenance.

The Fonzaso Formation (see above).

The base of this formation was classically assumed to be of Late Callovian/Oxfordian age (Fig. 3) It overlies the Vajont everywhere, but the age of radiolarian assemblages recovered near that contact is highly diachronous. At Ponte Serra, in fact, radiolarite facies are present below a distal expression of the Vajont Limestone (Bosellini *et al.*, 1981), suggesting interstratification of radiolarian-bearing pelagic sediments (Fonzaso) and platform-derived calciturbitites (Vajont).

4.2 Data of the studied sections

Ponte Serra. At Ponte Serra about 15 m of calciturbidites , interpreted as a distal expression of the Vajont limestone by Bosellini et al. (1981) occurs well above the Ammonitico Rosso Inferiore, set in a radiolarian-bearing sequence of thin - bedded cherty lime- and mudstones. Samples located well above the limestone (Fig. 8) are assigned to UAZ. 9-11 (middle Oxfordian to early Tithonian).

Val Ardo (5 km north of Belluno). Radiolarian samples recovered from cherty limestones interbedded with the last oolitic turbidites of the Vajont along the Val Ardo trail, can be assigned to UAZ. 9 (middle-late Oxfordian).

Vajont Dam. Radiolarian samples were collected at the upper entrance of the road tunnel, next to the Chapel comemorating the catastrophy of the Vajont Dam break. These samples are also interbedded with the topmost ooolitic turbidites of the Vajont Limestone and the extremely diverse and well preserved radiolarian assemblages are assignable to UAZ. 7 (late Bathonian-early Callovian). Further studies should show, whether a significant section of Vajont limestones can be found above these samples. This would place them in a siliceous interval within the Vajont.

References

BALDANZA, A., CRESTA, S. & MATTIOLI, E. (1990). Bajocian calcareous Nannofossils from Umbro-Marchean Apennines (Monte Nerone area). In Cresta, S. & Pavia, G. Eds. Proccedings of Meeting on Bajocian Stratigraphy - Memorie Descrittive della Carta geologica d'Italia. 40, 225-236.

BARBUJANI, C., BOSELLINI, A. & SARTI, M. (1986). L'Oolite di San Vigilio nel Monte Baldo (Giurassico, Prealpi Venete). *Annale della Univerità di Ferrara, Sezione 9, Geologia e Paleontologia*, **9**, 19-47.

BATHURST, R.G.C. (1987). Diagenetically enhanced bedding in argillaceous platform limestones: stratified cementation and selective compaction. *Sedimentology*, **34**, 749-778.

BAUMGARTNER, P., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BECCARELLI-BAUCK, L. (1988). Unter-bis mitteljurassische Karbonatformationen am Westrand der Trento-Platform (Sudalpen, Norditalien). *Münchner Geowissenschaftliche Abhandlungen. Reihe A, Geologie und Paläontologie*, **13**, 1-76.

BERTOTTI, G., PICOTTI, V., BERNOULLI, D. & CASTELLARIN, A. (1993). From rifting to drifting: tectonic evolution of the South-Alpine upper crust from the Triassic to the Early Cretaceous. *Sedimentary Geology*, **86**, 53-76.

BOSELLINI, A. & BROGLIO-LORIGA, C. (1971). I Calcari Grigi di Rotzo (Giurassico inferiore, Altopiano di Asiago) e il loro inquadramento nella paleogeografia e nella evoluzione tettono- sedimentaria delle Prealpi venete. *Annali della Universitá de Ferrara, Sezione IX, Scienze Geologica e Paleontogica*, **5**, 1-61.

BOSELLINI, A. & DAL CIN, R. (1968). Il Giurassico medio-superiore di Fonzaso (Feltrino occidentale). *Annali della Universitá de Ferrara, Sezione IX, Scienze Geologica e Paleontogica*, **4**, 235-247.

BOSELLINI, A., MASSETTI, D. & SARTI, M. (1981). A Jurassic "Tongue of the Ocean" infilled with oolitic sands: the Belluno Trough, Venetian Alps, Italy. *Marine Geology*, **44**, 59-95.

BUXTON, T.M. & SIBLEY, D.F. (1981). Pressure solution features in ashallow buried limestone. *Journal of Sedimentary Petrology*, **51**, 19-26.

CASATI, P. & TOMAI, M. (1968). Il Giurassico ed il Cretacico del versante settentrionale del Vallone Bellunese e del Gruppo del M. Brandol. *Rivista Italiana di Paleontologia e Stratigrafia*, **75**, 205-341.

CHANNELL, J.E.T., D'ARGENIO, B. & HORVÁTH, F. (1979). Adria, the African Promontory, in Mesozoic Mediterranean Palaeogeography. *Earth Science Reviews*, **15**, 213-292.

CITA, M.B., FORTI, A., RAFFI, G. & VILLA, F. (1959). Jurassic and Cretaceous microfacies from the Prealps and Central Apennines (Italy). *Proceeding of the Fifth World Petrological Congress, Section I/D*, 969-1002.

CLARI, P.A. (1975). Caratteristiche sedimentologiche e paleontologiche di alcune sezioni dei Calcari Grigi del Veneto. *Memorie dell'Istituto Geologico della Reale Universita di Padova*, **31**, 1-63.

CLARI, P.A., MARINI, P., PASTORINI, M. & PAVIA, G. (1984). Il Rosso Ammonitico Inferiore (Baiociano-Calloviano) nei Monti Lessini settentrionali. *Rivista Italiana di Paleontologia e Stratigrafia*, **90**, 15-86.

CLARI, P.A. & MARTIRE, L. (in press). The interplay of early cementation, compaction and pressure-dissolution: a case from the Rosso Ammonitico Veronese (N.E. Italy). *Journal of Sedimentary Research, Section B: Stratigraphy and Global Studies*.

CLARI, P.A., MARTIRE, L. & PAVIA, G. (1990). L'unità selcifera del Rosso Ammonitico Veronese (Alpi Meridionali). *In* Pallini, G.*et al.* Eds. *Atti del secondo convegno internazionale: Fossili, Evoluzione, Ambiente*, Pergola, 1987, 151-162.

COBIANCHI, M. (1992). Sinemurian-Early Bajocian calcareous nannofossil biostratigraphy of the Lombardy Basin (Southern Calcareous Alps; Northern Italy). *Atti Ticinense di Scienze della Terra*, **35**, 61-106.

COBIANCHI, M., ERBA, E. & PIRINI RADRIZZANI, C. (1992). Evolutionary trends of calcareous nannofossil genera Lotharingius and Watznaueria during the Early and Middle Jurassic. *Memorie di Scienze Geologica, Padova*, **43**, 27-40.

DELLA BRUNA, G. & MARTIRE, L. (1985). La successione giurassica (Pliensbachiano- Kimmeridgiano) delle Alpi Feltrine (Belluno). *Rivista Italiana di Paleontologia e Stratigrafia*, **91**, 15-62.

ERBA, E. (1990). Calcareous nannofossil biostratigraphy of some Bajocian sections from the Digne area (SE France). *Memorie Descrittive della Carta Geologica d'Italia*, **40**, 237-256.

FOGELGESANG, J.F. (1975). *Géologie du Monte Baldo septentrional (Prov. de Trente, Italie) et aspects géochimiques de la sédimentation pélagique tridentine et lombarde au Jurassique*. Thèse 3ème cycle. Université Pierre et Marie Curie (Unpublished), Paris, 178 p.

GAETANI, M. (1975). Jurassic stratigraphy of the Southern Alps: a review. *In* Squyres, C. Ed. *Geology of Italy* - Lybian Arab Republic Earth Sciences Society, 377-402.

GAETANI, M. & POLIANI, G. (1978). Il Toarciano ed il Giurassico medio in Albenza. *Rivista Italiana di Paleontologia e Stratigrafia*, **91**, 295-320.

GAETANI M. & ERBA E. (1990). Il Bacino Lombardo: un sistema paleoalto/ fossa in un margine continentale passivo durante il Giurassico. Guida escursioni del 75° Congresso della Società Geologica Italiana, Milano settembre 1990.

JENKYNS, H.C. (1971). The genesis of condensed sequences in the Tethyan Jurassic. *Lethaia*, **4**, 327-352.

KENEDY, W.J. & GARRISON, R.E. (1975). Morphology and genesis of nodular chalks and hard-grounds in the Upper Cretaceous of southern England. *Sedimentology*, **22**, 311-386.

KOCHER, R.N. (1981). Biochronostratigraphische Untersuchungen oberjurassischer radiolarien führender Gesteine, insbesondere der Südalpen. *Mitteilungen aus dem Geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge*, **234**, 1-184.

MARTIRE, L. (1989). *Analisi biostrastigrafica e sedimentologica del Rosso Ammonititco Veronese dell'Altopiano di Asiago (VI)*. Ph.D Thesis. Università di Torino (unpublished), 166 p.

MARTIRE, L. (1992). Sequence stratigraphy and condensed pelagic sediments. An example from the Rosso Ammonitico Veronese, northeastern Italy. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **94**, 169-191.

MASSARI, F. (1979). Oncoliti e stromatoliti pelagiche nel Rosso Ammonitico Veneto. *Memorie di Scienze Geologicha, Padova*, **32**, 1-21.

MASSARI, F. (1981). Cryptalgal fabrics in the Rosso Ammonititco sequences of Venetian Alps. *In* Farinacci, A. & Elmi, S. Eds. *Rosso Ammonitico Symposium Proceedings* - Tecnoscienza, Roma, 435-469.

MATTIOLI E. and ERBA E. (in prep.). Synthesis of Early to Middle Jurassic calcareous nannofossil events in tethyan sections (northern and central Italy)

PAPA, G. (1994). *Analisi stratigrafica del Rosso Ammonitico Veronese nell'area di Spiazzi di Monte Baldo (VR)*. Laurea Thesis (Unpublished). University of Torino.

PAVIA, G., BENETTI, A. & MINETTI, C. (1987). Il Rosso Ammonitico dei Monti Lessini Veronesi (Italia NE). Faune ad Ammoniti e discontinuità stratigraphiche nel Kimmeridgiano inferiore. *Bollettino della Società Paleontologica Italiana*, **26**, 63-92.

REALE, V., BALDANZA, A., MONECHI, S. & MATTIOLI, E. (1991). Calcareous nannofossil biostratigraphic events from the Early-Middle Jurassic sequences of the Umbria-Marche area. *In* Rio, D. & Proto-Decima, F. Eds. *Procedings of the International Nannofossils Association Meeting* - Memorie della Società Geologica di Padova, Florence, **43**, 41-76.

SARTI, C. (1981). Segnalazione di Ammonite nella formazione dei Calcari Grigi dell'Altopiano di Lavarone (Trentino). *Bollettino della Società Geologica Italiana*, **20** (1), 49-51.

SARTI, M., BOSELLINI, A. & WINTERER, E. (1992). Basin geometry and architecture of a Tethyan passive margin (Southern Alps, Italy): implications for rifting mechanisms. *In* Watkins, J.S., Zhiqiang, F. & McMillen, J. Eds. *Geology and geophysics of continental margins* - Bulletin of the American Association of Petroleum Geologists. **53**, 241-258.

STAMPFLI, G.M. & MARCHANT, R.H. (in press). Plate configuration and kinematics in the Alpine region. *Accademia Nazionale di Scienze Roma*.

STURANI, C. (1964). La successione delle faune ad Ammoniti nelle formazioni medio-giurassiche delle Prealpi Venete occidentali. *Memorie dell'Istituto geologico della Reale Universita di Padova*, **24**, 1-63.

Sturani, C. (1971). Ammonites and stratigraphy of the «Posidonia alpina» beds of the Venetian Alps (Middle Jurassic, mainly Bajocian). *Mem. Ist. Geol. Min. Padova*, **28**, 190 pp.

WINTERER, E.L. & BOSELLINI, A. (1981). Subsidence and sedimentation on a Jurassic passive continental margin, Southern Alps, Italy. *Bulletin of the American Association of Petroleum Geologists*, **65**, 394-421.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program.

POB19_TORRE_DE_BUSI: bottom 1-top 9
< 9 {RK 187}: 3020, 3036, 3055, 3065, 3087, 3171, 3263
< 8 {RK 332}: 3020, 3036, 3055, 3164, 3171
< 7 {RK 199}: 3017, 3020, 3036, 3055, 3066, 3105, 3126, 3161, 3162, 3164, 3171, 3226, 4069
< 6 {RK 206}: 3008, 3012, 3020, 3033, 3035, 3052, 3055, 3061, 3064, 3085, 3103, 3160, 3164, 3181, 3199, 3223, 3254
< 5 {RK 403}: 3012, 3020, 3033, 3035, 3052, 3055, 3059, 3061, 3064, 3085, 3103, 3181, 3223, 3254, 3277
< 4 {RK 207}: 3012, 3020, 3033, 3035, 3052, 3055, 3059, 3061, 3064, 3085, 3103, 3139, 3181, 3215, 3223, 3254, 3277
< 3 {RK 208}: 3012, 3033, 3052, 3055, 3061, 3064, 3085, 3103, 3181, 3215, 3254, 3277
< 2 {RK 414}: 3012, 3033, 3052, 3055, 3064, 3076, 3085, 3103, 3109, 3180, 3181, 3254
< 1 {POB1341}: {POB1341.ok18/12/91pob} 3001, 3004, 3006, 3007, 3010, 3011, 3030, 3039, 3041, 3048, 3071, 3072, 3073, 3074, 3089, 3096, 3109, 3125, 3148, 3149, 3194, 3195, 3216, 3231, 3247, 3253, 3278, 3302, 4061, 4063, 4066

SECTION 6_SERRADA: bottom 1-top 1
< 1 {POB1403: 3009, 3022, 3062, 3064, 3085, 3095, 3097, 3161, 3167, 3168, 3171, 3215, 3230, 3263, 3265, 3274, 4069

SECTION 44_CENIGA: bottom 1-top 4
< 4 {POB1704sample ch. 29/12/91pob}: 3095, 3161, 3171, 3181 , 3215, 3230, 3265, 4069, 4070
< 3 {POB1703sample ch. 29/12/91pob}: 3081, 3064, 3085, 3090, 3095, 3096, 3122, 3161, 3168, 3171, 3181, 3213, 3215, 3230, 3265, 3274, 3305, 4069, 4070
< 2 {POB1701 sample ch.29/12/91pob}: 3009, 3035, 3036, 3064, 3065, 3066, 3081, 3082, 3085, 3088, 3095, 3096, 3097 , 3103, 3117 , 3118, 3122, 3161, 3164 , 3168, 3171, 3177 , 3181, 3193 , 3210, 3213 , 3215, 3224, 3226, 3230, 3241, 3265 , 3274, 4015, 4069
< 1 {POB1695 sample ch. 29/12/91pob}: 3008, 3035, 3036, 3062, 3064, 3065, 3070, 3081, 3082, 3085, 3088, 3095, 3100, 3103, 3116, 3121, 3122, 3123, 3160 , 3161 , 3164, 3167, 3180, 3181, 3213, 3217, 3220, 3223, 3224, 3230, 3241, 3243, 3263, 3265, 3274, 4069

SECTION 44A_MADONNA_DELLA_CORONA_A: bottom 1-top 3
< 3 {MCB0.35}: 3113, 3009, 3065, 3082, 3103, 3115
< 2 {MCB0.90}: 3131, 3095, 3096, 3103, 3122, 3161, 3224, 4069
< 1 {MCA0.35}: 3008, 3061, 3064, 3085, 3110, 3117, 3121, 3123, 3161, 3169, 3180, 3181, 3215, 3244, 3270, 3274, 4063

SECTION 44B_KABERLABA: bottom 1-top 2
< 2 {K13.40 det 1/1/92pob:rads F sponges A ca. 90%}: 3008{R}, 3065{C}, 3082, 3095{A}, 3103{F}, 3113{VR}, 3181{R}, 3217, 3224, 3243{VR}, 4069{C}
< 1 {K12.00 det 1/1/92pob:rads only a few specs. sponge spics and raxes >>99%}: 3121, 3065, 3082, 3177, 3181, 3230, 3270, 4063

SECTION 44C_MAZZE: bottom 1-top 3
< 3 {21.75}: 3274, 3017, 3095{C}, 3161{R. COULD BE MINOR3286}, 3230{A}, 3265{C}, 3305, 4069{R}, 4070
< 2 {M20.60}:, 3009, 3095{R}, 3161{VR}, 3181{R}, 3230{A}, 3265{C}, 3274, 4069{R}, 4070
< 1 {M18.20}: 3082, 3064{R}, 3065{A}, 3085, 3224, 3265{F}, 4069{F}

SECTION VAJONT_DAM: bottom 1-top 2
< 2 {VAJ-FON3}: 3005, {TURANTA FLEXA PESS & BLOME 1982}, 3008, 3009, 3064, 3081, 3085, 3100, 3103, 3110, 3113, 3115, 3116, 3121, 3123, 3124, 3159, 3160, 3164, 3167, 3169, 3176, 3180, 3210, 3215, 3220, 3241, 3244, 3270, 3273, 3412, 3413, 3813, 4063
< 1 {VAJ-FON 0}: 3005, {TURANTA FLEXA PESS & BLOME 1982}, 3008, 3024, 3064, 3081, 3085, 3103, 3110, 3113, 3121, 3124, 3150, 3159, 3161, 3164, 3169, 3176, 3210, 3220, 3241, 3244, 3270, 3273, 3274, 3412, 4063, 4068

SECTION SVAL_ARDO: bottom 1-top 2
< 2 {VA C3.90}: 3008, 3009, 3065, 3082, 3095, 3096, 3103, 3106, 3113, 3115, 3117, 3118, 3121, 3123, 3129, 3160, 3161, 3163, 3164, 3166, 3169, 3176, 3180, 3181, 3215, 3224, 3230, 3241, 4068, 4069
< 1 {VA A10.60}: 3008, 3055, 3062, 3095, 3113, 3160, 3161, 3167, 3169, 3176, 3181, 3218, 3243, 3267, 3274, 4015, 4068

SECTION SPONTE_SERRA: bottom 1-top 2
< 2 {PS C15.00}: 3036, 3066, 3081, 3094, 3096, 3097, 3122, 3161, 3164, 3167, 3171, 3181, 3213, 3215, 3216, 3226, 3241, 3259, 3263, 3265, 3274, 3406, 4015, 4068, 4069, 4070
< 1 {PS B14.60}: 3122, 3160, 3161, 3164, 3181, 3224, 3241, 3259, 3263, 3267, 3274, 3305, 4068, 4069

12. Early Cretaceous Radiolarian Biostratigraphy of Umbria-Marche Apennines (Italy), Southern Alps (Italy and Switzerland) and Hawasina Nappes (Oman)

by Ruth Dumitrica-Jud

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
Mailing address: Könizstrasse 39, 3008 Bern, Switzerland

ABSTRACT

About 500 samples of uppermost Jurassic to lowermost Aptian cherty limestones, most of them in the Maiolica facies, were studied for their radiolarian content in order to make a comprehensive inventory of radiolarian assemblages and to establish a radiolarian biochronology calibrated and correlated to magnetostratigraphy, nannofossil and calpionellid zones established in the same sections. The samples were collected from 26 land sections in Switzerland, Italy and Oman. Of several hundred morphotypes recorded in 245 well-preserved samples from only 13 sections of the 26 examined, 175 radiolarian taxa were selected, and species occurrences were calculated with the computer program "BioGraph" (Savary & Guex, 1990). This resulted in 35 successive Unitary Associations (U.A.) that could be grouped into 11 U.A. zones (Jud, 1994) whose terminology follows and continues that of Baumgartner (1984). A protoreferential or "range chart" based on U.A. was finally synthetised for all species selected between the interval of the middle Tithonian and the lowermost Aptian.

Although the studied sections belong to several distinct paleogeographic areas with basinal and seamount facies - Prealpine Nappes (Northern Tethys), Southern Alps and Umbria-Marche Apennines (Apulian Plate, Southern Tethys) and Hawasina Complex (distal Arabian Margin) - the radiolarian Unitary Associations have proved to be a useful tool for correlation.

Precise correlation of the present radiolarian zonation, defined by co-existence of one or several species pairs within one zone, to most of the previous zonations is difficult, as most of them were defined by first or last appearances of one or two "marker" species, which either do not occur in the present zonation or have another range.

1. Geographic and geologic frame-work

During the late Tithonian to early Aptian the Tethys Ocean, located between Eurasia and Africa (Fig. 1) was bordered by deeply submerged margins and marginal basins in which pelagic nannofossil and radiolarian-rich limestones (e.g. the Maiolica Formation) uniformly accumulated over a large area. These sediments form now part of the Mesozoic sequences exposed in the Swiss Prealpine Nappes, in the Southern Alps and in the Umbria-Marche Apennines.

About 100 years ago radiolarians of the Maiolica Formation were discovered and described by Rüst (1885, 1888, 1898), Parona (1890), Vinassa de Regny (1898a, b, 1899) and Squinabol (1914). Only in the 1980's was this research renewed when studies of isolated samples from the lower Neocomian Maiolica were undertaken by Baumgartner *et al.* (1980), Baumgartner (1984), Schaaf (1985) and Aita & Okada (1986). A number of sections from the Southern Alps and of the Umbria Marche Apennines have been thoroughly studied for paleomagnetic research (e.g. Lowrie & Channell, 1984, Channell *et al.*, 1984, etc.), nannofossils (Monechi, 1981; Bralower, 1987; Bralower *et al.*, 1989) and calpionellids (Remane, 1985). Recently a comprehensive study was made on the radiolarian biostratigraphy of the Maiolica Formation (Jud, 1994). Radiolarians are the most frequent and diverse group of planktonic microfossils occurring at the level of this formation and their biostratigraphic value is as significant as that of the other microfossils.

The Upper Tithonian to Lower Aptian Maiolica Formation (Weissert, 1979), represented in the Southern Alps and in the Umbria-Marche Apennines, is a monotonous sequence of well-bedded whitish, beige to gray pelagic limestones with chert layers and nodules and abundant slumps. Black shales are intercalated in the Valanginian of the Southern Alps, (Weissert & Channell, 1989) and in the Barremian (Southern Alps and Umbria Marche Apennines). The Maiolica of the Southern Alps contains also breccia beds, dark-gray coarse-grained limestone horizons rich in Aptychi and chert grains, gray-green marls and intervals of cyclic sedimentation. The Maiolica limestones are rich in radiolarians but only rare ammonites have been found to date (Rieber, 1977 and Cecca *et al.*, 1994).

A basinal correlative facies of the Maiolica is represented in the eastern part of the Prealpine Nappes in Switzerland "Klippendecke" (Schardt, 1898), or "Nappes des Prealpes médianes plastiques internes" (Lugeon & Gagnebin, 1941; Baud, 1972) by the "Kummlischichten" (Bieri, 1925) or the "biancone-ähnliche Kalke" and the Neocomian "Fleckenkalke" (Boller, 1963), a sequence of beige limestones with chert layers and nodules and turbiditic intervals.

A series of samples which correspond to the stratigraphic level of the Maiolica Formation was studied from several sections of the Wahrah Formation belonging to

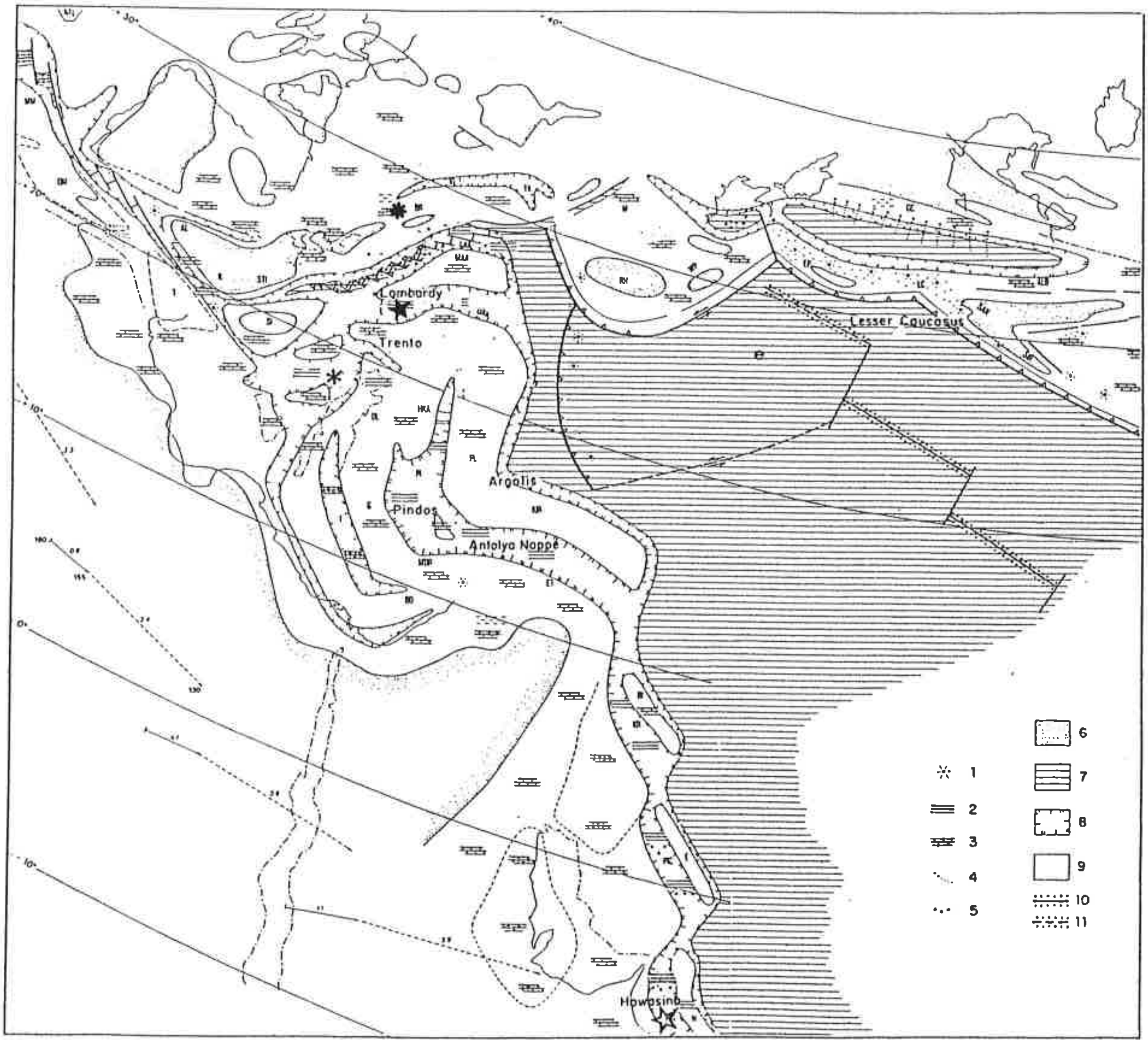


Figure 1. Paleogeographic map of the Upper Jurassic with location of sampling areas (modified after Dercourt *et al.*, 1985)
✱ Préalpes médianes, ★ Southern Alps, ✱ Umbria (basins and seamounts), ☆ Oman (Hawasina basin), **1.** Volcanism, **2.** Radiolarite, **3.** Limestone, **4.** Flysch, **5.** Breccia, **6.** Emergent land (on any type of crust), **7.** Oceanic crust, **8.** Thin continental crust (basin), **9.** Thick continental crust (platform), **10.** Active spreading ridge, **11.** Spreading ridge when dying out

the Hawasina Nappes (Oman, distal Arabian Margin). It consists of non metamorphic mudstones, mud-siltstones, cherts, siliceous clay beds and intercalated manganese horizons (Kickmeier & Peters, 1990).

2. Préalpes médianes plastiques: Pfaffengrat (Switzerland)

Access: The Pfaffengrat section (Fig. 2) is located south-west of the town of Thun, at the western end of the Lake of Thun. The outcrop is situated on the west of the Stockhorn peak on the eastern flank of the Pfaffengrat (topographic map Thun, scale 1:25'000, coordinates 605.410/170.910, north-east of point 1957.30).

Description of the outcrop: The upper Tithonian ("Kummlischichten") and the Berriasian-Valanginian ("Fleckenkalke") consist of thin-bedded limestones and thicker turbiditic coarse-grained beds (Fig. 3). The transition between the thick-bedded portion of the Jurassic ("Massivkalk" or "Formation des calcaires massifs", Spicher, 1965) and thin bedded "Kummlischichten" is gradual and the Jurassic-Cretaceous boundary is not marked by a visible lithological change. The thin-bedded upper portion of the sequence is characterized by intensive bioturbation and by the absence of chert horizons and nodules, and therefore was not sampled. The base level for sampling (0.00 m) lies at the top of the last massive bed.

Calpionellids: Boller (1963) made the first study of calpionellids from this section. Differences in the measurements of the sections enhanced a correlation of the results.

Radiolarians: Radiolarians are rare to common and poorly- to moderately-preserved, often replaced by calcite and with low diversity. The best sample was collected at 35.00 m. It represents the U.A. 7-10 and is comparable with the samples 1 and 2 of the section Capriolo, in the Southern Alps (163.00 m and 162.80 m, upper Berriasian) with stratigraphic control by correlation with calpionellids, nannofossils and paleomagnetics. Sample 5 at Pfaffengrat could therefore correspond to calpionellid Zone D1 identified at Capriolo in the interval between the FAD of the nannofossil *C. angustiforatus* and the LAD of *U. granulosa*, in the magnetic polarity chron M16 (Channell *et al.*, 1987).

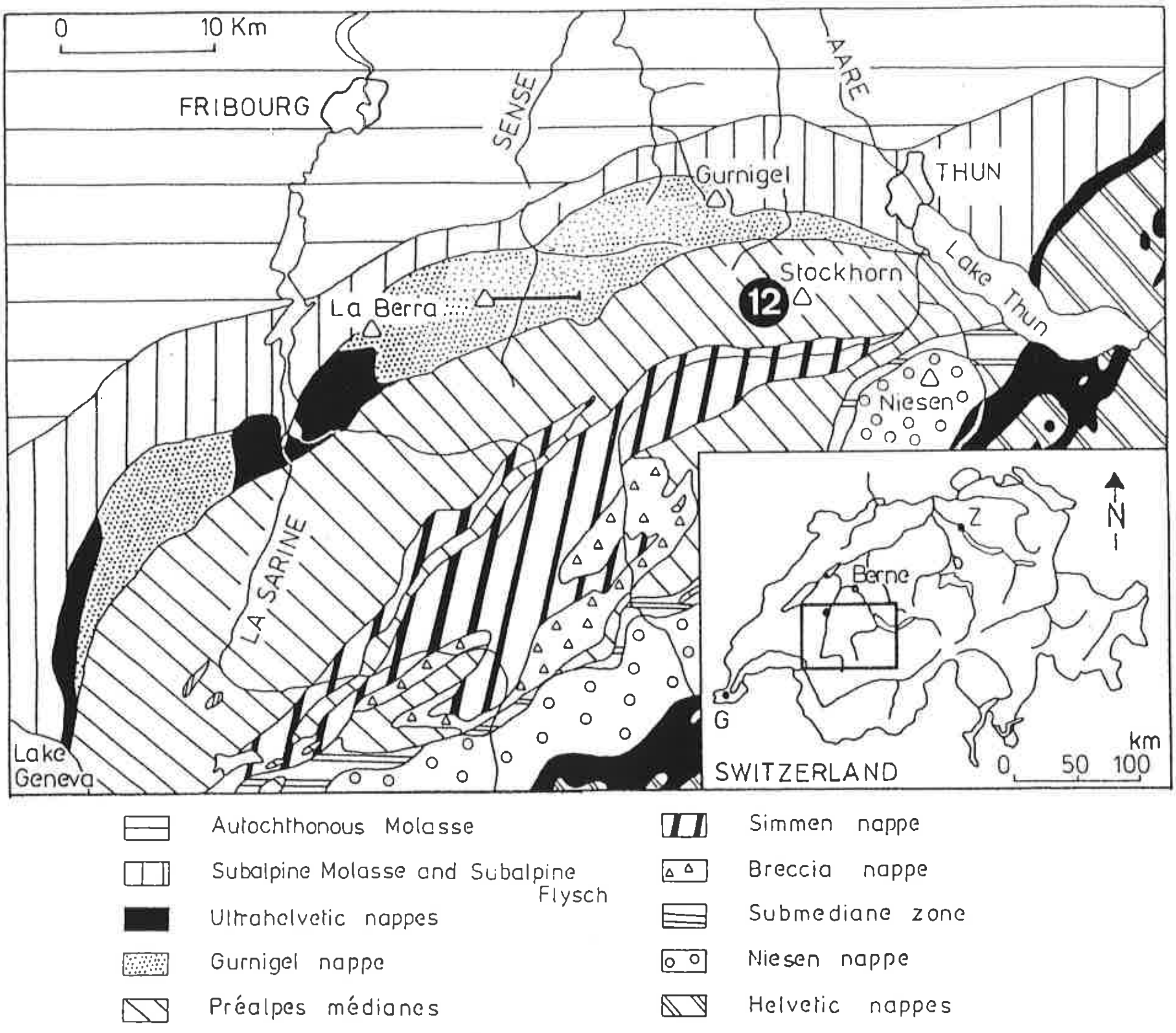


Figure 2. Tectonic map with location of Pfaffengrat section in the Préales médianes (modified after De Känel *et al.*, 1989)

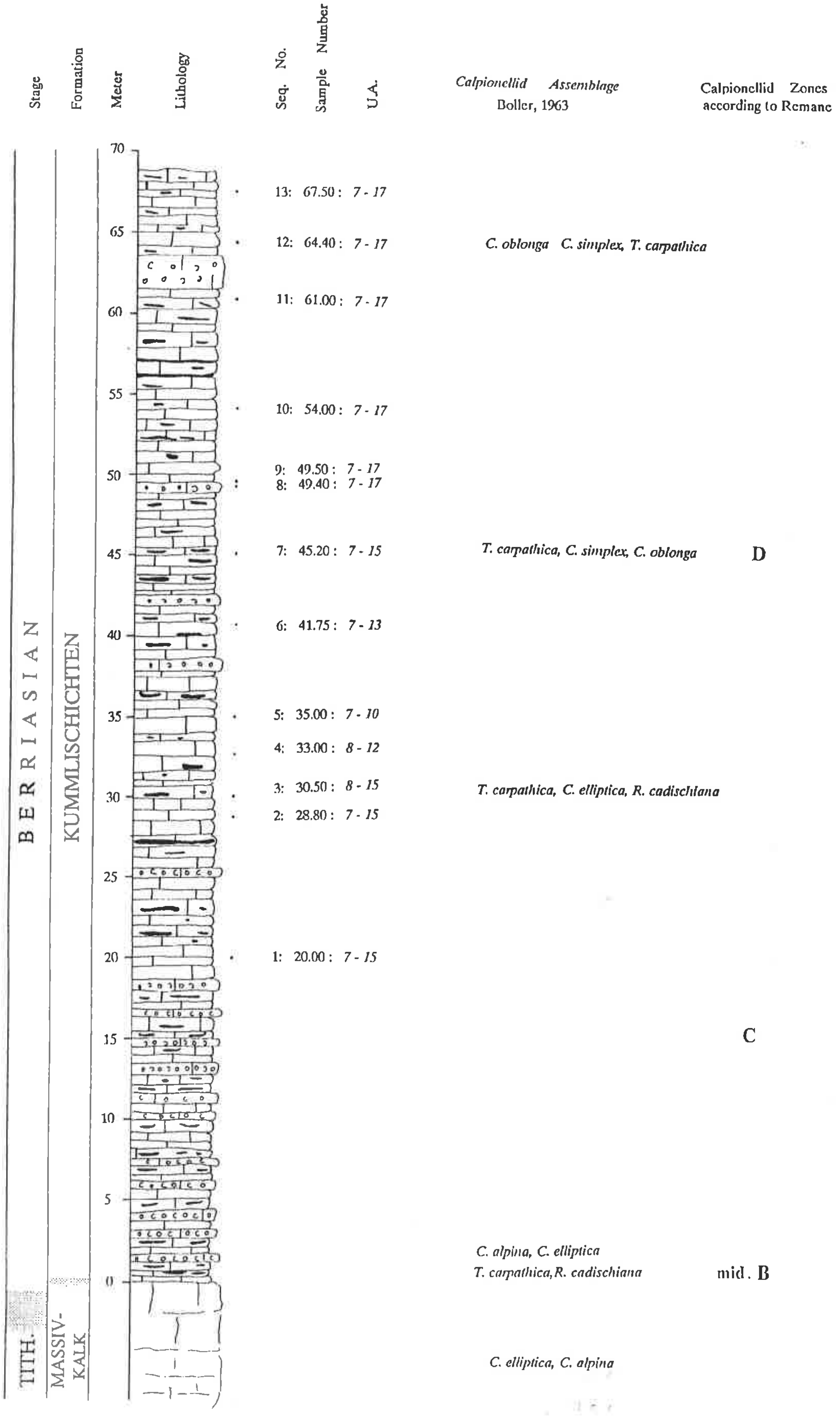


Figure 3. Pfaffengrat section: correlation of Unitary Association to Calpionellids assemblages and to lithostratigraphy (Jud, 1994)

3. Southern Alps: Breggia Gorge, Cava Rusconi, Capriolo

The 3 investigated sections: Breggia Gorge, Capriolo and Cava Rusconi are palaeogeographically situated in the Lombardian Basin. This is divided into several smaller basins or troughs which are separated from one another by small ridges (Fig. 4).

The Maiolica Formation overlies the Jurassic Rosso ad Aptici Formation and is overlain by the deep-water pelagic Aptian to Cenomanian Scaglia Variegata Formation. The Maiolica consists of white to grey coloured, well-bedded limestones with chert layers and chert nodules and pelitic intervals. Slumps and breccia horizons are frequent as well as laminated and cyclic bedding and intervals of pelitic sedimentation.

Recent investigations of many sections in the Southern Alps (Channell *et al.*, 1987, Channell & Erba, 1992, Lini *et al.,* 1992) have led to well-established correlations of magneto-, chemo-, nannofossil- and calpionellid-stratigraphy.

3.1. Breggia Gorge

Access: The Breggia-Gorge is located in Southern Switzerland north of Chiasso (Fig. 5), near the border to Italy (topographic map Mendrisio 1373, scale 1:25'000, coordinates 722.325/79.625). The section is situated in an abandoned quarry on the western side of the Breggia River, accessible by a small foot path which starts on the western side near the buildings of the former cement factory and follows the eastern border of the Breggia River.

Description of the outcrop: The Maiolica Formation (Fig. 6) was sampled at the western side of the river. Two large tunnel entrances divide the section into three portions of which the middle one was not completely sampled. The base (0.00 m) of the section is above the last red bed of the Jurassic Rosso ad Aptici Formation and is followed by two thick slump portions of about 23m. total thickness. The last sample of the lower portion of the section was taken at 74.80 m. The upper part was sampled 23 m downwards below the base of the Scaglia Variegata. The two portions were then linked by filling in the missing unsampled part and completing it to the total thickness of 130 m as measured by Weissert (1979).

Calpionellids: Several samples with rare and poorly-preserved calpionellids were examined by Remane (pers. comm., 1991). As we have at present no better results we could not correlate the radiolarian zones with calpionellid zones.

Nannofossils: Aita & Okada (1986) examined 17 samples spanning the Upper Jurassic-Barremian interval. Because of the poor-preservation they concluded that further investigations on nannofossils would be required. The section was studied in detail for nannofossils and carbon isotope events by Lini *et al.* (1992).

Aptychi: Renz & Habicht (1985) sampled the Breggia section for aptychi and defined the stages boundaries by correlating their data to those of DSDP Leg 76 (Site 534A and DSDP Leg 44, Site 391C.

Radiolarians: Baumgartner (1984) included the Breggia section in his Middle Jurassic-Early Cretaceous radiolarian zonation. His sample POB1330 was collected 10.50 m above the last steeply dipping bed of the Rosso ad Aptici Formation and was identified as U.A. 11, U.A. Zone D (uppermost Tithonian to lowermost Berriasian). Included within our data set, the same sample is identified as UAZ. 7, which corresponds to U.A. Zone D2 (lowermost Berriasian, Jud, 1994).

The radiolarian fauna is very well-preserved and highly diverse which led to the erection of 6 radiolarian zones.

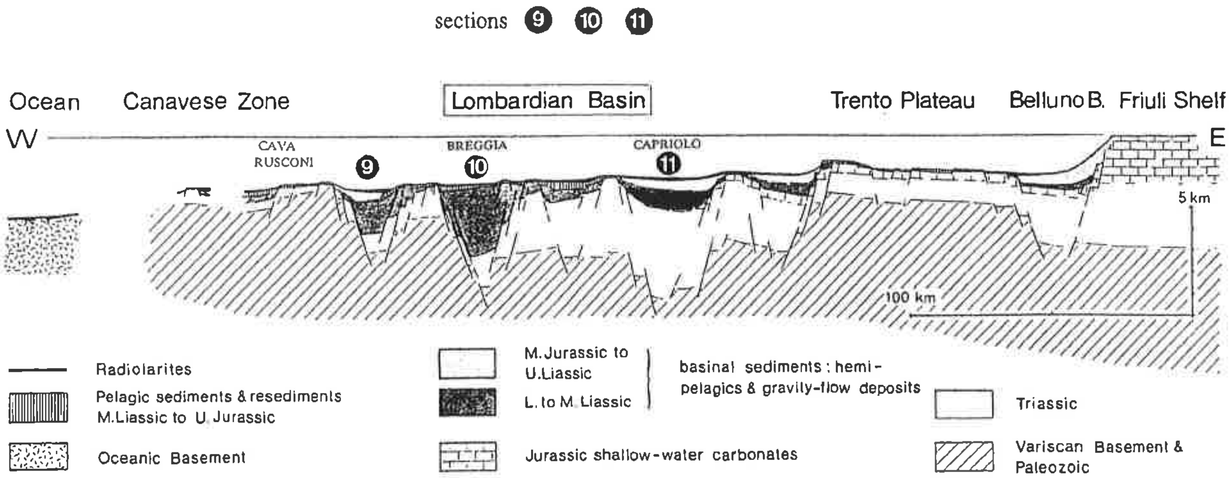


Figure 4. Palinspastic cross section through the southern continental margin of Tethys in the Late Jurassic with palaeogeographic position of the Cava Rusconi section (9), the Breggia section (10) and the Capriolo section (11) (modidied after Bernoulli *et al.*, 1979)

3.2. Cava Rusconi

Access: The section is located in an active quarry, which is the property of Cementi Rusconi and lies to the southwest of the small village of Cittiglio about 4 km southeast of Lago Maggiore, in the province Varese, Italy. (Fig 5).

Description of the outcrop: The section (Fig. 7) is tectonically much disturbed, showing large chevron folds and numerous fractures, and the uppermost part of the Maiolica Formation does not crop out. The base of the section was defined by the top of the last bed of the Rosso ad Aptici Formation. Breccia horizons and dark-grey beds with aptychi occur at several levels. Couplets or triplets of large chert bands were used for correlation in the folds.

Nannofossils and Magnetostratigraphy: This section has not yet been investigated for nannofossils and magnetostratigraphy.

Calpionellids: Remane (pers. comm.) studied the calpionellids. The micropaleontological content was very inconsistent, with barren intervals and intervals yielding only rare and mostly crushed specimens. Most samples seem to contain mixed faunas.

Radiolarians: Radiolarians are abundant and in some samples they are well-preserved and highly diverse. Five radiolarian zones were identified of which the uppermost, Zone F2 indicates a lowermost Hauterivian age for the slumped interval below the top of the outcropping sequence. Sample POB1205 (a little above the base of the section) corresponds to Breggia POB1330, identified as U.A. 7 (lowermost Berriasian, Jud, 1994).

3.3. Capriolo

Access: The section is located in Italy, north of the village Capriolo and south of Lago d'Iseo in an abandoned quarry.

Description of the outcrop: The base of the section is in the north on the bottom of the quarry and the top is in the south on the uppermost of the three terraces. The Maiolica Formation (Fig. 8) was sampled stratigraphically downwards, following the measurements of Channell *et al.* (1987). The 0.00 m level is just below the first shales of the Scaglia Variegata Formation and the end at 175.00 m at the lowermost part of the outcrop. The presence of thick breccia beds and cyclic bedding is very characteristic in the lower part of this section.

Magnetostratigraphy: Channell *et al.* (1987) investigated the section for magnetostratigraphy but correlated the lithology erroneously by 1 metre between the second and the third terrace. Therefore 1 metre should be added to all measurements in the interval between 84 m and 175 m. All our sample levels are not corrected on the stratigraphic columns (Fig. 8). The Capriolo Section was re-investigated by Channell & Erba (1992) and the definitions of the uppermost magnetic chrons were changed

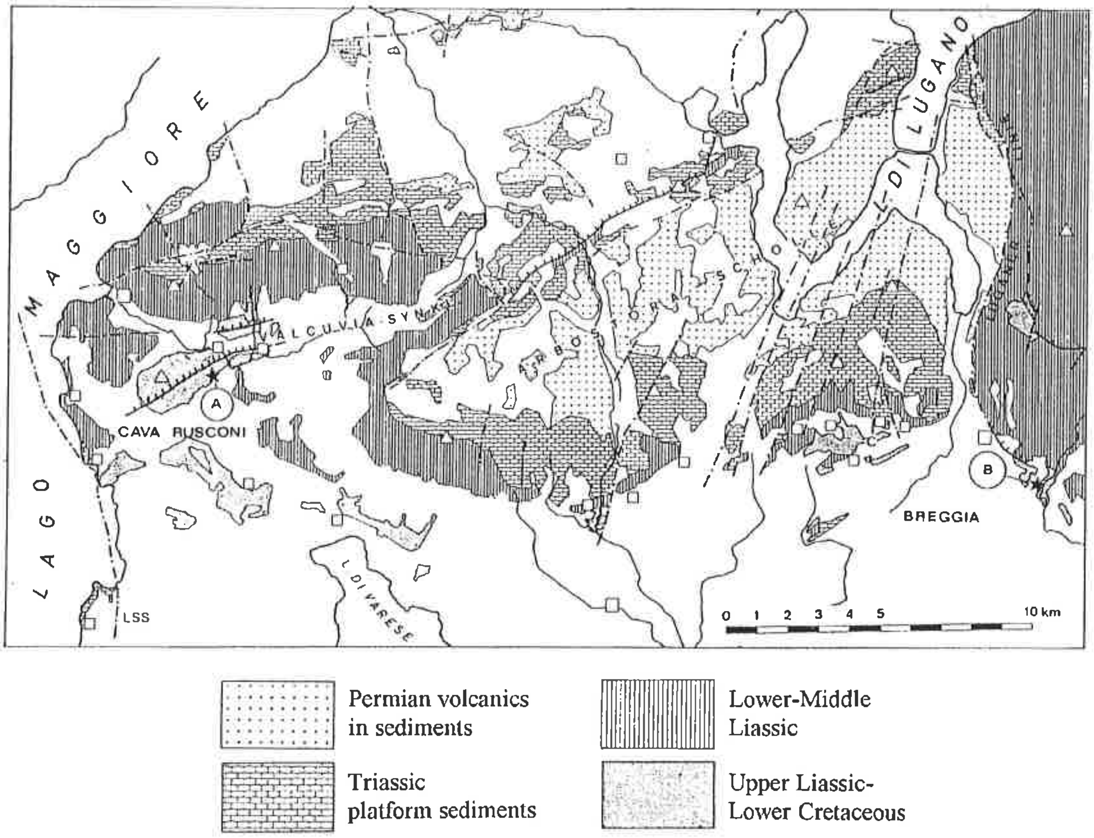


Figure 5. Geological-tectonic map of the western Southern Alps with location of Cava Ruscani section (A) and Breggia section (B) (modidied after Kälin & Trümpy, 1977)

Calpionellids: Grandesso (Channell *et al.*, 1987) examined the calpionellids. Remane (pers. comm., 1991) studied our calpionellid samples which due to their small number, do not allow a precise definition of the zonal boundaries. Therefore, the radiolarian zones are correlated to the calpionellid zones defined by Channell *et al.* (1987).

Nannofossils: Bralower (Channell *et al.*, 1987) examined the nannofossils which were re-investigated by Erba (in Channell & Erba, 1992). The FAD of *Rucinolithus irregularis* was then recorded 7 m deeper in the section, and Zone M3 redefined as ? M1-M3, and M1 as M0.

Radiolarians: Radiolarians at Capriolo are rather moderately-preserved. Six radiolarian zones were identified. The slumped portion between the interval of 12 m and 28 m, which could not be determined magnetostratigraphically (M1-M7), corresponds to the Zone F3 (U.A. 30-U.A. 31) which correlates well with the Presale Section in the Umbria-Marche Basin, where Zone F3 corresponds to the magnetic polarity zones M7-M4 (Jud, 1994).

Channell *et al.* (1987) mentioned the presence of a hiatus in the uppermost beds of the Maiolica but due to a lack of well-preserved radiolarian samples at the top of the section we cannot yet confirm this.

4. Umbria-Marche Apennines

4.1. Introduction

The Maiolica Formation (uppermost Tithonian to lowermost Aptian) of the Umbria-Marche Apennines is characterized by pelagic limestone sequences deposited on the passive continental margin of the Apulian Plate (Fig. 9). Eight sections have been studied: Fiume Bosso, Bottaccione, Valdorbia, Pieia, Gorgo a Cerbara, Presale, Ranchi superiore and Campo al Bello. The latter fragmented into a number of seamounts and basins between Jurassic and the Early Cretaceous times (Alvarez, 1989a, b). The Maiolica Formation is represented in both basinal and seamount facies. In the basinal areas (Fiume Bosso, Valdorbia, Gorgo a Cerbara, Bottaccione) it consists of about 300 metres of white to beige limestones with chert layers and nodules and pelitic intervals. It overlies the Jurassic Calcari a Saccocoma e Aptici and is in turn overlain by the Middle Cretaceous Marne a Fucoidi. In the seamount facies (Presale, Ranchi superiore, Campo al Bello) the Maiolica is condensed and rarely exceeds 100m. in thickness. It overlies the Bugarone Formation and is in turn overlain by the "Marne a Fucoidi". Slump horizons can be found in both the basinal and the seamount sequences.

4.2. Fiume Bosso

Access: The Fiume Bosso section is located near the Pianello-Cagli road which follows the course of the Bosso River.

Description of the outcrop: The Maiolica (Fig. 10a-c) consists of about 300 metres of whitish limestones with chert-layers and nodules and with pelitic intervals at the top of the section. In addition to several thin slump levels a long interval dominated mostly by thick slump deposits was recorded between 400m. and 455m.. The sampling started within the last thin, cherty, red coloured beds of the Jurassic Calcari a Saccocoma e Aptici, at 289.80 m, which is 10.2m. below the horizon marked 300m. (Lowrie & Channell, 1984). The uppermost samples of the section were collected from the Middle Cretaceous Selli Level representing the base of the Marne a Fucoidi Formation, which crops out just below and to the north of the very small bridge over a stream.

Magnetostratigraphy: Lowrie & Channell (1984) studied only the interval between 300 m and 386.5 m. The Jurassic-Cretaceous boundary was defined by Channell & Grandesso (1987) between the interval M19n and lowermost M17r. Lowrie & Channell (1984) had placed the Berriasian-Valanginian boundary in M16n, but Channell & Grandesso (1987) reinterpreted it to M14r.

Calpionellids: Grandesso (Channell *et al.*, 1987) and Remane (pers. comm., 1991) examined the calpionellids from this section. The individual biostratigraphic methods used in defining the first and last appearance datum of taxa caused some discrepancies between their zonal boundaries, but they are negligible.

Based on the calpionellid data of Remane we place the Jurassic-Cretaceous boundary at the lower part of M19n between 311m. and 312m.. It is of no relevance that the respective calpionellid sample was collected from an interval of slumps since at this level the radiolarian assemblage is similar to that of the following sample (312.90 m) where beds are undisturbed.

Nannofossils: Bralower *et al.* (1989) examined the nannofossil events between 300m. and 407m.. Differences in correlation exist for the FAD of *Percivalia fenestrata* at Fiume Bosso (M16n) if compared with Capriolo (upper M15) which is probably due either to incomplete observation and/or to poor-preservation at Capriolo.

Radiolarians: Radiolarians are generally very well-preserved and highly diverse. We have identified 10 radiolarian U.A. Zones of which four could be correlated to magnetic polarity zones in the lower part of the section. As Zones M12 and M13 have not been absolutely defined due to poor magnetic data precise correlation is impossible.

4.3. Valdorbia

Access: The Valdorbia section is located between Valdorbia and Ponte Calcara along the road Nr. 360 Scheggia-Sasso Ferrato.

Description of the outcrop: Baumgartner (1984, 1990) had already sampled the Calcari a Saccocoma e Aptici Formation and the lowermost part of the Maiolica sequence for radiolarians and calpionellids (Fig. 11). We used some of Baumgartner's samples again for our database. He had started sampling from the top of the Calcari a Saccocoma e Aptici Formation. Positive metre-levels were used for all older samples and negative metre-levels (0.00 m to -10.00 m) for the younger ones. Baumgartner changed the metre-levels of his 1987 samples, adding 20m. to the base (0.00 m) and consequently to each sample number. The interval

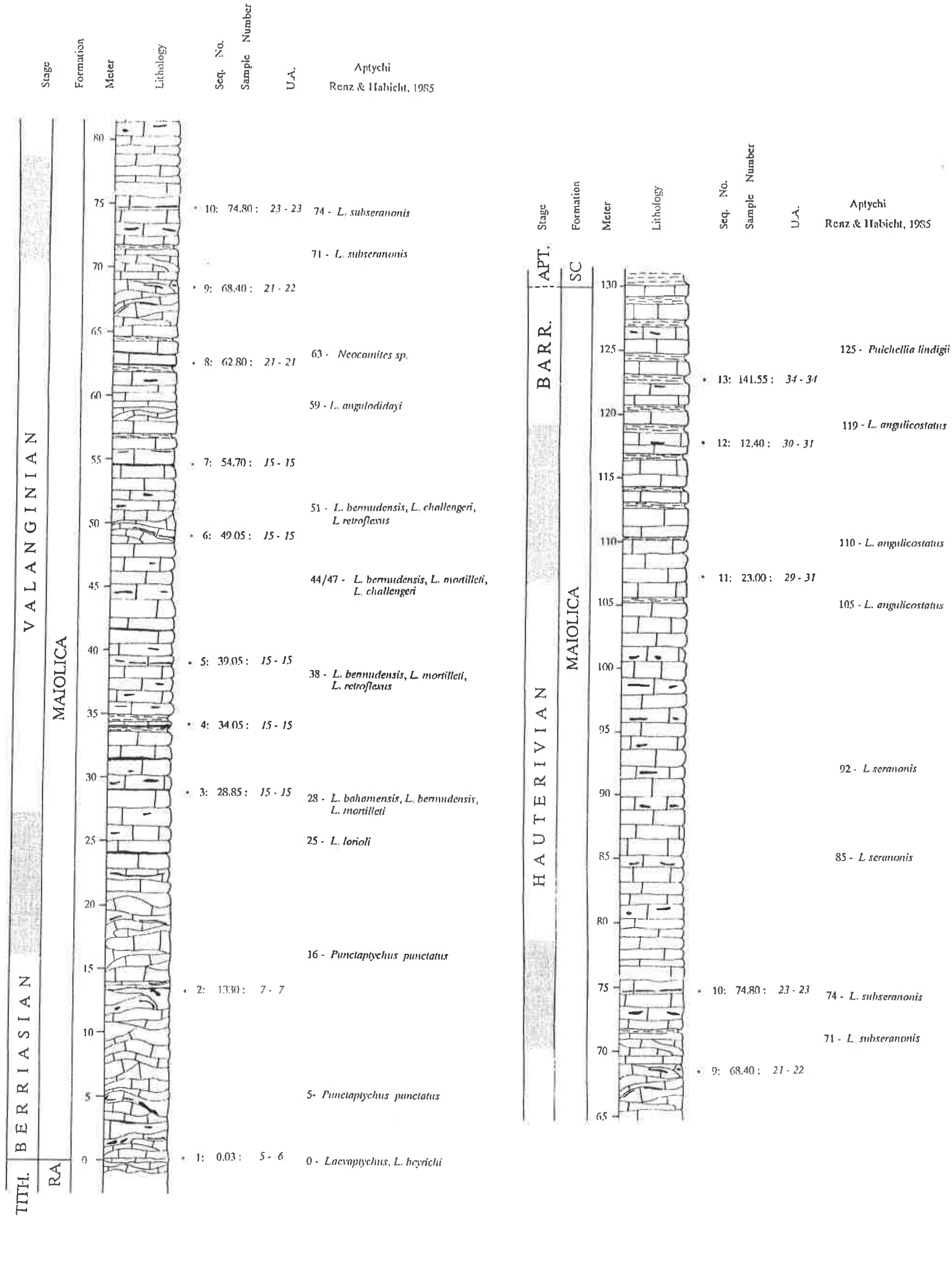


Figure 6. Breggia Gorge section: correlation of Unitary Associations to Aptichi assemblages and to lithostratigraphy (Jud, 1994).

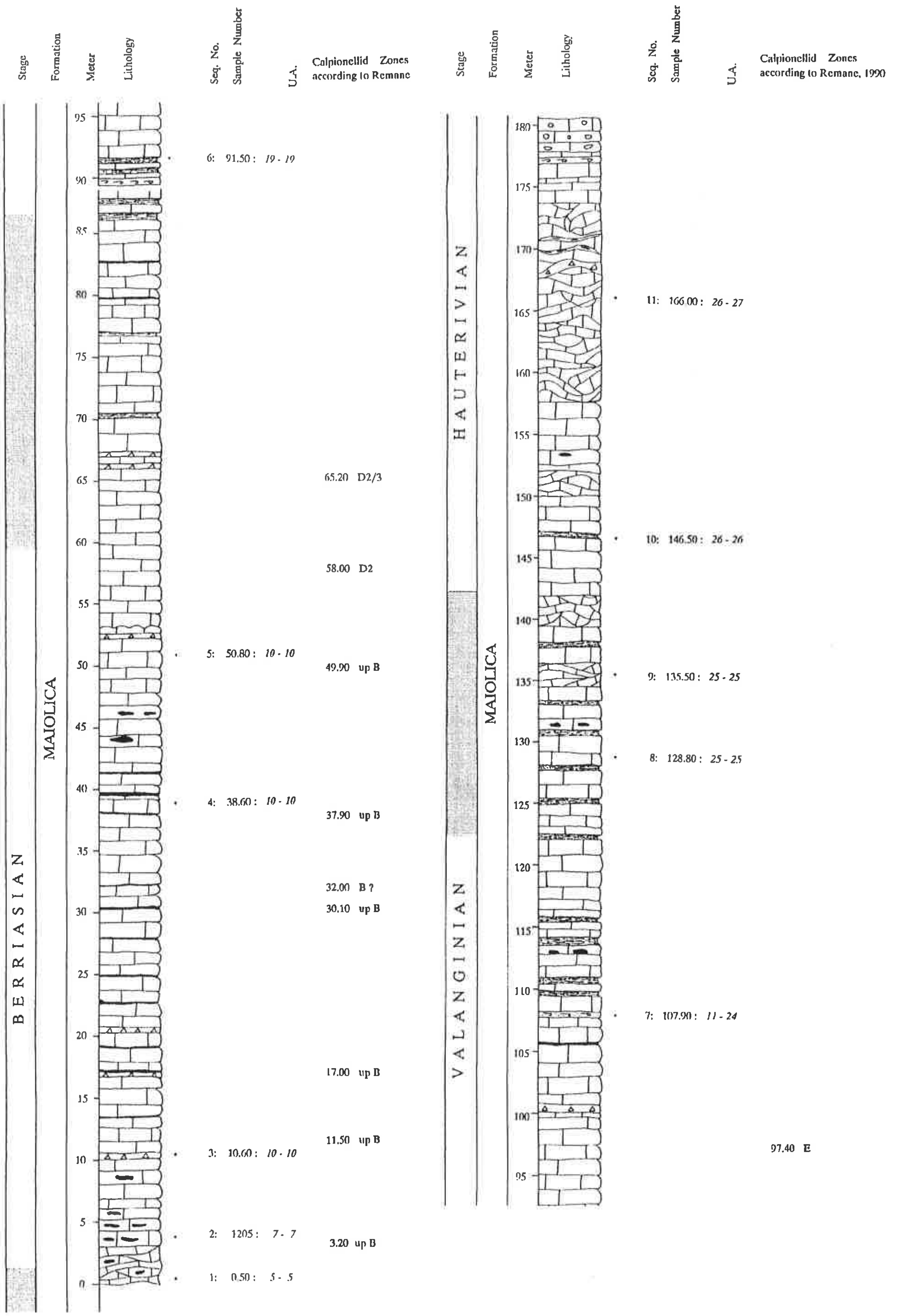


Figure 7. Cava Rusconi section: correlation of Unitary Associations to calpionellid zones and to lithostratigraphy (Jud, 1994).

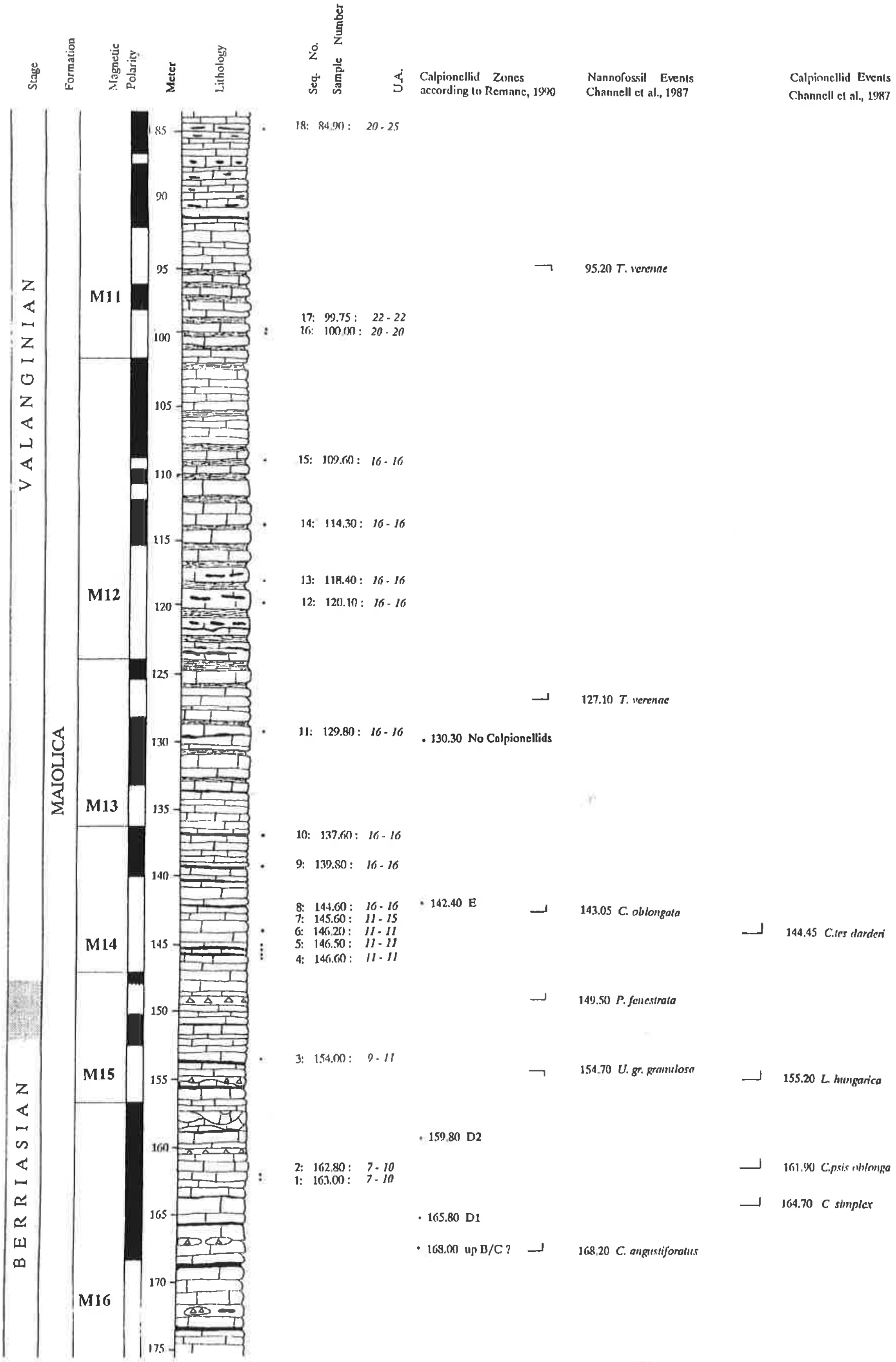


Figure 8. Capriolo section: correlation of Unitary Associations to nannofossil events, calpionellid zones, magnetostratigraphy and lithostratigraphy (Jud, 1994).

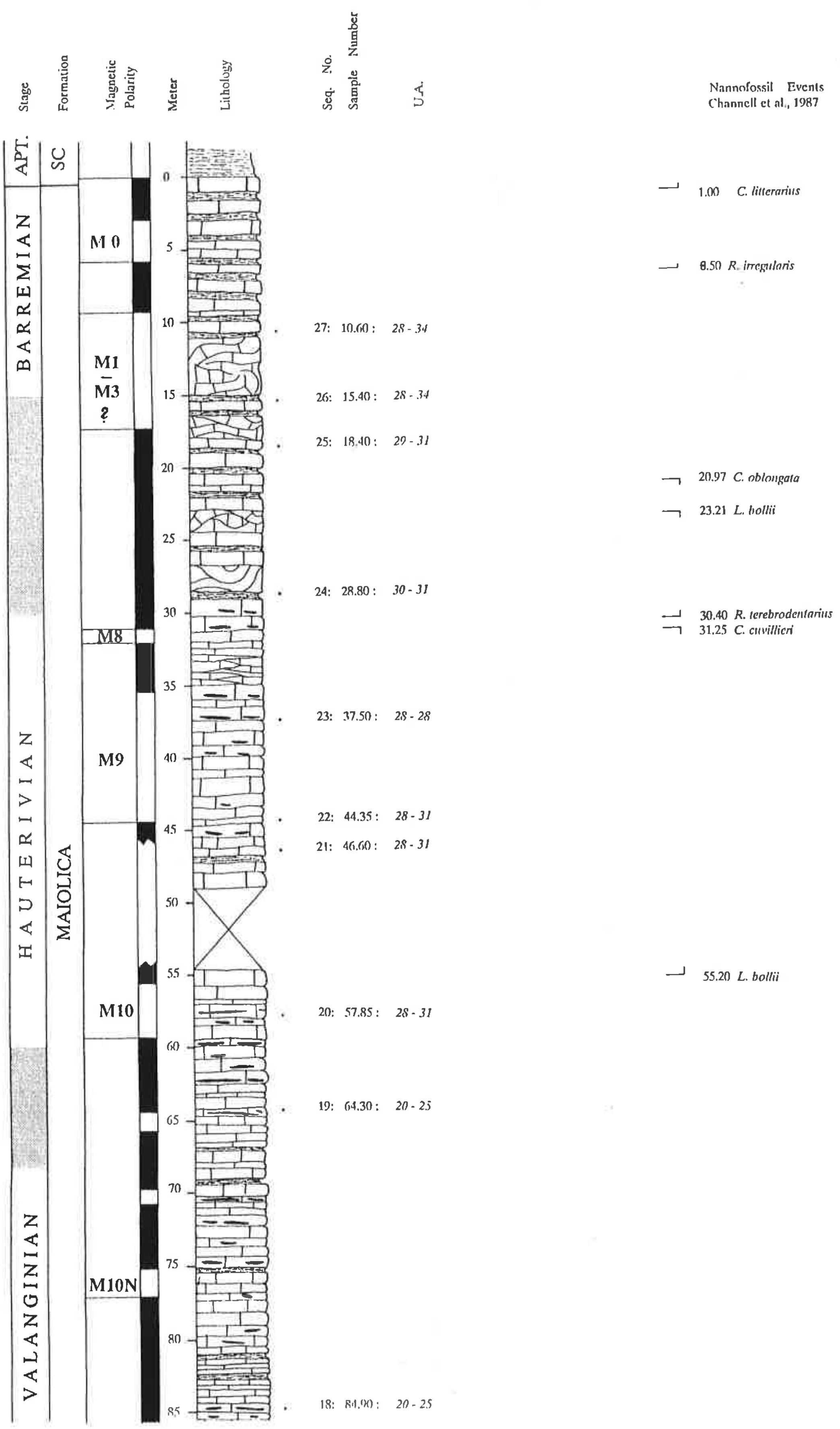


Figure 8. Continued.

between 0.00 and -10.0 m (now 20.00 m to -30.00 m), which is part of the Maiolica Formation, was re-sampled by us for radiolarians and calpionellids.

Calpionellids: Remane examined the calpionellids for Baumgartner (1987) and placed the A/B zonal boundary at about 9.30 m. Our samples collected from the interval between 0.00m. and 10.00m. contained (beside many saccocoma or radiolarians) calpionellid taxa which were not useful for precise biostratigraphic interpretations. Therefore the A/B boundary could not be defined precisely (Remane, pers. comm., 1991).

Radiolarians: Radiolarians are generally well-preserved. Three U.A. Zones were identified (Jud, 1994). These zones have been correlated and calibrated with those of Baumgartner (1984, 1987). The Tithonian/Berriasian boundary corresponds to U.A. 6 or U.A. 7 of Jud (1994).

4.4. Gorgo a Cerbara

Access: The section is located in the bed of the river Candigliano a few kilometers east of Piobbico near the road Nr. 257 to Aqualagna.

Description of the outcrop: The section (Figs. 12a, b) is well-exposed and we sampled on the southern border between 786.70 m and 893.30 m the uppermost part of the Maiolica Formation, and between 901.30 m and 911.35 m

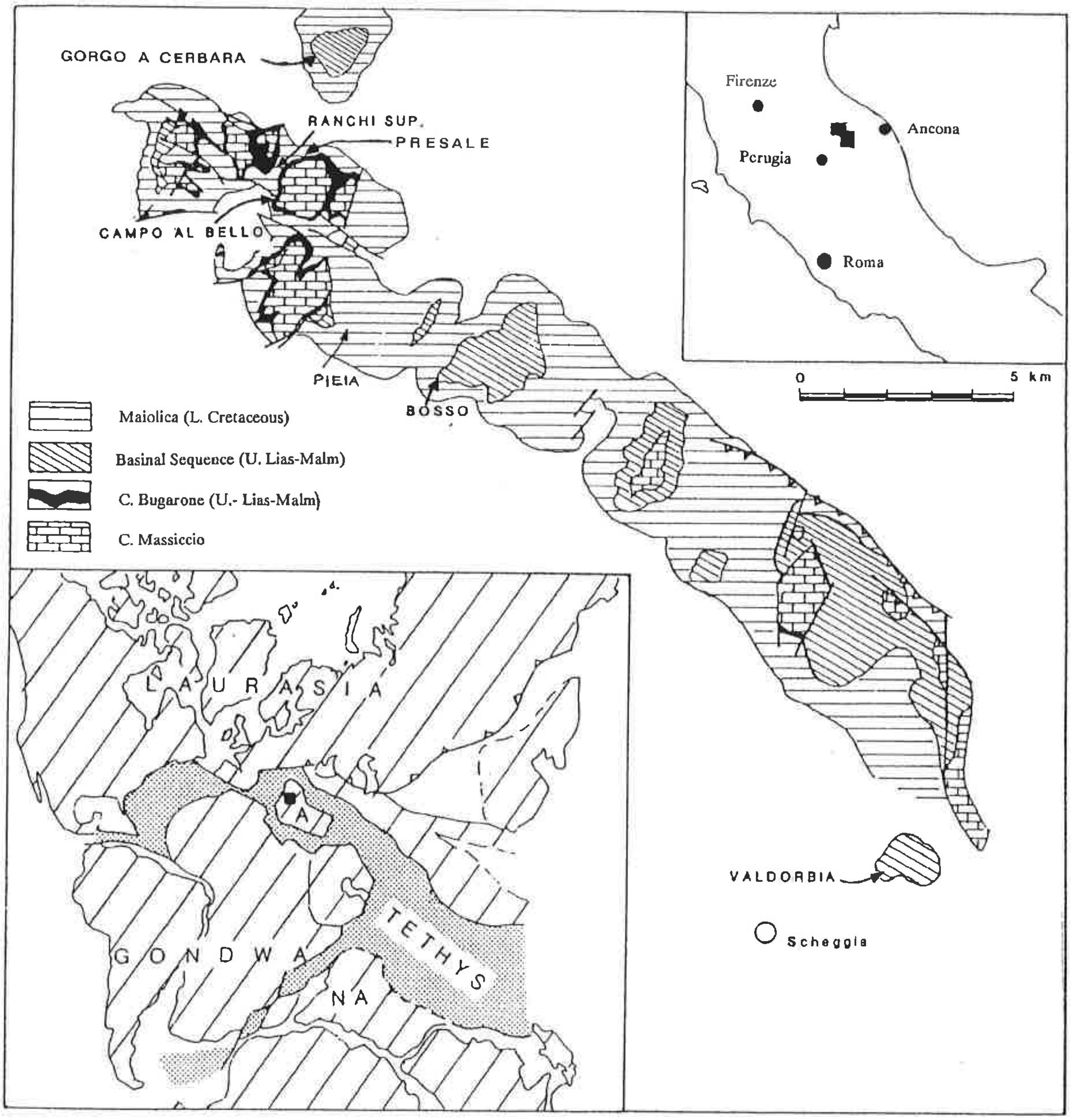


Figure 9. Geological map showing sampling localities in Italy. Inset on the lower left shows the paleogeographical position of the Umbria Marche Appenines on the Apulian plate (modified after Baumgartner, 1987).

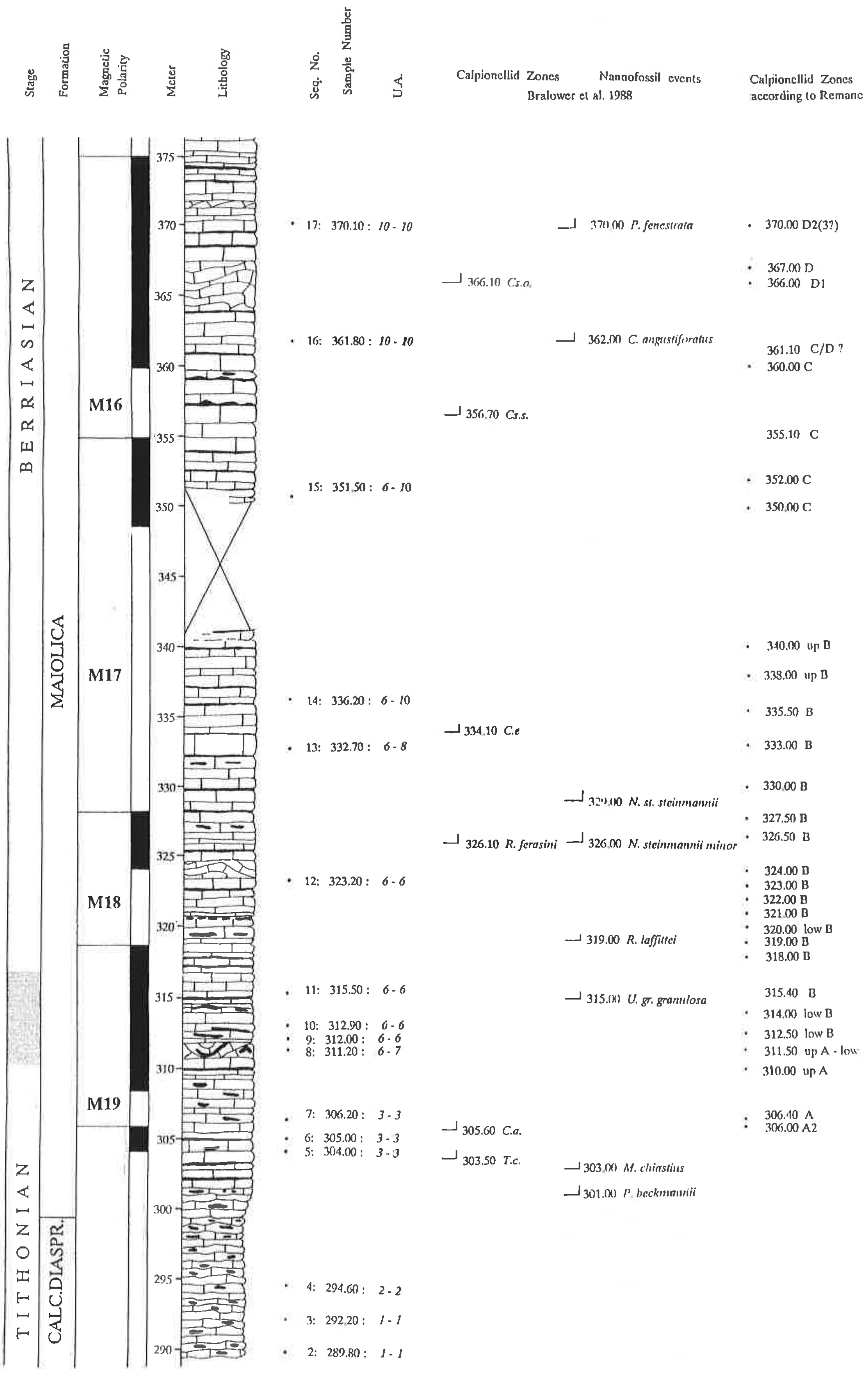


Figure 10a. Fiume Bosso section, part 1: correlation of Unitary Associations to nannofossil events, calpionellid zones, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

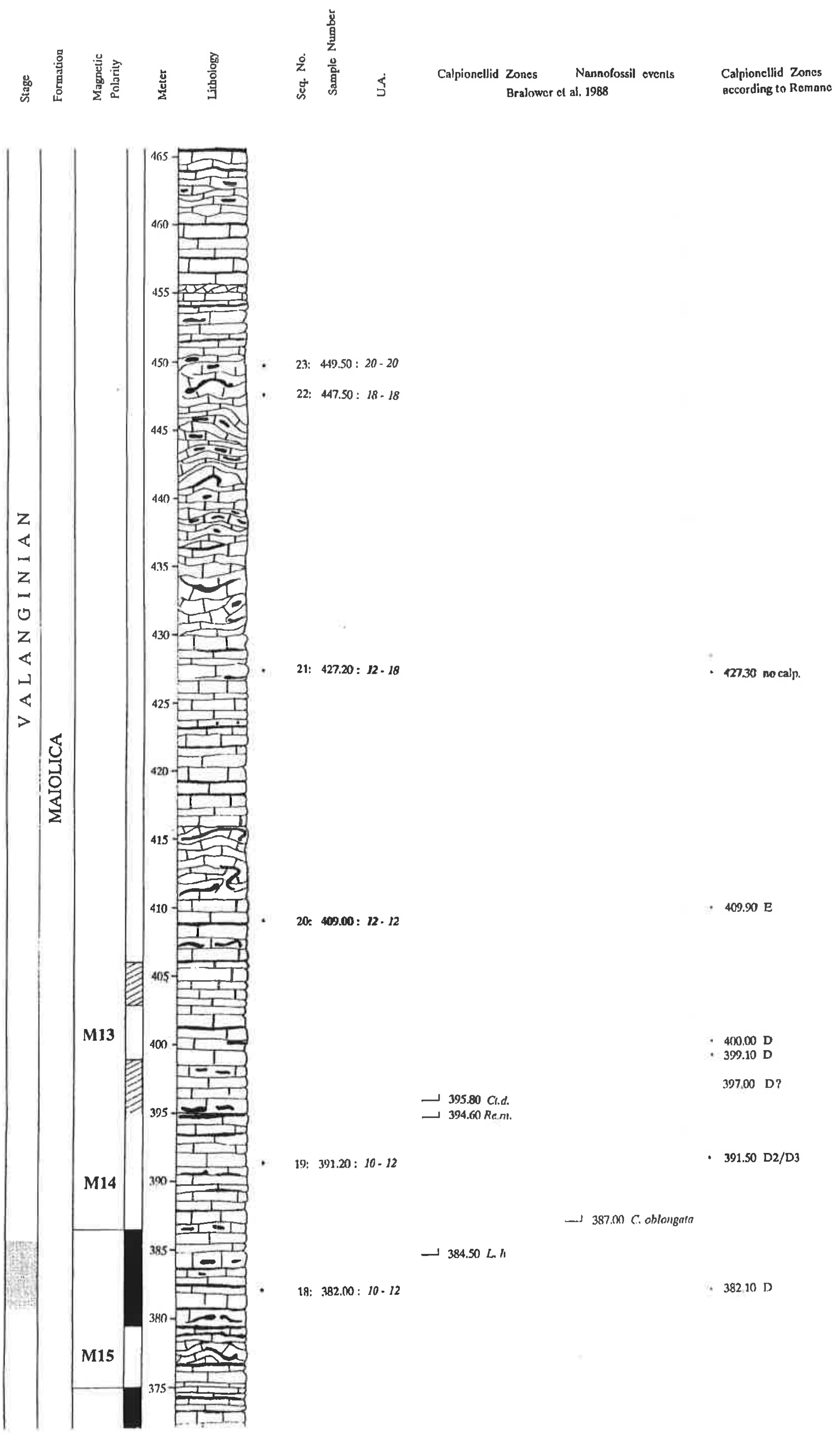


Figure 10b. Fiume Bosso section, part 2: correlation of Unitary Association to nannofossil events, calpionellid zones, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

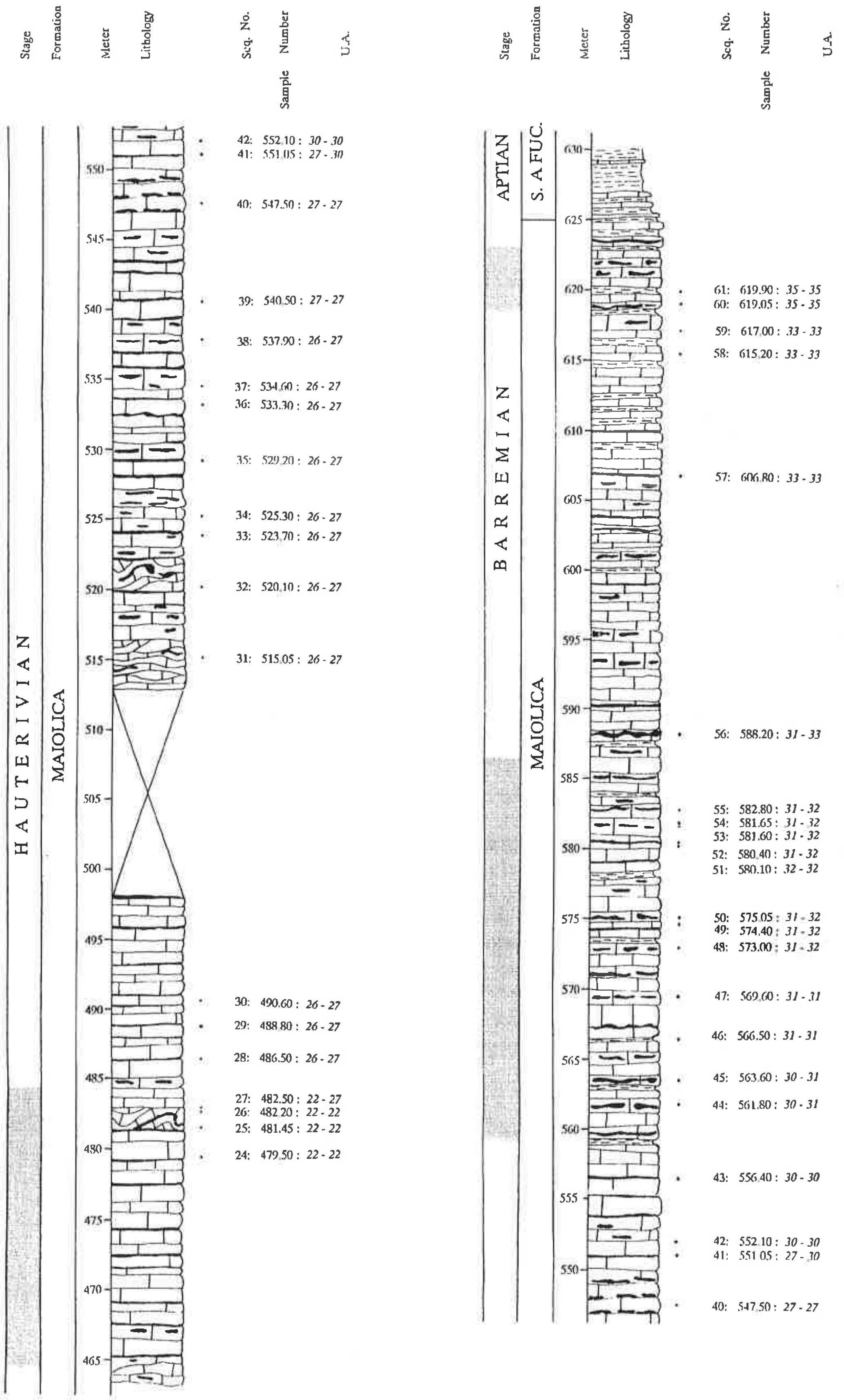


Figure 10c. Fiume Bosso section, part 3: correlation of Unitary Associations to nannofossil events, calpionellid zones, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

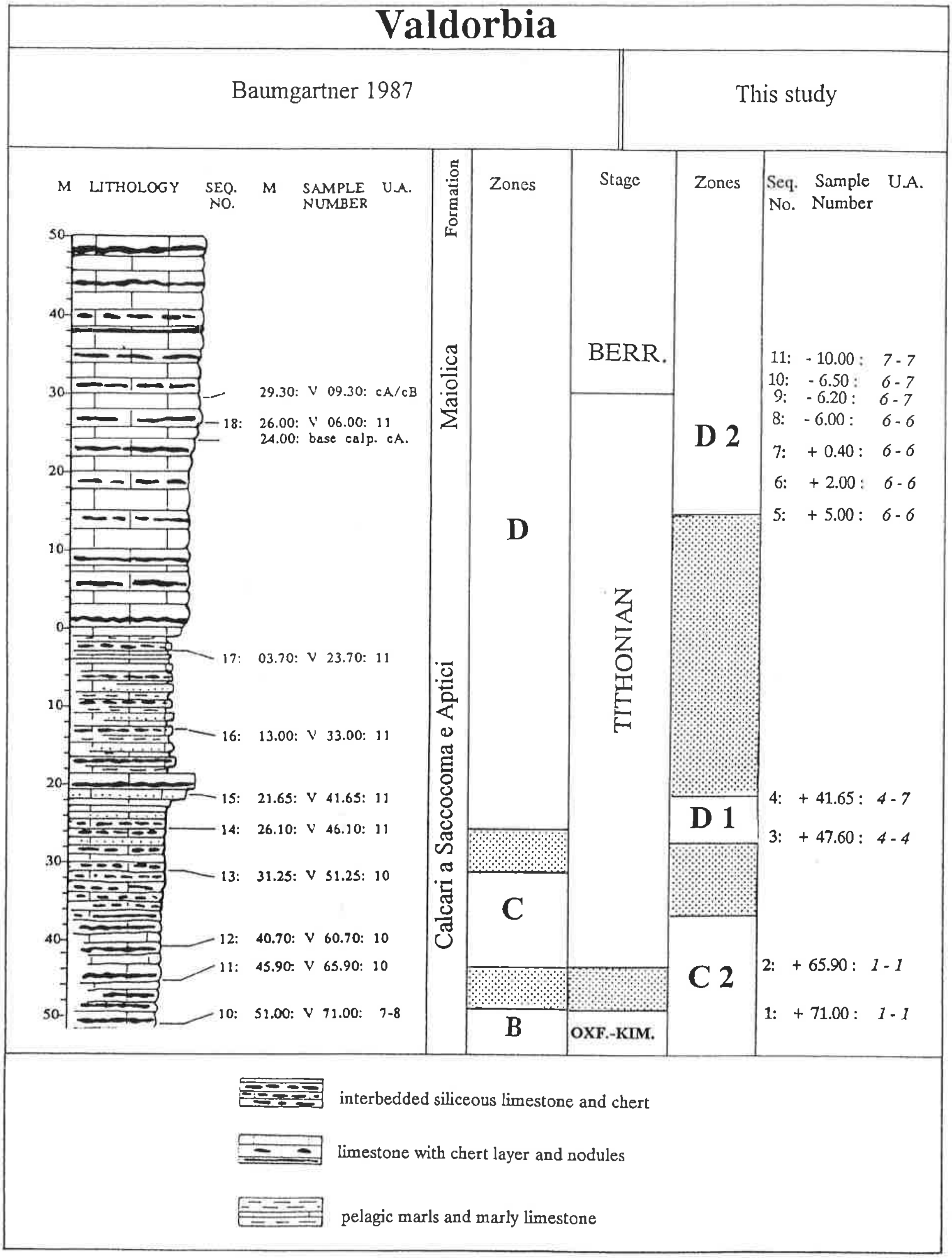


Figure 11. Valdorbia section: correlation of Unitary Associations to calpionellid zones from Baumgartner (1987) and to lithostratigraphy (Jud, 1994).

from the lowermost part of the Middle Cretaceous Marne a Fucoidi Formation. The section is disturbed by several fractures and slump deposits. The first pelitic intervals appear around 880 m. The base of the Selli Level is situated at 896 m. This lowermost member of the Marne a Fucoidi is almost completely covered by vegetation, but well-marked by a topographic depression of about 2 metres in width. The Marne a Fucoidi consist of thick red pelitic levels with short intervals of whitish siliceous limestone beds and radiolarian sands.

Magnetostratigraphy and nannofossils: Channell *et al.* (1984) studied the magnetostratigraphy and Bralower (1987) correlated the nannofossil events to the magnetic polarity zones.

Radiolarians: Radiolarians are well preserved and of high diversity in most samples. We have identified 4 Zones (Jud, 1994) which were correlated to magnetostratigraphy and nannofossil events (Figs 12a, b). There were some problems in correlating the upper parts of the sections of Gorgo a Cerbara and Presale. The top of Zone F3 is found at Gorgo a Cerbara in M2 but at Presale in the lower part of M3, whereas, the FAD of *Calcicalathina oblongata* is time-consistent, occurring at the base of M3r on both sections. It is worth mentioning here that Bralower (1987) correlated the data of the Gorgo a Cerbara Section with those of the Presale and of two other sections, and the magnetic zones and the nannofossil events fitted rather well. A possible explanation of this discrepancy is that parts of the section have undergone synsedimentary processes (reworking or sliding) of one or several limestone beds.

Ammonites: Recently the first ammonites were discovered by Cecca *et al.* (1994). The correlation of all data to magnetic chrons resulted in the location of the Hauterivian-Barremian boundary in upper M4.

4.5. Pieia

Access: The studied section is located north of Pianello along a small road leading up to the little village Pieia, south of Monte Nerone.

Description of the outcrop: The section (Fig. 13) is characterised by its special position on the seamount margin where the Maiolica was highly affected by synsedimentary sliding (Alvarez, 1989b). We sampled the outcrop situated on the eastern border of the small road, south-east of the bridge and south of the small quarry. The section had been marked by many people with several types of numbers and metre-levels. The lowermost sample POB10.00 (provided by P. O. Baumgartner), had been collected 10 m above the top of the Calcari a Saccocoma e Aptici Formation. About 8 m above it a slumped and also tectonically disturbed interval, covered partly by vegetation, was observed. The sampling level started with 0.00 m. just above this zone. The colour of the chert bands and nodules is generally blue-grey. Some rare chert bands have a rose colour in the interval between 35m. and 70 m. The last sample, situated just above a slump zone mostly covered by vegetation, was taken at 97.35 m.

Calpionellids: Remane (pers. comm.) examined 20 samples for calpionellids. Most of the specimens were badly preserved, many of them crushed, and positive identifications were impossible in most samples.

Radiolarians: Radiolarians were generally abundant and moderately- to well-preserved. Three Zones were recognized and correlated (Jud, 1994). U.A. 5 corresponds to the calpionellid Zone lower B, suggesting that U.A. 6, which also corresponds to lower B at Fiume Bosso (Fig. 10a), is coexistent with U.A. 5. The radiolarian zonal boundary D2/E1a falls either into the calpionellid subzones upper D1 or lower D2, which would correlate well with the Fiume Bosso Section and also with the Capriolo Section (Fig. 8a) if we suppose that the two lowermost samples are included in E1a. The radiolarian zonal boundary E1/E1b is probably in the upper calpionellid subzone D2 or lower D3. This correlates rather well with Capriolo where it is placed in the calpionellid subzone D3 but not with the Fiume Bosso Section, as discussed under the latter.

4.6. Presale

Access: The Presale section crops out along a path which deviates from the Piobbico-Secchiano road east of Monte Nerone at point S. Lorenzo (Fig. 14), near a small cemetery, (545 m topographic elevation). A path leads to the Fosso di Presale on the north-eastern flank of Monte Nerone.

Description of the section: The section (Fig. 15) represents a condensed limestone sequence. The Maiolica Formation overlies the Bugarone-5-Limestones which are of Kimmeridgian-Tithonian age (Alvarez, 1989a). The section is partly covered by vegetation and it contains abundant slumps at several levels which made sampling very difficult. We collected the last sample above the first visible pelitic horizon at 260 m.

Magnetostratigraphy and nannofossils: Channell *et al.* (1979) and Lowrie & Alvarez (1984) investigated the section for magnetostratigraphy. Bralower (1987) examined the nannofossils. The Presale Section and the Gorgo a Cerbara Section correlate well with the exception of the FAD of *Rucinolithus irregularis*. This event normally coincides with the Barremian-Aptian boundary and is placed in the Presale Section in M0 but in the Gorgo a Cerbara Section in the uppermost M1n.

Radiolarians: Radiolarians are abundant and well-preserved in the upper part of the section, and we correlated 3 Zones (Jud, 1994). The oldest sample belongs to Zone E1b and, by comparison with the Capriolo Section, indicates for the lowermost part of the sampled section, a lower to middle Valanginian age. Alvarez (1989a, 1989b) mentioned a hiatus during Berriasian and the Valanginian times but our data from this section and from Ranchi Superiore prove that the Valanginian is represented. Difficulties in correlating Zones F3 and G1 were discussed under part 4.4, Gorgo a Cerbara.

4.7. Ranchi superiore

Access: This section is situated at about 1000 m topographic elevation near the small road leading from Piobbico upwards to Monte Nerone (Fig. 14).

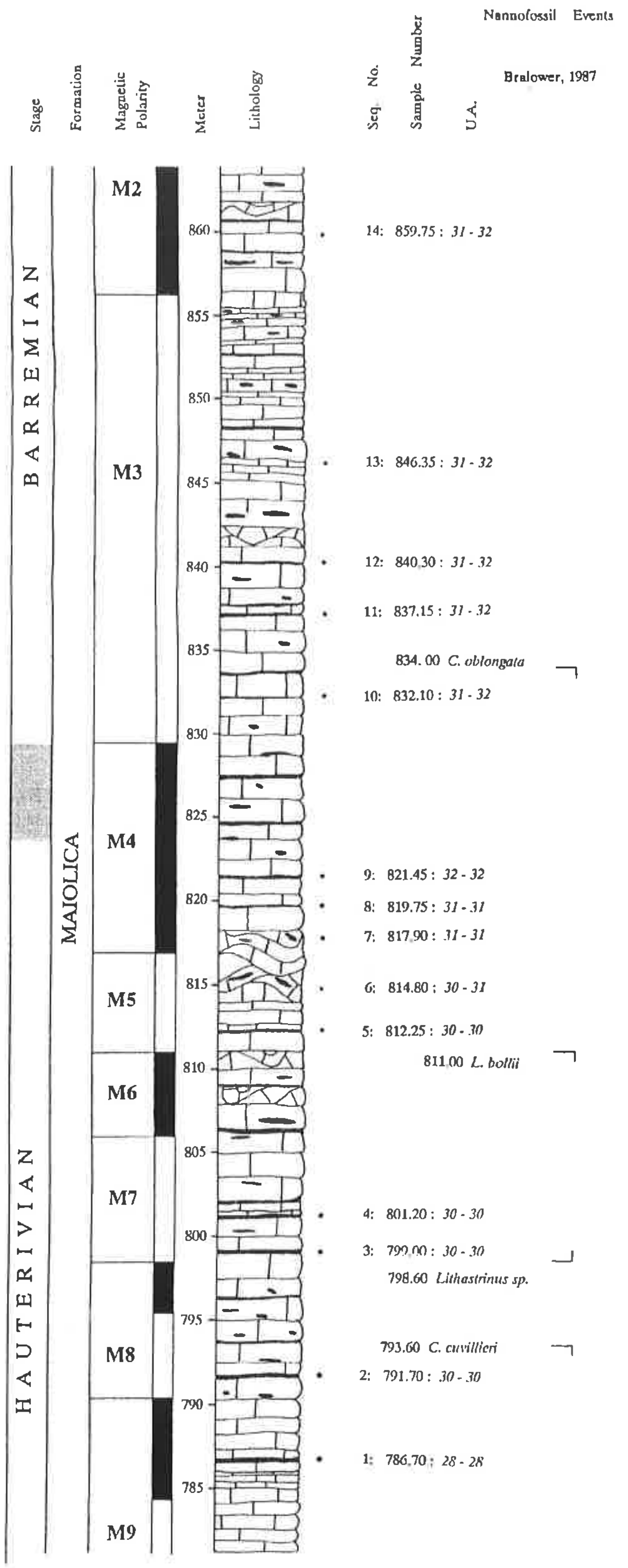


Figure 12a. Gorgo a Cerbara section, part 1: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

Description of the outcrop: Baumgartner (1987, p. 24, fig. 3) has studied in detail the lower part of this section (Fig. 16). Sampling was very difficult as the section was covered by wire-fence. We started sampling above a major unconformity which was observed at about 16-17 m above the base of the Lower Bugarone Formation, in calpionellid Zone E. In the interval of 17 m between the base of the Lower Bugarone and this unconformity are enclosed rather condensed the Lower Bugarone (3-4 m), the Calcari Diasprigni (4-5 m) and the Upper Bugarone (5 m). The latter is followed with a sharp contact by the Maiolica Formation. Several slumps were observed in the interval between this unconformity and the 45 m level. Sampling was successful in the lower part of the section whereas the upper one contained no good radiolarian samples. The pelitic intervals of the uppermost Maiolica sequence were not exposed.

Calpionellids: Calpionellid samples were taken below and above the unconformity. There the Maiolica is more or less dolomitised. The determinations of the calpionellids by Remane (pers. comm., 1991 and Baumgartner, 1990) prove that the Berriasian and Valanginian intervals are very condensed. The calpionellid Zone A is missing and Zone D could not be identified, probably due to too low a sampling density.

Radiolarians: We identified 4 radiolarian Zones (Jud, 1994). The lowest sample at 18.70 m, just above the sample 17.10 m (calpionellid Zone E), could not be precisely identified. At 24.50 m the same faunal assemblage (U.A. 17, lower to middle Valanginian) as in the Presale Section was identified. The Valanginian-Hauterivian boundary is placed between 15 m and 20 m above the unconformity. The uppermost samples represent parts of the radiolarian Zone F3 (Upper Hauterivian, Jud, 1994).

4.8. Campo al Bello

Access: The Campo al Bello section is situated on the eastern flank of the Monte Nerone (Fig. 14) approximately 700 m northeast of Monte Nerone peak at about 1350 m altitude, 250 m east of the road Piobbico-Monte Nerone.

Description of the outcrop: Campo al Bello is the most condensed seamount section. The 0.00m. level was placed by Baumgartner (1990, fig. 3, p. 24) at the top of the Lower Bugarone. It is followed by only 1m. of Calcari Diasprigni and by about 4m. of Upper Bugarone. We have studied 3 samples, POB1589, POB1590 and POB1592, which had been collected by Baumgartner from about 19m. - 21m. above the top of the Lower Bugarone.

Radiolarians: The 3 samples contained abundant and well-preserved radiolarian assemblages with high diversity. They were all identified as U.A. 31-32 (Upper Hauterivian, Jud, 1994).

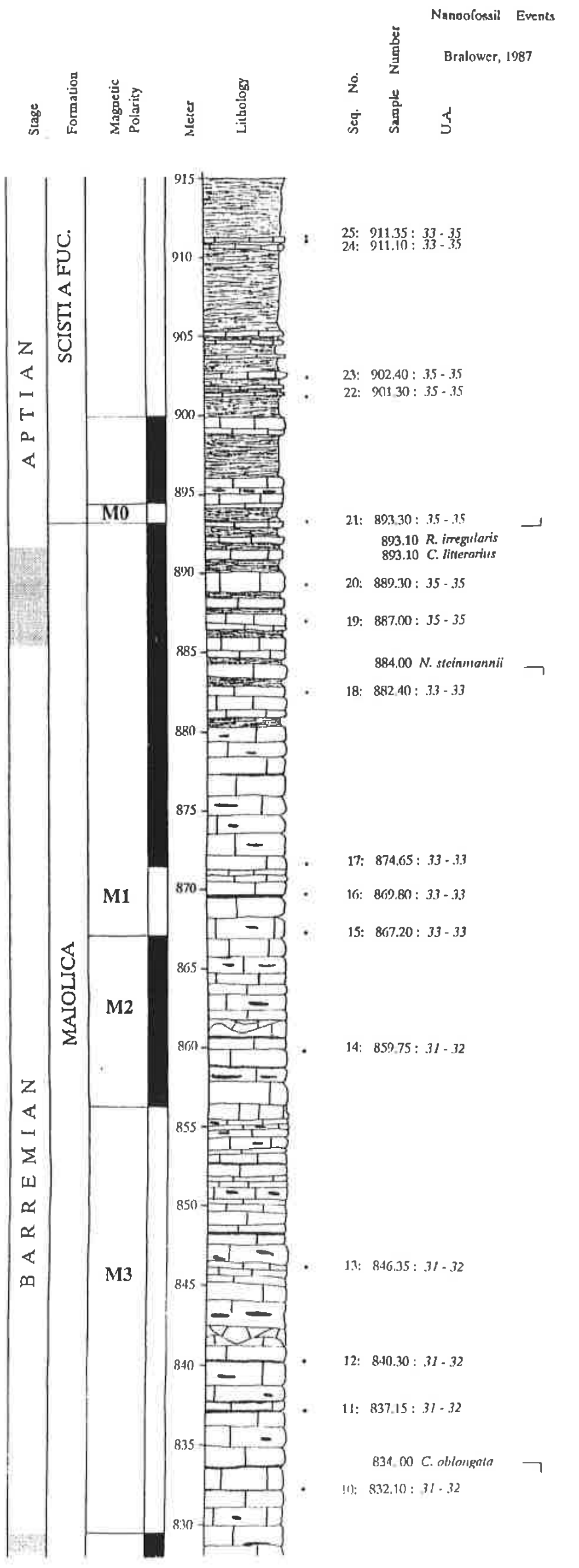


Figure 12b. Gorgo a Cerbara section, part 2: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

5. Hawasina Nappes: Wahrah-Formation (Al Hammah Range, Oman)

Access: The section is situated in the Al Hammah Range (Fig. 17a, b) which represents a segment of the Hawasina Complex and is situated about 125 km south of the town of Muscat.

Description of the outcrop: The Wahrah-Formation was studied and sampled by D. Biaggi, W. Kickmeier and P. Steinmann (unpublished) and by Kickmaier & Peters (1990). The Formation (Fig.18) contains fine-grained turbiditic limestones, coloured silt-mudstones and cherts and lime-free chert. The top of the sequence is characterised by 1-5 m of silicified limestones. The section includes several manganese horizons which have been supposed to be a result of sedimentary and tectonic enrichment processes. The cherts were determined as being of biogenic and not of hydrothermal origin (Kickmaier & Peters, 1990).

Radiolarians: About 90 radiolarian samples have been studied from several sections. Diversity and preservation of radiolarians is moderate to low with the exception of those sorted from the manganese horizons. Faunal assemblages are similar to those of all Italian and Swiss sections, although the paleogeographical area and sedimentological features are different. We recognized 3 radiolarian Zones. The lower manganese horizon is dated as Lower Valanginian (U.A.14-15) and the upper one as Upper Hauterivian-Lower Barremian (U.A.30-34, see sample 15) (Jud, 1994).

6. Biochronology

6.1. Introduction

Knowledge of Lower Cretaceous radiolarians started about 100 years ago and continued up until the beginning of this century with studies of samples from sections in Italy, Germany, Switzerland, Austria and Indonesia. The authors of these studies, which generally have a descriptive value as they were made on isolated and imperfectly dated samples, are Rüst (1885, 1888, 1898), Parona (1890), Vinassa de Regny (1899), Hinde (1900) and Fischli (1916). The original descriptions of many species they described were accompanied by carefully hand-drawn illustrations of taxa, most of them based, unfortunately, on thin sections studied in transmitted light. This makes difficult in many cases their recognition in radiolarian faunas studied according to modern standards. Because of these reasons, and also because of the artificiality of the taxonomic system they used all these pioneering studies are of little stratigraphic value.

Radiolarian-bearing Lower Cretaceous pelagic rocks are frequently devoid of any other fossil groups (e.g. ammonites) that would allow precise biostratigraphic dating. Therefore the search, and necessity, for "stand-alone" radiolarian biozonations was fundamental in the development of research into this group. Although biostratigraphical schemes of Lower Cretaceous radiolarians began to be developed on land sections (Aliev, 1965, 1969), it was the Deep Sea Drilling Project that opened a wide field for investigations of more complete deep sea sections. During the 1970's the first attempts of radiolarian zonations for the Early Cretaceous were made by Moore (1973), Renz (1974), Riedel & Sanfilippo (1974), Foreman (1975), Schaaf (1981, 1984) and others. At the same time land sections more or less dated with other fossil groups have been increasingly studied and correlated with DSDP data (Pessagno, 1977b, Baumgartner *et al.*, 1980, Kocher, 1981, Baumgartner, 1984, Tumanda, 1989, etc.).

The radiolarian zonation of Lower Cretaceous sediments based on various sections in Italy (Umbria and Southern Alps) and in Switzerland (Southern Alps and Ultrahelvetics) was initially developed by Baumgartner (1984) and more

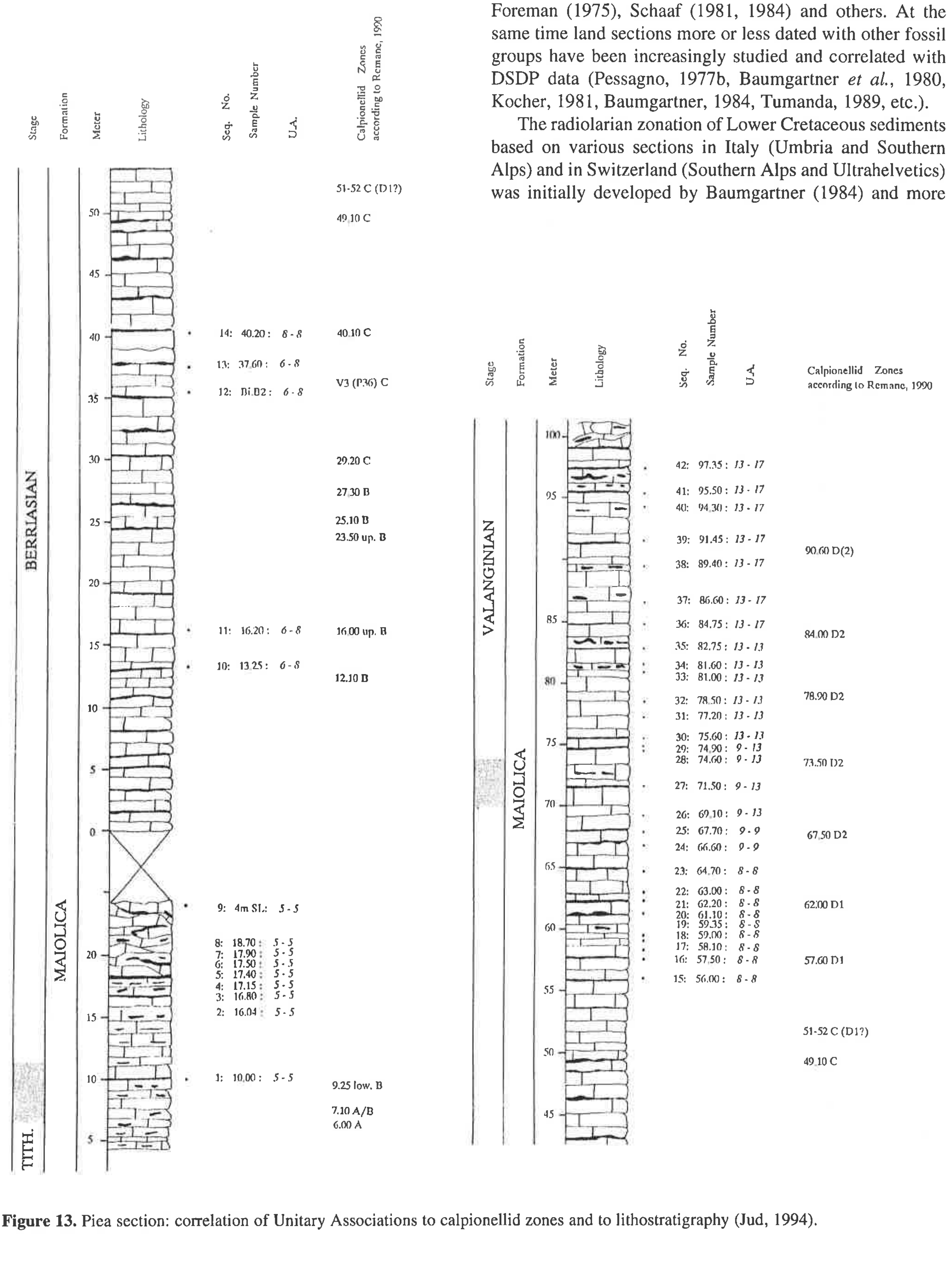


Figure 13. Piea section: correlation of Unitary Associations to calpionellid zones and to lithostratigraphy (Jud, 1994).

recently by Jud (1994). Some of Baumgartner's sections and several new ones were thoroughly sampled. For this purpose 245 samples from 13 sections were selected from about 500 samples collected. An artificial sample was added at the base of the Fiume Bosso section comprising species which due probably to diagenesis did not occur in sections but should have occurred at this level. This was necessary in order to refine the base of our range chart and to illustrate the major faunal change that occurred in the Middle to Upper Tithonian.

6.2. Methods

The radiolarians in the pure limestone beds of the Maiolica are generally replaced by calcite. The chert nodules and chert beds however contain zones which were not completely silicified. In these zones radiolarians remained preserved as silica and are often partly washed out of the limestone matrix (e.g. by rain water) and visible with the naked eye or with a hand lense. The assemblages of radiolarians can change within the same bed or from one nodule to the next one. Therefore several samples must be chosen from the same level to ensure recovery of abundant specimens.

In the laboratory samples were immersed in dilute Hydrochloric acid (5 to 10%) for between 30 and 60 minutes and then washed through a 63 μm sieve.

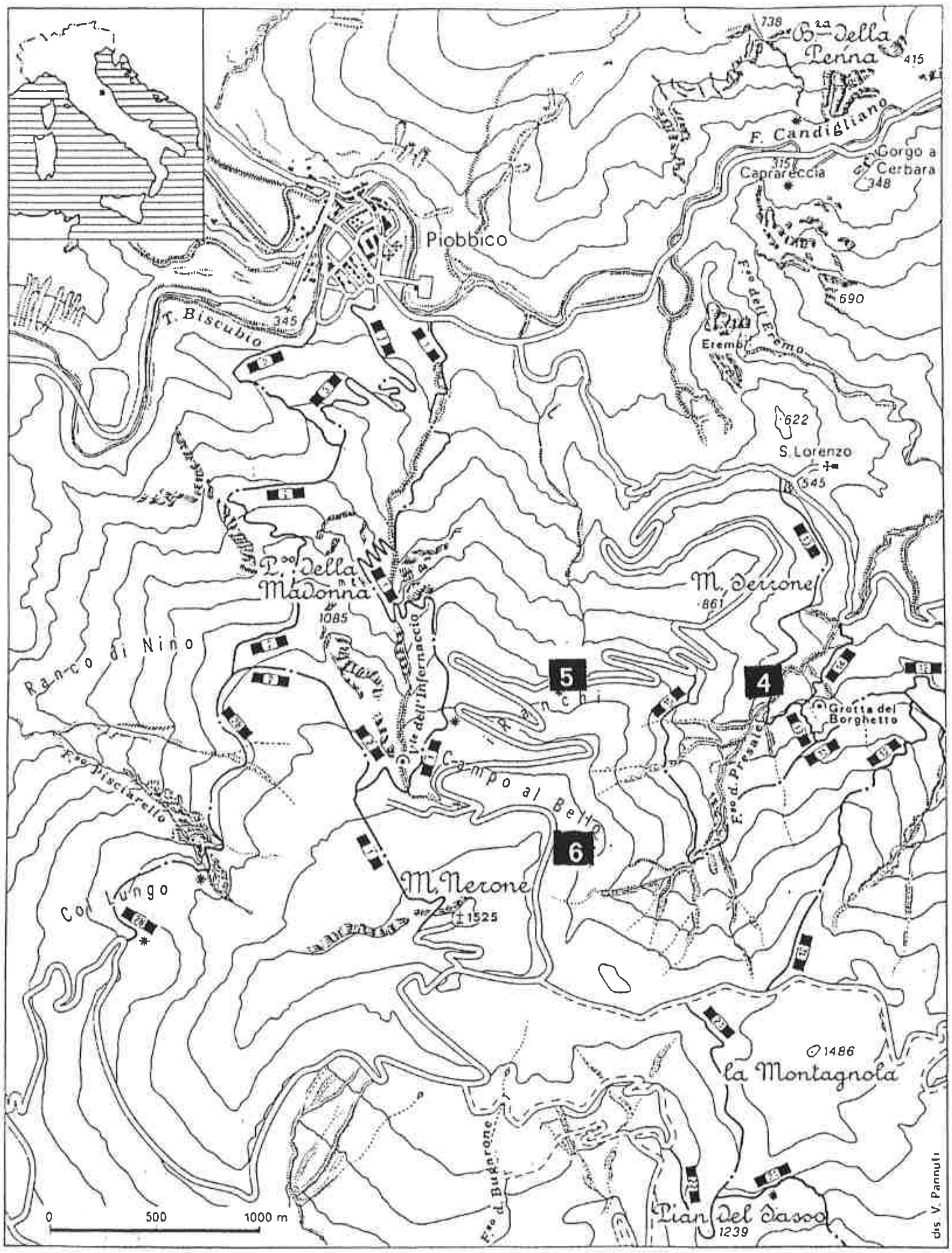


Figure 14. Map showing Monte Nerone and sampling localities Presale (4), Ranchi superiore (5) and Campo Bello (6) (Jud, 1994).

The more siliceous rocks were first decalcified and then the radiolarians extracted by treating them with 5% diluted HF acid for one or two days, and collected after washing through a 63 µm nylon sieve.

6.3. Unitary Associations and zones

The occurrence data of 175 selected taxa from 13 sections were processed by BioGraph (Guex & Savary 1991) and the 35 Unitary Associations grouped into 11 radiolarian Zones (Fig. 19, time scale by Haq *et al.* 1988). The boundaries of the biochronozones have been established by carefully studying the identified Unitary Associations, their superposition on the sections and their coincidence with lithological changes or boundaries between biostratigraphical units of other fossils such as nannofossils and calpionellids. Finally the biochronozones were calibrated by means of magnetic polarity zones, nannofossil and calpionellid events and zones.

6.4 .Definition of Unitary Associations and zones

For the definitions of the Unitary Associations and for the Zones see Figure 20.

Zone C1 (U.A. 1 - U.A. 2)

- U.A. 1: Co-occurrence of *Acanthocircus suboblongus* with *Ristola altissima* s. l., *Emiluvia hopsoni*, *Obesacapsula cetia* and many other species which range through the zone. As this is the lowest Unitary Association it cannot be defined more precisely.
- U.A. 2: Co-occurrence of *Tetratrabs bulbosa* with *Ditrabs sansalvadorensis.*

Zone D1 (U.A. 3 - U.A. 4)

- U.A. 3: Co-occurrence of *Triactoma jonesi* with *Tetratrabs zealis*, *Archaeodictyomitra excellens*, *Pantanellium berriasianum*, *Artocapsa* (?) *amphorella*, *Cinguloturris cylindra*, *Ristola cretacea*, *Hsuum feliformis*, *Parvicingula cosmoconica*, *Acanthocircus furiosus*, *Ditrabs* (?) *osteosa* and many other species.
- U.A. 4: Co-occurrence of *Tetratrabs zealis* with *Ditrabs* (?) *osteosa*

Zone D2 (U.A. 5 - U.A. 8)

- U.A. 5: Co-occurrence of *Podobursa spinosa* with *Bistarkum brevilatum*, *Obesacapsula rusconensis rusconensis*, *Obesacapsula verbana*, *Obesacapsula morroensis*, *Syringocapsa limatum* and *Angulobracchia* (?) *portmanni portmanni.*
- U.A. 6: Co-occurrence of *Bistarkum brevilatum* with *Acaeniotyle dentata*, *Sethocapsa uterculus*, *Pseudoeucyrtis scepteris*, *Obesacapsula polyedra* and many others.
- U.A. 7: Co-occurrence of *Artocapsa* (?) *amphorella*

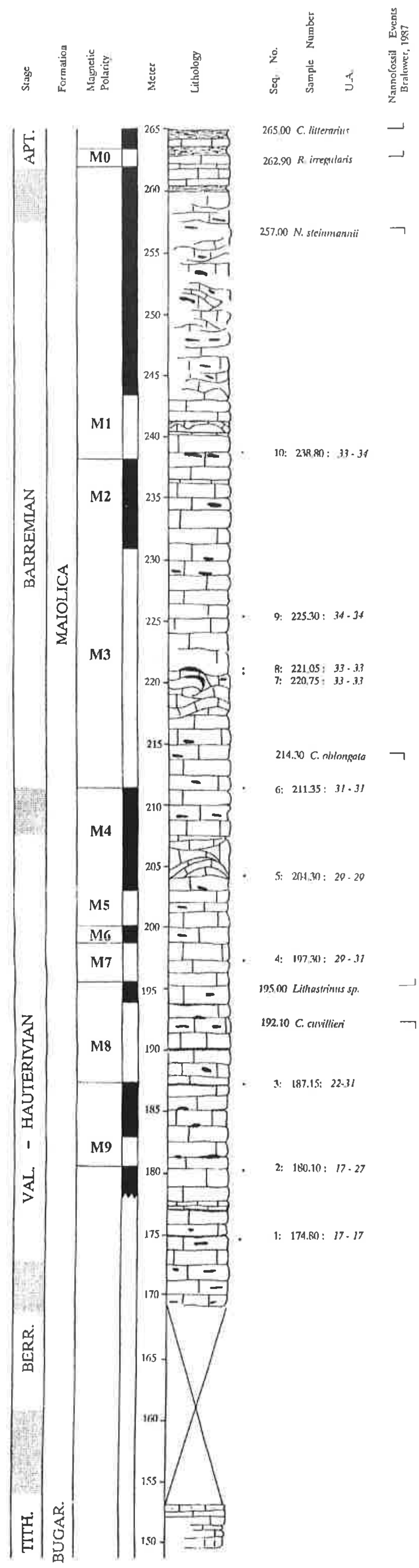


Figure 15. Presale Section: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and to lithostratigraphy (Jud, 1994).

with *Savaryella guexi*, *Pseudoaulophacus* (?) *pauliani*, *Sethocapsa trachyostraca*, *Wrangellium puga* and others.

U.A. 8: Co-occurrence of *Sethocapsa* (?) *concentrica* with *Paronaella* (?) *annemariae* and *Archaeodictyomitra lacrimula*.

Zone E1a (U.A. 9 - U.A. 12)

U.A. 9: Co-occurrence of *Obesacapsula rusconensis umbriensis* with *Cyclastrum rarum*, *Thanarla pulchra*, *Bernoullius spelae* and *Ristola asparagus*.

U.A. 10: Co-occurrence of *Pantanellium berriasianum* with *Pseudoeucyrtis acus*, *Dicroa periosa* and *Xitus sandovali*.

U.A. 11: Co-occurrence of *Emiluvia hopsoni* or *Hsuum feliformis* with *Parvicingula usotanensis*.

U.A. 12: Co-occurrence of *Hsuum raricostatum* or *Pseudoeucyrtis scepteris* with *Godia* (?) *lenticulata*.

Zone E1b (U.A. 13 - U.A. 17)

U.A. 13: Co-occurrence *of Parapodocapsa furcata* or *Parvicingula sphaerica* with *Mirifusus petzholdti* and *Archaeotritrabs gracilis*.

U.A. 14: Co-occurrence of *Paronaella* (?) *rugosa* with *Xitus channelli*.

U.A. 15: Co-occurrence of *Obesacapsula breggiensis* or *Sethocapsa kitoi* with *Cyclastrum* (?) *trigonum* and *Pseudoaulophacus* (?) *florealis*.

U.A. 16: Co-occurrence of *Syringocapsa longitubus* or *Ditrabs* (?) *osteosa* with *Eucyrtis columbaria* and *Pseudodictyomitra nuda*.

U.A. 17: Co-occurrence of *Obesacapsula lucifer* or *Canoptum banale* with *Crucella bossoensis* and *Crolanium* gr. *pythiae*.

Zone E2 (U.A. 18 - U.A. 21)

U.A. 18: Co-occurrence of *Obesacapsula cetia*, *Cinguloturris arabica and Obesacapsula polyedra* with *Cecrops septemporatus*, *Cyclastrum infundibuliforme* and *Crucella* (?) *inflexa*.

U.A. 19: Co-occurrence of *Emiluvia pessagnoi and Pseudoeucyrtis* (?) *fusus* with *Solenotryma ichikawai*.

U.A. 20: Co-occurrence of *Ristola cretacea* with *Cecrops* (?) *sexaspina*, *Acaeniotyle* (?) *florea*, *Acaeniotyle* (?) *glebulosa and Crolanium pythiae*.

U.A. 21: Co-occurrence of *Tretratrabs radix* and *Syringocapsa* (?) *vicetina* with *Crucella remanei* and *Stichocapsa pulchella*.

Zone F1 (U.A. 22 - U.A. 25)

U.A. 22: Co-occurrence of *Bistarkum valdorbiense* with *Ristola martae*, *Hexapyramis* (?) *precedis*, *Dibolachras tytthopora* and *Spongocapsula coronata*.

U.A. 23: Co-occurrence of *Mirifusus petzholdti* with *Dictyomitra pseudoscalaris*.

U.A. 24: Co-occurrence of *Wrangellium depressum* with *Acanthocircus variabilis*, *Thanarla elegantissima* and *Pseudocrolanium cristatum*.

U.A. 25: Co-occurrence of *Podocapsa amphitreptera* and *Emiluvia chica decussata* with *Podocapsa* (?) *imperialis*, *Suna hybum*, *Cyclastrum* (?) *luminosum*, *Zhamoidellum testatum* and *Xitus daneliani*.

Zone F2 (U.A. 26 - U.A. 28)

U.A. 26: Co-occurrence of *Katroma milloti* and *Obesacapsula bullata* with *Xitus horridus*, *Spongotripus* (?) *satoi* and *Novixitus* (?) *tuberculatus*.

U.A. 27: Co-occurrence of *Obesacapsula rusconensis rusconensis* with *Homoeoparonaella peteri*.

U.A. 28: Co-occurrence of *Crucella lipmanae* with *Sethocapsa orca* and *Cyclastrum* (?) *planum*.

Zone F3 (U.A. 29 - U.A. 32)

U.A. 29: Co-occurrence of *Syringocapsa coronata* ssp. with *Podobursa polyspina*, *Pseudocrolanium fluegeli*, *Stylospongia titirez*, *Godia* (?) *tecta* and *Phaseliforma ovum*.

U.A. 30: Co-occurrence of *Parvicingula longa* with *Thanarla gutta* and *Pseudodictyomitra lilyae*.

U.A. 31: Co-occurrence of *Mirifusus dianae minor*, *Acaeniotyle dentata* and *Cecrops* (?) *sexaspina* with *Archaeodictyomitra chalilovi*.

U.A. 32: Co-occurrence of *Sethocapsa leiostraca*, *Acanthocircus furiosus*, *Obesacapsula verbana*, *Wrangellium* (?) *columnarium*, *Parvivacca magna* and *Ristola martae* with *Bernoullius* (?) *manica*.

Zone G1 (U.A. 33 - U.A. 34)

U.A. 33: Co-occurrence of *Ditrabs sansalvadorensis*, *Obesacapsula morroensis*, *Xitus apenninicus*, *Cyclastrum rarum*, *Pseudoeucyrtis acus*, *Crucella*

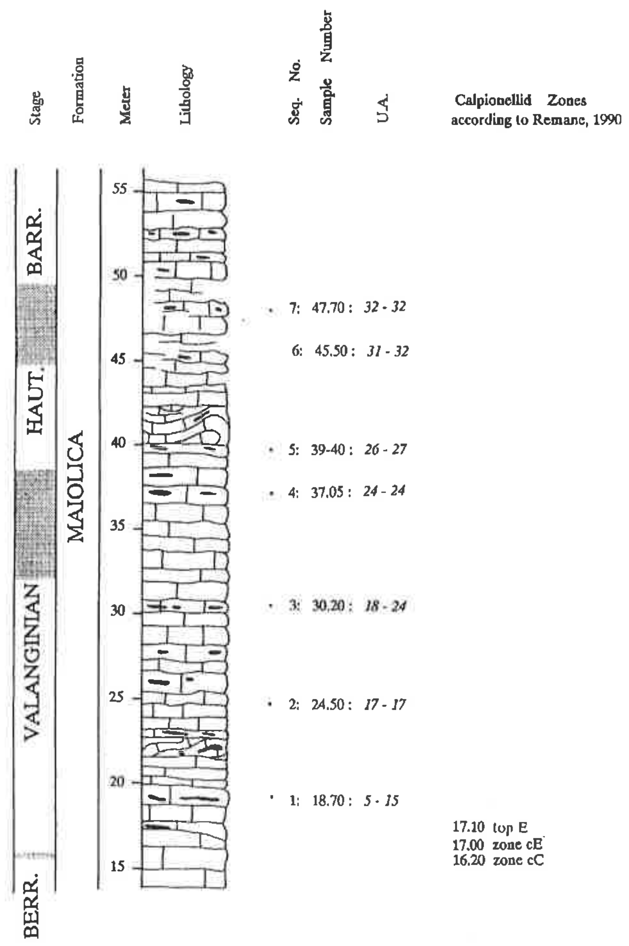


Figure 16. Ranchi Superiore Section: correlation of Unitary Associations to calpionellid zones and to lithostratigraphy (Jud, 1994).

remanei, *Spongocapsula tripes* and *Bernoullius* (?) *manica* with *Stichomitra euganea*.

U.A. 34: Co-occurrence of *Mirifusus odoghertyi*, *Syringocapsa limatum*, *Savaryella guexi*, *Pseudoaulophacus* (?) *pauliani*, *Paronaella* (?) *annemariae*, *Archeotritrabs gracilis*, *Xitus channelli*, *Cecrops septemporatus*, *Pseudocrolanium fluegeli and Thanarla gutta with Pseudodictyomitra* sp. aff. *P. lanceloti*.

Zone G2 (U.A. 35)

U.A. 35: Co-occurrence of a bulk of species such as *Acaeniotyle umbilicata*, *Mirifusus chenodes*, *Archaeodictyomitra apiarium*, *Alievium helenae*, *Archaeodictyomitra elegantissima*, *Angulobracchia* (?) *portmanni portmanni*, *Xitus* (?) *alievi*, *Sethocapsa uterculus*, *Sethocapsa trachyostraca*, *Archaeodictyomitra lacrimula*, *Bernoullius spelae*, *Ristola asparagus*, *Dicroa periosa*, *Xitus sandovali*, *Eucyrtis columbaria*, *Crucella bossoensis*, *Cecrops septemporatus*, *Spongocapsula coronata*, *Suna hybum*, *Zhamoidellum testatum*, *Sethocapsa orca*, *Pseudodictyomitra lanceloti*, *Stichomitra* sp. aff. *S. euganea* and others with *Pseudodictyomitra leptoconica*.

7. Integrated biostratigraphy and chronostratigraphy of four selected sections

7.1. Introduction

To date only rare ammonites have been found in the Maiolica Formation and biochronostratigraphy is mainly based on data from nannofossils, calpionellids and magnetic chrons. Generally correlations among nannofossils, calpionellids and magnetic polarity zones in sections of the Umbria Marche Apennines and of the Southern Alps did not present great problems. However, correlations however between the radiolarian Zones to the above mentioned zonations is sometimes difficult. Diachronies are probably caused by the different concepts used for biostratigraphic data acquisition and different methods of erecting the zonation.

The correlations of magnetic polarity patterns studied on land sections to the sea floor anomaly sequences often cause problems for precise identification of the chrons. Portions of the sections covered by vegetation, scree or water as well as faults, folds and slumps hamper the recognition of complete magnetic sequences. The calibrations of the chrons depend therefore on nannofossil and calpionellid occurrence data which in turn are dependent on the biostratigraphic methods used. Nannofossil and calpionellid zonations are based on species abundances and are thus influenced by sample density, sample preservation and individual judgement of the investigator. A good example is given by the recent reinvestigation of the nannofossils of the section Capriolo by Erba (Channell & Erba, 1992) where the identifications of the magnetic polarity zones in the uppermost portion of the section were changed and adapted to the new biostratigraphic data.

As the radiolarian zones are defined by the co-existence of several species within one zone influences of sample density and preservation on the occurrence data are minimalized. Diachrony in correlation of various fossil groups is to be expected as long as different biostratigraphic concepts are in use.

7.2. Correlation and calibration of zones and zonal boundaries

For an integrated correlation 4 sections were selected of which 3 are located in the Umbria Marche (Fiume Bosso, Gorgo a Cerbara and Presale) and 1 in the Southern Alps (Capriolo). The radiolarian zones were correlated to magnetic polarity zones, nannofossil and calpionellid events and zones (Fig. 21). Most of the Zones or of the Unitary Associations could be correlated and calibrated. Some of the only broadly identified Unitary Associations as e.g. U.A. 5-8 or U.A. 9-12 could only be calibrated by comparisons with the same intervals on sections which had a clear stratigraphic control. The detailed distribution of all UAZones on all sections is found in Jud (1994). In the following chapter only the definitions of the UAZones with regards to the magnetic chrons, the nannofossil events and the calpionellid zones or events are presented.

On the stratigraphic columns the magnetic chrons are marked by a lower reversed white zone and an upper normal black zone after Cox (in Harland *et al.*, 1989).

The Rome Standard Zonation (Allemann *et al.*, 1970) was used for the calpionellids and a "c" added in front of the letters which define the zones or subzones (e.g. cA, cB, cD1 etc.) in order to avoid confusion with the terms used for the radiolarian zones.

For the following discussion about the calibration and

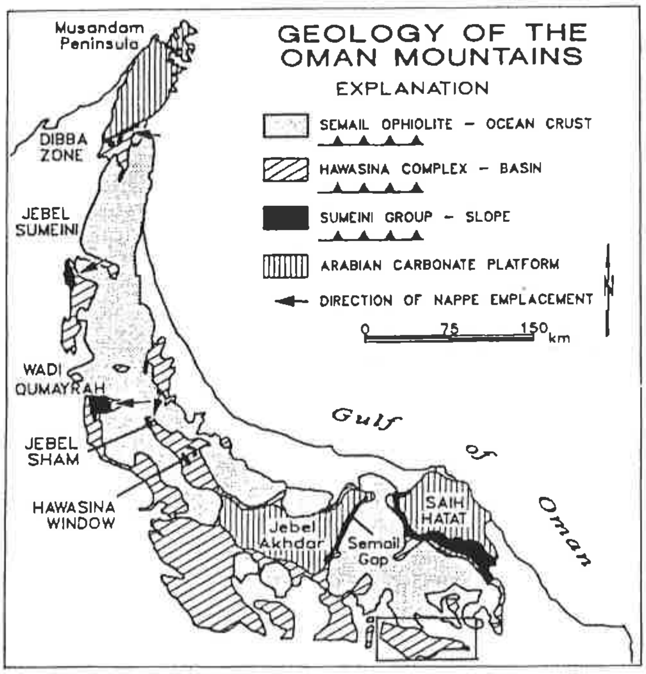


Figure 17a. Geological map of Oman with location of Hawasina complex and Wahrah Formation (Watts, 1990).

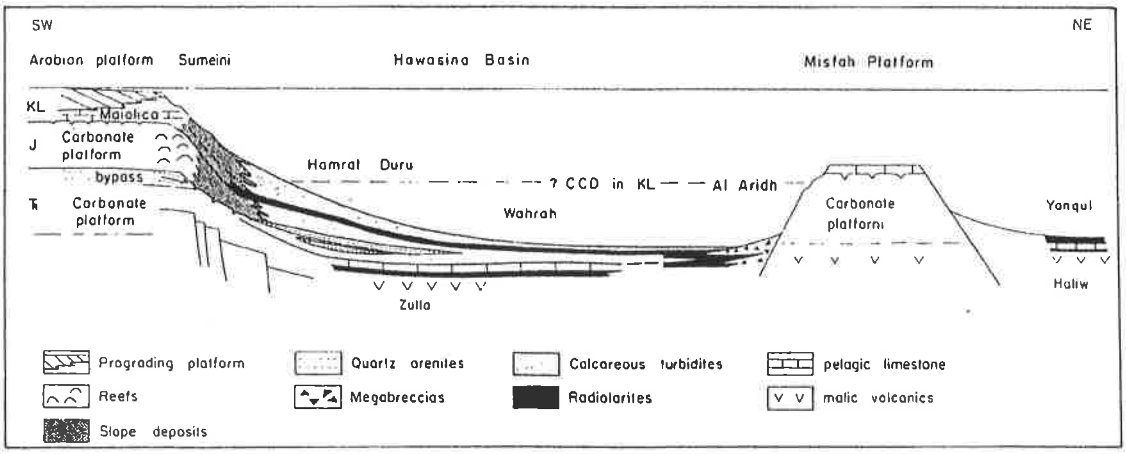


Figure 17b. Palinspastic cross section of the Hawasina Basin showing the position of the Wahrah Formation in the basin between between the Arabian and the Misfah Platform (Bernoulli *et al.*, 1990) .

the correlations of the radiolarian zones the reader is referred to the correlation table in the database, to the table of the reproducibility of the Unitary Associations on each section (Fig. 19), to the integrated correlation table (Fig. 21) and to the detailed stratigraphical columns of the sections.

Zone C2 (U.A. 1 and U.A. 2)

The lowermost identified zone at Fiume Bosso was C2 in the Calcari a Saccocoma e Aptici Formation and could only be calibrated and correlated by comparison with the corresponding zones B and C identified by Baumgartner (1984, 1987) at Fiume Bosso (U.A. 9, 289.80 m and U.A. 10, 292.20 m) and Valdorbia (U.A. 7-8, U.A. 10), and attributed an Upper Oxfordian (U.A. 7-8), Kimmeridgian (U.A. 9) and a Tithonian age (U.A. 10 and U.A. 11). The calpionellid events and zones have been determined by Remane (pers. comm., 1987-1991) and by Grandesso (Channel & Grandesso, 1987), and have led to different definitions and positions of the zonal boundaries which vary in the sections from between 3 to 6 metres. Grandesso defined the *Chitinoidella* Zone at Fiume Bosso in the interval 300.65 - 303.50 m and Remane stated that, except of saccocoma, globochaetetes, fibrospheres and radiolarians no chitinoidellas were present in our samples covering the interval between 293.6 - 304.90 m. He even considered a possible hiatus indicated by the absence of the *Chitinoidella* Zone and calpionellid Subzone A1. At present we have no samples with better preserved radiolarians within the respective interval. With regard to the presence of the FAD's of *Polycostella beckmannii* (301.00 m) and *Microstaurus chiastius* (303.00 m), which were correlated to the *Chitinoidella* Zone by Bralower *et al.* (1989), we cannot give at present any further interpretations for this questionable interval.

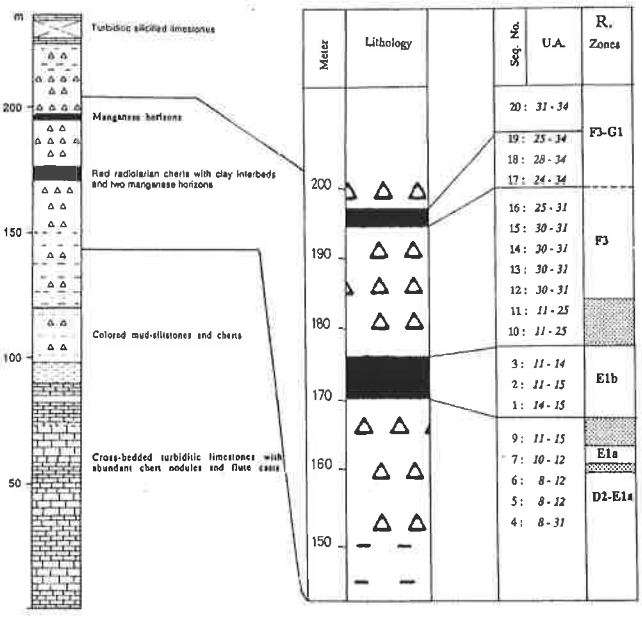


Figure 18. Correlation of Unitary Associations and UAZones to lithostratigraphy of a section representing the Wahrah Formation in the Al Hammah Range (modified after Kickmaier & Peters, 1990).

Zone D1 (U.A. 3 and U.A. 4)

Zone D1 is correlated to the interval between uppermost M20 and M19r and includes the calpionellid Zone cA. It is defined only above the FADs of the nannofossils *Polycostella beckmannii* and *Microstaurus chiastius*. Zone D1 could not be correlated to any of the three other sections. It corresponds to Baumgartners (1984, 1987) uppermost C2 and/or lowermost D Zone identified at Fiume Bosso and Valdorbia, and must be dated as upper Tithonian.

UAZone D2 (U.A. 5-8)

Zone D2 corresponds to the interval between M19n and lower M16r. It includes in M19n the Jurassic/Cretaceous boundary and the calpionellid cA/cB zonal boundary, the calpionellid Zone cB in M18 and M17, the calpionellid Zone cC in M17/M16. The FADs of the nannofossils *Umbria granulosa granulosa*, *Rothelapillus laffitei*, *Nannoconus steinmannii minor* and *Nannoconus steinmannii steinmannii* are also included in Zone D2. This zone cannot be correlated to the other three sections, but includes, in respect of the Valdorbia Section, parts of Baumgartner's (1984, 1987) Zone D (corresponding to U.A. 11) The upper zonal boundary includes the calpionellid cC/cD zonal boundary. Zone D2 spans the uppermost Tithonian and the lower Berriasian intervals.

Zone E1a (U.A. 9-12)

Zone E1a is included between lower M16n and M14r. Its lower boundary correlates to the calpionellid cC/cD zonal boundary. Zone E1a includes the FADs of the nannofossils *Cretarhabdus angustiforatus, Percivalia fenestrata and Calcicalathina oblongata* and the LAD of the nannofossil *Umbria granulosa granulosa.* Zone E1a includes the Upper Berriasian and the Berriasian/Valanginian boundary and the calpionellid cD2/cD3 Subzonal boundary. The E1a/E1b boundary is placed in the calpionellid Subzone cD3.

Zone E1b (U.A. 13-17)

Zone E1b corresponds to the interval between M14r and lower M12n and includes at its base the FAD of *Calcicalathina oblongata* and in the middle part of the zone the FAD of *Tubodiscus verenae.* Zone E1b spans the Lower Valanginian.

Zone E2 (U.A. 18-21)

Zone E2 is a very short ranged zone corresponding to parts of M11r and is placed between the FAD and the LAD of the nannofossil *Tubodiscus verenae.* Zone E2 is placed in the lower part of the Upper Valanginian.

Zone F1 (U.A. 22-25)

Zone F1 corresponds to the interval between M11r and upper M10n and includes at its base the LAD of the nannofossil *Tubodiscus venerae.* The upper zonal boundary is placed below the FAD of *Lithraphidites bollii.* Zone F1 spans the Upper Valanginian to lowermost Hauterivian and includes at its top the Valanginian-Hauterivian boundary.

Zone F2 (U.A. 26-28)

Zone F2 corresponds to M10 and M9 and includes in its lower part, in M10n, the FAD of *Lithraphidites bollii* and in the upper zonal boundary, in M8, the LAD of the nannofossil *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius,* and spans the Lower Hauterivian.

Zone F3 (U.A. 29-32)

Zone F3 corresponds to the interval between M8r and M3r and includes in its lower boundary the LAD of the nannofossil *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius,* in the middle of the zone the LAD of the nannofossil *Lithraphidites bollii,* and in its upper boundary the FAD of *Calcicalathina oblongata.* The zonal boundary F3/G1 corresponds roughly to the Hauterivian-Barremian boundary. Zone F3 includes the Middle and Upper Hauterivian.

Zone G1 (U.A. 33-34)

Zone G1 corresponds to the interval between M3r and lower M1n and is placed between the LADs of the nannofossils *Calcicalathina oblongata* (lower boundary) and *Nannoconus steinmannii* (upper boundary). Zone G1 spans the Lower to Middle Barremian.

Zone G2 (U.A. 35)

Zone G2 is included in the interval between upper M1n and M0 and reaches into the Middle Cretaceous "Quiet" zone. This zone contains in its lower part the LAD of the nannofossil *Nannoconus steinmannii* and the FADs of the nannofossils *Chiastozygus litterarius* and *Rucinolithus irregularis.* Zone G2 spans the Upper Barremian and the lowermost Aptian.

7.3. Definition of stage boundaries

Oxfordian-Kimmeridgian and Kimmeridgian-Tithonian boundary

The Oxfordian-Kimmeridgian boundary and the Kimmeridgian/Tithonian boundary have been placed by correlating the Unitary Associations (U.A. 1-4) of the present zonation with those of Baumgartner (U.A. 7-11) which have already been discussed by him in detail (Baumgartner, 1984, 1990).

Tithonian-Berriasian boundary

We place the Jurassic-Cretaceous boundary at the base of the combined *Berriasella jacobi-Pseudosubplanites grandis* Ammonite zone, as recommended at the "Colloque international sur la limite Jurassique-Cretace", Lyon-Neuchatel (1975), p. 392), and follow Ogg *et al.* (1991) correlating the boundary to the base of *Berriasella jacobi* at the base of M18r, respectively at the top of M19n. The calpionellid A/B zonal boundary varies at Fiume Bosso between 311.50 m (Remane 1991) and 315.2 - 332.9m. (Channell & Grandesso, 1987), and was correlated to M19n (in the case of Remane's data) or to the interval between M19n and M17r respectively according to Channell & Grandesso (1987). We correlate the Tithonian-Berriasian boundary to M19n. At Fiume Bosso it includes U.A. 6 and corresponds to the interval of the calpionellid zones upper A to lower B. At Pieia the calpionellid zone B corresponds to U.A. 5 which means that the two assemblages U.A. 5 and U.A. 6 are coexistent. Thus the Tithonian-Berriasian boundary is included in the lower portion of the radiolarian Zone D2.

Berriasian-Valanginian boundary

At Copenhagen 1984 it was recommended that the Berriasian-Valanginian boundary should be placed at the base of the ammonite *Thurmanniceras otopeta* Zone (Le Hegarat & Remane, 1968, Le Hegarat, 1973). We have followed Ogg *et al.* (1988 and 1991) who have placed its boundary on the basis of the data from Cehegin (Spain) in M15n. The boundary cannot be defined either with nannofossils or with calpionellids. It is at present placed between the FADs of the nannofossils *Percivalia fenestrata* and *Calcicalathina oblongata* (Bralower *et al.*, 1989, Channel & Erba, 1992) and correlates to the upper part of the calpionellid Subzone D2 at Fiume Bosso (Bralower *et al.*, 1989) and to the lower part of the calpionellid Zone D3 at Capriolo (Ogg *et al.*, 1991). The Berriasian-Valanginian boundary is included in the radiolarian Zone E1a.

Valanginian-Hauterivian boundary

It was recommended at Copenhagen 1984 that the boundary should be placed at the first occurrence of the ammonite genus *Acanthodiscus*. Thieuloy (1977) had proposed the base of *A. radiatus* at the stratotype (La Chacre, Drome, France). Haq *et al.* (1988) placed the Valanginian-Hauterivian boundary below *A. radiatus* in the upper M10n. Ogg *et al.* (1991) placed it between upper M11n and upper M10n, Channel & Erba (1992) in upper M10n, between the FAD of *Lithraphidites bollii* and the LAD of the nannofossil *Tubodiscus verenae*. We followed Haq *et al.* (1988) and placed the boundary in upper M10n which is included in the uppermost portion of the radiolarian Zone F1.

Hauterivian-Barremian boundary

At Copenhagen 1984 it was recommended that a choice be made of either the base or the top of the *Pseudothurmannia* beds for the position of this boundary. In Kent & Gradstein (1985) and in Haq *et al.* (1988) the Hauterivian-Barremian boundary is placed above *P. angulicostata* in the middle of M3. Several authors (Channell *et al.*, 1979, 1987, Bralower, 1987 and Ogg *et al.*, 1991) placed the boundary between M5r and M7r.

Radiolarian occurrence data of Rumanian samples (Murguceva section) with Middle to Upper Hauterivian ammonite control (Dumitrica, pers. comm.) were calculated together with our database by "BioGraph" (unpublished data) and the results clearly show that the H/B boundary cannot be placed in the proposed interval between M5 and M7 but must be placed either in M4 or in M3 as indicated by Kent & Gradstein (1985) and Haq *et al.* (1988).

Cecca *et al.* (1994) have found ammonites of the *Angulicostata* Zone and of the *Hugii-Nicklesi* Zones in the Gorgo a Cerbara section which correspond respectively to middle M4, and to the lower part of M3 (lower Barremian). The Hauterivian-Barremian boundary was then placed in the upper part of M4 between the FAD of *C. oblongata* (lowermost M3) and the FAD of *L. bollii*. In the present paper we have followed their decision although the boundary could also be placed at the base of M3.

Barremian-Aptian boundary

At the meeting in Copenhagen in 1984 it was recommended that the Barremian-Aptian boundary was placed at the first appearance of *Prodeshayesites*. Kent & Gradstein (1985) and Haq *et al.* (1987) have correlated it to the uppermost part of M1n, a little below M0r respectively. Bralower (1987) has correlated the boundary at Gorgo a Cerbara and Presale to the FAD of *Rucinolithus irregularis* which was placed in M0. Cecca *et al.* (1994) concluded that the boundary should be placed in M0 and that the nannoplankton is not useful for establishing the B/A boundary.

We decided to place the boundary at present following Kent & Gradstein (1985) and Haq *et al.* (1987) in the uppermost part of M1n. The boundary is included in the lower part of zone U.A.G2.

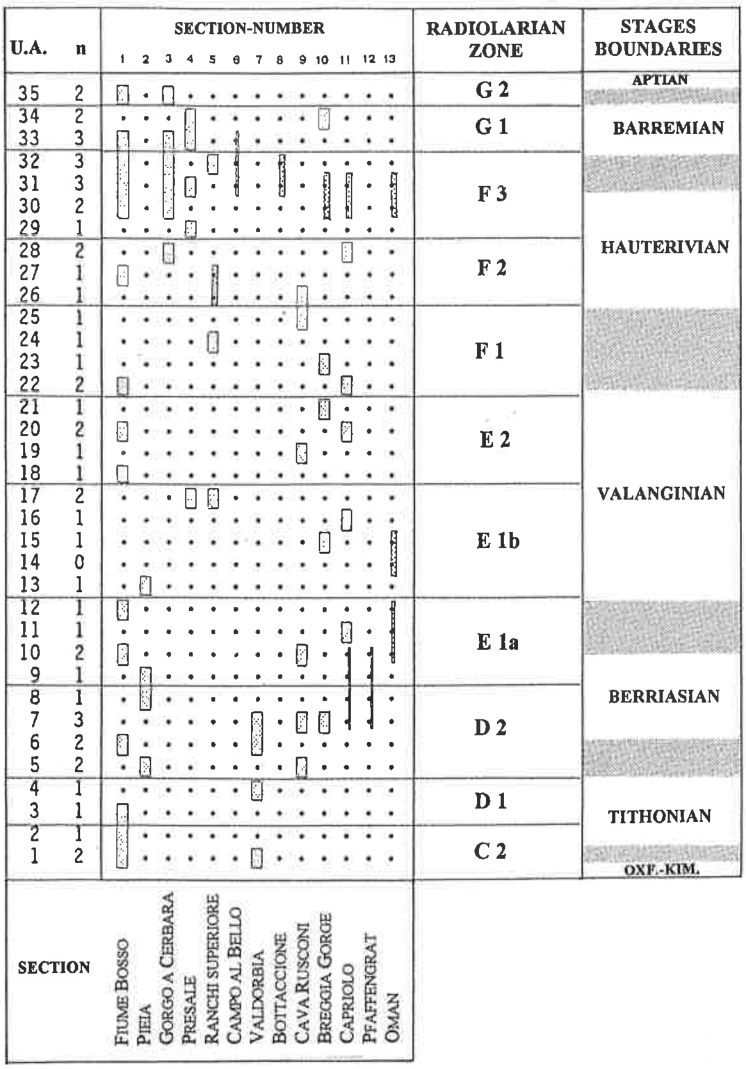


Figure 19. Reproductibility table of 35 Unitary Association (U.A.) and Zones on 13 sections.

8. Correlation of the Zones to previous zonations

8.1. Introduction

In the last 20 years several attempts were made to develop Lower Cretaceous radiolarian zonations from DSDP Drilling cores and land-based sections (Moore, 1973; Riedel & Sanfilippo, 1974; Renz, 1974; Foreman, 1973, 1975; Pessagno, 1977b; Baumgartner *et al.*, 1980; Schaaf, 1981, 1984; Kocher, 1981; Nakaseko & Nishimura, 1981; Baumgartner, 1984; Sanfilippo & Riedel, 1985; Thurow, 1988; Matsuoka 1992, etc.). Most of these zonations (except Kocher, 1981 and Baumgartner, 1984) were generally based on first and final appearances of some selected taxa considered as "marker" species. A correlation to all these former zonations is very difficult because of differences in the time-equivalence of the stages, of the species definitions or even of the different paleogeographic position of the

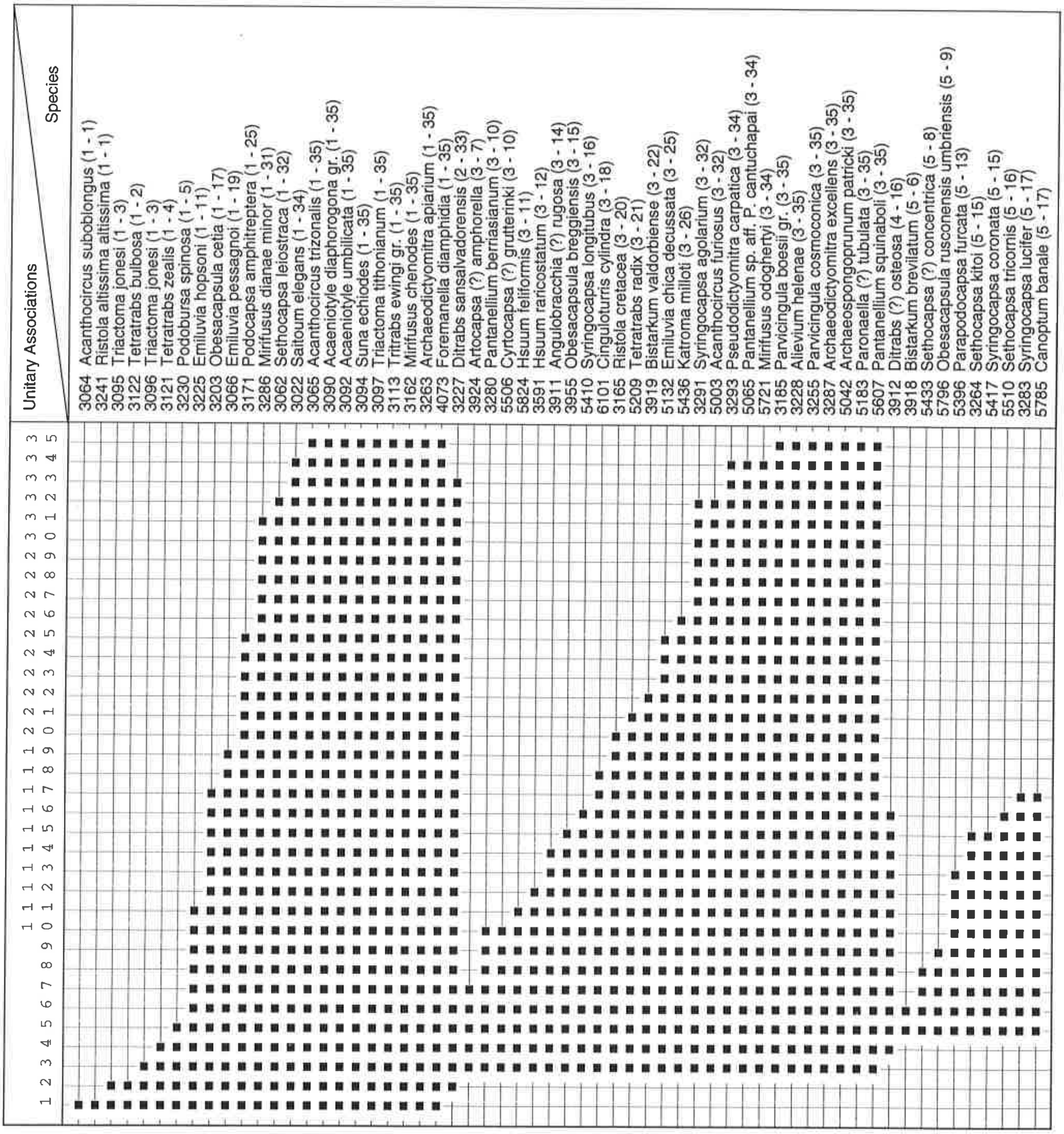


Figure 20. Occurrence of radiolarian species arranged in order of their first and last occurrence.

sections. A correlation table is given in Figure 22.

Differences in time equivalence appear mostly for the correlations with Moore (1973) and Foreman (1975) where we correlated mostly on the level of the faunal assemblages only.

8.2. Correlation with Moore (1973)

Moore (1973) studied radiolarians from DSDP samples from the Pacific and proposed 7 zones for the Tithonian-Maastrichtian interval of which only the first 3 are of interest in this discussion. Lower Cretaceous radiolarians are poorly-preserved and because of this only few species can be used for correlation. Moreover problems arise because the biostratigraphic control of calcareous microfossils is inadequate.

The RK1 Zone (Moore 1973) is defined by the interval between the first appearance of *Lithocampe mediodilatata* and the first appearance of *Stichocapsa rotunda*. This would correspond to the interval between U.A. 1 and U.A. 5. The

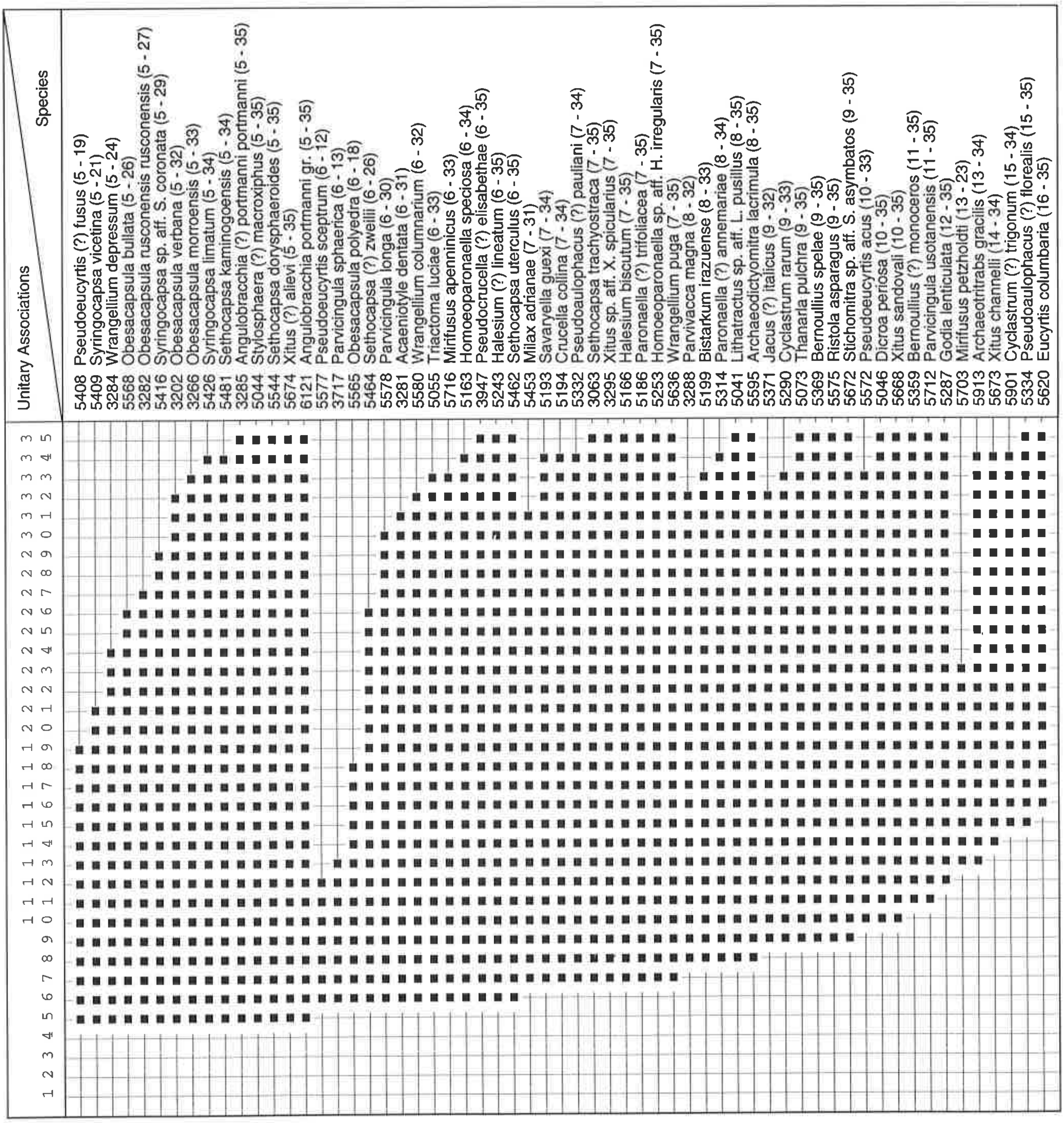


Figure 20. continued

range of *Spongosaturnalis dicranacanthos*, which according to Moore (1973) appears first below the top of RK1, is extended further down in the present zonation to U.A. 1. Zone RK1 would correspond therefore to the interval between U.A. 1 and U.A. 4 (UAZones C2 and D1).

Stichocapsa rotunda defines the base of Zone RK2 and corresponds to U.A. 5. *Lithomitra excellens* was reported to appear also at the base of this zone but in the present zonation this species ranges further down to U.A. 3. *Staurosphaera septemporata* appears first at the base of the Valanginian together with *Lithocampe altissima* (= *Xitus alievi*), which does not correlate to our data where these species appear in U.A. 18 (E2), in the Middle Valanginian, and in U.A. 5, respectively. Zone RK2 corresponds to the interval between D2 and E2.

The base of Zone RK3 is marked by the first appearance of *Spongosaturnalis variabilis* and correlates to U.A. 24 (F1). Moore includes in this species also *Acanthocircus carinatus* Foreman which has its first occurrence in U.A. 32. The top of RK3 is defined by the last occurrence of

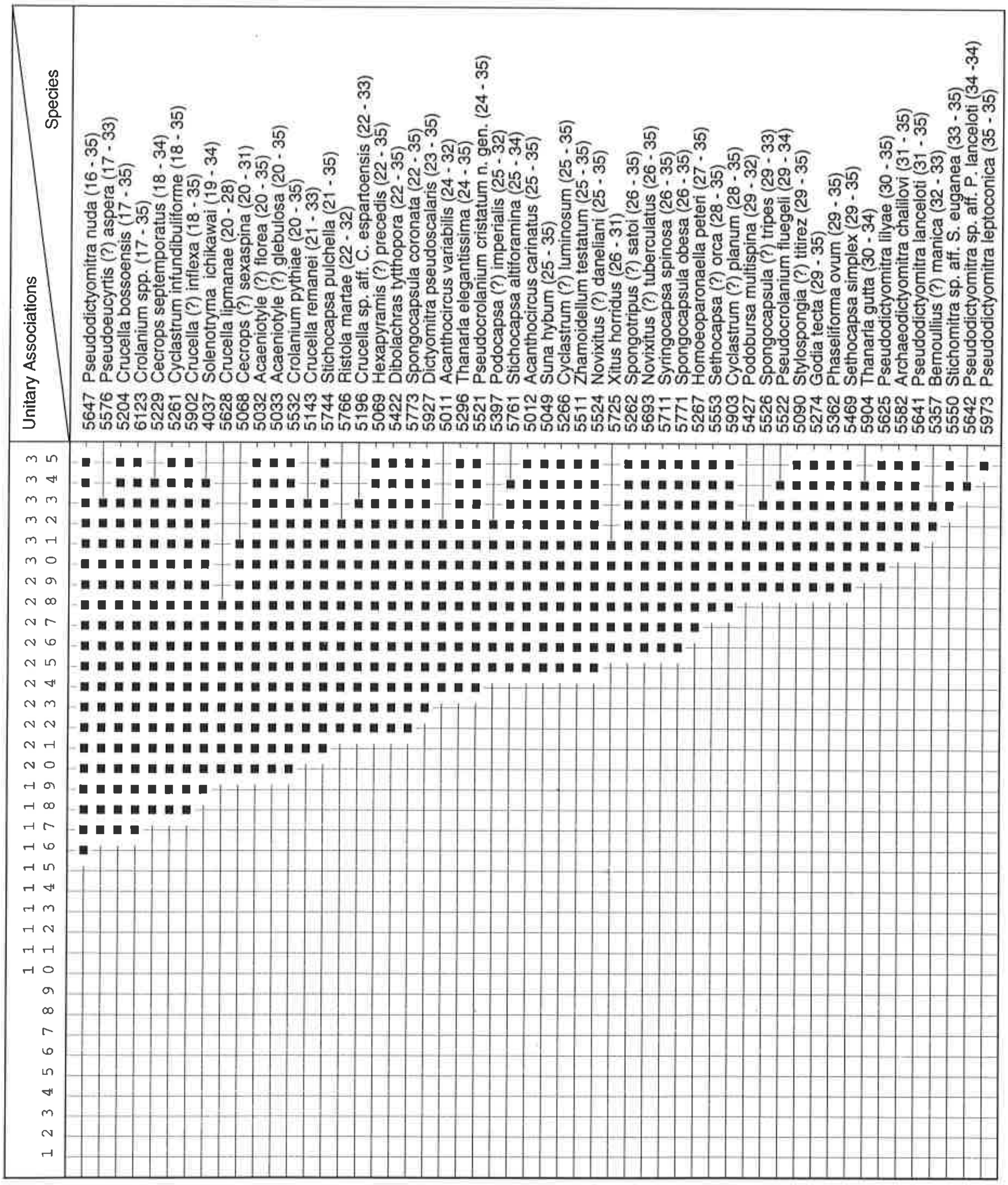


Figure 20. continued

Lithocampe altissima. Spongosaturnalis dicranacanthos has its last occurrence a little below the top which corresponds to U.A. 35. RK3 is equivalent to the interval between U.A. 24 and U.A. 35 (E2-G2). It is worth noting that all ranges of the species defining the interval between RK1 and RK3 are much too long (reaching the Lower Cenomanian) and were never observed in the Tethyan material.

8.3. Correlation with Foreman (1975)

Foreman (1975) studied radiolarians in DSDP samples from the North Pacific and proposed 6 zones for the lower Berriasian-Santonian interval. The zonations of the nannofossils and foraminifers showed a diachrony of one stage which made it difficult to calibrate the radiolarian zones. Because of this very long-ranging zones resulted, as for example the *Sethocapsa trachyostraca* Zone and the *Eucyrtis tenuis* Zone which correspond to Foreman's Valanginian or Hauterivian to Barremian interval. The first appearance of *Dibolachras tytthopora* which marks the base of the latter zone has an undefined place within this interval.

The *Spaerostylus lanceola* Zone, defined by Riedel & Sanfilippo (1974), was emended by Foreman (1975).The first appearance of the species *Staurosphaera septemporata* which marked the top of this zone was replaced by that of *Sethocapsa trachyostraca* and thus the base of the following zone was lowered. The base of the *Sphaerostylus lanceola* Zone is defined by the first appearance of *Sphaerostylus lanceola* and correlates to the interval between U.A. 1 and U.A. 7, (C2, D1 and D1/D2 boundary).

The base of the *Sethocapsa trachyostraca* Zone is defined by the first appearance of *Sethocapsa trachyostraca*, and the top by the first appearance of *Dibolachras tytthopora* which corresponds to U.A. 22. *Sethocapsa* (?) *orca*, which is part of the faunal assemblage of the zone, creates correlation problems, because its first appearance corresponds to U.A. 28. The result of this is that the top of this zone is not correlative. Examination of the lists of events recorded by Foreman shows that *Dibolachras tytthopora* and *Sethocapsa (?) orca* were never found together in this zone. Several species which according to Foreman have also their first appearance in this zone, range in the present zonation further down as for example *Triactoma echiodes* (U.A. 1) or further up, *Parvicingula cosmoconica* (U.A. 35) and *Stichocapsa* (?) *rotunda* reaching U.A. 35 and U.A. 32 respectively. The *Sethocapsa trachyostraca* Zone correlates to the interval between U.A. 7 and U.A. 21 (D2, respectively the Jurassic-Cretaceous boundary and E2).

The *Eucyrtis tenuis* Zone has been defined by Sanfilippo & Riedel (1974) and emended by Foreman (1975) who changed the marker species *Eucyrtis tenuis* versus *Dibolachras tytthopora*. The top is defined by the last occurrence of the *Sphaerostylus lanceola group*, which is approximately synchronous with *Dibolachras tytthopora* and *Sethocapsa (?) orca* and correlates to U.A. 35 (G2). *Acanthocircus carinatus* and *Triactoma hybum* are included in the faunal assemblage, appearing at the base of the zone and extending through the interval between U.A. 25 and U.A. 35. This zone corresponds to the interval between Zones F1 and G2.

8.4. Correlation with Pessagno (1977b)

Pessagno (1977b) studied radiolarians from land sections in the California Coast Ranges (Great Valley sequence and Franciscan Complex). He proposed 10 zones for the interval between the Upper Kimmeridgian and the Lower Cenomanian. Many of his key species were not used in the present zonation and a correlation is therefore not possible.

The base of the *Parvicingula altissima* Zone (Pessagno 1977a) is defined by the first appearance of *Obesacapsula cetia* and the top by the final appearances of *Parvicingula altissima* and other species not used in the present zonation. As *Parvicingula altissima* becomes extinct in U.A. 1. this zone correlates to C2. *Obesacapsula cetia* has another specific determination and its first appearance is not included in the present zonation.

The succeeding *Obesacasula rotunda* Zone (Oppel zone) is divided into three subzones of which the base of the lowest *Parvicingula jonesi* Subzone can be correlated by the first appearance of *Obesacapsula rotunda* to U.A. 5. As Pessagno used different marker species from us the top of the first subzone as well as the base of the following *Pseudoeucyrtis paskentaensis* Subzone are not correlative. The *Cecrops septemporatus* Subzone includes the total range of *Cecrops septemporatus* and the last occurrences of the Parvicingulidae and in second order of *Acanthocircus dicranacanthos* and *Obesacapsula rotunda.* The Parvicingulidae and *Cecrops septemporatus* have an extended range in the present zonation further up to U.A. 35 and to U.A. 34 respectively. The last occurrence of *Obesacapsula rotunda* corresponds to U.A. 32. This subzone correlates to the interval between U.A. 18 and U.A. 34 and invalidates therefore partly the following *Parvicingula-Thanarla conica* Zone.

8.5. Correlation with Schaaf (1985)

The lower zones only will be discussed here as the upper ones are common together with other authors and will be discussed in the next part (8.6).

The base of the lowermost *Acanthocircus dicranacanthos* Zone is defined by the first appearance of *Acanthocircus dicranacanthos* and the top by the first appearance of *Parvicingula cosmoconica.* The ranges of both marker species were extended in the present zonation further down to U.A. 1 and U.A. 3 respectively. The base of the *Acanthocircus dicranacanthos* Zone correlates to U.A. 1 (C2). The first appearance of *Stichocaopsa rotunda* is included in this zone but correlates to U.A. 5 which is placed above the first appearance of *Parvicingula cosmoconica* in the present zonation.

The base of the *Parvicingula cosmoconica* Zone was defined by the first appearance of *Parvicingula cosmoconica* and the top by *Alievium helenae* which correspond both to U.A. 3. This zone is therefore invalidated as the marker species is included in the

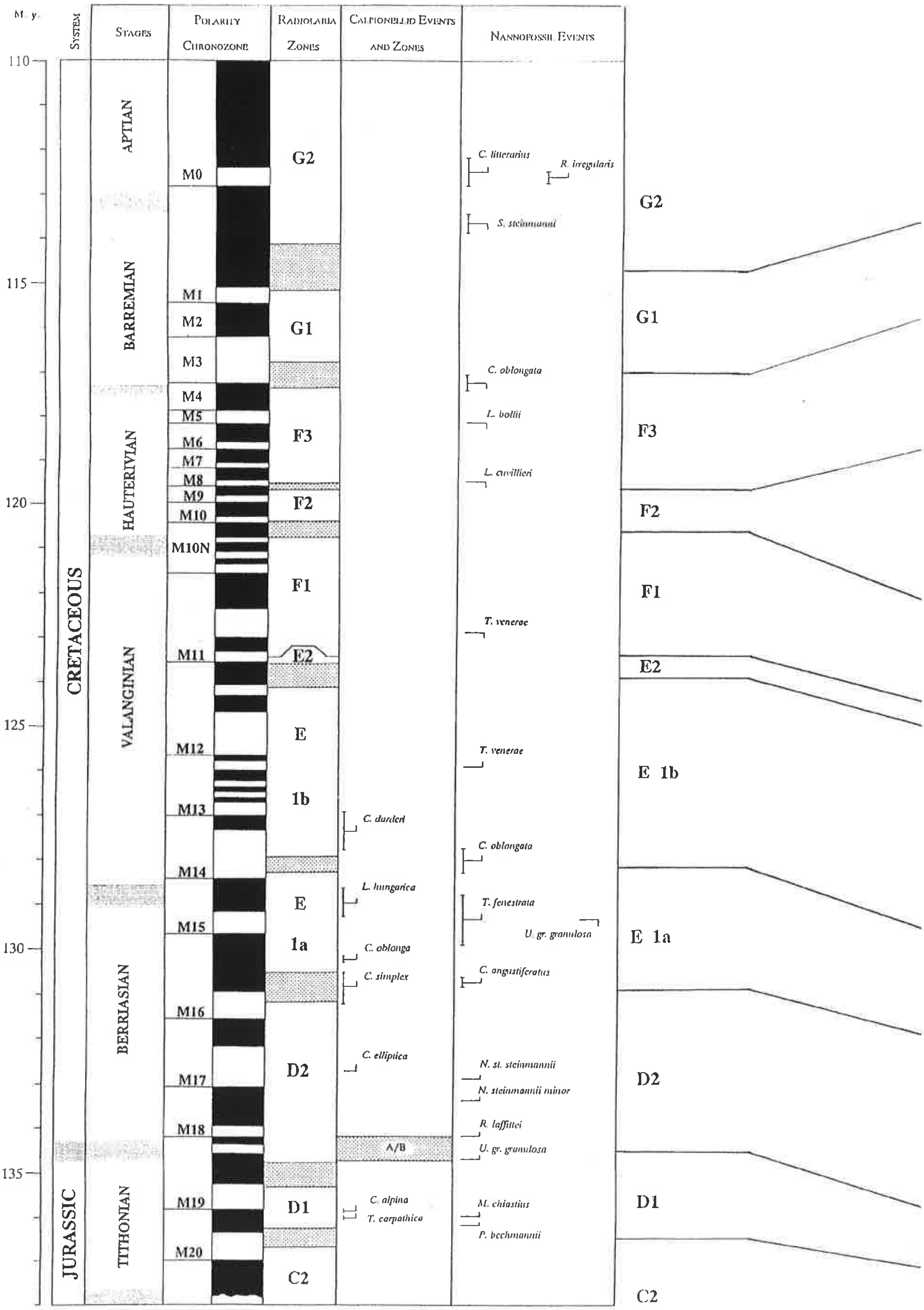


Figure 21. Correlation of radiolarian zones to lithostratigraphy, biostratigraphy and magnetostratigraphy of 4 selected sections (Jud, 1994).

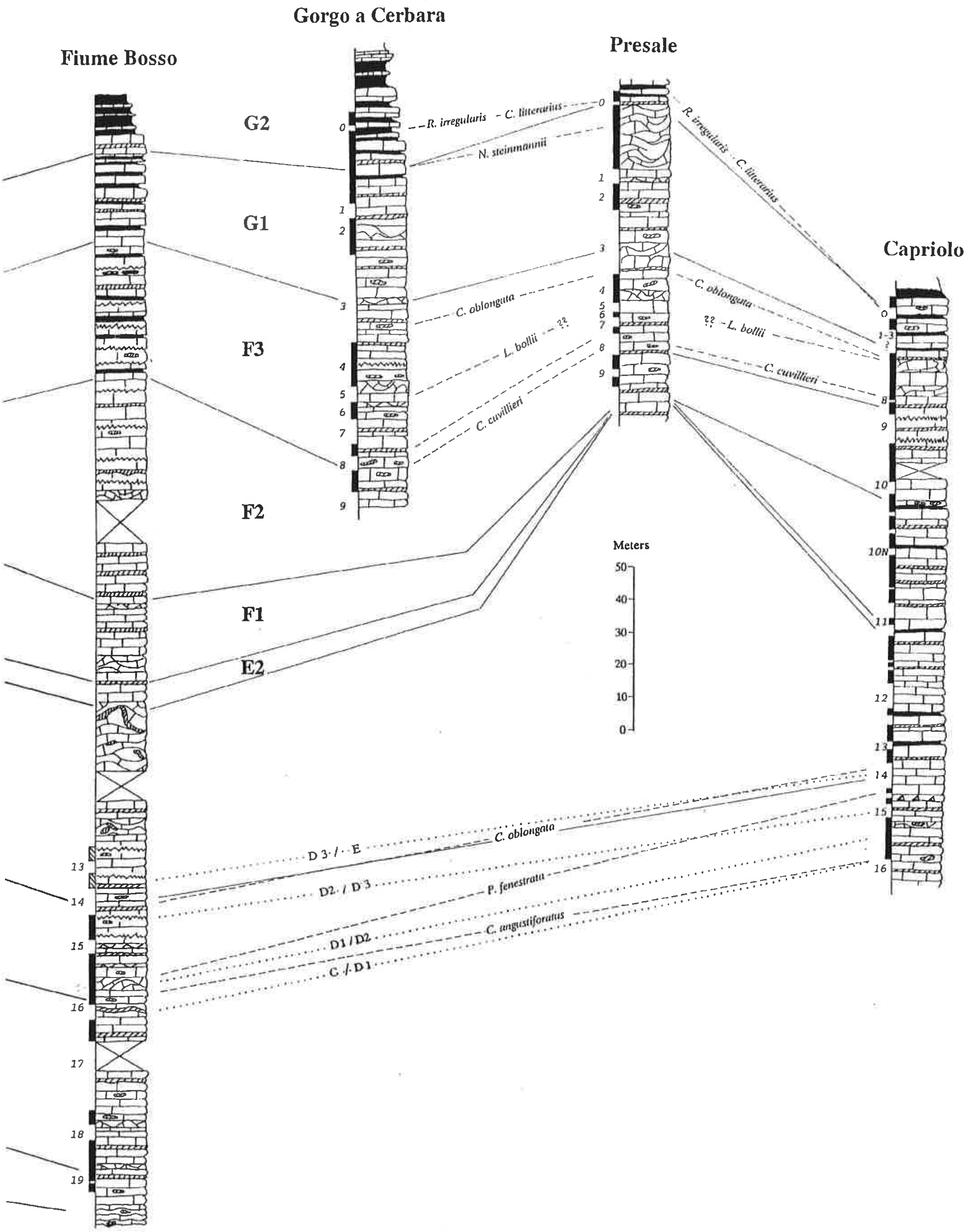


Figure 21. continued.

Acanthocircus dicranacanthos Zone.

The base of the *Alievium helenae* Zone is defined by the first appearance of *Alievium helenae* and the top by the first appearance of *Sethocapsa trachyostraca* which correlate to U.A. 3 and U.A. 7 respectively. This zone corresponds to the interval between D1 and D2 (Jurassic-Cretaceous boundary). The last occurrence of *Podocapsa* is included in the *Alievium helena* Zone but it ranges in the present zonation to U.A. 25.

The *Sethocapsa trachyostraca* Zone is defined by the first appearance of *Sethocapsa trachyostraca* and the top by the first appearance of *Cecrops septemporatus*. The last occurrence of *Sethocapsa cetia* is included in this zone but its range was extended in the present zonation further up to U.A. 18 where *Sethocapsa cetia* co-exists with *Cecrops septemporatus*. The *Sethocapsa trachyostraca* Zone corresponds to the interval between U.A. 7 and U.A. 17 (D2-E1b).

8.6. Correlation with Sanfilippo & Riedel (1985), Schaaf (1985), Thurow (1988) and Matsuoka (1992)

Sanfilippo & Riedel (1985), Schaaf (1985), Thurow (1988) and Matsuoka (1992) were using in their zonations equal marker species, but most of the species defining also the zones differ from one author to the other. Therefore generally we discuss the marker species for the respective zones only.

The *Cecrops septemporatus* Zone (defined by Riedel & Sanfilippo, 1974, emend. Schaaf, 1981) is defined by the first occurrence of *Cecrops septemporatus* and correlates to U.A. 18. The top is defined by the first appearance of *Dibolachras tytthopora*. Most of the other species which define this zone have extended ranges in the present zonation and are not correlative (e.g. *Archaeodictyomitra lacrimula*, *Podocapsa amphitreptera* and *Sethocapsa uterculus*). *Archaeodictyomitra lacrimula* ranges further down to U.A. 8. *Podocapsa amphitreptera* does not co-exist with *Cecrops septemporatus* in Sanfilippo & Riedel (1985) but reaches U.A. 25. *Sethocapsa uterculus* appears in the next younger *Dibolachras tytthopora* Zone in Sanfilippo & Riedel (1985), but is co-occurrent with *Cecrops septemporatus* in the present zonation. The *Cecrops septemporatus* Zone correlates to the interval between U.A. 18 and U.A. 21 which corresponds to E2.

Schaaf has divided the interval of the Lower and Middle Valanginian into two zones, the lower *Cecrops septemporatus* Zone and the upper *Mirifusus chenodes* Zone. *Mirifusus chenodes* which defines the base of the upper zone already occurs in the present zonation in U.A. 1. Some other species included in this zone invalidate it completely. The next younger *Dibolachras tytthopora* Zone also includes the first appearance of *Eucyrtis columbaria*, but Sanfilippo & Riedel (1985) found it in the *Cecrops septemporatus* Zone which correlates to the present zonation where it appears first in U.A. 16, even below the first appearance of *Cecrops septemporatus*. *Sethocapsa uterculus* has an extended range further down to U.A. 6 in the present zonation and co-exists with *Cecrops septemporatus*.

The *Dibolachras tytthopora* Zone (Schaaf, 1981) is defined by the first appearance of *Dibolachras tytthopora* and correlates to U.A. 22. *Mirifusus mediodilatatus* does not reach this zone. Matsuoka (1992) has observed, however, the co-existence of *Crolanium pythiae* (which defines the base of the next younger zone) with *Mirifusus mediodilatatus* and also remarks that the first appearances of *Dibolachras tytthopora* and *Crolanium pythiae* are inversed which correlates well with the present zonation. *Mirifusus mediodilatatus* reaches U.A. 31 and co-exists with both *Dibolachras tytthopora* and *Crolanium pythiae*. *Crolanium pythiae* appears in U.A. 20 and *Dibolachras tytthopora* in U.A. 22. *Sethocapsa orca* and *Triactoma hybum* were included in the *Dibolachras tytthopora* Zone by Schaaf (1981) and appear first in U.A. 28 and U.A. 25 respectively in the present zonation. Sanfilippo & Riedel (1985) included the first appearances of *Sethocapsa uterculus* and *Thanarla elegantissima* in this zone which correlate to U.A. 6 and U.A. 24 respectively. The final occurrences of *Sethocapsa trachyostraca* and *Acanthocircus dicranacanthos* are also included in this zone but their ranges extended to U.A. 35. The *Dibolachras tytthopora* Zone therefore does not exist or is included in the *Crolanium pythiae* Zone which correlates with the interval between U.A. 20 and U.A. 32. As the first occurrence of *Cecrops septemporatus* is in the same zone as that of *Crolanium pythiae* the *Crolanium pythiae* Zone includes also most of the *Cecrops septemporatus* Zone. All three zones correspond to the interval between the Zones E2 and F3.

Schaaf (1981) has defined the *Stichocapsa euganea* Zone by the first appearance of *Stichocapsa euganea* which has an extended range further down to U.A. 33 in the present zonation. The last occurrence of *Cecrops septemporatus* is not included in the *Stichocapsa euganea* Zone but it ranges to U.A. 35 in the present zonation. The *Stichocapsa euganea* Zone corresponds to the interval between U.A. 33 and U.A. 35 (Zones G1 and G2).

8.7. Correlation with Kocher (1981)

Kocher (1981) studied Upper Jurassic radiolarians from DSDP and land sections (some of them placed in the Southern Alps) and proposed 6 biozones based on 9 Unitary Associations for the interval between the late Callovian and the Lower Hauterivian.

Zone IV (U.A. 6 and 7) can be defined by the co-existence of *Acanthocircus dicranacanthos*, *Triactoma tithonianum s. l.*, *Acaeniotyle umbilicata*, *Triactoma echiodes* with *Podobursa spinosa*, *Tetratrabs bulbosa*, *Tretratrabs zealis*, *Triactoma blakei* and corresponds to U.A. 1.

Zone V (U.A. 8) is defined by the co-occurrence of *Alievium helenae*, *Parvicingula cosmoconica*, *Ditrabs sansalvadorensis* and *Parvicingula (?) cretacea* with *Emiluvia hopsoni*, *Triactoma jonesi*, *Tritrabs ewingi*, *Emiluvia pessagnoi*, *Podocapsa amphitreptera* and *Sethocapsa cetia*. *Cecrops septemporatus* has its first appearance at the base of the next younger Zone VI which corresponds to U.A. 18. Therefore zone V correlates to the interval between U.A. 2 and U.A. 17.

Zone VI (U.A. 9) is defined by the co-existence of *Emiluvia chica* s.l., *Mirifusus mediodilatatus*, *Lithocampe chenodes*, *Archaeodictyomitra apiarium*, *Sethocapsa trachyostraca*, *Syringocapsa rotunda* and other species. The top of this zone was not defined and cannot be correlated. By the first appearance of *Cecrops septemporatus* Zone VI corresponds to the interval between U.A. 18 and U.A. 25 which is the maximum range of *Emiluvia chica* in the present zonation).

8.8. Correlation with Baumgartner (1984)

Baumgartner (1984) studied radiolarians from 43 localities, most of them situated in the Atlantic and some in the Tethyan area. Some of the sections were re-investigated by us. The occurrence data of 109 radiolarian taxa were calculated by a computer program for Unitary Associations after Guex & Davaux (1984). Baumgartner proposed 9 zones, including 14 Unitary Associations, spanning the Bathonian to Hauterivian. For comparison we mark Baumgartner's zones by adding POB (e.g. POB-Zone A0 and POB-U.A. 1).

POB-U.A. 10 is defined by the co-occurrences of *Mirifusus mediodilatatus minor*, *Podobursa spinosa* and *Tetratrabs bulbosa* and many other species which we did not use in the present zonation. With regards to the last occurrence of *Tetratrabs bulbosa* the POB-C2 Zone corresponds to U.A. 1 and U.A. 2 and therefore to Zone C2. *Podobursa spinosa* ranges in the present zonation further up to U.A. 5.

POB-ZoneD (U.A. 11 and U.A. 12) is defined by the co-existence of *Pantanellium* (?) *berriasianum*, *Ristola cretacea*, *Parvicingula cosmoconica*, *Archaeodictyomitra excellens*, *Alievium helenae*, *Triactoma jonesi*, *Obesacapsula rotunda*, *Obesacapsula rusconensis*, *Pseudodictyomitra depressa* and many others. *Thanarla pulchra* appears first in the next younger zone, POB-E1 Zone (U.A. 13) which corresponds to U.A. 9 in the present zonation. POB-Zone D therefore correlates to the interval between U.A. 3 and U.A. 8 respectively to Zone D1 and Zone D2. Some of the other species also defining POB-Zone D have an extended range in the present zonation further down such as *Ditrabs sansalvadorensis* (U.A. 2) or further up such as *Podocapsa amphitreptera* (U.A. 25), *Emiluvia pessagnoi* (U.A. 19) or *Emiluvia hopsoni* (U.A. 11) and *Pantanellium* (?) *berriasianum* (U.A. 10).

POB-Zone E1 (U.A. 13) is defined by the co-existence of *Thanarla pulchra* and *Ristola cretacea* and can be correlated to U.A. 9. *Ristola cretacea* has now an extended range in the present zonation further up to U.A. 20. As the next younger zone is also defined by *Cecrops septemporatus* which correlates to U.A. 18, POB-Zone E1 corresponds to the interval between U.A. 9 and U.A. 17 (E1a and E1b).

POB-Zone E2 (U.A. 14) is defined by the co-existence of *Cecrops septemporatus*, *Sethocapsa uterculus* and many other species and correlates to U.A. 18 (Zone E2). *Sethocapsa uterculus* reaches U.A. 6 in the present zonation and co-exists therefore with all the other species mentioned in POB-U.A. 11-13.

8.9. Correlation with Nakaseko & Nishimura (1981), Tumanda (1989) and Aita (1987)

The Japanese radiolarian fauna highly resembles our Tethyan fauna. and some assemblages are therefore generally comparable.

Nakaseko & Nishimura (1981) studied Upper Jurassic and Cretaceous radiolarians from the Shimanto Group in Southwest Japan. Of a total of 7 zones only 3 zones spanning the interval between the Tithonian and Hauterivian will be discussed. The authors described the *Parvicingula altissima* assemblage of which the key species *Parvicingula altissima, Mirifusus mediodilatatus* and *Archeodictyomitra apiarium* have in the present zonation an extended range further down to U.A. 1. We have not yet found *Parvicingula altissima* at a level younger than that corresponding to U.A. 1. The *Obesacapsula rotunda* assemblage is defined by the species *Cecrops septemporatus*, *Mirifusus mediodilatata*, *Obesacapsula rotunda* and others, and correlates to U.A. 18. The *Eucyrtis tenuis* assemblage is not correlative because we did not use *Eucyrtis tenuis* for the present zonation, and all the other co-existing species are not useful for precise definitions as they are very long-ranging. The authors have no range chart or occurrence list which would have allowed us a more precise correlation.

Tumanda (1989) studied Cretaceous radiolarians in the Esashi Mountain area on Hokkaido Island in Japan. She worked on the level of assemblages and described a *Staurosphaera septemporata-Parvicingula usotanensis* assemblage Zone for the interval between the Valanginian and Barremian. This assemblage zone is defined by the co-occurrence of *Staurosphaera septemporata*, *Parvicingula usotanensis*, *Sethocapsa trachyostraca*, *Sethocapsa uterculus*, *Thanarla pulchra* and many others. On the basis of *Staurosphaera septemporatus* the base of this assemblage zone is correlated to U.A. 18 and the top may correspond to U.A. 35.

Aita (1987) studied Middle Jurassic to Lower Cretaceous radiolarians in Japan and made a reference to sections in Lombardy and Sicily. The definition of the *Podocapsa amphitreptera* and the *Sethocapsa cetia* Interval-zone is not precise so it was impossible to correlate them. It is not clear, for example, why the author mentioned the first appearances of *Obesacapsula rotunda* twice in two different zones. There are also differences in species determination as is the case of *Syringocapsa limatum*. The base of the *Ditrabs sansalvadorensis* Interval-zone is defined by the first appearance of *Ditrabs sansalvadorensis* and the top by the first appearance of *Cecrops septemporatus*. Many species also defining this zone range down in the present zonation to U.A. 1. This zone correlates therefore to the interval between U.A. 1 and U.A. 17 (C2-E1b). The *Sphaerostylus septemporatus* Zone (Sanfilippo & Riedel, 1985) is based on the first appearance of *Cecrops septemporatus* and correlates to U.A. 18 in E2. The top of this zone was not defined by the author.

8.10. Remarks

Most of the zones could be correlated on the basis of one or several marker species. Many zones however were defined by species which have extended ranges in the present zonation and which consequently make a correlation difficult or impossible. Cases have occurred when the base and the top of a zone became equal in time or even reversed. The ranges of most additional species also defining the zones have in the present zonation an extended range further down and/or further up. Also certain species which were before clearly separated in different zones are proven to co-exist.

We recorded an elevated number of first appearances of species in POB-D in the interval of the upper Tithonian and lower Berriasian, the Jurassic/Cretaceous boundary included. This correlates well with the present zonation where more than 1/3 of the new appearances of all species occurring between the upper Tithonian and the lower Aptian are in Zones D1 and D2. This may be caused by a major faunal change which coincides with the appearance of the calpionellids in the western Tethys and which could be connected with a major change in paleoceanography (Baumgartner, 1987).

9. Correlation to carbon isotope curve

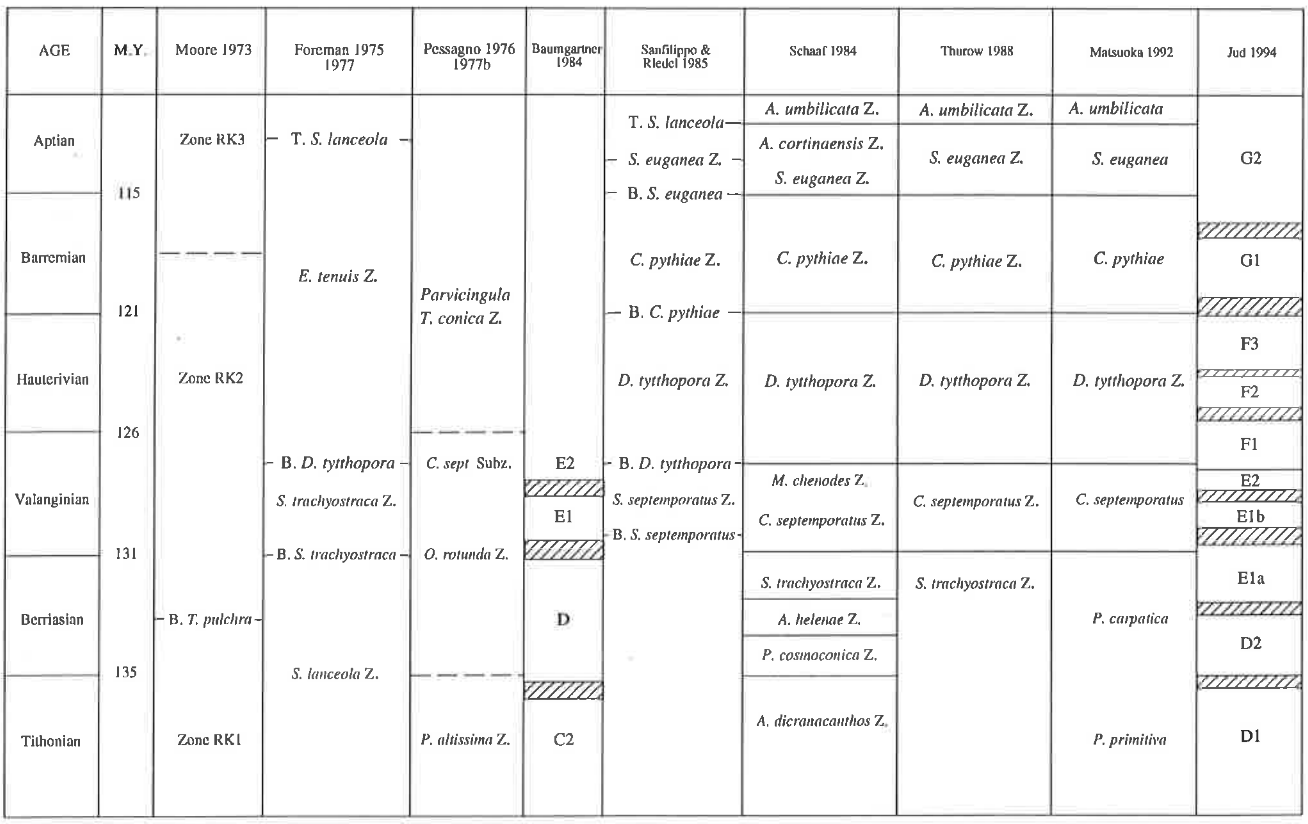
Since Fiume Bosso was the only complete section within the Tithonian to Aptian interval 19 samples (spanning the Berriasian-lowermost Aptian) were investigated for abundances of about 150 taxa. Of all these species the data of 8 long-ranged taxa and 6 shorter ranged taxa have been chosen and correlated to the radiolarian zones (Fig. 23). Minimum abundance values correspond generally to the U.A. Zones E1a, E1b (Upper Berriasian, Lower Valanginian) and F2 (Lower Hauterivian), maximum values to the U.A. Zones E2, F1 (Upper Valanginian), F3 (Upper Hauterivian). The minimum values correlate to a certain degree to moderate preservation of the samples.

On all investigated sections of the Southern Alps were recognized within the lithological interval which correspond to the ^{13}C excursion (Fig. 24) levels of rhythmically bedded, grey-coloured, bioturbated and sometimes laminated limestones with intercalated green to black pelitic horizons.

Therefore, we think that not only moderate preservation controls the abundances of the radiolarians but that certain palaeoecological effects highly influence the faunal assemblages. High abundances of the taxa *Pantanellium squinaboli squinaboli* are observed in Zones E2 and F1. The Pantanelliids were suggested as an indicator of upwelling conditions by Baumgartner (1987).

The rate of faunal change (see range chart, FADs x LADs per million years) was tentatively correlated to the composite carbonate isotope stratigraphy (Weissert & Lini, 1991) of the Southern Alps. The high rate of the U.A. Zone E2 coincides with the excursion of the ^{13}C excursion (Fig. 24).

It is to be proved in a future study if the high abundances of taxa in the U.A. Zones E2 and F1 in the Umbria-Marche (Fiume Bosso section) can be correlated to the ^{13}C excursion.



Figurre 22. Correlation of the U.A. Zones with other zonal schemes.

10. Conclusions

The radiolarians have proven to be very good biostratigraphic markers for the stratigraphic interval studied. Using the Unitary Associations and the radiolarian zones established the sections studied have been successfully correlated although they belonged to several paleogeographic areas with either basinal or seamount facies. Certainly, detailed systematic and biostratigraphic studies are still necessary to improve the systematics of this group and the biozonation established at present, and to make known the large number of still undescribed taxa.

The diachrony sometimes remarked in the correlation of radiolarian zones is probably caused by lithostratigraphic disturbances, insufficient definition and frequency of species, imperfect calibration with magnetic chrons and imperfect definition of these chrons.

A distinct change in the radiolarian assemblages is observed in the radiolarian Zones upper C2 to lower D2 between the middle Tithonian and the Tithonian-Berriasian boundary (U.A. 3-6). This change from the occurrence of common Jurassic taxa to forms of the Cretaceous type coincides with the appearance of calpionellids and with the lithological change in the sedimentation from pinch and swell bedded chert (Umbria-Marche) and interbedded cherty limestones (Southern Alps) to siliceous limestones as represented by the Maiolica Formation. Major changes in palaeoclimate seemed to have caused these changes (Baumgartner, 1987).

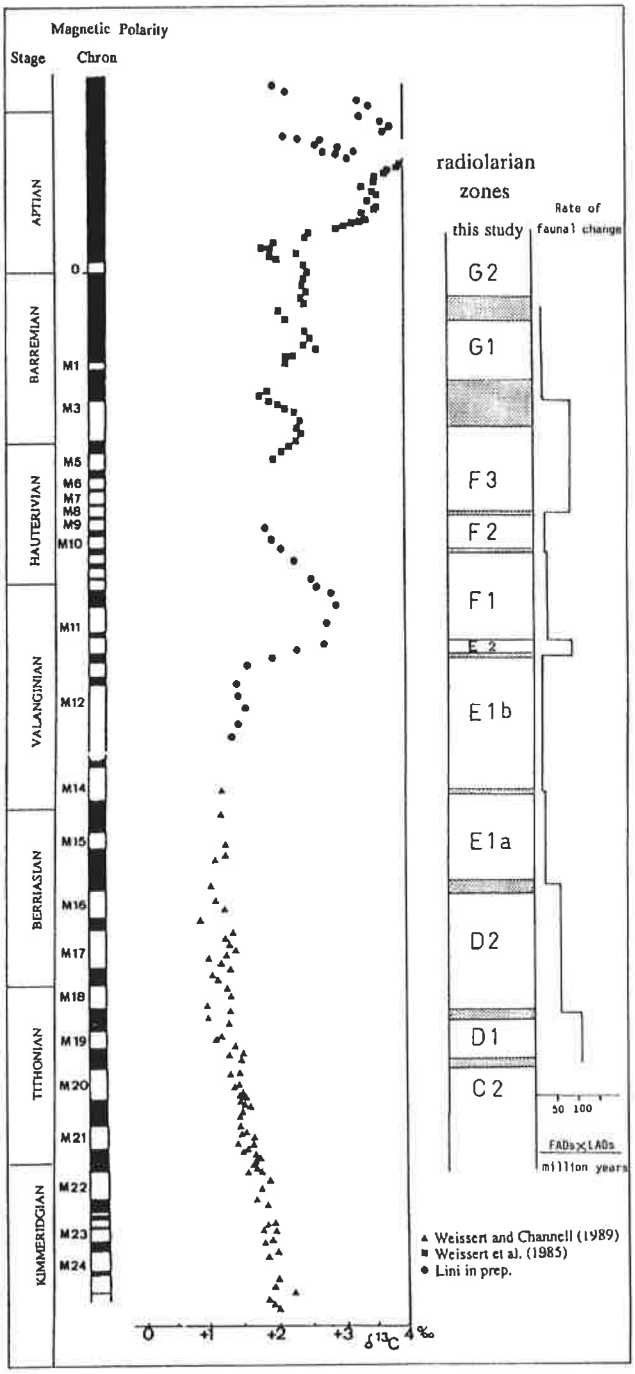


Figure 23. Correlation of radiolarians zones and rate of faunal change to carbon isotope stratigraphy and magnetostratigraphy of the Southern Alps (modified after Weissert & Lini, 1991).

References

Aita, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombard. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

Aita, Y. & Okada, H. (1986). Radiolarians and calcareous nannofossils from the uppermost Jurassic and lower Cretaceous strata of Japan and Tethyan regions. *Micropaleontology*, **32** (2), 97-128.

Aliev, K.S. (1965). *Radiolarians of the Lower Cretaceous deposits of northeastern Azerbaidzhan and their stratigraphic significance* - Izdatel'stvo Akademii Nauk, Azerbaidzhanskoi SSR, Baku. 124 p.

Aliev, K.S. & Smirnova, R.F. (1969). New radiolarian species from the deposits of the Albian stage in the central areas of the Russian platform. *In* Vialov, O.S. Ed. *Fossil and Recent Radiolarians: Materials of the Second All Union Seminar on Radiolarians* - Lvov University, Lvov, USSR, 62-72. *(in Russian)*

Alleman, F., Catalano, R., Farès, F. & Remane, J. (1971). Standard calpionellid zonation (Upper Tithonian-Valanginian) of the western Mediterranean Province. *Proceedings of the II Planktonic Conference, Roma*, **2**, 1337-1340.

Alvarez, W. (1989a). Evolution of the Monte Nerone Seamount in the Umbria-Marche Apennines: 1. Jurassic-Tertiary stratigraphy. *Bolletino della Societa Geologica Italiana*, **108**, 3-21.

ALVAREZ, W. (1989b). Evolution of the Monte Nerone Seamount in the Umbria-Marche Apennines: 2. Tectonic control of the seamount-basin transition. *Bolletino della Societa Geologica Italiana*, **108**, 23-39.

BAUD, A. (1972). Observations et hypothèses sur la géologie de la partie radicale des Préalpes médianes. *Eclogae Geologicae Helvetiae*, **65** (1), 43-55.

BAUMGARTNER, P., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BAUMGARTNER, P.O. (1990). Genesis of Jurassic Tethyan radiolarites - The example of Monte Nerone (Umbria-Marche Apennines). *In* Pallini, G. *et al.* Eds. *Atti del II Convegno Internazionale Fossili Evoluzione Ambiente, Pergola 1987*, 19-32.

BERNOULLI, D., KÄLIN, O. & PATACCA, E. (1979). A sunken continental margin of the Mesozoic Tethys: The Northern and Central Apennines. *Symposium sur la Sédimentation jurassique W-européen* - Publication Spéciale de la Association Sédimentologique française. **1**, 197-210.

BERNOULLI, D., WEISSERT, H. & BLOME, C.D. (1990). Evolution of the Triassic Hawasina Basin, Central Oman Mountains. *In* Robertson, A.H.F., Searle, M.P. & Ries, A.C. Eds. *The geology and tectonics of the Oman Region* - Special Publications of the Geological Society of London, **49**, 189-202.

BIERI, P. (1925). *Der Bau der Klippendecke zwischen Gantrisch und Simmental.* Jahrbuch der philosophisch (n° 5). Fakultät II. Universität Bern.

BOLLER, K. (1963). Stratigraphische und mikropaläontologische Untersuchungen im Neocom der Klippendecke (östlich der Rhone). *Eclogae Geologicae Helvetiae*, **56** (1), 19-96.

BRALOWER, T.J. (1987). Valanginian to Aptian Calcareous Nannofossil stratigraphy and correlation with the upper M-Sequence magnetic anomalies. *Marine Micropaleontology*, **11**, 293-310.

BRALOWER, T.J., MONECHI, S. & THIERSTEIN, H.R. (1989). Calcareous Nannofossil Zonation of the Jurassic-Cretaceous Boundary Interval and Correlation with the Geomagnetic Polarity Timescale. *Marine Micropaleontology*, **14**, 153-235.

CECCA, F., PALLINI, G., ERBA, E., PREMOLI-SILVA, I. & COCCIONI, R. (1994). Hauterivian-Barremian chronostratigraphy based on ammonites, nannofosils, planktonic foraminifera, and magnetic chrons from Mediterranean Domain. *Cretaceous Research*, **15** (4), 457-468.

CHANNELL, J.E.T., BRALOWER, T.J. & GRANDESSO, P. (1987). Biostratigraphic correlation of Mesozoic polarity chrons CM1 to CM23 at Capriolo and Xausa (Southern Alps, Italy). *Earth and Planetary Science Letters*, **85**, 203-221.

CHANNELL, J.E.T., D'ARGENIO, B. & HORVÁTH, F. (1979). Adria, the African Promontory, in Mesozoic Mediterranean Palaeogeography. *Earth Science Reviews*, **15**, 213-292.

CHANNELL, J.E.T. & ERBA, E. (1992). Early Cretaceous polarity chrons CM0 to CM11 recorded in northern Italian land sections near Brescia. *Earth and Planetary Science Letters*, **108**, 161-179.

CHANNELL, J.E.T. & GRANDESSO, P. (1987). A revised correlation of Mesozoic polarity chrons and calpionellid zones. *Earth and Planetary Science Letters*, **85**, 222-240.

CHANNELL, J.E.T., LOWRIE, W., PIALLI, P. & VENTURI, F. (1984). Jurassic magnetic stratigraphy from Umbrian (Italian) land sections. *Earth and Planetary Science Letters*, **68**, 309-325.

Colloque sur la limite Jurassique-Crétacé, Lyon, Neuchâtel, septembre1973, (1975) - *Mémoires du Bureau de Recherches Géologiques et Minières*, **86**, 393 p.

DE KÄNEL, E., PERCH-NIELSEN VON SALIS, K. & LINDINGER, M. (1989). The Cretaceous/Tertiary boundary in the Gurnigel-Flysch (Switzerland). *Eclogae Geologicae Helvetiae*, **82** (2), 555-581.

DERCOURT, J., ZONENSHAIN, L.P., RICOU, L.E., KAZMIN, V.G., LE PICHON, X., KNIPPER, A.M., GRANDJACQUET, C., SBORSHCHIKOV, I.M., BOULIN, J., SOROKHTIN, O., GEYSSANT, J., LEPVRIER, C., BIJU DUVAL, B., SIBUET, J.C., SAVOSTIN, L.A., WESTPHAL, M. & LAUER, J.P. (1985). Présentation de 9 cartes paléogéographiques au 1.20.000.000e s'étendant de l'Atlantique au Pamir pour la Période du Lias à l'Actuel. *Bulletin de la Société Géologique de France, Série VIII*, **1** (5), 637-652.

FISCHLI, H. (1916). Beitrag zur Kenntnis der fossilen Radiolarien in der Riginagelfluh. *Mitteilungen der Naturwissenschaftlichen Gesellschaft in Winterthur, Jahrgang 1915-1916*, **11**, 44-47.

FOREMAN, H.P. (1973). Radiolaria from DSDP Leg 20. *In* Heezen, B.C., MacGregor, J.D. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **20**, 249-305.

FOREMAN, H.P. (1975). Radiolaria from the North Pacific, Deep Sea Drilling Project, Leg 32. *In* Larson, R.L., Moberly, R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **32**, 579-676.

FOREMAN, H.P. (1977). Mesozoic Radiolaria from the Atlantic Basin and its borderlands. *In* Swain, F.M. Ed. *Stratigraphic Micropaleontology of Atlantic Basin and Borderlands* - Elsevier, Amsterdam, The Netherlands, 305-320.

GUEX, J. & DAVAUD, E. (1984). Unitary Associations Method: use of graph theory and computer algorithnm. *Computers & Geosciences*, **10** (1), 69-96.

HAQ, B.U., HARDENBOL, J. & VAIL, P.R. (1988). Mesozoic and Cenozoic Chronostratigraphy and Eustatic Cycles. *In* Wilgus, C.K. *et al.* Eds. *Sea level changes. An integrated approach* - Special Publication of the Society of Economic Paleontologists and Mineralogists, **42**, 71-108.

HARLAND, H.B., ARMSTRONG, R.L., COX, A.V., CRAIG, L.E., SMITH, A.G. & SMITH, D.G. (1989). *A geologic time scale* - Cambridge University Press, Cambridge/New York/Port Chester/Melbourne/Sydney, 263 p.

HINDE, G.J.O.A. (1900). Fossil Radiolaria. *Geological Magazine*, **7**, 29-33.

JUD, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

KÄLIN, O. & TRÜMPY, M. (1977). Sedimentation und Paläotektonik in den westlichen Südalpen: Zur triasicsh-jurassischen Geschichte des Monte Nudo-Beckens. *Eclogae Geologicae Helvetiae*, **70** (2), 295-350.

KENT, D.V. & GRADSTEIN, F.M. (1985). A Cretaceous and Jurassic geochronology. *Geological Society of America, Bulletin*, **96**, 1419-1427.

KICKMAIER, W. & PETERS, T.J. (1990). Manganese occurrences in the Al Hammah Range - Wahrah Formation, Oman Mountains. *In* Robertson, A.H.F., Searle, M.P. & Ries, A.C. Eds. *The geology and tectonics of the Oman Region* - Special Publications of the Geological Society of London, **49**, 239-249.

KOCHER, R.N. (1981). Biochronostratigraphische Untersuchungen oberjurassischer radiolarien führender Gesteine, insbesondere der Sudalpen. *Mitteilungen aus dem Geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge*, **234**, 1-184.

LE HÉGARAT, G. (1973). Le Berriasien de Sud-Est de la France. *Document des Laboratoires de Géologie de la Faculté des Sciences de Lyon*, **43**, 1-575.

LE HÉGARAT, G. & REMANE, J. (1968). Tithonique supérieur et Berriasien de la bordure cévenole. Correlations des ammonites et des calpionelles. *Geobios*, **1**, 7-70.

LINI, A., WEISSERT, H. & ERBA, E. (1992). The Valanginian carbon isotope event: a first episode of greenhouse climate conditions during the Cretaceous. *Terra Nova*, **4**, 374-384.

LOWRIE, W. & ALVAREZ, W. (1984). Lower Cretaceous magnetic stratigraphy in Umbrian pelagic limestone sections. *Earth and Planetary Science Letters*, **71**, 315-328.

LOWRIE, W. & CHANNELL, J.E.T. (1984). Magnetostratigraphy of the Jurassic-Cretaceous boundary in the Maiolica limestone (Umbria, Italy). *Geology*, **12**, 44-47.

LUGEON, M. & GAGNEBIN, E. (1941). Observations et vues nouvelles sur la géologie des Préalpes romandes. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **7** (1), 84-89.

MATSUOKA, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MONECHI, S. (1981). Aptian-Cenomanian calcareous nannoplankton from some sections in the Umbrian Apennine. *Rivista Italiana di Paleontologia*, **87** (2), 193-226.

MOORE, T.C. (1973). Radiolaria from Leg 17 of the Deep Sea Drilling Project. *In* Winterer, E.L., Ewing, J.I. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **17**, 797-869.

NAKASEKO, K. & NISHIMURA, A. (1981). Upper Jurassic and Cretaceous Radiolaria from the Shimanto Group in Southwest Japan. *Science Reports, College of General Education, Osaka University*, **30** (2), 133-203.

OGG, J.G., HASENYAGER, R.W., WIMBLEDON, W.A., CHANNELL, J.E.T. & BRALOWER, T.J. (1991). Magnetostratigraphy of the Jurassic-Cretaceous boundary interval-Tethyan and English faunal realms. *Cretaceous Research*, **12**, 455-482.

OGG, J.G., STEINER, M.B., COMPANY, M. & TAVERA, J.M. (1988). Magnetostratigraphy across the Berriasian-Valanginian stage boundary (Early Cretaceous) at Cehegin (Murcia Province, southern Spain). *Earth and Planetary Science Letters*, **87**, 205-215.

PARONA, C.F. (1890). Sugli schisti silicei a radiolarie di Cesana presso il Monginevra. *Atti della Reale Accademie delle Scienze di Torino*, **27**, 305-319.

PESSAGNO, E.A. (1977a). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. (1977b). Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. *Contribution Cushman Foundation for Foraminiferal Research, Special Publication*, **15**, 1-87.

REMANE, J. (1985). Calpionellids. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne/Sidney, 555-572.

REMANE, J. (1991). The Jurassic-Cretaceous boundary: problems of definition and procedure. *Cretaceous Research*, **12**, 447-453.

RENZ, G.W. (1974). Radiolaria from Leg 27 of the Deep Sea Drilling Project. *In* Veevers, J.J., Heirtzler, J.R. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **27**, 769-841.

RENZ, O. & HABICHT, K. (1985). A correlation of the Maiolica Formation of the Breggia section (southern Switzerland) with Early Cretaceous coccolith oozes of Site 534A, DSDP Leg 76 in the western Atlantic. *Eclogae geologicae Helvetiae*, **78** (2), 383-431.

RIEBER, H. (1977). Eine Ammonitenfauna aus der oberen Maiolica der Breggia-Schlucht (Tessin/Schweiz). *Eclogae Geologicae Helvetiae*, **70** (3), 777-787.

RIEDEL, W.R. & SANFILIPPO, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

RÜST, D. (1885). Beitrage zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura. *Palaeontographica*, **31**, 269-321.

RÜST, D. (1888). Beitrage zur Kenntniss der fossilen Radiolarien aus Gesteinen der Kreide. *Palaeontographica*, **34**, 181-213.

RÜST, D. (1898). Neue Beitrage zur Kenntniss der Fossilen Radiolarien aus Gesteinen des Jura und der Kreide. *Palaeontographica*, **45**, 1-67.

SANFILIPPO, A. & RIEDEL, W.R. (1985). Cretaceous Radiolaria. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne/Sidney, 573-630.

SAVARY, J. & GUEX, J. (1990). BioGraph, version 2.02. *Institute of Geology and Paleontology, University of Lausanne.*

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SCHAAF, A. (1981). Late Early Cretaceous Radiolaria from Deep Sea Drilling Project Leg 62. *In* Thiede, J., Vallier, T.L. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **62**, 419-470.

SCHAAF, A. (1984). Les radiolaires du Crétacé inférieur et moyen: biologie et systématique. *Science géologiques (Strasbourg), Mémoire*, **75**, 1-189.

SCHAAF, A. (1985). Un nouveau canevas biochronologique du Crétacé inférieur et moyen: les biozones à radiolaires. *Sciences géologique (Strasbourg), Bulletin*, **38** (3), 227-269.

SCHARDT, H. (1898). Les régions exotiques du versant N des Alpes suisses. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **34**, 114-219.

SPICHER, J.P. (1965). Géologie des Préalpes Médianes dans le massif des Bruns. *Eclogae Geologicae Helvetiae*, **58** (2), 592-742.

SQUINABOL, S. (1914). Contributo alla conoscenza dei Radiolarii fossili del Veneto. Appendice - Di un genera di Radiolari caratteristico del Secondario. *Memorie dell'Istituto Geologico della Reale Universita di Padova*, **2**, 249-306.

THIEULOY, J.-P. (1977). La zone à *callidiscus* du Valanginien supérieur vocontien (Sud-Est de la France). Lithostratigraphie, ammonitofaune, limite Valanginien-Hauterivien, correlations. *Géologie Alpine*, **53**, 83-143.

THUROW, J. (1988). Cretaceous radiolarians of the North Atlantic Ocean: ODP Leg 103 (Sites 638, 640 and 641) and DSDP Legs 93 (Site 603) and 47B (Site 398). *In* Boillot, G., Winterer, E.L. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program), **103**, 379-418.

TUMANDA, F. (1989). Cretaceous radiolarian biostratigraphy in the Eashi Mountain area, Northern Hokkaido, Japan. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences*, **10**, 1-44.

VINASSA DE REGNY, P.E. (1898a). Nuove famiglie e nuove generi di radiolari (New families and newgenera of Radiolaria). *Rivista Italiana di Paleontologia*, **4** (2), 1-4.

VINASSA DE REGNY, P.E. (1898b). I radiolari delle ftaniti titoniane di Carpena presso Spezia (Radiolaria from the Tithonian phtanites of Carpena near Spezia). *Atti della Reale Accademia dei Lincei, Serie 5, Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali*, **7**, 34-39.

VINASSA DE REGNY, P.E. (1899). I radiolari delle ftaniti titoniane di Carpena (Spezia). *Paleontographia Italica*, **4**, 217-238.

WATTS, K.F. (1990). Mesozoic carbonate slope facies marking the Arabian platform margin in Oman: depositional history, morphology and paleogeography. *In* Robertson, A.H.F., Searle, M.P. & Ries, A.C. Eds. *The geology and tectonics of the Oman Region* - Special Publications of the Geological Society of London, **49**, 139-159.

WEISSERT, H. (1979). Die Paläozeanographie der südwestlichen Tethys in der Unterkreide. *Mitteilungen aus dem geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge*, **226**, 174 p.

WEISSERT, H. & CHANNELL, J.E.T. (1989). Tethyan carbonate carbon isotope stratigraphy across the Jurassic-Cretaceous boundary: an indicator of decelarated global carbon cycling?. *Paleoceanography*, **4** (4), 483-494.

WEISSERT, H. & LINI, A. (1991). Ice Age Interludes During the Time of Cretaceous Greenhouse Climate? *In* Müeller, D.W., McKenzie, J.A. & Weissert, H. Eds. *Controversies in Modern Geology: Evolution of Geological Theories in Sedimentology, Earth History and Tectonics* - Academic Press, London/San Diego/New York/Boston/Sydney/Tokyo/Toronto, 173-191.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991). Listing by datum. The systematics of taxa are discussed in detail in Jud (1994).

SECTION 1
Fiume Bosso

bottom 1-top 63

3022: 1 - 23
3062: 1 - 46
3063: 17 - 63
3064: 1 - 1
3065: 1 - 62
3066: 1 - 17
3090: 1 - 63
3092: 1 - 63
3094: 1 - 62
3095: 1 - 4
3096: 1 - 7
3097: 1 - 63
3113: 1 - 60
3121: 1 - 7
3122: 1 - 4
3162: 1 - 62
3165: 5 - 23
3171: 1 - 23
3185: 7 - 61
3202: 8 - 55
3203: 1 - 19
3225: 1 - 10
3227: 4 - 30
3228: 5 - 63
3230: 1 - 4
3241: 1 - 3
3255: 6 - 60
3263: 1 - 61
3264: 17 - 18
3266: 15 - 29
3280: 5 - 17
3281: 8 - 44
3282: 8 - 40
3283: 12 - 20
3284: 8 - 23
3285: 8 - 62
3286: 1 - 43
3287: 5 - 62
3288: 22 - 47
3291: 5 - 47
3293: 5 - 56
3295: 17 - 63
3591: 7 - 12
3717: 17 - 17
3911: 7 - 12
3912: 9 - 17
3918: 9 - 12
3919: 7 - 26
3924: 6 - 12
3947: 10 - 57
3955: 7 - 20
4037: 38 - 52
4073: 1 - 63
5003: 6 - 52
5011: 36 - 48
5012: 42 - 62
5032: 23 - 63
5033: 40 - 63
5041: 51 - 60
5042: 7 - 63
5044: 44 - 53
5046: 17 - 63
5049: 37 - 62
5055: 8 - 52
5065: 7 - 57
5069: 45 - 63
5073: 16 - 63
5090: 45 - 59
5132: 7 - 23
5143: 45 - 46
5163: 23 - 47

5166: 20 - 63
5183: 7 - 59
5186: 23 - 57
5193: 26 - 58
5194: 22 - 57
5196: 24 - 59
5199: 17 - 51
5204: 23 - 63
5209: 7 - 17
5229: 22 - 59
5243: 17 - 59
5253: 16 - 60
5261: 22 - 62
5262: 31 - 61
5266: 51 - 59
5267: 39 - 62
5274: 42 - 60
5287: 20 - 63
5290: 17 - 24
5296: 33 - 63
5314: 25 - 54
5332: 42 - 54
5334: 41 - 60
5357: 51 - 51
5359: 40 - 60
5362: 45 - 60
5369: 23 - 52
5371: 17 - 54
5396: 9 - 9
5397: 42 - 47
5408: 17 - 17
5409: 8 - 23
5410: 6 - 17
5416: 8 - 28
5422: 24 - 62
5426: 9 - 51
5427: 46 - 54
5433: 8 - 13
5436: 7 - 24
5453: 17 - 46
5462: 12 - 61
5464: 12 - 18
5481: 8 - 51
5506: 7 - 17
5510: 8 - 19
5511: 37 - 61
5521: 42 - 61
5522: 45 - 46
5524: 43 - 61
5526: 42 - 54
5532: 23 - 60
5544: 8 - 59
5550: 57 - 63
5553: 44 - 63
5565: 10 - 22
5568: 8 - 19
5572: 16 - 42
5575: 19 - 63
5576: 46 - 46
5577: 8 - 20
5578: 10 - 43
5580: 12 - 47
5582: 46 - 63
5595: 16 - 62
5607: 5 - 62
5620: 23 - 62
5625: 42 - 61
5628: 23 - 37
5636: 17 - 63
5641: 46 - 61
5647: 61 - 61
5668: 17 - 60
5672: 20 - 61
5673: 23 - 54
5674: 23 - 63
5693: 46 - 61
5703: 23 - 26
5711: 42 - 61
5712: 24 - 61
5716: 12 - 57
5721: 7 - 46
5725: 42 - 47
5744: 45 - 62
5761: 46 - 51
5766: 27 - 46
5771: 28 - 59
5773: 24 - 63
5785: 12 - 19
5796: 8 - 12
5824: 7 - 17
5901: 46 - 59
5902: 22 - 60
5903: 42 - 60
5904: 45 - 47
5913: 36 - 54
5927: 42 - 63
5973: 60 - 63
6101: 5 - 22
6121: 8 - 60
6123: 24 - 59

SECTION 2
Pieia

bottom 1-top 42

3022: 1 - 30
3062: 1 - 40
3063: 19 - 40
3065: 1 - 42
3066: 1 - 42
3090: 3 - 42
3092: 3 - 42
3094: 1 - 35
3097: 1 - 35
3113: 1 - 41
3162: 1 - 37
3165: 1 - 42
3171: 1 - 41
3185: 1 - 42
3202: 1 - 42
3203: 1 - 42
3227: 2 - 42
3228: 2 - 35
3230: 1 - 9
3255: 1 - 42
3263: 3 - 42
3264: 3 - 35
3266: 1 - 42
3280: 6 - 25
3281: 16 - 40
3282: 1 - 42
3283: 3 - 38
3284: 4 - 41
3285: 1 - 42
3286: 1 - 42
3287: 1 - 42
3288: 22 - 35
3291: 9 - 42
3293: 3 - 41
3295: 20 - 40
3591: 1 - 25
3717: 13 - 35
3912: 11 - 24
3918: 1 - 1
3924: 1 - 6
3947: 22 - 39
3955: 1 - 35
4073: 13 - 42
5003: 21 - 21
5041: 14 - 22
5042: 6 - 42
5044: 6 - 40
5055: 16 - 35
5065: 14 - 24
5073: 25 - 42
5132: 1 - 42
5163: 36 - 36
5166: 25 - 29
5183: 9 - 42
5186: 22 - 40
5193: 27 - 36
5194: 16 - 21
5199: 14 - 40
5209: 1 - 41
5243: 14 - 41
5253: 22 - 40
5290: 32 - 42
5314: 19 - 19
5369: 24 - 32
5396: 3 - 35
5408: 5 - 40
5409: 1 - 40
5410: 6 - 27
5416: 5 - 35
5417: 6 - 20
5426: 1 - 32
5433: 1 - 23
5436: 1 - 35
5453: 30 - 40
5462: 15 - 32
5464: 30 - 42
5481: 3 - 42
5506: 1 - 24
5510: 1 - 30
5544: 1 - 42
5565: 13 - 42
5568: 1 - 42
5575: 25 - 25
5577: 10 - 14
5578: 13 - 42
5580: 10 - 40
5595: 22 - 39
5607: 1 - 42
5672: 24 - 41
5674: 1 - 40
5703: 30 - 42
5716: 13 - 39
5721: 22 - 41
5785: 10 - 42
5796: 1 - 25
5824: 14 - 16
5913: 30 - 40
6101: 1 - 35
6121: 2 - 4

SECTION 3
Gorgo a Cerbara

bottom 1-top 25

3062: 1 - 9
3063: 1 - 18
3065: 1 - 25
3090: 1 - 25
3092: 1 - 25
3094: 1 - 25
3097: 2 - 23
3113: 1 - 21
3162: 1 - 25
3185: 1 - 21
3202: 1 - 3
3227: 1 - 18
3228: 1 - 20
3255: 1 - 2
3263: 2 - 15
3266: 15 - 15
3281: 1 - 7
3285: 1 - 22
3286: 1 - 9
3291: 1 - 14
3293: 1 - 8
3295: 1 - 25
3947: 1 - 25
4037: 1 - 16
4073: 1 - 24
5011: 1 - 9
5012: 8 - 21
5032: 2 - 9
5033: 7 - 7

5042: 2 - 18
5044: 1 - 19
5046: 2 - 25
5049: 1 - 23
5055: 7 - 7
5069: 2 - 25
5073: 1 - 23
5090: 2 - 20
5143: 1 - 18
5163: 1 - 9
5166: 1 - 18
5183: 1 - 25
5186: 1 - 20
5193: 4 - 18
5194: 4 - 13
5196: 4 - 4
5199: 2 - 18
5204: 1 - 25
5229: 1 - 18
5243: 1 - 21
5253: 1 - 9
5261: 1 - 21
5262: 1 - 20
5266: 7 - 20
5267: 4 - 20
5274: 2 - 25
5287: 1 - 25
5290: 2 - 18
5296: 1 - 23
5314: 1 - 16
5334: 1 - 21
5357: 9 - 9
5359: 2 - 18
5362: 7 - 9
5369: 2 - 20
5397: 2 - 9
5422: 2 - 21
5426: 1 - 8
5427: 7 - 9
5453: 7 - 7
5462: 1 - 21
5469: 8 - 19
5481: 2 - 15
5511: 2 - 18
5521: 2 - 9
5522: 2 - 8
5524: 17 - 20
5526: 7 - 17
5532: 1 - 20
5544: 1 - 22
5550: 15 - 25
5553: 2 - 21
5572: 8 - 18
5575: 1 - 20
5576: 8 - 18
5578: 1 - 5
5580: 1 - 7
5582: 7 - 25
5595: 1 - 21
5607: 2 - 21
5620: 1 - 21
5625: 7 - 23
5628: 1 - 1
5636: 7 - 25
5641: 18 -25
5668: 2 - 18
5672: 1 - 25
5673: 1 - 9
5674: 1 - 21
5693: 7 - 23
5711: 1 - 20
5712: 1 - 18
5721: 1 - 9
5725: 2 - 7
5744: 2 - 19
5766: 2 - 8
5771: 4 - 19
5773: 5 - 19
5901: 1 - 13
5902: 1 - 18
5903: 1 - 23
5904: 2 - 8
5913: 1 - 17
5927: 1 - 18
5973: 19 - 23
6121: 1 - 25
6123: 5 - 19

SECTION 4
Presale

bottom 1-top 10

3022: 8 - 8
3062: 1 - 5
3063: 1 - 10
3065: 1 - 10
3090: 4 - 10
3092: 4 - 10
3094: 4 - 10
3097: 5 - 10
3113: 1 - 9
3162: 4 - 10
3185: 1 - 10
3202: 1 - 2
3203: 1 - 1
3227: 1 - 5
3228: 4 - 10
3255: 1 - 10
3263: 1 - 9
3266: 1 - 2
3281: 6 - 6
3282: 2 - 2
3283: 1 - 1
3284: 1 - 1
3285: 1 - 10
3286: 1 - 5
3287: 1 - 10
3288: 4 - 5
3291: 4 - 5
3293: 6 - 10
3295: 1 - 10
3947: 5 - 10
4037: 9 - 9
4073: 1 - 10
5011: 4 - 5
5012: 6 - 10
5032: 5 - 8
5033: 5 - 10
5041: 9 - 9
5042: 5 - 9
5044: 5 - 10
5046: 6 - 10
5049: 9 - 10
5055: 5 - 8
5065: 8 - 8
5068: 6 - 6
5069: 6 - 10
5073: 4 - 10
5090: 5 - 10
5143: 7 - 8
5163: 5 - 10
5166: 5 - 10
5183: 4 - 10
5186: 5 - 8
5193: 2 - 10
5194: 2 - 10
5199: 4 - 8
5204: 2 - 10
5229: 4 - 9
5243: 5 - 6
5253: 7 - 7
5261: 4 - 10
5262: 4 - 10
5266: 5 - 9
5267: 5 - 8
5274: 4 - 10
5287: 5 - 10
5296: 4 - 10
5314: 5 - 8
5332: 9 - 9
5334: 9 - 10
5357: 8 - 8
5359: 6 - 10
5362: 5 - 5
5369: 5 - 9
5397: 5 - 5
5409: 1 - 1
5416: 5 - 5
5422: 5 - 10
5426: 1 - 9
5427: 5 - 6
5462: 2 - 10
5469: 4 - 10
5481: 2 - 10
5511: 5 - 10
5521: 8 - 10
5522: 5 - 9
5524: 8 - 9
5526: 4 - 6
5532: 4 - 10
5544: 1 - 10
5550: 7 - 10
5553: 4 - 10
5575: 4 - 8
5578: 1 - 1
5580: 4 - 5
5582: 10 - 10
5595: 6 - 10
5607: 1 - 10
5620: 4 - 10
5625: 9 - 9
5636: 1 - 10
5641: 6 - 10
5642: 9 - 9
5668: 4 - 10
5672: 6 - 10
5673: 4 - 10
5674: 1 - 10
5711: 5 - 10
5712: 5 - 10
5721: 5 - 9
5744: 8 - 10
5761: 9 - 9
5771: 9 - 10
5773: 3 - 8
5785: 1 - 1
5901: 1 - 10
5902: 5 - 10
5903: 6 - 10
5904: 9 - 9
5913: 5 - 8
5927: 5 - 10
6121: 4 - 10
6123: 1 - 9

SECTION 5
Ranchi Superiore

bottom 1-top 7

3062: 2 - 7
3063: 2 - 7
3065: 2 - 7
3066: 1 - 1
3090: 3 - 7
3092: 3 - 7
3094: 4 - 7
3097: 6 - 7
3113: 2 - 7
3162: 3 - 7
3185: 2 - 6
3202: 2 - 7
3203: 2 - 2
3227: 2 - 4
3228: 4 - 7
3255: 2 - 7
3263: 2 - 7
3266: 1 - 4
3281: 3 - 4

3282: 1 - 5
3283: 1 - 2
3284: 2 - 4
3285: 1 - 7
3286: 1 - 5
3287: 2 - 7
3288: 7 - 7
3291: 1 - 7
3293: 2 - 7
3295: 2 - 7
3947: 3 - 7
3955: 1 - 1
4037: 7 - 7
4073: 2 - 7
5003: 3 - 4
5011: 4 - 7
5012: 7 - 7
5032: 4 - 7
5033: 4 - 6
5041: 5 - 5
5044: 7 - 7
5046: 6 - 6
5055: 4 - 4
5069: 7 - 7
5073: 4 - 7
5090: 7 - 7
5132: 1 - 1
5143: 7 - 7
5163: 5 - 7
5166: 6 - 7
5183: 2 - 7
5186: 3 - 7
5193: 6 - 7
5194: 3 - 7
5196: 7 - 7
5199: 4 - 7
5204: 2 - 7
5229: 4 - 7
5243: 4 - 7
5253: 4 - 4
5261: 3 - 7
5262: 5 - 7
5267: 7 - 7
5274: 7 - 7
5287: 5 - 7
5290: 4 - 5
5296: 4 - 7
5314: 7 - 7
5357: 7 - 7
5359: 2 - 7
5369: 6 - 6
5397: 7 - 7
5409: 2 - 2
5416: 4 - 4
5426: 2 - 7
5427: 7 - 7
5462: 2 - 6
5481: 2 - 7
5511: 6 - 7
5521: 4 - 7
5524: 6 - 7
5526: 7 - 7
5532: 7 - 7
5544: 4 - 7
5553: 7 - 7
5568: 1 - 1
5572: 2 - 2
5575: 4 - 7
5576: 2 - 7
5578: 2 - 4
5580: 2 - 7
5582: 6 - 7
5595: 4 - 7
5607: 2 - 7
5620: 6 - 7
5636: 4 - 7
5668: 6 - 7
5672: 2 - 4
5673: 7 - 7
5674: 4 - 7
5711: 7 - 7
5712: 3 - 7
5716: 4 - 4
5721: 7 - 7
5744: 7 - 7
5766: 7 - 7
5771: 6 - 7
5773: 7 - 7
5785: 1 - 2
5902: 5 - 7
5903: 6 - 7
5913: 4 - 7
5927: 5 - 7
6121: 4 - 5
6123: 2 - 6

SECTION 6
Campo al Bello

bottom 1-top 3

3063: 1 - 1
3065: 1 - 3
3090: 1 - 3
3092: 1 - 3
3094: 1 - 3
3097: 1 - 1
3113: 2 - 2
3162: 1 - 3
3185: 3 - 3
3228: 1 - 3
3255: 1 - 3
3285: 1 - 3
3293: 3 - 3
3295: 1 - 2
3947: 1 - 2
4037: 3 - 3
4073: 1 - 2
5012: 1 - 3
5042: 1 - 3
5044: 1 - 1
5046: 1 - 1
5049: 3 - 3
5055: 1 - 1
5065: 2 - 2
5069: 1 - 3
5073: 1 - 3
5090: 1 - 3
5163: 3 - 3
5166: 1 - 2
5183: 1 - 1
5186: 1 - 3
5193: 1 - 3
5194: 3 - 3
5196: 2 - 2
5199: 1 - 3
5204: 1 - 3
5243: 1 - 2
5253: 1 - 1
5261: 1 - 3
5262: 1 - 3
5266: 1 - 3
5267: 3 - 3
5274: 1 - 3
5287: 1 - 3
5314: 3 - 3
5359: 3 - 3
5422: 1 - 3
5462: 2 - 2
5469: 3 - 3
5511: 1 - 3
5521: 3 - 3
5532: 3 - 3
5544: 1 - 1
5553: 1 - 3
5595: 1 - 3
5607: 1 - 3
5620: 1 - 3
5636: 2 - 2
5641: 3 - 3
5674: 1 - 3
5711: 1 - 1
5901: 1 - 3
5902: 1 - 2
5903: 1 - 2
5913: 1 - 3
5927: 1 - 3
6121: 3 - 3
6123: 1 - 1

SECTION 7
Valdorbia

bottom 1-top 11

3022: 5 - 11
3062: 5 - 11
3064: 1 - 2
3065: 3 - 11
3066: 7 - 11
3090: 3 - 11
3092: 5 - 11
3094: 9 - 11
3095: 2 - 2
3096: 1 - 2
3097: 2 - 11
3113: 1 - 11
3121: 1 - 3
3122: 1 - 2
3162: 7 - 8
3165: 3 - 11
3171: 2 - 11
3185: 7 - 11
3202: 8 - 10
3203: 3 - 11
3225: 4 - 6
3227: 4 - 8
3228: 5 - 11
3230: 1 - 2
3241: 1 - 2
3255: 6 - 11
3263: 1 - 11
3266: 7 - 8
3280: 5 - 9
3281: 5 - 11
3282: 6 - 11
3283: 10 - 11
3284: 8 - 11
3285: 6 - 11
3286: 2 - 11
3287: 6 - 11
3291: 6 - 9
3293: 6 - 10
3591: 6 - 11
3717: 6 - 6
3911: 8 - 9
3912: 3 - 8
3918: 5 - 8
3919: 8 - 10
3924: 4 - 11
3947: 6 - 11
3955: 6 - 6
4073: 6 - 11
5003: 5 - 10
5042: 5 - 11
5132: 3 - 11
5163: 6 - 6
5183: 5 - 11
5186: 11 -11
5209: 5 - 11
5243: 6 - 11
5396: 6 - 10
5409: 6 - 11
5416: 10 - 11
5426: 5 - 11
5433: 9 - 11
5436: 5 - 9
5462: 10 - 10
5481: 9 - 10
5506: 9 - 11

5510 11 - 11
5544: 6 - 10
5565: 11 -11
5568: 6 - 11
5577: 6 - 11
5578: 6 - 11
5580: 10 - 10
5607: 5 - 11
5674: 8 - 9
5721: 5 - 11
5785: 7 - 10
5796: 5 - 11
5824: 5 - 11
6101: 3 - 11
6121: 7 - 11

SECTION 8
Bottaccione

bottom 1-top 1

3062: 1 - 1
3063: 1 - 1
3065: 1 - 1
3090: 1 - 1
3092: 1 - 1
3094: 1 - 1
3097: 1 - 1
3113: 1 - 1
3162: 1 - 1
3228: 1 - 1
3255: 1 - 1
3263: 1 - 1
3285: 1 - 1
3291: 1 - 1
3295: 1 - 1
3947: 1 - 1
4073: 1 - 1
5012: 1 - 1
5032: 1 - 1
5033: 1 - 1
5042: 1 - 1
5046: 1 - 1
5055: 1 - 1
5069: 1 - 1
5073: 1 - 1
5090: 1 - 1
5143: 1 - 1
5163: 1 - 1
5166: 1 - 1
5183: 1 - 1
5186: 1 - 1
5193: 1 - 1
5196: 1 - 1
5204: 1 - 1
5229: 1 - 1
5243: 1 - 1
5261: 1 - 1
5262: 1 - 1
5267: 1 - 1
5274: 1 - 1
5287: 1 - 1
5359: 1 - 1
5397: 1 - 1
5426: 1 - 1
5427: 1 - 1
5469: 1 - 1
5511: 1 - 1
5522: 1 - 1
5532: 1 - 1
5544: 1 - 1
5553: 1 - 1
5575: 1 - 1
5580: 1 - 1
5582: 1 - 1
5595: 1 - 1
5607: 1 - 1
5620: 1 - 1
5672: 1 - 1
5673: 1 - 1
5674: 1 - 1
5712: 1 - 1
5766: 1 - 1
5902: 1 - 1
5903: 1 - 1
5904: 1 - 1
5913: 1 - 1
6121: 1 - 1

SECTION 9
Cava Rusconi

bottom 1-top 11

3022: 1 - 10
3062: 2 - 11
3063: 8 - 10
3065: 1 - 11
3066: 2 - 6
3090: 2 - 11
3092: 2 - 11
3094: 8 - 11
3097: 1 - 10
3113: 1 - 10
3162: 9 - 11
3165: 2 - 2
3171: 2 - 9
3185: 1 - 10
3202: 5 - 11
3203: 2 - 3
3225: 2 - 2
3227: 2 - 10
3228: 2 - 11
3230: 1 - 1
3255: 1 - 11
3263: 1 - 11
3266: 2 - 10
3280: 1 - 5
3281: 2 - 8
3282: 2 - 11
3283: 2 - 3
3284: 1 - 7
3285: 2 - 11
3286: 1 - 11
3287: 1 - 11
3288: 5 - 10
3291: 2 - 10
3293: 1 - 11
3295: 2 - 11
3591: 1 - 3
3717: 2 - 3
3912: 2 - 2
3924: 2 - 2
3947: 2 - 10
3955: 1 - 3
4037: 6 - 6
4073: 2 - 10
5003: 2 - 9
5011: 9 - 11
5012: 9 - 10
5032: 9 - 10
5033: 9 - 10
5041: 9 - 9
5042: 5 - 9
5044: 9 - 9
5046: 3 - 10
5049: 8 - 11
5055: 2 - 10
5065: 1 - 10
5068: 8 - 10
5069: 9 - 9
5073: 9 - 11
5132: 1 - 9
5143: 9 - 10
5163: 2 - 10
5166: 10 - 10
5183: 2 - 10
5186: 5 - 11
5193: 5 - 10
5194: 2 - 10
5196: 10 - 10
5199: 9 - 10
5204: 9 - 10
5209: 2 - 6
5229: 8 - 11
5243: 2 - 10
5253: 2 - 9
5261: 9 - 10
5262: 10 - 10
5266: 9 - 9
5296: 9 - 10
5314: 9 - 10
5332: 2 - 10
5334: 9 - 10
5359: 6 - 9
5369: 9 - 10
5371: 9 - 10
5397: 9 - 10
5408: 2 - 6
5409: 2 - 5
5410: 2 - 5
5416: 3 - 9
5417: 2 - 2
5422: 9 - 9
5426: 2 - 11
5436: 2 - 10
5453: 2 - 6
5462: 6 - 11
5464: 10 - 10
5481: 2 - 11
5506: 1 - 5
5510: 2 - 2
5511: 8 - 8
5524: 9 - 10
5532: 10 - 10
5544: 2 - 10
5565: 3 - 3
5568: 2 - 10
5575: 8 - 10
5578: 5 - 10
5580: 2 - 10
5607: 1 - 11
5620: 9 - 11
5628: 10 - 10
5636: 8 - 11
5672: 8 - 10
5673: 10 - 10
5674: 5 - 10
5693: 10 - 11
5711: 10 - 10
5712: 6 - 10
5716: 8 - 10
5721: 11 - 11
5725: 10 - 10
5761: 8 - 10
5766: 10 - 10
5771: 10 - 10
5773: 9 - 10
5785: 1 - 2
5796: 1 - 1
5824: 2 - 2
5901: 9 - 10
5913: 8 - 10
5927: 9 - 11
6101: 1 - 3
6121: 2 - 10
6123: 9 - 10

SECTION 10
Breggia Gorge

bottom 1-top 13

3022: 3 - 13
3062: 2 - 9
3063: 2 - 13
3065: 2 - 13
3066: 2 - 7
3090: 2 - 13
3092: 2 - 13

3094: 3 - 13
3097: 2 - 13
3113: 2 - 10
3162: 2 - 13
3165: 1 - 7
3171: 1 - 10
3185: 1 - 13
3202: 2 - 10
3203: 1 - 3
3225: 2 - 2
3227: 2 - 11
3228: 2 - 13
3255: 2 - 13
3263: 1 - 13
3264: 2 - 3
3266: 1 - 10
3280: 2 - 2
3281: 2 - 12
3282: 1 - 3
3283: 2 - 3
3284: 2 - 7
3285: 2 - 13
3286: 1 - 10
3287: 2 - 13
3288: 3 - 11
3291: 2 - 8
3293: 2 - 13
3295: 2 - 13
3591: 1 - 2
3717: 2 - 2
3911: 2 - 2
3912: 2 - 2
3918: 1 - 1
3919: 6 - 9
3924: 2 - 2
3947: 2 - 11
3955: 2 - 3
4073: 2 - 13
5003: 3 - 10
5011: 11 - 11
5012: 12 - 13
5032: 11 - 11
5033: 9 - 13
5041: 8 - 13
5042: 2 - 12
5044: 2 - 13
5046: 6 - 13
5049: 13 - 13
5055: 2 - 8
5065: 4 - 13
5068: 8 - 9
5069: 12 - 13
5073: 4 - 13
5132: 1 - 7
5143: 8 - 12
5163: 11 - 11
5166: 2 - 10
5183: 2 - 13
5186: 3 - 13
5193: 2 - 8
5194: 2 - 8
5204: 11 - 13
5209: 2 - 8
5229: 8 - 13
5243: 2 - 13
5253: 2 - 13
5261: 11 - 11
5266: 11 - 13
5274: 11 - 13
5287: 3 - 13
5290: 6 - 10
5314: 3 - 13
5332: 3 - 3
5334: 3 - 3
5359: 3 - 10
5362: 13 - 13
5369: 3 - 8
5371: 3 - 3
5408: 2 - 7
5409: 2 - 8
5410: 2 - 3
5416: 3 - 8
5417: 2 - 7
5422: 11 - 13
5426: 10 - 10
5436: 2 - 8
5453: 2 - 8
5462: 4 - 13
5464: 4 - 5
5481: 2 - 13
5506: 2 - 2
5510: 2 - 4
5511: 12 - 13
5521: 13 - 13
5524: 12 - 13
5532: 10 - 13
5544: 2 - 13
5553: 11 - 13
5565: 3 - 3
5568: 2 - 10
5572: 3 - 6
5575: 8 - 10
5578: 3 - 10
5580: 2 - 10
5595: 10 - 13
5607: 2 - 13
5620: 8 - 13
5625: 12 - 13
5636: 2 - 13
5641: 13 - 13
5642: 13 - 13
5668: 10 - 13
5672: 4 - 13
5673: 3 - 10
5674: 2 - 13
5693: 13 - 13
5703: 3 - 10
5711: 11 - 11
5712: 8 - 13
5716: 3 - 10
5721: 2 - 8
5744: 8 - 13
5761: 13 - 13
5773: 13 - 13
5785: 2 - 7
5824: 2 - 2
5901: 3 - 13
5902: 8 - 8
5913: 6 - 13
5927: 10 - 13
6101: 1 - 2
6121: 2 - 13
6123: 8 - 13

SECTION 11
Capriolo

bottom 1-top 27

3022: 1 - 21
3062: 4 - 25
3063: 3 - 25
3065: 1 - 27
3066: 4 - 13
3090: 1 - 26
3092: 1 - 27
3094: 1 - 26
3097: 1 - 23
3113: 1 - 21
3162: 3 - 23
3165: 8 - 16
3171: 1 - 17
3185: 1 - 25
3202: 3 - 24
3225: 4 - 6
3227: 1 - 25
3228: 1 - 27
3255: 1 - 26
3263: 1 - 15
3264: 2 - 2
3266: 3 - 15
3280: 1 - 2
3281: 3 - 23
3282: 2 - 12
3283: 4 - 4
3284: 1 - 17
3285: 1 - 27
3286: 3 - 24
3287: 2 - 23
3288: 3 - 25
3291: 1 - 25
3293: 1 - 25
3591: 6 - 6
3717: 3 - 3
3912: 3 - 15
3919: 7 - 17
3947: 4 - 20
3955: 1 - 3
4037: 23 - 25
4073: 10 - 23
5003: 2 - 25
5011: 20 - 25
5012: 25 - 27
5032: 18 - 25
5033: 16 - 25
5042: 1 - 25
5044: 9 - 25
5046: 6 - 24
5049: 21 - 25
5055: 1 - 25
5065: 2 - 27
5068: 16 - 25
5069: 17 - 17
5073: 7 - 26
5090: 25 - 25
5132: 1 - 19
5163: 23 - 23
5166: 13 - 23
5183: 2 - 27
5186: 2 - 24
5193: 15 - 15
5194: 1 - 13
5199: 5 - 21
5204: 19 - 26
5209: 1 - 15
5229: 16 - 27
5243: 3 - 18
5253: 12 - 24
5261: 21 - 25
5262: 23 - 23
5266: 20 - 21
5287: 15 - 27
5290: 3 - 15
5296: 21 - 21
5314: 16 - 27
5334: 15 - 25
5359: 5 - 23
5369: 15 - 23
5371: 3 - 16
5396: 3 - 3
5397: 23 - 24
5408: 3 - 15
5409: 1 - 16
5410: 1 - 13
5416: 12 - 12
5417: 4 - 7
5422: 23 - 25
5426: 15 - 24
5436: 1 - 14
5453: 1 - 13
5462: 1 - 4
5481: 3 - 25
5506: 2 - 2
5510: 14 - 14
5532: 20 - 25
5544: 4 - 23
5553: 20 - 27
5565: 3 - 3
5568: 3 - 15
5572: 6 - 12

5578: 4 - 10
5580: 3 - 25
5595: 24 - 24
5607: 1 - 27
5620: 8 - 25
5628: 23 - 23
5636: 4 - 25
5647: 8 - 8
5668 23 - 23
5672: 3 - 25
5674: 13 - 23
5712: 4 - 20
5716: 13 - 17
5721: 3 - 17
5766: 17 - 17
5771: 23 - 23
5773: 23 - 23
5785: 3 - 7
5824: 2 - 6
5901: 21 - 23
5902: 23 - 23
5903: 23 - 23
5904: 24 - 24
5913: 8 - 25
6121: 1 - 26
6123: 16 - 25

SECTION 12
Pfaffengrat

bottom 1-top 13

3062: 13 - 13
3065: 1 - 13
3066: 3 - 4
3090: 13 - 13
3092: 4 - 4
3094: 1 - 6
3113: 2 - 13
3162: 3 - 4
3171: 1 - 10
3185: 2 - 10
3202: 1 - 13
3203: 3 - 13
3227: 4 - 7
3228: 3 - 13
3255: 2 - 12
3263: 1 - 12
3266: 1 - 2
3280: 5 - 5
3281: 3 - 3
3282: 3 - 4
3283: 1 - 3
3284: 2 - 6
3285: 1 - 3
3286: 3 - 6
3287: 3 - 10
3291: 12 - 12
3591: 4 - 4
3947: 3 - 12
3293: 2 - 13
3295: 4 - 6
3955: 1 - 7
5042: 2 - 4
5132: 1 - 13
5183: 3 - 13
5186: 1 - 12
5193: 7 - 7
5194: 13 - 13
5243: 7 - 7
5253: 7 - 7
5314: 4 - 4
5396: 6 - 6
5416: 6 - 13
5426: 4 - 4
5436: 13 - 13
5453: 2 - 3
5464: 10 - 10
5481: 10 - 10
5565: 3 - 13
5568: 2 - 7
5595: 3 - 3
5607: 1 - 13
5674: 2 - 2
5785: 3 - 6
6101: 1 - 3
6121: 3 - 13

SECTION 13
Oman

bottom 1-top 19

3063: 7 - 19
3065: 1 - 19
3090: 7 - 19
066: 7 - 7
3092: 5 - 7
3094: 15 - 15
3113: 7 - 7
3171: 5 - 5
3185: 2 - 18
3202: 5 - 5
3228: 1 - 19
3255: 3 - 15
3263: 2 - 15
3264: 4 - 8
3266: 6 - 6
3281: 7 - 7
3284: 3 - 8
3285: 3 - 8
3286: 1 - 15
3287: 1 - 18
3291: 6 - 10
3293: 2 - 19
3295: 2 - 19
3591: 2 - 4
3911: 8 - 8
4073: 4 - 6
5041: 16 - 16
5042: 4 - 7
5049: 18 - 19
5046: 4 - 9
5073: 9 - 18
5132: 2 - 10
5183: 4 - 4
5261: 15 - 16
5287: 19 - 19
5296: 14 - 19
5453: 5 - 7
5462: 4 - 17
5464: 4 - 10
5481: 1 - 16
5521: 17 - 19
5553: 17 - 17
5580: 2 - 7
5595: 1 - 19
5607: 1 - 19
5625: 11 - 14
5636: 9 - 15
5641: 19 - 19
5647: 12 - 12
5673: 6 - 6
5674: 19 - 19
5693: 19 - 19
5712: 5 - 18
5761: 15 - 15
6101: 2 - 8
6121: 1 - 19

13. Radiolarian Biostratigraphy of the Cherts in the Sedimentary Cover of the Apenninic Ophiolites (Italy)

by Marta Marcucci[1] and Maurizio Conti[2]

[1] Dipartimento di Scienze della Terra, Università di Firenze, Via La Pira, 4, 50121 Firenze, Italy
[2] Ecosystems s.a.s., Via G.F. Mariti, 10, 50127 Firenze, Italy

ABSTRACT

This paper represents a synthesis of radiolarian faunas found in Jurassic cherts from the sedimetary cover of the Apenninic ophiolites in both the Northern and the Southern Apennines. A detailed repertory of the Jurassic formation of Monte Alpe Cherts is the lowest unit in the sedimentary cover of ophiolites and ophiolite breccias in the Northern Apennines. A section of this formation has been studied at Ponte di Lagoscuro, Val Graveglia (Liguria), and an exceptionally rich radiolarian assemblage of middle Callovian age has been isolated from chert nodules in its lower part. Several new species are described in this assemblage.

1. Introduction

The present paper is part of a research programme on Jurassic radiolarian biostratigraphy in the Apennines, regarding both the oceanic sequences (Ligurid sequences) and the sequence of the continental margin (Tuscan sequence). The aims of this research are to define of radiolarian taxonomy and evolution in addition to the dating of initial siliceous deposits above carbonate formations (Tuscan Sequence) and ophiolites (Ligurid Sequences); ten sections have been so far examined in the Ligurid Sequences (Bonechi, 1980; Conti et al., 1985; Picchi 1985; Abbate et al., 1986; Conti & Marcucci, 1986; Nozzoli, 1986; Marcucci et al., 1987; Conti *et al.*, 1988), and one section in the Tuscan Sequence (Conti, 1986).

The Val Graveglia section belongs to the formation of Monte Alpe Cherts, which is the lowest lithostratigraphic unit in the sedimentary cover of ophiolites and ophiolite breccias in Ligurid Sequences. This formation consists of radiolarian ribbon cherts, generally red, and siliceous shales. The basal section of the formation is often shaly and manganese-rich, sometimes with thin levels of ophiolite sandstones.

The Monte Alpe Cherts constitute the oldest dated pelagic deposit in the basin with oceanic crust which developed during Jurassic times between the diverging continental plates of Adria and Europe. The floor of this oceanic basin was constituted by largely serpentinized ultramafics discontinuously covered by ophiolitic breccias and discontinuous basalt flows, with thin intercalated lenses of siliceous shales and cherts. The Monte Alpe Cherts rest on top of either basalts or breccias. Basalts often show pillow structure. Breccias may constitute coarse and thick levels or be reduced to a thin ophicalcite cover on top of serpentinite. The Monte Alpe Cherts show a remarkable lateral variability in both lithology and thickness (0 to above 200 m). The age of their base is also variable (Abbate *et al.*1986; Marcucci *et al.*1988).

The Monte Alpe Cherts are overlain by the pelagic Calpionella Limestones (Berriasian; see Andri & Fanucci 1973, 1975) and then by the Palombini Shales, a shaly calcareous-arenaceous turbidite formation whose basal age ranges from Berriasian to Valanginian.

The absence of Calpionella Limestones can place the

Palombini Shales in direct contact with the Monte Alpe Cherts. This lateral variability in ophiolites and their sedimentary cover is suggestive of a rugged sea floor due to oceanic tectonics. For more detailed stratigraphical and tectonic accounts of this areas, reference can be made to Decandia & Elter 1972; Abbate *et al.* 1980a; Abbate *et al.*, 1980b; also see Cortesogno *et al.*, 1987).

The section examined at Ponte di Lagoscuro in Val Graveglia belongs to the "Internal Ligurids" (Piccardo 1977) and more specifically to the Val di Vara Supergroup (Abbate & Sagri 1970), which locally constitutes the uppermost tectonic unit in the nappe edifice of the Northern Apennines. The Monte Alpe Cherts are here part of a complex pile of eastward verging recumbent folds at the interior of the Vara Supergroup involving ophiolites and their sedimentary cover (Monte Alpe Cherts, Calpionella Limestones and Palombini Shales).

2. Northern Apennines

The Monte Alpe Cherts comprise a formation of ribbon cherts and siliceous shale that constitutes an almost continuous Jurassic blanket at the top of the ophiolitic suite in the Northern Apennines.

The radiolarian assemblages of the Monte Alpe Cherts have been studied from 11 sections: Val Graveglia, Monte Rossola, Rocchetta di Vara, Riparbella, Monte Vitalba, Il Romito, Le Capannelle, Sovana-Elmo, Costa Scandella, Il Conventino and Murlo.

The age of the lowest levels of the Monte Alpe Cherts varies from the late Bathonian-early Callovian in Liguria, to the late Oxfordian-Kimmeridgian in Tuscany.

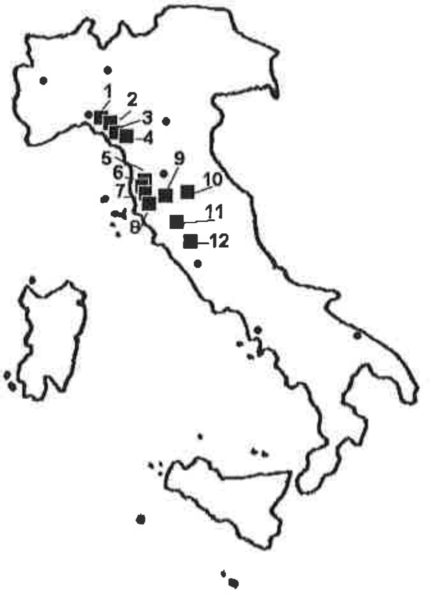


Figure 1. Northern Apennine sections: **1.** Costa Scandella; **2.** Val Graveglia; **3.** Monte Rossola; **4.** Rocchetta di Vara; **5.** Monte Vitalba; **6.** Il Romito; **7.** Riparbella; **8.** Quercianella; **9.** Murlo; **10.** Il Conventino; **11.** Capannelle; **12.** Sovana-Elmo.

In the Southern Apennines (Lucania and Calabria) the sedimentary cover of the ophiolites includes a chert formation very similar to the Monte Alpe Cherts. In a section of this formation at Timpa delle Murge (Lucania), the lowest levels have been dated as late Bathonian-middle Callovian.

2.1. Geological framework

Ophiolites (serpentinites, gabbros and basalts), with their sedimentary cover, are found in different positions in the Ligurid units which are part of the Northern Apennine nappe structure. A part of these ophiolites represents a primary oceanic substratum of Jurassic age at the base of the Vara Supergroup, which in turn constitutes a tectonic unit in a geometrically high position in the Apennine structure. Other ophiolites are olistoliths and olistostromes intercalated in Cretaceous to Eocene flysch sequences of lower units (Calvana Supergroup, Trebbia Supergroup, etc.). The Vara Supergroup is part of the so-called "Internal Ligurids", the lower units belong to the "External Ligurids", in relation to their original position in the Apennine sedimentary basin. The presence of an oceanic substratum at the base of some External Ligurid units is still under debate. The nappe emplacement has taken place since the Palaeogene (Marcucci *et al.*, 1982).

The Apenninic ophiolites include a lower section of serpentinized tectonitic and intrusive rocks, and an upper volcanic-sedimentary section.

The lower section is composed of serpentinized lherzolites, interpreted as more or less depleted mantle ultramafics, and mafic and ultramafic cumulates. The volcanic-sedimentary cover consists of coarse ophiolitic breccias, basalt flows (often pillowed) and radiolarian cherts or siliceous shales (see Abbate *et al.*, 1986).

The ophiolites of the Apennines are distinguished from classic ophiolites of the Oman or Troodos type by the abundance of breccias, the absence of a well-developed sheeted dike complex, and the more fragmentary character of cumulite suites. In these ophiolites, the volcanic-sedimentary section directly covered tectonitic and cumulitic rocks which had previously been exposed at the ocean floor. The mechanism of the unroofing of this substratum is still controversial.

In the volcanic-sedimentary cover, the basalt flows show a relatively modest thickness (generally below 200 metres) and may even be absent. The ophiolite breccias also are discontinuous, although an ophicalcite level of variable thickness currently forms the base of the volcanic-sedimentary cover.

The siliceous deposits can be found intercalated in the breccias and in the basalts or, more frequently, they constitute an almost continuous blanket at their top (Monte Alpe Cherts). When the basalts and thick ophiolite breccias are absent, the Monte Alpe Cherts rest on the tectonitic and cumulitic substratum, often with the above mentioned ophicalcite level lying in-between.

The Monte Alpe Cherts are a typical formation of red to green ribbon chert and siliceous shales. Their thickness is currently a few tens of metres; the formation locally reaches up to 200 metres, or is reduced to a few metres, occasionally disappearing completely. The composition of this formation varies from dominantly siliceous to largely shaly sediments.

The Monte Alpe Cherts are often topped by pelagic limestones (Calpionella Limestones). Siliceous marls (Nisportino Formation and Murlo Marls) can be locally found in between. The Calpionella Limestones are overlain in their turn (and locally replaced) by alternating terrigenous and carbonate deposits ("Argille a Palombini"). The sedimentary sequence continues upwards with Late Cretaceous turbidite formations.

In spite of their local variability in thickness and composition, the Monte Alpe Cherts were part of an almost continuous blanket of radiolarian siliceous deposits which covered this part of the Jurassic Tethys. These deposits extended over the ophiolites of the Alps and Southern Apennines and, beyond the oceanic domain, over part of the continental margin of Adria (Tuscan and Umbrian Successions, Trento Plateau, etc.).

Eleven sections of the Monte Alpe Cherts and the underlying minor siliceous deposits have been examined from the point of view of radiolarian biostratigraphy. In the Monte Alpe Cherts, special attention has been focused on the lower levels, immediately above the ophiolites or ophiolite breccias.

Eight of the studied sections (Val Graveglia, Monte Rossola, Rocchetta di Vara, Riparbella, Monte Vitalba, Il Romito, Le Capannelle and Sovana-Elmo) belong to the Vara Supergroup. Two sections are in olistoliths in the external Ligurid units (Costa Scandella, Val Trebbia Supergroup, and Il Conventino, Calvana Supergroup); for the last section (Murlo) the structural and palaeogeographic positions are still dubious.

The radiolarian ages assigned herein to our samples are tied to chronostratigraphy following Baumgartner (1987) and O'Dogherty *et al.* (1989).

2.2. Section descriptions

Val Graveglia

This section is exposed at Ponte di Lagoscuro (Val Graveglia) along the road from Frisolino to Reppia (Figs. 2, 3).

In comparison with the average composition of the Monte Alpe Cherts, this section is particularly poor in typical radiolarian cherts, being mainly constituted by more or less siliceous shales. These shales are generally unfossiliferous. Radiolarians are present in samples from rare cherty levels but they are badly preserved, the only exception being sample GR 6 in the lower part of the section

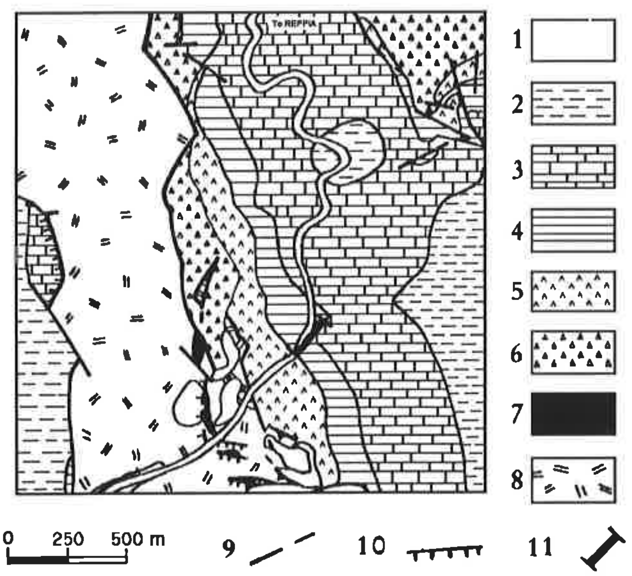


Figure 2. Schematic geological map of Val Graveglia area (from Abbate *et al.* 1980b). **1.** Alluvium; **2.** Palombini Shale; **3.** Calpionella Limestone; **4.** Monte Alpe Chert; **5.** Basalt: pillow lavas, pillow and pillow breccia; **6.** Monte Capra breccia; **7.** Gabbro; **8.** Serpentinite; **9.** Faults; **10.** Thrust fault; **11.** Location of the section.

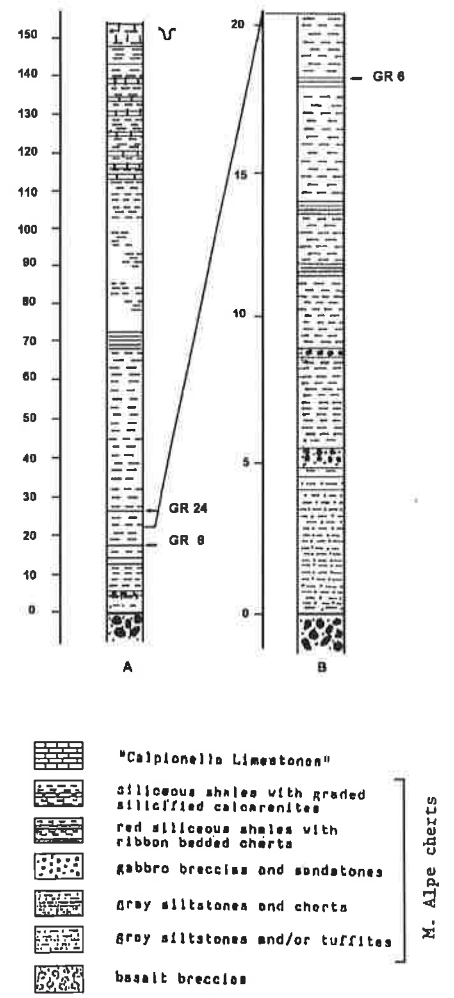


Figure 3. A. Lithological column of Ponte di Lagoscuro section, Val Graveglia area. **B.** Detail of the basal part of the section. Isoclinal folding in shale and chert has not been represented.

which yielded a rich and well-preserved radiolarian assemblage.

From base to the top, the section includes:

1. Pillow basalts overlain by basalt breccias;

2. The Monte Alpe Cherts constituted by (from bottom to top):
- 5m. of grey siltstone and/or tuffite with some chert intercalations towards the top.
- 80cm. of fine breccia made of gabbro clasts.
- 6m. of reddish siliceous shale with a level of gabbro "sandstone" in the middle.
- about 90m. of reddish siliceous shale with scattered levels of radiolarian chert. The rich radiolarian assemblage of sample GR-6 comes from a cherty nodule about 6m. from the base of this level.
- Scattered chert nodules occur in the same zone. Other chert levels yielded Radiolaria which are either badly preserved, or represent assemblages of little significance. The uppermost 30m. are partly covered by soil. The original thickness of this shale is locally altered by isoclinal folding.
- 40m. of yellowish to reddish siliceous shale with scattered siliceous beds.

3. The Calpionella Limestones; a transitional zone occurs between the latter formation and the Monte Alpe Cherts, where red to green shale alternates with limestone along some metres of thickness. *Calpionella alpina* LORENZ and *Calpionellopsis oblonga* (CADISCH) from the lower levels of the Calpionella Limestones indicate a mid-late Berriasian age. Tectonic disturbances are present 1.5 m above the lowest limestone layer.

The sample GR 6 yielded a rich and well-preserved radiolarian assemblage:

Acaeniotyle dentata BAUMGARTNER
Acaeniotylopsis variatus variatus (OZVOLDOVA)
Acanthocircus suboblongus s.l. (YAO)
Acanthocircus trizonalis trizonalis (RÜST)
Alievium sp. A
Angulobracchia sp.
Archaeodictyomitra sp.
Archaeospongoprunum sp.
Bernoullius (?) *monoceros* JUD
Bernoullius cristatus BAUMGARTNER
B. rectispinus delnortensis PESSAGNO, BLOME & HULL
Bernoullius rectispinus leporinus CONTI & MARCUCCI
Bernoullius rectispinus rectispinus KITO, DE WEVER, DANELIAN & CORDEY
Bernoullius spelae JUD
Emiluvia hopsoni PESSAGNO
Emiluvia premyogii BAUMGARTNER
Emiluvia sedecimporata (RÜST)
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
Eucyrtis sp. B in CONTI & MARCUCCI,
Eucyrtis sp. C in CONTI & MARCUCCI
Halesium PESSAGNO, emend. BAUMGARTNER
Haliodictya (?) *antiqua* s.l. (RÜST)
Hexalonche (?) sp. B in CONTI & MARCUCCI
Hexastylus (?) *tetradactylus* CONTI & MARCUCCI
Higumastra imbricata (OZVOLDOVA)
Homoeoparonaella argolidensis BAUMGARTNER
Mirifusus dianae s.l. (KARRER)
Mirifusus fragilis s.l. BAUMGARTNER
Mirifusus guadalupensis PESSAGNO
Napora deweveri BAUMGARTNER
Napora pyramidalis BAUMGARTNER
Palinandromeda podbielensis (OZVOLDOVA)
Palinandromeda praepodbielensis (BAUMGARTNER)
Pantanellium sp.
Paronaella bandyi PESSAGNO
Paronaella kotura BAUMGARTNER
Paronaella mulleri PESSAGNO
Paronaella sp.
Paronaella pygmaea BAUMGARTNER
Perispyridium ordinarium gr. (PESSAGNO)
Podobursa helvetica (RÜST)
Podobursa spinosa (OZVOLDOVA)
Podocapsa(?) *hexaptera* CONTI & MARCUCCI
Pseudocrucella sanfilippoae (PESSAGNO)
Pseudoeucyrtis sp. J
Sethocapsa leiostraca FOREMAN
Spongocapsula palmerae PESSAGNO
Tetraditryma pseudoplena BAUMGARTNER
T. corralitosensis bifida CONTI & MARCUCCI
T. corralitosensis corralitosensis (PESSAGNO)
Tetratrabs zealis (OZVOLDOVA)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma cornuta BAUMGARTNER
Triactoma jonesi (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)
Tritrabs rhododactylus BAUMGARTNER
Turanta sp.

This assemblage seems to suggest a late Bathonian-early Callovian age for this sample from the co-occurrence of *Bernoullius cristatus* with *Emiluvia hopsoni, Eucyrtidiellum ptyctum, Napora deweveri, Paronaella kotura, Tritrabs ewingi* and *Zanola cornuta* (assigned age referred to O'Dogherty *et al.*, (1989) and Conti & Marcucci (1991)

Monte Rossola

At the south-eastern flank of M. Rossola (Levanto, Eastern Liguria) a level of siliceous shale and ophiolitic sandstone resting on serpentinite breccia underlain by ophicalcite and serpentinite has been examined (Fig. 4). This level is overlain in turn by basalt, several hundreds of metres in thickness with chert intercalations and ophiolite breccia (Abbate *et al.*, 1980b, Abbate *et al.*, 1980c, Cortesogno *et al.*, 1981, 1987).

The following radiolarian assemblage was recovered from a chert nodule at the top of the siliceous shale (Sample, RS3) :

Emiluvia premyogii BAUMGARTNER
Emiluvia salensis PESSAGNO
Eucyrtis HAECKEL
Gorgansium PESSAGNO & BLOME

Haliodictya (?) *hojnosi* Riedel & Sanfilippo
Higumastra imbricata (Ozvoldova)
Leugeo hexacubicus (Baumgartner)
Napora deweveri Baumgartner
Palinandromeda podbielensis (Ozvoldova)
Pantanellium sp.
Paronaella bandyi Pessagno
Paronaella mulleri Pessagno
Paronaella pygmaea Baumgartner
Parvicingula dhimenaensis s.l. Baumgartner
Perispyridium ordinarium gr. (Pessagno)
Podobursa helvetica (Rüst)
Saitoum pagei De Wever
Sethocapsa leiostraca Foreman
Stichomitra sp.
Tetraditryma pseudoplena Baumgartner
T. corralitosensis corralitosensis (Pessagno)
Transhsuum brevicostatum gr. (Ozvoldova)
Transhsuum maxwelli gr. (Pessagno)
Triactoma jonesi (Pessagno)
Tritrabs casmaliaensis (Pessagno)

This assemblage is consistent with an late Bathonian-late Callovian age assignment. (data after Abbate *et al.* (1986) and original data).

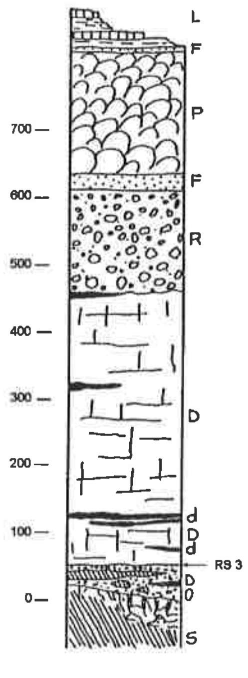


Figure 4. Schematic stratigraphic column of Mt. Rossola section. **S.** Serpentinite; **O.** Ophicalcite and other serpentinite breccia; **d.** Radiolarite and radiolarian-bearing shale; **R.** Mt. Rossola Breccia; **F.** Siliceous-shaly sediments with ophiolite sandstone and breccia; **P.** Pillow basalt; **L.** Palombini shale. (After Abbate *et al.*, 1980a).

Costa Scandella

The Monte Alpe Cherts crop out at Costa Scandella, in the M. Penna-M. Aiona Group of Eastern Liguria, together with the underlying pillow basalts (Figs. 5, 6). The cherts and basalts constitute an olistolith of the Casanova Complex, an ensemble of ophiolitic olistoliths, olistostromes and ophiolitic or sialic turbidites belonging to the Trebbia Supergroup. The olistolith is included in one of the largest outcrops of the Casanova Complex, constituting the M. Aiona - M. Penna ridge.

The Casanova Complex is Late Cretaceous to Paleocene according to Passerini (1965), Late Cretaceous according to Bertotti *et al.* (1986) and early Campanian, according to Marroni & Perilli (1992), and corresponds to the phase of consumption of the ophiolite basin, while the onset of radiolarian chert deposition records the end of oceanic basalt extrusion in the Late Jurassic. This is one of the rare occurrences of a well-preserved sequence of radiolarian cherts on top of ophiolite olistoliths in the Casanova Complex.

The geological setting of the Costa Scandella radiolarian chert is illustrated in Figs. 5 and 6; the sequence is normal in its western outcrop and becomes overturned to the east.

The sampled section consists, from bottom to top, of pillowed or massive doleritic basalts, some decimetres of hyaloclastite, about 4 m of greenish siliceous shale and siltstone, 40 cm of greenish to red brecciated siliceous siltstone, 1 m of pink porous cherts and siliceous shale, about 10 m of red ribbon chert, with a fault disturbing their upper zone.

An argillitic-calcareous olistostrome and polygenetic breccias of the Casanova Complex, lie unconformably on top of radiolarian chert.

Radiolarians are generally recrystallized; only two samples from the lower part of the section (AI 3 and AI 4) yielded well-preserved specimens.

Sample AI 3:
Archaeospongoprunum sp.
Eucyrtis sp.
Higumastra imbricata (Ozvoldova)
Leugeo hexacubicus (Baumgartner)
Mirifisus sp.
Mirifusus fragilis s.l. Baumgartner
Palinandromeda podbielensis (Ozvoldova)
Ristola altissima altissima (Rüst)
Ristola procera (Pessagno)
Stylocapsa oblongula Kocher
Transhsuum brevicostatum gr. (Ozvoldova)
Transhsuum maxwelli gr. (Pessagno)
Tritrabs ewingi s.l. (Pessagno)

The co-occurrence of *Mirifusus fragilis* and *Stylocapsa oblongula* with *Ristola procera*, indicates a possible mid Callovian age

Sample AI 4:
Acanthocircus suboblongus s.l. (Yao)
Dibolachras sp.
Emiluvia sp.
Eucyrtidiellum unumaense pustulatum Baumgartner

Eucyrtis sp.
Higumastra imbricata (OZVOLDOVA)
Leugeo hexacubicus (BAUMGARTNER)
Mirifusus guadalupensis PESSAGNO
Napora pyramidalis BAUMGARTNER
Palinandromeda podbielensis (OZVOLDOVA)
Podobursa sp.
Protunuma sp.
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)

This sample gives a less exact age determination (mid Bathonian to Callovian)

The age of chert 4 m above the basalt at Costa Scandella is thus referable to mid Callovian (Conti *et al.*, 1988).

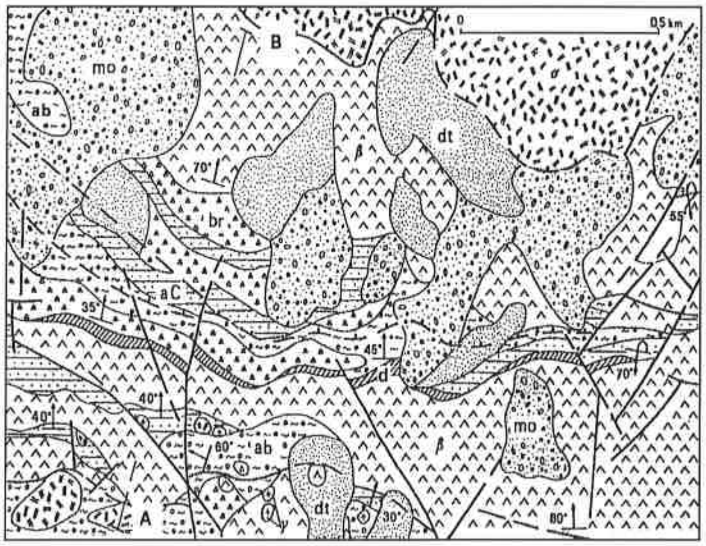


Figure 5. Schematic geological map of Costa Scandella (Casnedi *et al.*, 1972). **s.** Sepentinite and subordinate lherzolitic peridotite; t - "granite"; **ß.** Pillow and massive basalt; **d.** Radiolarian chert and siliceous shale; **br.** Prevailingly basaltic breccias; **aC.** Casanova Sandstone; **ab.** Olistostrome; **mo.** Moraines; **dt.** Talus; A-B cross section illustrated in Figure 6.

Rocchetta di Vara

The outcrop considered is situated along the trunk-road from Borghetto di Vara to Rocchetta di Vara (Eastern Liguria), immediately south of the latter village (Fig. 7). The Monte Alpe Cherts are underlain by the Monte Zenone Breccia, one of the clastic formations of the volcanic-sedimentary cover of the ophiolites, mainly made up of gabbro boulders, and overlain by Palombini Shales. At the top of the Monte Zenone Breccia, fine-grained sandstones occur, and the transition to the Monte Alpe Cherts is marked by chert beds alternating with these sandstones measuring from a few tens of centimetres to about two metres thick. The whole chert section is 200 m thick. Its original thickness is difficult to estimate because of isoclinal folding. The most significant sample (RV 11) comes from about 20 m above the base of the formation.

The sample yielded the following radiolarian assemblage:

Deviatus diamphidius s.l. (FOREMAN)
Mirifisus sp.
Mirifusus dianae s.l. (KARRER)
Parvicingula dhimenaensis s.l. BAUMGARTNER
Podobursa spinosa (OZVOLDOVA)
Protunuma sp.
Spongocapsula perampla (RÜST)
Stichomitra sp.
Triactoma sp.
Tritrabs rhododactylus BAUMGARTNER

This assemblage is characteristic of a late Oxfordian age.

An older radiolarian assemblage has been described in the same section by Baumgartner (1984). The samples analysed here were collected about 20 m above the base of the formation, while Baumgartner's sample came from the basal chert-sandstone alternation. (cf. Conti & Marcucci, 1986).

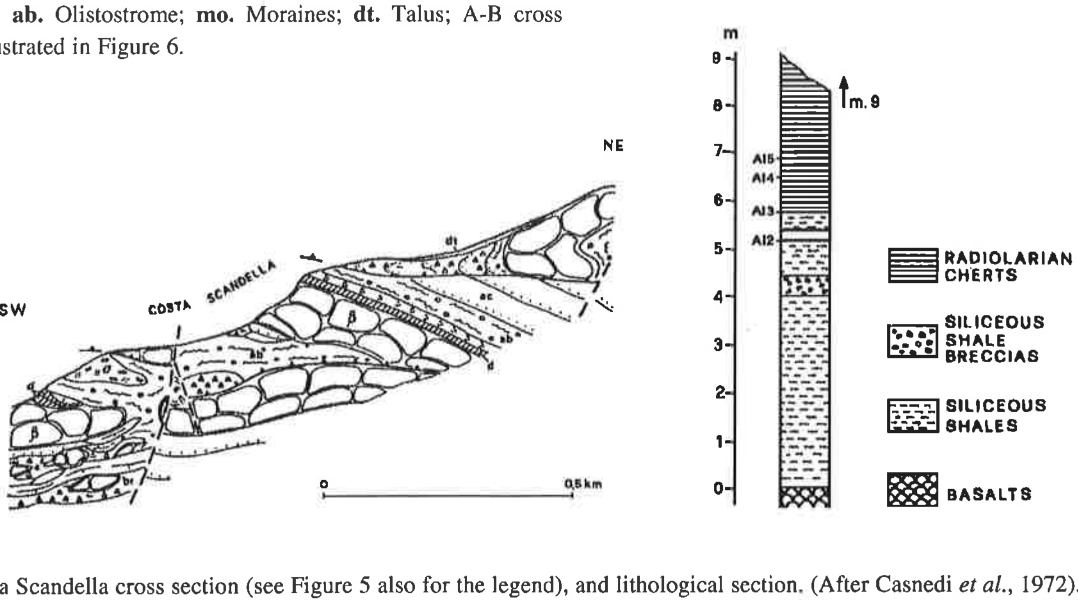


Figure 6. Costa Scandella cross section (see Figure 5 also for the legend), and lithological section. (After Casnedi *et al.*, 1972).

Il Conventino

The Monte Alpe Cherts in the Monti Rognosi (Bortolotti 1961, 1962) are well-exposed near Il Conventino, along the Anghiari-Le Strette-Caprese Michelangiolo road and in the left side of the "Il Rio" creek, near Arezzo, Tuscany (Figs. 8, 9). These cherts lie on top of pillow basalt and below the Calpionella Limestones of Berriasian age (Bortolotti, 1962). The whole succession is part of a large olistolith intercalated in the Monte Morello Formation, an Eocene marly-calcareous turbidite of the Calvana Supergroup. The contact between the pillow basalts and the Monte Alpe Cherts is almost vertical. The base of the chert is exposed within a horizon of variable thickness (10 to 40 cm) of siliceous shales.

The section A (Fig. 9), already studied by Conti & Marcucci (1986 - samples CC 1 and CC 4), was sampled again (CC 10), and another sample (CC 12, see section B of Fig. 9) has been taken from the same level few metres along the contact.

The samples CC 1 and CC 4 were collected from levels 70 and 74 cm above the base of the cherts while samples CC 10 and CC 12 were collected from 20 and 40 cm respectively above the basalt. In CC 1, the assemblage is characterised by:

Dibolachras sp.
Mirifisus sp.
Mirifusus dianae s.l. (Karrer)
Mirifusus guadalupensis Pessagno

In CC 4 the following species have been recognised:

Archaeodictyomitra Pessagno
Dibolachras sp.
Eucyrtidiellum ptyctum (Riedel & Sanfilippo)
Homoeoparonaella argolidensis Baumgartner
Transhsuum maxwelli gr. (Pessagno)

Both assemblages can be referred to late Callovian-late Oxfordian times.

Sample CC 10 yielded tetraxone sponge spicules and the following radiolarian assemblage:

Archaeodictyomitra apiarium (Rüst)
Dibolachras sp.
Emiluvia orea s.l. Baumgartner
Eucyrtidiellum nodosum Wakita
Eucyrtidiellum ptyctum (Riedel & Sanfilippo)
Mirifusus guadalupensis Pessagno
Pseudoristola sp.
Ristola altissima s.l. (Rüst)

The sample CC 12 yielded the following radiolarian assemblage:

Acanthocircus suboblongus suboblongus (Yao)
Archaeodictyomitra apiarium (Rüst)
Deviatus Li
Dibolachras sp.
Emiluvia orea s.l. Baumgartner
Eucyrtidiellum ptyctum (Riedel & Sanfilippo)
Podobursa sp.

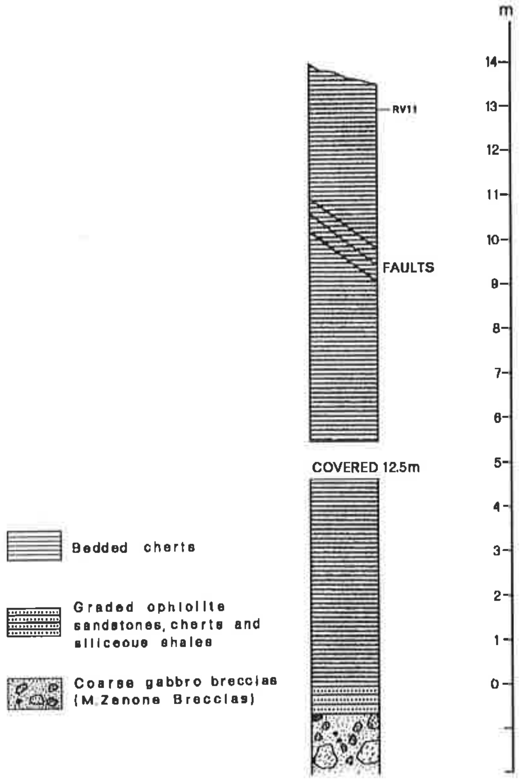


Figure 7. Schematic stratigraphic column at Rocchetta di Vara.

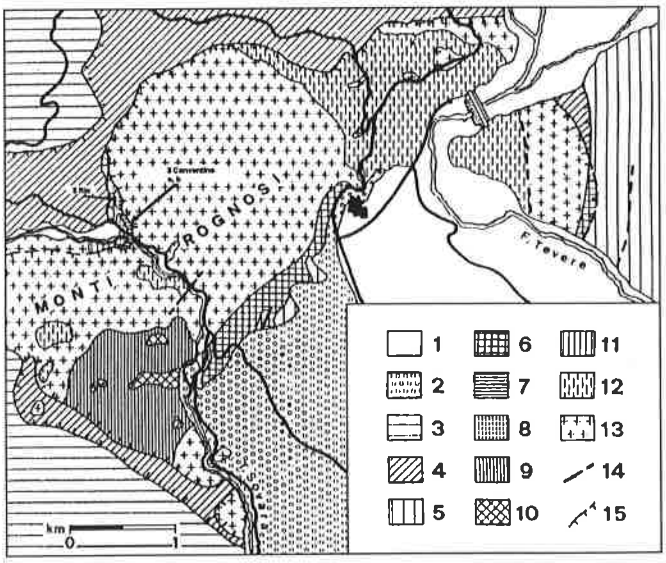


Figure 8. Geological map of Il Conventino (after Bortolotti, 1992). **1.** Alluvial deposits; **2.** Fluvial-lacustrine deposits; **3.** Monte Cervarola Sandstone; **4.** Sillano Formation; **5.** Monte Morello Formation with basal ophiolite breccia (**6**); **7.** Basalt; **8.** Monte Alpe Chert; **9.** Casa Boeno Breccia including predominantly gabbroic levels (**10**); **11.** Ophicalcite; **12.** Gabbro; **13.** Serpentinized mantle ultramafic; **14.** Normal faults; **15.** Thrust faults.

Pseudoristola sp.
Ristola altissima altissima (RÜST)
Sethocapsa sp.
Stichomitra sp.
Tetratrabs bulbosa BAUMGARTNER
Transhsuum brevicostatum gr. (OZVOLDOVA)
Triactoma sp.

Both assemblages can be referred to the mid-late Oxfordian.

Along the Il Rio creek, the succession is overturned. The lithological column (see Fig. 9) shows the chert overlying the pillow basalts. The lowest and richest sample is CC 28 (from 50 cm above the contact) and yielded the following radiolarian assemblage:

Archaeodictyomitra apiarium (RÜST)
Deviatus diamphidius diamphidius (FOREMAN)
Emiluvia orea s.l. BAUMGARTNER
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
Protunuma japonicus MATSUOKA & YAO
Ristola altissima s.l. (RÜST)
Stichomitra sp.
Tetratrabs sp.
Tritrabs casmaliaensis (PESSAGNO)

Sample CC 26 yielded the following radiolarian assemblage:

Archaeodictyomitra apiarium (RÜST)
Podobursa sp.
Ristola altissima altissima (RÜST)

The radiolarian assemblage found in the upper sample CC 23, about 2.5m. above the contact, contains the following species: Archaeodictyomitra apiarium (RÜST)

Mirifisus sp
Podocapsa amphitreptera FOREMAN
Protunuma sp.

The age of the base is Late Oxfordian and the age of the upper part of the section (CC 23) is Late Oxfordian-Early Berriasian. (*cf.* Conti & Marcucci, 1986 and Conti & Marcucci, 1992).

Murlo

The base of the Monte Alpe Cherts has been examined about 600m East-North East of Crevole, uphill from the Crevole-Murlo road, Siena, Southern Tuscany (Fig. 10). In this area the M. Alpe Cherts lie on top of pillow basalt and below a formation of siliceous marl and shale (Murlo Marls). The latter is overlain in its turn by the Calpionella Limestones and Palombini Shales.

The samples have been taken in shale and chert, within 2m. above the contact of the Monte Alpe Cherts with the underlying pillow basalt. The samples richest in Radiolaria are B1, B3 and B4. B1 and B3 come from the same level, 1 m above the basalt, B4 comes from 1.85 m above it. The assemblages recognised are as follows:

Samples B1 and B3:

Archaeodictyomitra apiarium (RÜST)
Archaeodictyomitra PESSAGNO
Dibolachras sp.
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO)
Mirifisus sp.
Mirifusus dianae s.l. (KARRER)
Mirifusus guadalupensis PESSAGNO
Podobursa sp.
Ristola altissima altissima (RÜST)
Spongocapsula palmerae PESSAGNO
Syringocapsa sp.
Tetratrabs bulbosa BAUMGARTNER
Transhsuum brevicostatum gr. (OZVOLDOVA)
Triactoma cornuta BAUMGARTNER
Tritrabs hayi (PESSAGNO)

Sample B4:

Angulobracchia digitata BAUMGARTNER
Dibolachras sp.
Higumastra sp.
Mirifisus sp.
Mirifusus guadalupensis PESSAGNO
Napora sp.
Paronaella sp.
Protunuma sp.
Pseudocrucella sp.
Ristola altissima altissima (RÜST)
Spongocapsula perampla (RÜST)
Stichocapsa HAECKEL

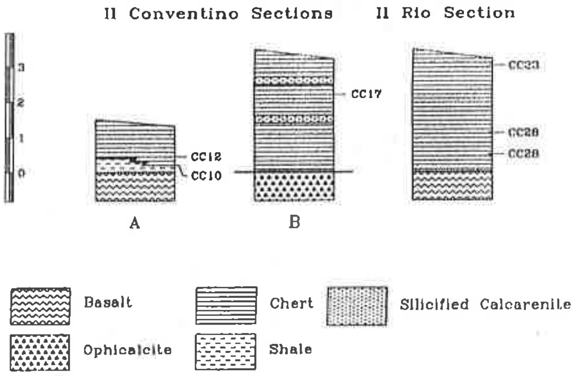


Figure 9. Il Conventino: stratigraphic columns.

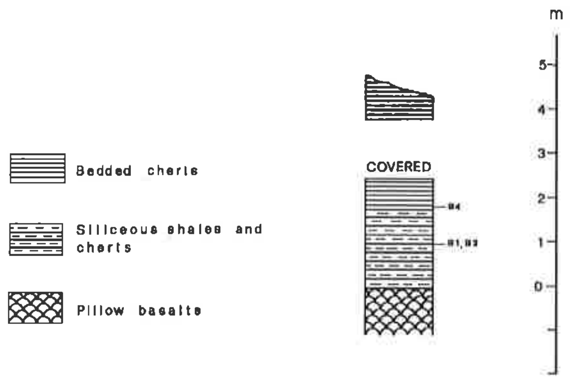


Figure 10. Schematic stratigraphic column at Murlo.

Stichomitra sp.
Transhsuum brevicostatum gr. (OZVOLDOVA)
Tritrabs rhododactylus BAUMGARTNER

The former assemblage, which is the closest to the bottom of the cherts, is typical of the mid-late Oxfordian while the latter has a broader range, mid Callovian-late Oxfordian. (*cf.* Conti & Marcucci, 1986).

Il Romito

This section is exposed along a creek which ends at "Porticciolo del Romito" along the Aurelia road, 3 Km south of Leghorn (Fig. 11). In this creek the base of the M. Alpe Cherts crops out above the gabbroic M. Zenone Breccia and consists of some 20 cm of unfossiliferous siliceous red shale. The lowest samples rich in radiolarians (S 3, S 5) come from chert immediately above the shale.

These samples yielded the following radiolarian assemblage:
Angulobracchia digitata BAUMGARTNER
Archaeodictyomitra apiarium (RÜST)
Deviatus diamphidius diamphidius (FOREMAN)
Emiluvia hopsoni PESSAGNO
Haliodictya (?) *hojnosi* RIEDEL & SANFILIPPO
Homoeoparonaella BAUMGARTNER
Homoeoparonaella elegans (PESSAGNO)
Mirifusus guadalupensis PESSAGNO
Napora deweveri BAUMGARTNER
Palinandromeda podbielensis (OZVOLDOVA)
Pantanellium sp.
Paronaella mulleri PESSAGNO
Podobursa spinosa (OZVOLDOVA)
Pseudocrucella sp.
Ristola procera (PESSAGNO)
Triactoma cornuta BAUMGARTNER
Triactoma jonesi (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)

This assemblage characterises the late Oxfordian, given the co-occurrence of *Foremanella diamphidia* and *Archaeodictyomitra apiarium* with *Mirifusus guadalupensis*, *Andromeda podbielensis* and *Tritrabs casmaliaensis*. (*cf.* Marcucci & Marri, 1990).

Riparbella

The section "Il Terriccio" is located immediately east of the farm Il Terriccio, 20 Km westward of Riparbella, Leghorn, Southern Tuscany (Fig. 12). This section includes two chert levels: the lower level, 40 cm in thickness, is intercalated in the lower part of a two hundred metres thick basaltic layer, about 3 m above its base; the upper level (M. Alpe Cherts) lies on top of the basalts and is about 8 m in thickness. The basalts are underlain by ophicalcites. The upper chert level is overlain by Palombini Shales.

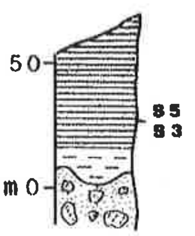


Figure 11. Stratigraphic column at Il Romito.

The radiolarian assemblage from the lower chert level at Il Terriccio includes:
Acanthocircus suboblongus s.l. (YAO)
Deviatus diamphidius hipposidericus (FOREMAN)
Eucyrtidiellum unumaense pustulatum BAUMGARTNER
Higumastra inflata BAUMGARTNER
Homoeoparonaella elegans (PESSAGNO)
Protunuma sp.
Stichocapsa convexa YAO
Transhsuum brevicostatum gr. (OZVOLDOVA)
Tritrabs rhododactylus BAUMGARTNER

This assemblage is assigned an mid-late Oxfordian age.

In the upper level (Monte Alpe Cherts), near its base, the following forms have been recognized:
Acaeniotyle umbilicata (RÜST)
Acanthocircus suboblongus s.l. (YAO)
Emiluvia salensis PESSAGNO
Mirifusus guadalupensis PESSAGNO
Podocapsa amphitreptera FOREMAN
Saitoum elegans DE WEVER
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi worzeli (PESSAGNO)

This assemblage seems to correspond to an late Oxfordian-Kimmeridgian age.

Three metres above the preceding sample, an assemblage has been recovered which is characterised by:
Acanthocircus suboblongus s.l. (YAO)
Acanthocircus trizonalis dicranacanthos (SQUINABOL), emend. FOREMAN
Dibolachras sp.
Podocapsa amphitreptera FOREMAN
Tritrabs hayi (PESSAGNO)

This assemblage seems to correspond to an Kimmeridgian age. (*cf.* Nozzoli, 1986).

Quercianella

This section outcrops 1 Km North of Quercianella (Leghorn) along the Aurelia road. In this section the Monte Alpe Cherts are underlain by basalt and overlain by Palombini Shales. Near the (tectonically disturbed) base of the M. Alpe Cherts, the radiolarian assemblage is as follows:
Higumastra inflata BAUMGARTNER
Mirifisus sp.
Mirifusus dianae s.l. (KARRER)
Mirifusus guadalupensis PESSAGNO
Tetratrabs sp.
Triactoma jonesi (PESSAGNO)
Tritrabs casmaliaensis (PESSAGNO)
Tritrabs ewingi s.l. (PESSAGNO)

The assemblage is consistent with an late Bathonian-late Oxfordian age.

The M. Alpe Cherts contain the following species 1.6 metres below the top:

Acanthocircus trizonalis dicranacanthos (SQUINABOL)
Deviatus diamphidius diamphidius (FOREMAN)
Dibolachras sp.
Emiluvia salensis PESSAGNO
Podocapsa amphitreptera FOREMAN
Triactoma tithonianum RÜST

These forms suggest a possible Kimmeridgian-Tithonian age (*cf.* Nozzoli, 1986).

Monte Vitalba

The section examined is near the top of Monte Vitalba, immediately east of Castellina Marittima, Pise Province of Tuscany (Fig. 13). In this section the Monte Alpe Cherts, 15 m in thickness, rest on the M. Zenone Breccia and lie below a formation of shaly marlstones, shales and radiolarian cherts (Nisportino Formation). The Calpionella Limestones are found above this formation. A radiolarian assemblage found 0.35 m above the base of Monte Alpe Cherts includes the species:

Emiluvia sedecimporata (RÜST)
Paronaella mulleri PESSAGNO
Podocapsa amphitreptera FOREMAN

This assemblage corresponds to an late Oxfordian-Kimmeridgian age assignment.

The base of the Calpionella Limestone yielded: *Calpionellopsis oblonga* (CADISH), *Calpionella alpina* Lorenz and *Tintinnopsella carpatica* (MURGEANU & FILIPESCU), indicating a late Berriasian age (*cf.* Picchi, 1985).

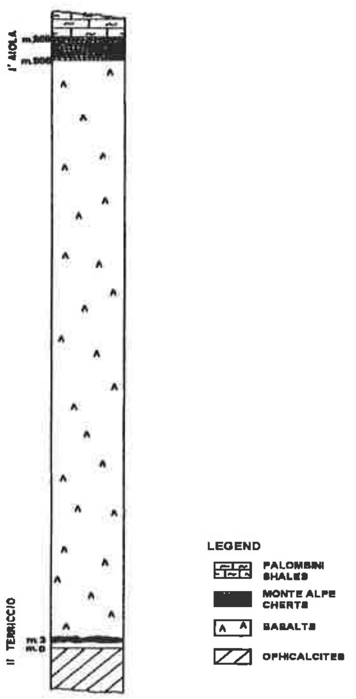


Figure 12. Stratigraphic column at Riparbella (After Nozzoli, 1986).

Capannelle

This section is a small quarry along the road from Paganico (Grosseto) to Petriolo, near Capannelle (Fig. 14). The M. Alpe Cherts overlie ophiolitic breccias with calcite cement (ophicalcites s.l.). The sample C1, 20 cm above the lowest exposed chert bed, presents the following assemblage:

Deviatus diamphidius diamphidius (FOREMAN)
Dibolachras sp.
Emiluvia salensis PESSAGNO
Podobursa sp.
Podocapsa amphitreptera FOREMAN
Transhsuum brevicostatum gr. (OZVOLDOVA)
Triactoma sp.
Tritrabs ewingi s.l. (PESSAGNO)

This assemblage belongs to late Oxfordian-Tithonian as indicated by the presence of *Podocapsa amphitreptera* and *Foremanella diamphidia* with *Dibolachras chandrika* and *Triactoma blakei.*

The sample C2, 90 cm above sample C1, yielded a radiolarian assemblage with many species in common with C1 but the additional presence of *Paronaella broennimanni* PESSAGNO restricts the age-range of the radiolarian assemblage of this sample to late Oxfordian - Kimmeridgian (*cf.* Marcucci & Marri, 1990).

Sovana-Elmo

This section is SSW of Elmo along the road to Sovana (Grosseto, Southern Tuscany), 400 m south of Case Gorla (Fig. 15). The M. Alpe Cherts are well-exposed in a small quarry where they overlie pillow basalts. The formation is about 1.5m thick and is overlain by the Palombini Shales. The lowest sample rich in radiolarians (SO 3) comes from 25 cm above the top of the pillow basalt and yielded the following radiolarian assemblage:

Acaeniotyle diaphorogona gr. FOREMAN
Archaeodictyomitra apiarium (RÜST)
Mirifusus guadalupensis PESSAGNO
Obesacapsula sp.
Palinandromeda podbielensis (OZVOLDOVA)
Podobursa helvetica (RÜST)
Protunuma sp.
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)

The presence of *Archaeodictyomitra apiarium* and *Mirifusus guadalupensis* allows this assemblage to be assigned to an mid-late Oxfordian age.

The highest sample (SO 6) has been collected 75 cm above SO 3. The radiolarian assemblage found in this sample contains the following species:

Acanthocircus suboblongus s.l. (YAO)
Archaeospongoprunum sp.
Emiluvia orea orea BAUMGARTNER
Emiluvia pessagnoi s.l. FOREMAN
Emiluvia sedecimporata (RÜST)

Mirifusus guadalupensis PESSAGNO
Pantanellium sp.
Paronaella mulleri PESSAGNO
Paronaella sp., emend. BAUMGARTNER
Podobursa helvetica (RÜST)
Ristola procera (PESSAGNO)
Tetratrabs zealis (OZVOLDOVA)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma cornuta BAUMGARTNER
Triactoma jonesi (PESSAGNO)
Triactoma tithonianum RÜST
Tritrabs casmaliaensis (PESSAGNO)

The co-occurrence of *Archaeodictyomitra apiarium* and *Emiluvia orea*, with *Mirifusus guadalupensis*, *Hsuum maxwelli* and *Tritrabs casmaliaensis* suggests that this assemblage should be assigned an age of mid-late Oxfordian. (*cf.* Marcucci & Marri, 1990).

3. SOUTHERN APENNINES

The ophiolites of the Southern Apennines of northern Calabria and southern Lucania (southern Italy) consist of highly dismembered and variously metamorphosed mantle ultramafics, mafic plutonics and basalts which are capped by cherts and terrigenous sediments (Lanzafame *et al.*, 1978, Beccaluva *et al.*, 1983). Only one section (Timpa delle Murge) in the sedimentary cover of the Southern Apennines ophiolites has been examined regarding radiolarian biostratigraphy.

3.1. Timpa delle Murge

The Timpa delle Murge section (near Terranova del Pollino, Lucanian Apennines, Figs. 16-18), shows a well-

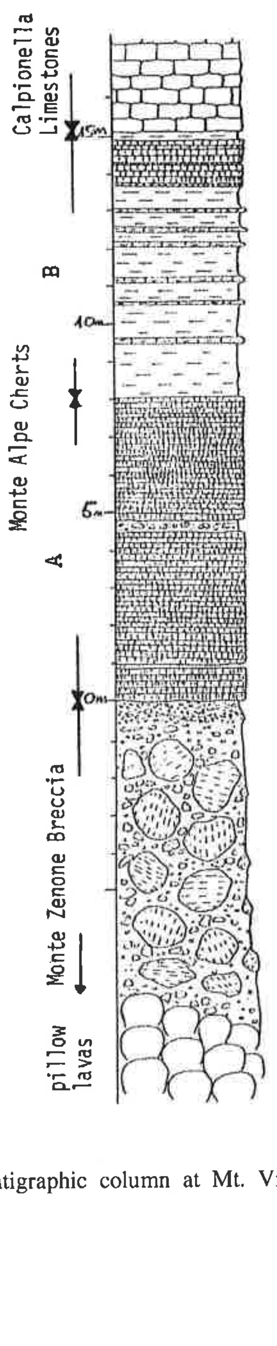


Figure 13. Stratigraphic column at Mt. Vitalba (After Picchi, 1985).

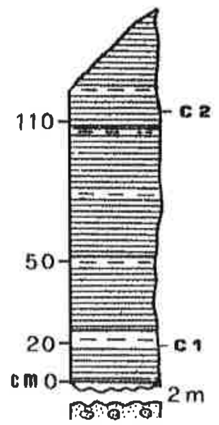


Figure 14. Stratigraphic column at Capannelle.

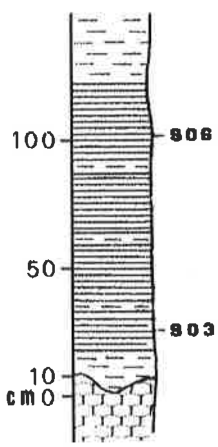


Figure 15. Stratigraphic column at Sovana-Elmo.

exposed sedimentary cover resting on basalt. This cover consists of a basal shale and chert overlain by marly limestone; these are overlain by varicoloured shale and quartzarenite. A chert bed 20 cm above the volcanics yielded the following radiolarian assemblage:

Archaeospongoprunum sp.
Eucyrtidiellum unumaense pustulatum BAUMGARTNER
Leugeo hexacubicus (BAUMGARTNER)
Mirifusus dianae s.l. (KARRER)
Mirifusus fragilis s.l. BAUMGARTNER
Mirifusus proavus TONIELLI
Palinandromeda podbielensis (OZVOLDOVA)
Transhsuum brevicostatum gr. (OZVOLDOVA)
Transhsuum maxwelli gr. (PESSAGNO)
Triactoma cornuta BAUMGARTNER
Triactoma sp.

This assemblage corresponds to late Bathonian-mid Callovian (*cf.* Marcucci *et al.,* 1987). This age is consistent with previous data on *Calpionella* and *Stomiosphaera* faunas (Tithonian-Berriasian) described from marly limestones overlying the cherts (Bousquet, 1962; Vezzani, 1968).

References

ABBATE, E., BECCALUVA, L., BORTOLOTTI, V., GALBIATI, B., PICCARDO, G.B., PRINCIPI, G. & SERRI, G. (1980a). Excursion F. Eastern Liguria Ophiolite Nappe. *Field excursion guidebook, VI Ophiolite Field Conference, GLOM*, Florence, 65-97.

ABBATE, E., BORTOLOTTI, V., CONTI, M., MARCUCCI, M., PRINCIPI, G., PASSERINI, P. & TREVES, B. (1986). Apennines and Alps ophiolites and the evolution of the western Tethys. *Memorie della Società Geologica Italiana*, **31**, 23-44.

ABBATE, E., BORTOLOTTI, V., GALBIATI, B. & PRINCIPI, G.F. (1980b). Carta geologica delle ofioliti del Bargonasco e dell'Alta Val Graveglia 1:25.000. *L.A.C. Firenze.*

ABBATE, E., BORTOLOTTI, V. & PRINCIPI, G.F. (1980c). VI. western area: Apennine ophiolites, a peculiar oceanic crust. *In* Rocci, G. Ed. - Ofioliti, Special Issue, 59-96.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1984). Comparison of unitary associations and probabilistic ranking and scaling as applied to Mesozoic radiolarians. *Computers and Geosciences*, **10** (1), 167-183.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BECCALUVA, L., MACCIOTTA, G. & SPADEA, P. (1983). Petrology and geodynamic significance of the Calabria-Lucania ophiolites. *Rendiconti della Societa Italiana di Mineralogia e Petrologia*, **38**, 973-987.

Figure 16. Southern Apennine section: Timpa delle Murge (1).

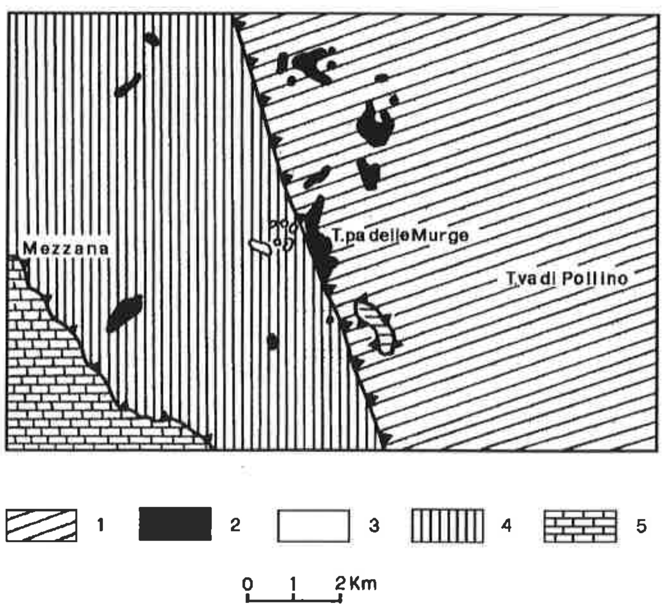


Figure 17. Schematic map of Timpa delle Murge area (from Lanzafame *et al.* 1978). **1.** "Flysch Calabro-Lucano"; **2.** Ophiolites; **3.** Cataclastic gneiss; **4.** Metamorphic flysch unit; **5.** Carbonate rocks unit.

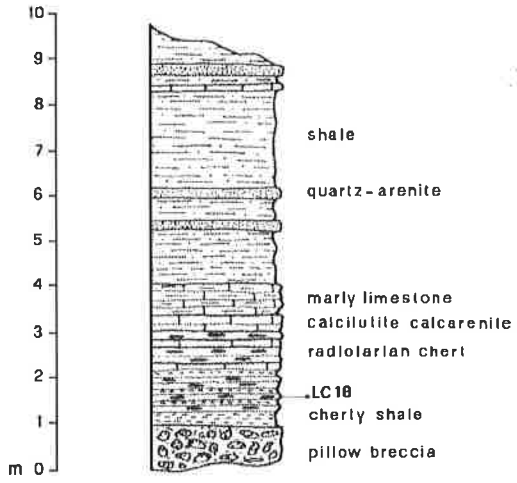


Figure 18. Lithological column at Timpa delle Murge.

BERTOTTI, G., ELTER, P., MARRONI, M. & SANTI, S. (1986). Le Argilliti a Blocchi di M. Veri: Considerazioni sulla evoluzione tettonica del bacino ligure nel Cretaceo Superiore. *Ofioliti*, **11** (3), 193-220.

BORTOLOTTI, V. (1961). Sui rapporti ofioliti - alberese tra Pieve S. Stefano e Borgo Sansepolcro (Arezzo). *Bollettino della Società Geologica Italiana*, **80** (3), 269-274.

BORTOLOTTI, V. (1962). Sulla giacitura della serie ofiolitifera dei Monti Rognosi (Arezzo). *Bollettino della Società Geologica italiana*, **81** (2), 313-322.

BORTOLOTTI V. ED. (1992). *L'Appennino tosco-emiliano - Guide geologiche regionali*, **4** - A cura della Società Geologica Italiana, Milano.

BOUSQUET, J.C. (1962). Age de la série des diabases-porphyrites (roches vertes du flysch calabro-lucanien, Italie méridionale). *Bulletin de la Société Géologique de France, Série VI*, **4**, 712-718.

CASNEDI, R., GALBIATI, B., GALLO, F., VERNIA, L. & ZANZUCCHI, G. (1972). Carta geologica delle ofioliti del gruppo di M. Penna e M. Aiona (Appennino ligure - parmense). *Memorie Descrittive della Carta Geologica d'Italia.*

CONTI, M. & MARCUCCI, M. (1986). The onset of radiolarian deposition in the ophiolite sequences of the Northern Apennine. *Marine Micropaleontology*, **11**, 129-138.

CONTI, M. & MARCUCCI, M. (1991). Radiolarian assemblage in the Monte Alpe cherts at Ponte di Lagoscuro, Val Graveglia (eastern Liguria, Italy). *Eclogae Geologicae Helvetiae*, **84** (3), 791-817.

CONTI, M. & MARCUCCI, M. (1992). Radiolarian dating of the Monte Alpe Chert at Il Conventino, Monti Rognosi (Eastern Tuscany, Italy). *Ofioliti*, **17** (2), 243-248.

CONTI, M., MARCUCCI, M. & ZANZUCCHI, G. (1988). Radiolarian dating of the Mt. Alpe cherts at Costa Scandella, Mt. Penna - Mt. Aiona group (Ligurian Apennines). *Ofioliti*, **13** (1), 81-84.

CORTESOGNO, L., GALBIATI, B. & PRINCIPI, G. (1987). Note alla "Carta geologica delle ofioliti del Bracco" e ricostruzione della paleogeografia Giurassico-Cretacica. *Ofioliti*, **12** (2), 261-342.

CORTESOGNO, L., GALBIATI, B., PRINCIPI, G. & VERCESI DEL CASTELLAZZO, G. (1981). Carta geologica delle ofioliti del Bracco tra Levanto e Velva. *S.E.L.C.A., Firenze.*

LANZAFAME, G., SPADEA, P. & TORTORICI, L. (1978). Provenienza ed evoluzione dei flysch cretacico-eocenici della regione calabro-lucana. II: Relazioni tra ofioliti e flysch calabro-lucano. *Ofioliti*, **3**, 189-210.

MARCUCCI, M., CONTI, M. & SPADEA, P. (1987). Radiolarian association in cherts from Timpa delle Murge (Lucanian Appennine, Italy). *Ofioliti*, **12** (2), 411-414.

MARCUCCI, M. & MARRI, C. (1990). Radiolarian assemblages in ophiolite sequences of southern Tuscany: new data. *Ofioliti*, **15** (1), 185-190.

MARCUCCI, M., PASSERINI, P. & SAGRI, M. (1982). Northern paleoapennine: subducion or scattered crumping?. *Modern Geology*, **8**, 107-113.

MARRONI, M. & PERILLI, N. (1992). Biostratigrafia a nannofossili calcarei del flysh ad elmintoidi di Ottone-S.Stefano (Appennino Ligure-Emiliano). *"L'Appennino Settentrionale"* - Riassunti del Convegno "Minerogenesi Appenninica". Società Geologica Italiana, Firenze 21-23 septembre 1992, 143.

NOZZOLI, N. (1986). Micropaleontological study of radiolarian cherts in the ophiolitic sequences south of Leghorn. *Ofioliti*, **11** (3), 339-342.

O'DOGHERTY, L., SANDOVAL, J., MARTIN-ALGARRA, A. & BAUMGARTNER, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

PASSERINI, P. (1965). Rapporti tra le ofioliti e le formazioni sedimentarie fra Piacenza e il Mar Tirreno. *Bolletino della Società Geologica Italiana*, **84** (5), 93-176.

PICCHI, F. (1985). Late Jurassic-Early Cretaceous ophiolite cover, Casellina M., Pise, Italy. *Ofioliti*, **10** (1), 77-80.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles,* 80 (**3**), 317-340.

VEZZANI, L. (1968). Rapporti tra ofioliti e formazioni sedimentarie nell'area compresa tra Viggianello, Francavilla sul Sinni, Terranova nel Pollino e S. Lorenzo Bellizzi. *Accademia Gioenia di Scienze Naturale di Catania, Supplemento di Scienze Geologica,* **19**, 109-144.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

MONTE VITALBA SECTION: bottom 1 - base 1
< 1 {0.35 m above the base}: 3216, 3171, 3139

RIPARBELLA SECTION: bottom 1 - top 3
< 3 {3 metres above the preceding sample}: 3087, 3064, 3624, 3171, 3116
< 2 {upper level}: 3092, 3064, 3215, 3160, 3171, 3022, 3115, 3117
< 1 {lower chert level at Il Terriccio}: 3064, 3013, 3111, 3106, 3104, 3181, 3682, 3055, 3118

QUERCIANELLA SECTION: bottom 1 - top 2
< 2 {1.6 metres below the top}: 3087, 3624, 3215, 3112, 3171, 3097
< 1 {Near the base}: 3106, 3160, 3161, 3658, 3642, 3096, 3117, 3113

SECTION MCCT_01_COSTA_SCANDELLA: bottom 1 - top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {AI3+AI4}: 3008, 3013, 3052, 3059, 3064, 3088, 3117, 3159, 3163, 3164, 3180, 3181, 3244

SECTION MC_01_CAPANNELLE: bottom 1 - top 1
{MC= Marcucci Marta}
< 1 {C1}: 3215, 3095, 3112, 3113, 3171, 3181, 4073

SECTION MCCT_01_MURLO: bottom 1 - top 2
{MC= Marcucci Marta. CT= Conti Maurizio}
< 2 {B4}: 3181, 3118 {Stichocapsa sp. 1, 3160, 3161, 3164, 3241, 3267
{Podobursa sp. 1 not codified}
< 1 {B1+B2}: 3263, 3017, 3116, 3122, 3160, 3161, 3164, 3181, 3241
SECTION MCCT_01_ROCCHETTA_DI_VARA: bottom 1 - top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {RV11}: 3161, 3095, 3118, 3197, 3230, 3267, 4072

SECTION MCCT_01_TIMPA_DELLE_MURGE: bottom 1 - top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {LC18}: 3008, 3013, 3052, 3095, 3159, 3161, 3166, 3180, 3181, 3244

SECTION MCCT_01_VAL_GRAVEGLIA: bottom 1 - top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {GR6}: 3008, 3017, 3033, 3035, 3062, 3063, 3064, 3088, 3096, 3100, 3103, 3110, 3113, 3117, 3121, 3123, 3133, 3135, 3139, 3140, 3159, 3160, 3161, 3166, 3169, 3176, 3180, 3181, 3210, 3216, 3218, 3221, 3230, 3243, 3267, 3274, 4006, 4010, 4027 {, 4033}, 4064

SECTION MC_01_ROMITO: bottom 1 - top 1
{MC= Marcucci Marta}
< 1 {SO3+SO5}: 3008, 3096, 3104, 3112, 3113, 3117, 3147, 3160, 3166, 3225, 3254, 3263, 4073

SECTION MC_01_SOVANA_ELMO: bottom 1 - top 2
{MC= Marcucci Marta}
< 2 {SOV6}: 3008, 3090, 3160, 3180, 3181, 3263
< 1 {SOV3}: 3088, 3064, 3096, 3097, 3117, 3121, 3139, 3160, 3166, 3180, 3181, 3216, 4069

MONTE ROSSOLA: bottom 1 - top 1
< 1 {Sample RS3}: 3008, 3210, 3215, 3633, 3636, 3254, 3110, 3181, 3180, 3035, 3661, 3667, 3135, 3139, 3133, 3197, 3100, 3169, 3244, 3020, 3062, 3697, 3124, 3123, 3096, 3117
IL CONVENTINO: bottom 1 - top 7
< 7 {CC 1}: 3624, 3160, 3658, 3161.
< 6 {CC 4}:3608, 3624, 3017, 3103, 3180, 3242.
< 5 {CC 10}: 3263, 3624, 4069, 3014, 3017, 3160, 3164
< 4 {CC 12}: 3088, 3263, 3624, 4069, 3017, 3634, 3181, 4062, 3677, 3241, 3689, 3697, 3122, 3655, 3242.
< 3 {CC 28}: 3263, 4069, 3017, 3112, 3292, 3164, 3697, 3642, 3117.
< 2 {CC 26}: 3263, 3677, 3241.
< 1 {CC 23}: 3263, 3658, 3171, 3681, 4034.

14. Radiolarian Biostratigraphy of the Tuscan Cherts (Tuscan Succession) from Val di Lima, Tuscany, Northern Apennines (Italy)

by Giuseppe Cortese

Dipartimento di Scienze della Terra, Università di Firenze, Via La Pira, 4, 50121 Firenze, Italy

ABSTRACT

Tuscan Cherts are the most important radiolarite formation of the Tuscan Sequence. The studied section yielded 6 samples with rich radiolarian assemblages. A latest Bajocian age can be deduced for the beginning of the Tuscan Chert deposition in the Lima Valley.

1. Geological framework

The Tuscan Succession was deposited, from the Triassic onwards, at the outer (western) part of the Adria continental margin (Channell *et al.*, 1979), whereas the Umbrian Succession had a more internal (eastern) position. Further to the west the Ligurid successions were deposited, partly at least, in the adjoining oceanic domain (Abbate *et al.*, 1980; Abbate *et al.*, 1986). These successions are now unrooted and stacked in the Apenninic nappe structure.

Siliceous deposition is recorded in Middle and Late Jurassic successions (Conti & Marcucci, 1991) and gave rise to the following formations: Monte Alpe Cherts (Val di Vara Supergroup), Tuscan Cherts (Tuscan Succession) and Calcari Diasprigni (Umbrian Succession). The Tuscan Cherts are the most important radiolarian-bearing formation of the Tuscan Succession. A distinct increase of the carbonate component upsection has been observed in several localities of Tuscany (including the Lima valley). This part of the section is referable to Rosso ad Aptici, as defined by Kälin *et al.* (1979) in Southern Tuscany.

In the Lima valley (Fig. 1) the erosion of an overturned anticline exposes the Tuscan Succession of Late Triassic to Oligocene age formations. Chert beds first appear in the upper part of the Posidonia Marls, a formation mainly constituted by marl, marly limestone and calcareous grainstone. These beds are known to contain poorly-preserved radiolarians which are, as yet, unstudied in any detail. The base of this formation has been dated as Toarcian in Southern Tuscany by ammonites (Fazzini *et al.*, 1968).

Whereas in many parts of Tuscany the Posidonia Marls lie directly below the Tuscan Cherts, in Val di Lima and neighbouring areas they are overlain by the Val di Lima Cherty Limestone, a calcareous turbidite formation with diagenetic chert nodules (Fig. 2).

2. Description of the section

The studied section is located to the NE of the village of Cappelle (Fig. 1), from 1035 to 1120 metres above sea level, at the southern flank of Monte Pratofiorito (Val di Lima, Lucca, Northern Tuscany).

The basal 23 metres yielded 5 samples (P2 to P6) with rich radiolarian assemblages (see Cortese, 1993). The adopted radiolarian biostratigraphic scheme is based on the biochronological scheme established by Baumgartner (1984, 1987), and revised by O' Dogherty *et al.* (1989).

The studied section is lithologically composed of:

Green cherts (from base of formation to 2 m.); strata are wavy, nodular, bedded and 3-5 cm. thick. Radiolaria are very rare and poorly-preserved. Ghosts of Radiolaria are present and most of them are pyritized or haematite-stained.

Red radiolarites (from 2 to 8m.); chert beds, a packstone with abundant Radiolaria, up to 15cm. thick. Shale partings are very thin (few mm.) and almost absent in the lower part of this unit, somewhat thicker (about 1 cm.) and more frequent in the upper part of the unit.

Two samples were collected from this interval (the reader is referred to the appendix for a detailed data-set of radiolarian faunas)

Sample P2 (2.4 m. above base of formation) of late Bathonian-early Oxfordiàn age according to the co-occurrence of:

Bernoullius sp.
Cinguloturris carpatica DUMITRICA
Mirifusus fragilis BAUMGARTNER trans. *guadalupensis* PESSAGNO.
Podobursa spinosa (OZVOLDOVA)
Podobursa triacanta (FISCHLI)
Ristola altissima (RÜST)
Tritrabs casmaliaensis (PESSAGNO)

Sample P3 (5.6 m.) late Bathonian in age according to the co-occurrence of:

Bernoullius dicera (BAUMGARTNER)
Paronaella kotura BAUMGARTNER
Tetraditryma praeplena BAUMGARTNER.

Clayey cherts alternating with siliceous shales (from 8 to 40.7 m.); they are porcellanite (*sensu* Jones & Murchey, 1986). The maximum thickness of chert strata is 10-15 cm. Vitreousness (SiO2/Clay ratio) increases 2-3 metres above the base of this unit. Mn-stains are widespread.

Three samples were collected from this interval (the reader is referred to the appendix for a detailed dataset of radiolarian faunas)

Sample P4 (9.8m.) late Bathonian-middle Callovian in age according to the co-occurrence of:

Tetraditryma praeplena BAUMGARTNER
Tritrabs ewingi (PESSAGNO)
Eucyrtidiellum ptyctum (RIEDEL & SANFILIPPO).

Sample P5 (18.5m.), late Callovian-early Oxfordian age according to the co-occurrence of:

Acaeniotyle diaphorogona FOREMAN
Napora pyramidalis BAUMGARTNER
Podobursa triacantha (FISCHLI)

Sample P6 (22.2m.) early Oxfordian age according to the co-occurrence of:

Podobursa spinosa (OZVOLDOVA)
Hsuum maxwelli PESSAGNO
Eucyrtidiellum unumaense ssp. (YAO).

Marly cherts (from 40.7 to 61 m.); pink to brown, alternating with pale red siliceous shales. Carbonate content becomes significant. The beds are 5-6 cm thick and recovered radiolarians are recrystallized and poorly-preserved.

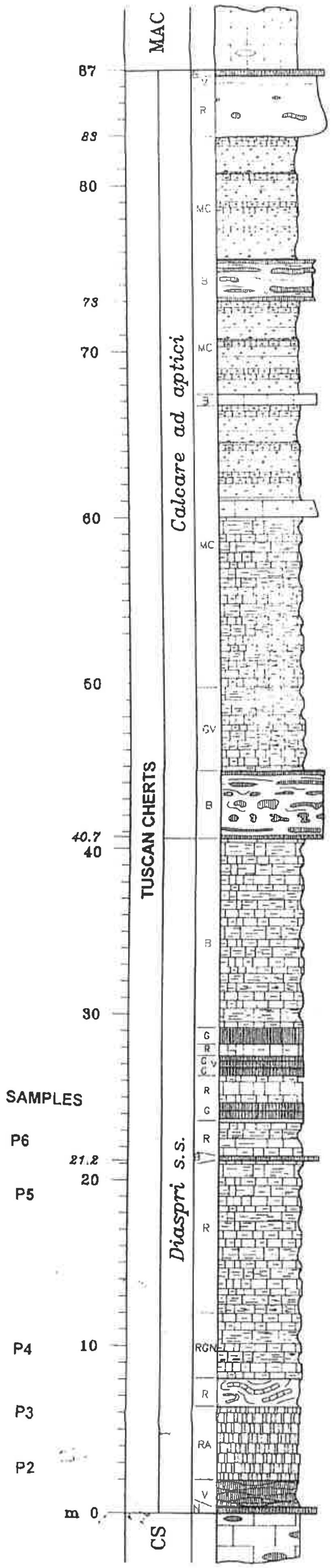
Siliceous marls (from 61 to 87 m., top of formation). Red siliceous marls with red chert nodules. An interval 4 m. thick marks the transition to Maiolica facies.

In addition to these lithologies there are three slump levels and/or carbonate strata:

- From 23.7 to 23.9m. siliceous slump conglomerate, containing black, red, green and violet chert fragments occurs. The boundary surfaces are wavy. Upsection from this member, radiolarites become more rare and clayey cherts prevail, showing an increase in grain diameter and in clay content.
- From 40.7 to 44.7m. calcilutites are present, laminated towards contacts, more chaotic in the middle, with rounded chert nodules (3 cm. in diameter) disposed along preferential directions. This member, 4 m. thick and stratigraphically continuous with underlying strata, marks the transition to the Rosso ad Aptici, siliceous shales with a little carbonate content increasing upsection.
- From 73 to 75.5m., the lithologies comprise calcilutite with rounded chert nodules. This member is similar to the one occurring at 40.7 m., but is less disturbed and laminations are evident.

The Tuscan Cherts, 40.7 m. thick, are dominantly siliceous; Rosso ad Aptici, 46 m. thick, overlying Tuscan Cherts, includes abundant carbonate. For further studies concerning the stratigraphy in this area the reader is referred to Aiello (1992).

Figure 1. Localization map of the Val di Lima section



References

ABBATE, E., BORTOLOTTI, V., CONTI, M., MARCUCCI, M., PRINCIPI, G., PASSERINI, P. & TREVES, B. (1986). Apennines and Alps ophiolites and the evolution of the western Tethys. *Memorie della Società Geologica Italiana*, **31**, 23-44.

ABBATE, E., BORTOLOTTI, V. & PRINCIPI, G. (1980). Apennine ophiolites: a peculiar oceanic crust. *Ofioliti, Special Issue*, **1**, 59-96.

AIELLO, I.W. (1992). Livelli guida nei diaspri della Serie Toscana nella Val di Lima ed aree adiacenti. *L'Appennino Settentrionale. Riassunti* - 76° Riunione estiva della Società Geologica Italiana, Firenze.

AITA, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

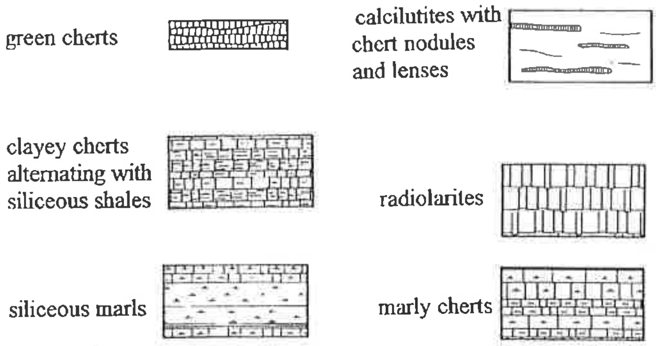


Figure 2. Lithological section of the Val di Lima section. **CS.** Val di Lima Cherty Limestone, **MAC.** Maiolica. **1.** Green cherts, **2.** Clayely cherts alternating with siliceous shales, **3.** Siliceous marls, **4.** Radiolarites, **5.** Marly cherts, **6.** Calcilutites with chert nodules and lenses, **N.** Black, **V.** Green, **R.** Red, **RA.** Orange-red, **M.** Brown, **MC.** Pale brown, **B.** White-pale grey, **G.** Yellow.

CHANNELL, J.E.T., D' ARGENIO, B. & HORVATH, F. (1979). Adria, the african promontory, in Mesozoic Mediterranean palaeogeography. *Earth Science Reviews*, **15**, 213-292.

CONTI, M. & MARCUCCI, M. (1991). Radiolarian assemblage in the Monte Alpe cherts at Ponte di Lagoscuro, Val Graveglia (eastern Liguria, Italy). *Eclogae Geologicae Helvetiae*, **84** (3), 791-817.

CORTESE, G. (1993). Radiolarian biostratigraphy of the Tuscan Cherts (Tuscan Succession) from Val di Lima, Tuscany, Northern Apennines). *Paleopelagos*, **3**, 165-185.

FAZZINI, P., PAREA, G.C. & MANTOVANI, M.P. (1968). Ricerche sul Mesozoico della Toscana a sud dell' Arno. *Memorie della Società Geologica Italiana*, **7** (2), 129-194.

JONES, D. & MURCHEY, B. (1986). Geologic significance of Paleozoic and Mesozoic radiolarian chert. *Annual Review of Earth and Planetary Sciences*, **14**, 455-492.

KÄLIN, O., PATACCA, E. & RENZ, O. (1979). Jurassic pelagic deposits from southeastern Tuscany: aspects of sedimentation and new biostratigraphic data. *Eclogae Geologicae Helvetiae*, **72** (3), 715-762.

O'DOGHERTY, L., SANDOVAL, J., MARTIN-ALGARRA, A. & BAUMGARTNER, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

TAKEMURA, A. (1986). Classification of Jurassic Nassellarians (Radiolaria). *Palaeontographica. Abteilung A: Palaozoologie-Stratigraphie*, **195** (1-3), 29-74.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

Section 1-Lima-Valley: bottom 1 - top 5

< 5 {P6 - 22.2 m.}: 3608, 3052, 3180, 3658, 3678, 3230, 3292, 3062, 3267, 3696, 3263

< 4 (P5 - 18.5 m}: 3090, 3911, 3658, 3033, 3169, 3677, 3678, 3292, 3241, 3655, 3166, 3117

< 3 {P4 - 9.8 m}: 3600, 3088, 5011, 3147, 6121, 3144, 3608, 3193, 4014, 3213, 3210, 3017, 3015, 3012, 5711, 3254, 3110, 3103, 3181, 3180, 3649, 3658, 3159, 3661, 3033, 3204, 3205, 3667, 3078, 4031, 3135, 4072, 3239, 3675, 3681, 3292, 3290, 4034, 3129, 3126, 3024, 3020, 3242, 4048, 3125, 3123, 3277, 3096, 3051, 3117, 3115, 3231, 3309, 5514, 3643, 5824, 3672, 3028, 3689, 3055, 3696, 3669, 4060, 3293

< 2 {P3 - 5.6 m}: 3065, 3610,3223, 4009, 4010, 3193, 5132, 3210 3216, 3254, 3658, 3204, 3078, 3140, 3139, 3672, 3028, 3126, 3242, 3123, 3096, 3117, 3116, 3118, 3603, 3212

< 1 {P2 - 2.4 m. above base of formation}: 3092, 3610, 3614, 3193, 3644, 3181, 3159, 3230, 3677, 3241, 3062, 3123, 3096, 4055, 3117, 3116,3603, 6006

15. Middle and Late Jurassic Radiolarian Biostratigraphy of the Colle Bertone and Terminilletto Sections (Umbria-Marche-Sabina Apennines, Central Italy): an Integrated Stratigraphical Approach

by Annachiara Bartolini[1, 2], Peter O. Baumgartner[1] and Emanuela Mattioli[2]

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Dipartimento di Scienze della Terra, Università di Perugia, Piazza dell' Universitá, 06100 Perugia, Italy

ABSTRACT

In the South-East Umbria-Marche-Sabina Apennines the Middle-Late Jurassic siliceous pelagic sediments contain abundant platform derived carbonate. These sediments are particularly suitable for an integrated stratigraphy based on radiolarians, calcareous nannofossils and stable isotope data. An apparently continuous 230 m section of cherty limestones at Monte Terminilletto (Rieti) allowed us to study a stratigraphic succession of radiolarian associations from Aalenian to Kimmeridgian-lower Tithonian. Radiolaria data are correlated to (a) two previously documented (Tonielli, 1991) and two new ammonite levels, (b) calcareous nannofossil biostratigraphy and (c) carbon isotope stratigraphy. A rich and stratigraphically continuous *Mirifusus* population allowed us to calibrate the first occurrence and the distribution of this genus.

1. Introduction

The Terminilletto section offered the exceptional opportunity to study the physical stratigraphic sequence of radiolarian associations for a time interval ranging from Middle Aalenian to Kimmeridgian. The cherty limestone lithology allowed us to use an integrated stratigraphical approach to calibrate the age of the radiolarian assemblages by means of ammonites, calcareous nannofossils and carbon isotope data.

The Aalenian-lower Bajocian samples of Terminilletto and Colle Bertone sections were directly calibrated by ammonites and calcareous nannofossils.

Calcareous nannofossil biostratigraphy was a useful tool to better define the chronostratigraphic range of radiolarian Unitary Associations (U.A.), where ammonites are lacking. In the last five years, Jurassic calcareous nannofossil events have been calibrated to ammonite zonations. Biostratigraphic schemes have been proposed in the Umbria-Marche area by Baldanza *et al.* (1990), Reale *et al.* (1991), Baldanza & Mattioli (1992) and Mattioli (1995). In the Lombardy basin, nannofossil stratigraphy has been studied by Cobianchi *et al.* (1991) and Cobianchi (1992), and for the Digne area of France by Erba (1990). Mattioli *et al.* (in press) are attempting to produce an updated biostratigraphical synthesis of calcareous nannofossil events of the Jurassic.

We analysed the carbon isotopes in micritic limestones and the results are discussed in detail in Bartolini *et al.* (in press). The $\delta^{13}C$ curve in the upper Toarcian-Kimmeridgian interval indicates positive anomalies that we have dated as lower-middle Bajocian, Callovian and middle Oxfordian. Analogous lower-middle Bajocian carbon isotope shifts were documented by Corbin (1994) in the section of Chaudon-Norante (Digne area, South-Eastern France), where it was perfectly calibrated by ammonites. The Chaudon-Norante section studied by Corbin (1994) yielded in fact an excellent Bajocian ammonite record (Pavia, 1973, 1983). The lower-middle Callovian and middle Oxfordian positive excursions were also recorded by

Jenkyns (in press) in the Camposilvano Section (Southern Alps, Italy) and the Chabrières Section (Southern France), both of which yielded ammonite levels. Bill *et al.*, (1995) found a $\delta^{13}C$ positive excursion in the *Transversarium* Zone (middle Oxfordian) in the platform carbonates of the Liesberg Beds Member of the Swiss Jura. A similar Upper Jurassic $\delta^{13}C$ trend has recently been reported by Weissert & Mohr (in press), from the Helvetic nappes of eastern Switzerland, and the middle Oxfordian (Birmensdorfer Schichten Formation) in the Swiss Jura. When the $\delta^{13}C$ curve is well-defined in shape and biostratigraphically calibrated it can be used as a stratigraphical correlation tool (Scholle & Arthur, 1980; Jenkyns *et al.*, 1994). Although further analysis will be needed to precisely define the Middle-Upper Jurassic $\delta^{13}C$ curve, we have used these preliminary isotope data to check our radiolarian calibration.

2. Geological setting

During the Mesozoic, the Umbria-Marche-Sabina (UMS) Basin of Central Italy was part of the southern continental margin of the Penninic branch of the Tethyan Ocean. During the Lower Liassic, a large carbonate shelf located in the Umbria-Marche-Sabina region became fragmented and drowned due to the intensified extensional tectonics related to continental rifting. Pelagic sedimentation then replaced the preceding neritic limestones. Differential subsidence of fault bounded blocks and overall low sedimentation rates favoured substantial paleoenvironmental differentiation in the UMS basin. The sea-floor became fragmented into depressed and elevated zones, characterized by pelagic sediments and differentiated on the basis of lithology and thickness (Colacicchi *et al.*, 1970; Colacicchi *et al.*, 1988). At this time neritic carbonate sedimentation persisted to the south of the UMS basin, in the adjacent Lazio-Abruzzi carbonate shelf.

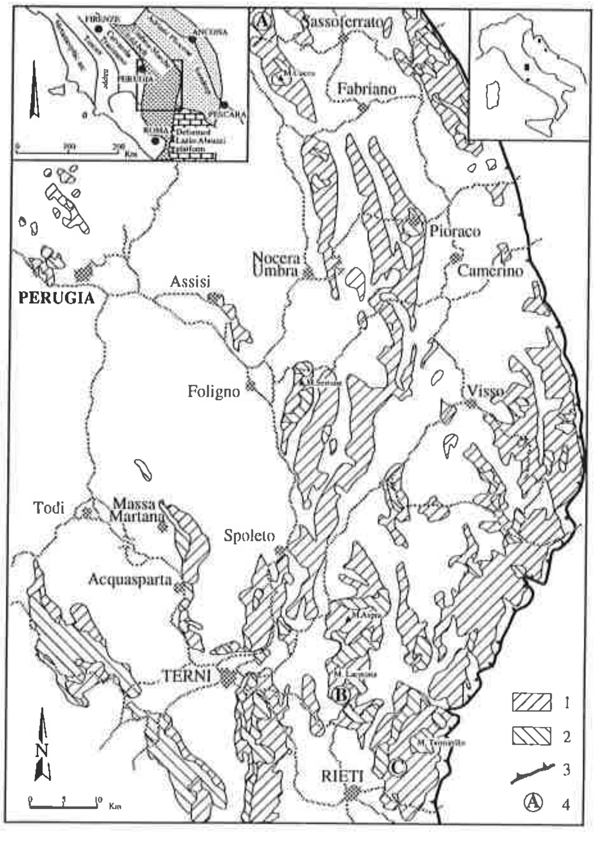


Figure 1. Simplified geological map of the Umbria Marche area with section locations. **1.** Jurassic pelagic sediments; **2.** Jurassic platform sediments; **3.** Overthrust; **4.** Studied sections: **B.** Colle Bertone Section, **C.** Terminilletto section.

The studied sections (Colle Bertone and Monte Terminilletto) crop out in the southern part of the Umbria-Marche-Sabina Apennines, proximal to the adjacent Lazio-Abruzzi platform (Fig. 1). Such areas were characterised by carbonate re-sedimentation from the platform, and probably by a stronger subsidence compared to the more internal basinal areas. For this reason, the successions studied are thicker and more calcareous than those from the more central part of the Umbria-Marche Basin, such as Valdorbia (Ponte Calcara-Valdorbia, Pesaro) and Bosso (Cagli-Pianello, Pesaro).

At Colle Bertone and M. Terminilletto, the basinal succession is well-developed and continuous from the Corniola Formation (Lower-Middle Lias) to the Maiolica Formation (upper Tithonian). The present study is focused on the Calcari e Marne a Posidonia (upper Toarcian-lower Bajocian), and the Calcari Diasprigni (lower Bajocian-lower Tithonian). These units represent, in the Umbria-Marche area, the lithostratigraphic interval in which radiolarians become more abundant and are better preserved. The Calcari e Marne a Posidonia are well-bedded limestones with occasional chert in nodules or ribbons, and frequent horizons of thin shelled bivalves (posidonids). The Calcari Diasprigni sediments are characterised by cherty limestones and interbedded cherts. The boundary between the two units can be placed where visible chert becomes more abundant (30-50%), and where bedding becomes thinner (15-20 cm) and more regular.

2.1. Colle Bertone section

The Colle Bertone section crops out on the south-western flank of Monte La Pelosa, along an unpaved track branching off the Polino-Colle Bertone road, shortly after the Fountain of Acquaviva. ("Foglio" 138, 1:100000, Carta Geologica d'Italia; "tavoletta" Poggio Bustone, 138 I S.E., 1:25.000).

The overall thickness of the section, from the base of the Corniola, to the upper part of the Calcari Diasprigni unit is estimated to be 610 metres. In the present work only the Calcari e Marne a Posidonia were studied (Fig. 2). Intraformational pebbly mudstones within the succession of Colle Bertone, particularly in the Corniola (Lower-Middle Lias) and the Calcari e Marne a Posidonia (upper Toarcian-Bajocian) indicate that this area was close to a paleoslope. The scarcity of resedimented carbonate platform debris suggests that the section was probably protected from direct platform input, however, the influx of periplatform ooze must have greatly diluted the background pelagic sedimentation.

The interval from 0.00 m to 43.00 m (lower portion of the Calcari a Posidonia, upper Toarcian-Bajocian) is characterised almost entirely by pale brown micritic limestones, rich in posidonid remains and in radiolarians. Centimetric greenish marly intercalations are also present. Bedding thickness ranges between 20 and 30 cm. Grey chert is found discontinuously as ribbons and nodules. Within the lower part of the unit resedimented beds, mainly intraformational pebbly mudstones, are largely composed of micritic limestone intraclasts rich in echinoderms and posidonids. The interval from 43.00 m to 69.00 m (upper portion of the Calcari a Posidonia, Bajocian) is constituted by whitish micritic limestones, containing posidonids and radiolarians. Bed thickness is about 15-20 cm. Grey-white chert is found regularly and continuously in ribbons ranging from a few to 20 cm in thickness. Chert becomes red from the 64.35 m upward. Resedimented beds and pebbly mudstones occur only occasionally upsection.

2.2. Monte Terminilletto section

The section is exposed along the E-SE side of Monte Terminilletto (Terminillo Group) and its base crops out along the road that leads from Terminillo to Campoforogna and to Sella di Leonessa ("Foglio" 139, 1:100000 scale, Carta Geologica d'Italia; "tavoletta" Monte Terminillo, 139 III N.O., scale 1:25.000).

During Jurassic time, the Terminillo Group was close to a series of N-S trending normal faults separating the Umbria-Marche-Sabin Basin from the Lazio-Abruzzi carbonate shelf (Castellarin *et al.* 1978; Cantelli *et al.* 1982). Within the pelagic units of this area, there are abundant carbonate detrital intercalations, mainly mass flows coming from the carbonate shelf. The M. Terminilletto section (Fig. 3) is more or less continuously exposed from the upper part of the Marne di Monte Serrone unit to the Maiolica, for a total thickness of about 515 metres.

The interval from 0.00 m to 40.00 m (lower portion of Calcari a Posidonia, lower-middle Aalenian) shows medium bedded (10-20 cm) pale brown micritic limestones, comprised of mudstones and wackestones with posidonids. Platform resedimentation consists of intercalations of oolitic grainstones 20-30 cm thick, with parallel and cross lamination, and rare pebbly mudstones. White chert is sporadically present (visible chert 0-5 %) in small nodules (2-3 cm in diameter).

The interval from 40.00 m to 110 m (middle portion of the Calcari e Marne a Posidonia, Aalenian to middle Bajocian) is mainly constituted by micritic limestone, with resedimented beds that decrease in abundance towards the upper part of the section. Bed thickness ranges around 5 cm. The visible chert content tends to rise (visible chert 10-15%), and occurs as nodules and thin, laterally continuous ribbons. Upwards from the 45 m level chert becomes red. From the 100 m level upwards resedimented oolitic grainstones, partially replaced by chert, are present.

The interval from 110 m to 160 m (upper portion of the Calcari e Marne a Posidonia, middle Bajocian to lower Bathonian) is characterised by light brown limestones with numerous resedimented beds. At 146 m, a thick resedimented lens-shaped body (11m) bearing ooids and bioclasts occurs. Chert tends to become sporadic and it disappears completely between 130 m and 160 m.

The interval from 160 m to 168 m (lower part of the Calcari Diasprigni, lower-upper Bathonian) is mainly constituted by thin beds (4-10 cm) of whitish micritic limestones, radiolarian bearing micrites with abundant red chert (30-40 %) in irregular nodules and ribbons. Sporadic levels of detrital oolitic white chert (16-18 cm) are found.

The interval from 168 m to 196 m (middle part of the Calcari Diasprigni, Bathonian to upper Oxfordian) consists of micritic limestones and greenish laminated cherty limestones, that are thinly stratified (2-8 cm), rich in radiolarians, and rhythmically alternating with varicoloured ribbon chert (40-50% visible chert). Chert is dominantly green in colour. Horizons bearing radiolarian and spiculitic sands are also present. Resedimented lens-shaped bodies of 3-5 m in thickness reappear abundantly, and are often comprised of ooids, crinoids and bioclasts coming from the carbonate shelf. Levels of detrital oolitic white chert are present.

The interval from 196 m to 256 m (upper part of the Calcari Diasprigni, upper Oxfordian-Kimmeridgian) is characterised by whitish radiolaria rich micritic limestones and fine-grained detrital pale brown limestones arranged in thin beds (8-10 cm) bearing ribbons and nodules of red chert. Up to the 236 m level chert is abundant (40-50 %), while the upper part of the outcrop (236 - 254.50 m) shows an evident decrease in chert content (visible chert 18-26%). Resedimented beds are mainly oolitic up to 220 m, and tend to become bioclastic above. At 244.80 m, a large detrital lens-shaped body of about 18 m in thickness is present.

3. Biostratigraphic data

3.1. Ammonites

Colle Bertone section.

In the Colle Bertone (CB) succession, an ammonite horizon was found at 34.95 m. It contains *Stephanoceras* sp., which indicates an early Bajocian age. The specimen shows signs of abrasion and has probably undergone transportation, however, its stratigraphic position within the succession is compatible with calcareous nannofossil data.

Terminilletto section.

At M. Terminilletto from T74 level, Tonielli (1991) recovered ammonites from the Leioceratid group and *Tmetoceras* sp. In the Umbria-Marche Appennines, *Tmetoceras* sp. has an occurrence acme in the upper part of *Comptum* Zone (lower Aalenian) and its range can be referred from lower Aalenian to middle Aalenian p.p. (lower part of *Murchisonae* Zone), depending on morphological features of the specimens (Cresta, pers. comm). The T74 level has been tentatively correlated to the first 10-11 metres of our Terminilletto lithologic log. The Aalenian-Bajocian boundary is placed by Tonielli (1991) at 141m, due to the presence of *Ebetoxites* sp., an ammonite referable to the *Laeviuscula* Zone (lower Bajocian). This level may be correlated to ~ 80 m in our log. In addition, a specimen of *Holcophylloceras* aff. *ultramontanum* ZITTEL, has been recovered at 8.10 m. The fossil is typical of the

Aalenian assemblages (Cresta, pers. comm).

3.2. Calcareous nannofossils

A total of 70 samples from the Colle Bertone Section and 113 samples from the Terminilletto section have been analysed. Calcareous nannofossils are almost always present in the studied samples although they are often rare. In both sections, the preservational state is poor in most of samples, to moderate in a few, depending on lithology. Seventeen events of primary biostratigraphical significance have been recognized in the Colle Bertone Section (Fig. 2) and twelve in the Terminilletto section (Fig.3). This succession of events is consistent throughout the Umbria-Marche Basin (Baldanza *et al.*, 1990; Reale *et al.*, 1991; Baldanza & Mattioli, 1992; Mattioli, 1995), the Lombardy Basin (Cobianchi *et al.*, 1992; Cobianchi, 1992) and the Digne area (Erba, 1990). In the cited papers each nannofossil event is correlated with an ammonite biohorizon. Some consistencies in the dating of the nannofossil events are present also within the Boreal realm, as shown from comparisons with the papers of Bown *et al.* (1988) and Bown *et al.* (in press). For a wider discussion and comparison of data originating from different palaeogeographic domains, the reader is referred to Mattioli *et al.* (in press). Most of the events recognised in the Colle Bertone and Terminilletto sections are therefore indirectly correlated with the ammonite biostratigraphy. In particular, the Aalenian-Bajocian boundary is well-defined on the basis of integrated calcareous nannofossil and ammonite biostratigraphies, as reported in the literature (Erba, 1990; Cobianchi *et al.*, 1991; Reale *et al.*, 1991; Cobianchi, 1992; Mattioli *et al.*, in press).

Colle Bertone Section.

1. Interval from 0 m to 16.20 m. In this interval total abundances of nannofossils range from few to common and the preservational states from poor to moderate. The most significant species in the assemblages from the base of the succession are: *Schizosphaerella* spp., *Lotharingius hauffii* GRÜN & ZWEILI, *Lotharingius crucicentralis* (MEDD) GRÜN & ZWEILI, *Lotharingius velatus* BOWN & COOPER, *Carinolithus superbus* (DEFLANDRE) PRINS, *Discorhabdus ignotus* (GORKA) PERCH-NIELSEN, *Discorhabdus striatus* MOSHKOVITZ & EHRLICH, and *Watznaueria* sp. 1. Some species characteristic of a Liassic age, such as *Mitrolithus jansae* (WIEGAND) BOWN & YOUNG, *Calyculus* spp., *Biscutum dubium* (NOËL) GRÜN, *Biscutum novum* (GOY) BOWN, have been recovered discontinuously, in some cases probably due to reworking. Two first occurrences (FO) have been detected: the FO of *Discorhabdus criotus* BOWN, at 9.60 m and of *Biscutum depravatum* (GRÜN & ZWEILI) BOWN, at 13.35 m, both characteristic of the late Toarcian, with respect to other Umbria-Marche successions (Mattioli *et al.*, in press). The last occurrence (LO) of *Biscutum dubium* is at 17 m.

2. Interval from 16.2 m to 20.85 m. Total abundance values are rare to few and the preservational state is poor. Because of the FO of *Watznaueria* sp. 1 in Mattioli, 1995 (16.2 m) and of *Watznaueria contracta* (BOWN & COOPER) COBIANCHI *et al.*, (16.2 m), the age of this interval can be restricted to the early Aalenian (Cobianchi *et al.*, 1992; Mattioli *et al.* in press).

3. Interval from 20.85 m to 26.8 m. Total abundances range from rare to common, the preservational state is always poor. At the base of this interval *Cyclagelosphaera margerelii* NOËL, first occurs (20.85 m). This event is characteristic of the middle Aalenian, both in Umbria-Marche and Lombardy basins (Baldanza & Mattioli, 1992; Cobianchi, 1992). At 21.15 m the FO of *Watznaueria* aff. *W. manivitae* in Cobianchi et al. (1991) and the last occurrence (LO) of *Mitrolithous jansae* were found. The LO of *Tubirhabds palutus* is at 26.8 m. The assemblage composition changes in this interval but the specimens characteristic of a Liassic age still persist. Nevertheless the assemblages tend to decrease and to be gradually substituted by

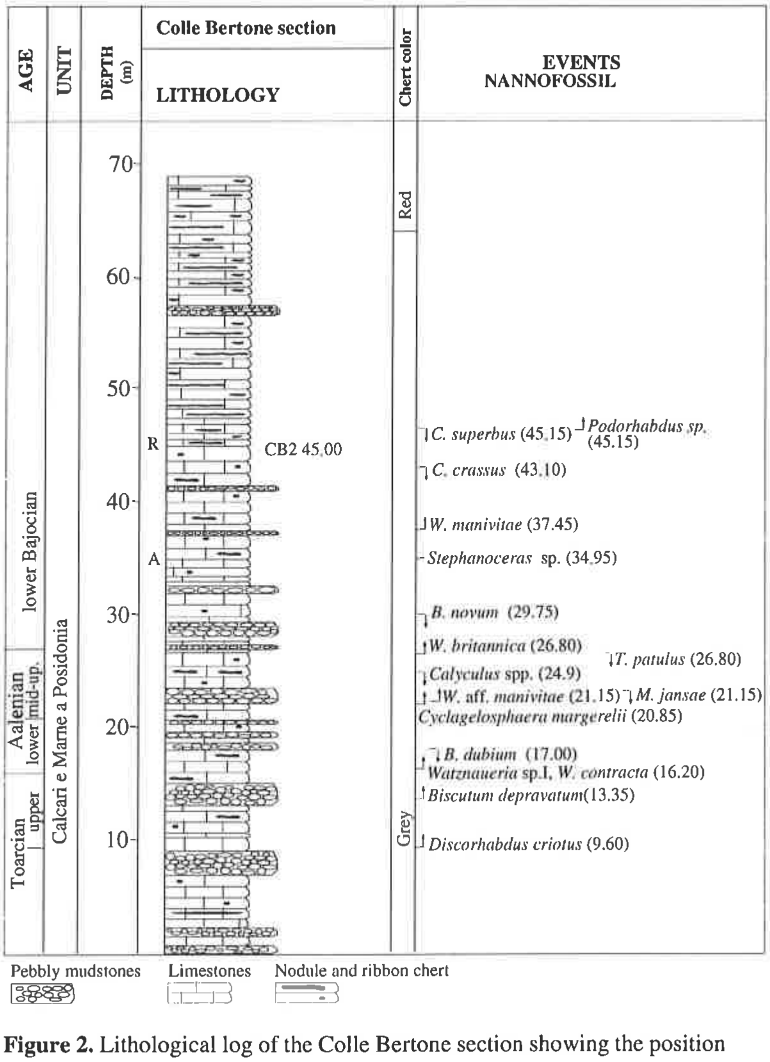


Figure 2. Lithological log of the Colle Bertone section showing the position of radiolarian samples (on the right), the nannofossil events and ammonite levels. **R.** presence of radiolarian at this level, **A.** presence of ammonite.

Watznaueriaceae.

4. Interval from 26.8 m to 37.45 m. The total abundances vary from rare to common and the preservational state is poor or moderate. The base of this interval can be attributed to the Lower Bajocian, due to the FO of *Watznaueria britannica* (STRADNER) REINHARDT, (26.80m), which can be considered as a marker for the Aalenian/Bajocian boundary (Mattioli *et al.*, in press). The LO of *Biscutum novum* is at 29.75 m.

5. Interval from 37.45 m to 45.15 m. In this interval total abundances are generally rare and common in only a few samples. Preservation is poor or moderate. The assemblage is composed almost exclusively of Watznaueriaceae and only a few specimens of *D. ignotus* are present discontinuously. The FO of *Watznaueria manivitae* is at 37.45 m. This event can be considered as characteristic of the middle part of the early Bajocian, because Erba (1990) and Cobianchi *et al.* (1992) found this species in the *Laeviuscula* Zone of the Digne area and Lombardy Basin, respectively. At 42.13 m the LO of *Crepidolithus crassus* was found.

6. Interval from 45.15 m to 69 m. The LO of *Carinolithus superbus* is at 45.15 m. Both in Tethyan and Boreal realms this event is reported by most authors from the upper Bajocian (Hamilton, 1979; Bown *et al.* 1988; Erba 1990). On the contrary Medd (1982) recorded this species within the upper Bathonian, from England.

Terminilletto section.

1. Interval from 0 m to 8.10 m. Total abundances range from common to very abundant and the preservational state is variable from very poor to moderate. The assemblage is characterised from the base by abundant *Schizosphaerella* spp. and subordinate *L. hauffi, C. superbus, D. ignotus, D. striatus, Watznaueria* sp. 1, *Watznaueria* sp. 1, *W. contracta* and *Hexalithus magharensis* MOSHKOVITZ & EHRLICH. The Liassic species become quite rare or disappear (LO of *B. finchii* at 3.84 m; LO of *Crepidolithus cavus* (ROOD) HAY & BARNARD at 6.00 m; LO of *B. dubium* and *T. patulus* REINHARDT at 8.00 m). This assemblage possibly indicates an early Aalenian age.

2. Interval from 8.10 m to 69 m. Total abundances are variable from rare to abundant and the preservational states vary from very poor to moderate. The FO of *C. margerelii* is at the base of this interval (8.10 m), indicating a middle Aalenian age. The assemblage of this interval and of the interval below is clearly Aalenian due in part to the presence of *Triscutum* spp., whose distribution is restricted to an early Aalenian-earliest Bajocian age in Portuguese and Moroccan successions (Bown *et al.*, 1988; De Kaenel & Bergen, 1993).

3. Interval from 69 m to 157 m. Total abundances are few and the preservational states are poor. The age of the base of this interval can be attributed to the early Bajocian, because of the FO of *W. britannica* (69.00 m), marker of the Aalenian/Bajocian boundary (Mattioli *et al.* 1995), was found.

4. Interval from 157 m to 165 m. Total abundances vary from rare to common, preservation is poor except in a few samples. The assemblages are dominated by the genus *Watznaueria*. The age of this interval is early Bathonian, because of the FO of *Watznaueria barnesae* (157.40 m). Erba (1990) found this event to be concomitant with ammonites of the *Zigzag* Zone (lower Bathonian) in the Digne area. At 157.40 m the LO of *C. superbus* was also observed. *Ansulasphaera helvetica*, commonly found at the Bathonian/Callovian boundary (Bown *et al.*, 1988), occasionally occurs.

5. Interval from 165 m to 180 m. The FO of *Cyclagelosphaera wiedmanni* REALE & MONECHI is at the base of this interval (165.22 m). According to the study of Reale & Monechi (1994), this species can be considered as an important biostratigraphical marker for the base of the Callovian. The assemblage composition is

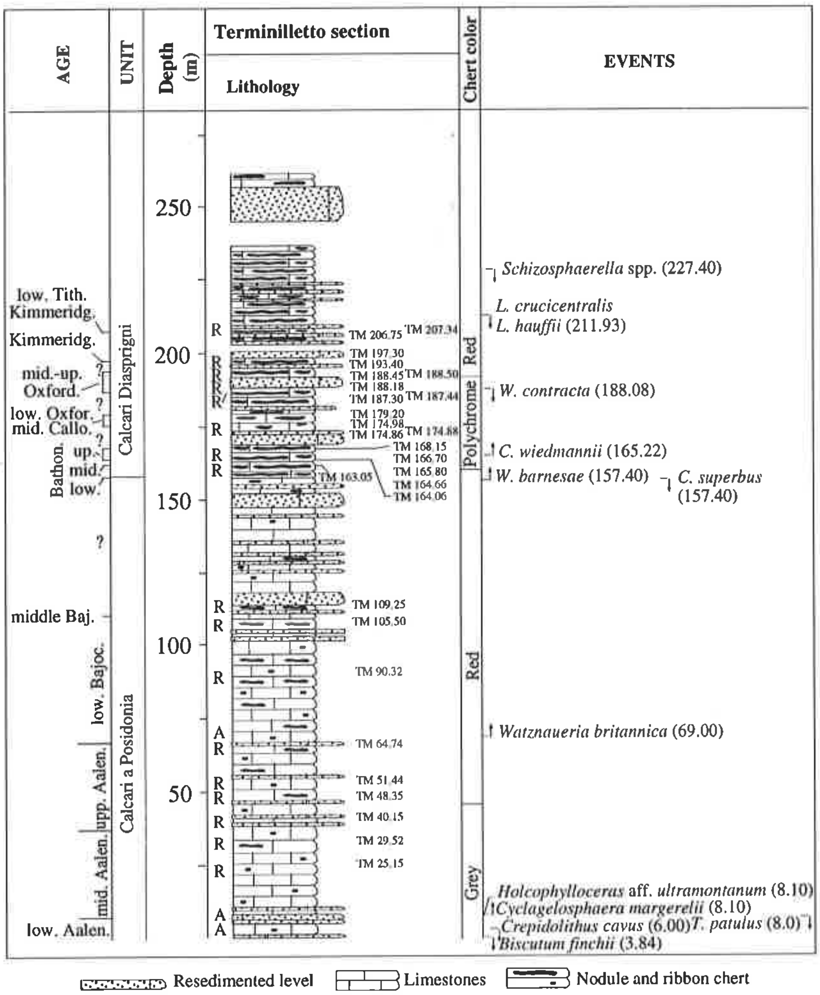


Figure 3. Lithological log of the Terminilletto section showing the position of radiolarian samples (on the right), the nannofossil events and ammonite levels. **R.** presence of radiolarian at this level, **A.** presence of ammonite.

very similar to that of the interval below. *Schizosphaerella* spp., which was continuously present (abundance common to few), becomes rare in this interval.

6. Interval from 180 m to 200 m. The assemblages are dominated by *W. britannica* and *W. manivitae*. Total abundance is sometime very high and preservation is occasionally moderate. *Watznaueria contracta* disappears at 188.08 m (middle Oxfordian based on radiolarian correlation). Erba (1990) noted this event in the *Garantiana* Zone (upper Bajocian) in the Digne area, while Bown & Cooper (1989) reported it in the *Macrocephalus* Zone (Callovian). On the basis of the present work, this event seems to be therefore younger. *Schizosphaerella* spp. has been observed discontinuously.

7. Interval from 200 m to 235 m. The assemblage composition is fairly monotonous in this interval, although some important disappearances have been noted. We found LO of *Lotharingius hauffii* and *L. crucicentralis* at 211.93 m and of *Schizosphaerella* spp. at 227.40 m. These taxa dominated the Lower and Middle Jurassic assemblages. *L. hauffii* and *L. crucicentralis* have been noticed in literature until the Middle Jurassic (see Mattioli et al. in press for a wider discussion). The disappearance of *Schizosphaerella* spp. is an event commonly referred to the early Kimmeridgian in the Boreal domain (Bown *et al.* 1988).

3.3. Radiolarians

In both the sections we selected samples which were mainly calcareous with nodules and thin ribbons of chert, or chert with micrite inclusions. Generally the best preserved radiolarians were found in the transitional zones between chert and micrite. The radiolarians were extracted using HCl 5%, and were further washed with a diluite solution of desogene. Finally, if the radiolarians were aggregated or encrusted, we treated them with HF 1-2 %. From about 600 samples we selected 31 (1 from the Colle Bertone Section and 30 from the Terminilletto Section) for a detailed taxonomic study (Figs. 2 and 3). Many samples showed good preservation and a total of 361 different taxa were identified (Bartolini, 1995). Of these taxa 175 are also included in the INTERRAD Jurassic-Cretaceous database. The distribution of the taxa in the samples is shown in Figure 6 and listed in the appendix of this chapter.

Colle Bertone Section.

Only one sample has been studied (CB2 45.00, lower Bajocian), which is characterised by the following assemblage: *Canotpus* sp. aff. *C. tipperi* PESSAGNO & WHALEN, *Transhsuum medium* TAKEMURA, *Linaresia beniderkoulensis* EL KADIRI, *Unuma echinatus* ICHIKAWA & YAO, *Unuma typicus* YAO, *Mirifusus proavus* TONIELLI, *Linaresia chrafatensis* EL KADIRI, *Parahsuum* (?) *hiconocosta* n.sp. BAUMGARTNER & DE WEVER, *Angulobracchia* cf. *A digitata* BAUMGARTNER, *Transhsuum hisuikyoense* (ISOZAKI & MATSUDA), *Parahsuum olorizi* (EL KADIRI), *Parahsuum natorense* (EL KADIRI), *Angulobracchia sicula* KITO & DE WEVER, *Emiluvia splendida* CARTER and *Dictyomitrella komaensis* MIZUTANI & KIDO.

Terminilletto section.

Rich radiolarian assemblages have been recovered from the Terminilleto section, which are listed in Figure 6. The taxa are arranged in order of their first and last occurrences. Correlation to standard chronostratigraphic stages is given in Figure 3. Unitary Associations (U.A.) refer to the protoreferential NMRD 40 (*Chapter* 32), and UA Zones (UAZ.) to the zonation presented in this book (*Chapter* 32).

1. Interval from TM 25.15 to TM 40.15 (U.A. 2-3, UAZ. 1, middle Aalenian based on calcareous nannofossils and ammonites of Terminilletto section). This interval is characterised by the co-occurence of *Parahsuum cruciferum* TAKEMURA, *Parahsuum grande* HORI & YAO, *Hexasaturnalis hexagonus* (YAO), *Hsuum matsuokai* ISOZAKI & MATSUDA. This interval yields some taxa in common with *Parahsuum grande* assemblage zone of Hori (1990) and with the middle-upper part of *Archicapsa pachyderma* and the lower part of *Laxtorum* (?) *jurassicum* zones of Matsuoka and Yao (1986). The FO of *Ristola praemirifusus* nsp. BAUMGARTNER & BARTOLINI is in the TM 29.52 sample. In the TM 40.15 sample the FO of *Unuma echinatus* ICHIKAWA & YAO and *Tetraditryma praeplena* BAUMGARTNER were found. The FO of *Unuma echinatus* marks the base of the 1B zone (lower Bajocian) in Pessagno & Mizutani (1992). *Tetraditryma praeplena* first occurs in the 11 zone (upper Callovian) in Pessagno et al. (1993). In the Terminilletto section we found these two events older (middle Aalenian) and in the same sample. Both the samples TM 29.52 and TM 40.15 show many taxa in common with sample C-156399 of Carter & Jacobs (1991), which was correlated to the NW European *Murchisonae* ammonite zone.

2. Interval from TM 48.35 to TM 64.74 (U.A. 5-8, UAZ. 2, middle-late Aalenian age based on calcareous nannofossils of Terminilletto section). *Parahsuum* (?) *magnum* TAKEMURA ranges into this interval. The co-occurrence of *T. hisuikyoense* (ISOZAKI & MATSUDA) and *U. echinatus* ICHIKAWA & YAO between the samples TM 51.44 and TM 64.74 allows a correlation with the middle-upper part of the *Laxtorum* (?) *jurassicum* Zone of Matsuoka & Yao (1986). In the TM 64.74 sample we observed the LO of *Ristola praemirifusus* and the FO of *Mirifusus proavus* TONIELLI. Moreover, in the TM 64.74 sample the LO of *Aceniotylopsis ghostensis* (CARTER) sensu KITO, *Triactoma jacobsae* CARTER and the FO of *Linaresia rifensis* (EL KADIRI), *Linaresia chrafatensis* EL KADIRI, *Parahsuum* (?) *hiconocosta* BAUMGARTNER & DE WEVER are present.

3. Interval from TM 90.32 to TM 109.25 (U.A. 9-12, UAZ. 3, early-middle Bajocian age based on calcareous nannofossils and ammonites of Terminilletto section). On the basis of the co-occurrence and abundance of *Unuma echinatus* ICHIKAWA & YAO and *Unuma typicus* ICHIKAWA & YAO a correlation with *Tricolocapsa plicarum* Zone (Middle Jurassic) of Matsuoka & Yao 1986 can be established. The TM 90.32 sample (lower Bajocian) records the FO of *Linaresia beniderkoulensis* EL KADIRI, *Transhsuum maxwelli* gr. (PESSAGNO) and the LO of *Parasaturnalis*. The LO of *Parasaturnalis* allow the correlation with the top of 1B zone of Pessagno et al. (1987), emendated by Pessagno & Mizutani (1992) as upper

Aalenian or lower Bajocian (*Concavum* Zone or *Discites* Zone). In the Terminilletto section this event falls in the lower Bajocian. On the other hand, Pessagno et al. (1993) correlated the FO of *Linaresia beniderkoulensis* with the 2δ subzone (middle Oxfordian) and the FO of *Transhsuum maxwelli* with the top of 2δ subzone (middle Oxfordian). In the Terminilletto section we found these events to be older (early Bajocian) and co-occurrent. The interval from TM 105.50 to TM 109.25 (middle Bajocian) is characterised by *Paronaella bandy* PESSAGNO, *Unuma latusicostatus* (AITA), *Hsuum* sp. cf. *H. mirabundum* PESSAGNO & WHALEN, *Mirifusus fragilis* BAUMGARTNER, *Paronaella kotura* BAUMGARTNER and *Palinandromeda praepodbielensis* (BAUMGARTNER). Most of the taxa of this interval occur in the middle-upper part of the *Tricolocapsa plicarum* Zone of Matsuoka & Yao (1986). In the sample TM 105.50 the FO of *Mirifusus fragilis* BAUMGARTNER was found. The FO of *M. fragilis* was attribuited to the lower part of lower Oxfordian by Pessagno et al. (1993). Baumgartner (1984, 1987) considered the FO of *M. fragilis* to be in the A0 zone, calibrated to late Bajocian and older according to O'Dorgherty et al. (1989). Matsuoka (1988) indicated the FO of *M. fragilis* in the middle part of *Tricolocapsa plicarum* zone (Middle Jurassic) of Matsuoka and Yao (1986). The data in this work assign a middle Bajocian age to this event. The TM 109.25 sample records the FO of *Mirifusus fragilis guadalupensis* nsp. BAUMGARTNER & BARTOLINI.

4. TM 163.05 sample (U.A. 24, UAZ. 6, middle Bathonian age based on calcareous nannofossils of Terminilletto section and on Spanish sections, see *Chapter 32*). This sample is characterised by the co-occurrence of *Mirifusus fragilis*, *Mirifusus fragilis guadalupensis*, *Mirifusus guadalupensis* PESSAGNO, *Angulobracchia purisimaensis* (PESSAGNO), *Higumastra* sp. aff. *H. inflata* BAUMGARTNER, *Eucyrtidiellum unumaense dentatum* nsp. BAUMGARTNER, *Bernoullius cristatus* BAUMGARTNER, *Stylocapsa tecta* MATSUOKA, *Stichomitra* (?) *takanoensis* gr. AITA, *Tetraditryma corralitosensis bifida* CONTI & MARCUCCI, *Amphipyndax durisaeptum* AITA.

5. Interval from TM 164.06 to TM 168.15 (U.A. 27-30, UAZ. 7, late Bathonian age based on Spanish sections, see *Chapter* 32). This interval is characterised by the co-occurrence of *Mirifusus fragilis*, *Mirifusus fragilis guadalupensis*, *Mirifusus guadalupensis*, *Ristola procera* (PESSAGNO), *Amphipyndax tsunoensis* AITA, *Triactoma brooksi* (PESSAGNO & YANG), *Pseudoristola nova* YANG & WANG, *Stichocapsa convexa* YAO, *Tetraditryma corralitosensis corralitosensis* (PESSAGNO), *Podobursa helvetica* (RÜST), *Pseudoeucyrtis* sp. J, *Staurolonche robusta* RÜST sensu PESSAGNO, *Ristola altissima major* n.sp. BAUMGARTNER & DE WEVER, *Leugeo hexacubicus* (BAUMGARTNER) and *Stichocapsa decora* RÜST. The TM 168.15 sample records the LO of *Mirifusus fragilis fragilis* and the FO of *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO). The FO of *Eucyrtidiellum ptyctum* is characteristic of the middle part of *T. conexa* zone of Matsuoka & Yao (1986). Pessagno et al. (1993) considered the FO of *Eucyrtidiellum ptyctum* as primary marker taxa of the top of 2δ subzone (middle part of middle Oxfordian). Moreover, the interval TM 163.05-TM 168.15 yields many taxa in common with the JO 34 sample of Pessagno et al. (1993) (base of the 2δ subzone), such as *Mirifusus fragilis*, *Mirifusus guadalupensis*, *Emiluvia premyogii* BAUMGARTNER, *Tritrabs ewingi* (PESSAGNO), *Achantocircus suboblongus* (YAO), and *Emiluvia hopsoni* PESSAGNO.

6. Interval from TM 174.86 to TM 174.98 (U.A. 41-44, UAZ. 8, middle Callovian-early Oxfordian age based on Spanish sections, see *Chapter 32*) This interval is characterised by the co-occurrence of *Eucyrtidiellum ptyctum* (RIEDEL &SANFILIPPO), *Turanta flexa* PESSAGNO & BLOME, *Monotrabs plenoides* BAUMGARTNER, *Acaeniotilopsis variatus variatus* (OZVOLDOVA), *Emiluvia premyogii* BAUMGARTNER, *Emiluvia orea orea* BAUMGARTNER, *Triactoma cornuta* BAUMGARTNER. In the 174.98 sample the LO of *Emiluvia premyogii* BAUMGARTNER and *Turanta* spp. were found. Pessagno et al. (1993) indicated the LO of *Emiluvia premyogii* as secondary marker taxa of the top of subzone 2γ (middle Oxfordian) and the LO of *Turanta* of that of the upper part of subzone 3α (lower Tithonian). In the Terminilletto section these two events are older (middle Callovian-early Oxfordian) and co-occur.

7. TM 179.20 sample (U.A. 41-47, U.A.Z. 8) corresponds to the middle Callovian-lower Oxfordian, correlation based on Spanish and Italian sections (Chapter 32). In this sample the FO of *Mirifusus fragilis* s.l. and *Obesacapsula morroensis* PESSAGNO are present.

8. Interval from TM 187.30 to TM 187.44 (U.A. 50-52, UAZ. 9, middle Oxfordian based on correlation with Spanish and Italian sections, see Chapter 32). This interval is characterised by the co-occurrence of *Triactoma tithonianum* RÜST, *Triactoma cornuta* BAUMGARTNER, *Ristola procera* (PESSAGNO),. *Parvicingula mashitaensis* MIZUTANI, *Sethocapsa* (?) *sphaerica* (OZVOLDOVA), *Ristola altissima altissima* (RÜST), *Dibolachras chandrika* KOCHER. In the sample TM 187.44 the FO *Mirifusus dianae dianae* (KARRER), *Mirifusus dianae baileyi* PESSAGNO, *Podobursa* (?) sp. *aff. P. quadriaculeata* STEIGER and the LO of *Ristola procera* (PESSAGNO) were found. Pessagno et al. (1993) considered the FO of *Mirifusus* with two rows of pores between ridges as selected secondary taxa of subzone 2γ (middle Oxfordian). This events is in agreement with the Terminilletto data. In any case, Pessagno et al. 1993 distinguished the FO of *Mirifusus dianae dianae* (subzone 2γ, middle Oxfordian) and the FO of *Mirifusus dianae baileyi* (primary taxon of the base of subzone 3β, Kimmeridgian/Tithonian boundary), while in the Terminilletto section they co-occur.

9. Interval from TM 188.18 to TM 193.40 (U.A. 50-54, UAZ. 9, middle-upper Oxfordian, correlation based on Spanish and Italian sections, see chapter 32). The FO of *Podobursa spinosa* and the LO of *Mirifusus guadalupens* and *Transhuum maxwelli* are in the sample TM 192.44. Pessagno *et al.* (1993) considered the FO of *Podobursa spinosa* characteristic of the upper part of 2γ subzone (middle Oxfordian), the LO of *Transhuum maxwelli* as the selected secondary marker taxon of the upper part of subzone 3α (lower Tithonian), and the LO of *Mirifusus guadalupens* as the primary marker taxon of the top of

Subzone 3β (lower Tithonian). In the Terminilletto section we found these event co-occurring in the same middle-late Oxfordian in age sample.

10. TM 197.03 and TM 197.30 samples (U.A. 58-59, UAZ. 11, Kimmeridgian, correlation based on Spanish and Italian sections, *Chapter 32*). This interval is characterised by the co-occurrence of *Sethocapsa dorysphaeroides* NEVIANI sensu SCHAAF, *Acanthocircus suboblungus minor* nsp. BAUMGARTNER, *Mirifusus dianae dianae* (KARRER), *Mirifusus dianae minor* nsp. BAUMGARTNER, *Suna echiodes* (FOREMAN), *Triactoma blakei* PESSAGNO, *Angulobracchia biordinalis* OZVOLDOVA & SYKORA, *Wrangellium okamurai* (MIZUTANI), and *Obesacapsula verbana* (PARONA). In the sample TM 197.30 the FO of *Emiluvia orea ultima* n.sp. BAUMGARTNER & DUMITRICA and the LO of *Mirifusus dianae dianae* were found.

11. Interval from TM 206.75 to 207.34 (U.A. 62, UAZ. 11, upper Kimmeridgian-lower Tithonian, correlation based on Spanish sections, see *Chapter 32).* The FO of *Podocapsa amphitreptera* FOREMAN and *Syringocapsa* sp. aff. *S. coronata* STEIGER are in the sample TM 206.75.

4. Integrated stratigraphical calibration

In this paragraph we correlate our samples to the chronostratigraphy. This integrated stratigraphy is based on the calibration with other fossil groups present in the studied sections, as well as on the isotope stratigraphy.

- TM 25.15 (U.A. 2, UAZ. 1) falls in the middle Aalenian because of the calibration of the ammonites and calcareous nannofossils. At 8.10 m in the Terminilletto Section the occurrence of *Holcophylloceras* aff. *ultramontanum* ZITTEL indicates an Aalenian age and the FO of *C. margerelii* is characteristic of the middle Aalenian.

- TM 64.74 (U.A. 8, UAZ. 2) may be attributed to the uppermost part of the Aalenian. The FO of *W. britannica* at 69 m in Terminilletto Section indicates the Aalenian/Bajocian boundary. Our data do not allow precise location of the boundary between the middle and upper Aalenian ages in the Terminilletto Section.

- TM 90.32 (U.A. 9, UAZ. 3) and CB2 45.00 (U.A. 13, UAZ. 3) can be referred to the lower Bajocian by means of an integrated study of ammonites, calcareous nannofossils and positive carbon isotope data. In the Colle Bertone and Terminilletto Sections we observed a positive carbon shift (Fig. 4) in the lower-middle Bajocian interval (Bartolini *et al.* in press). The increase of $\delta^{13}C$ values in the Colle Bertone Section starts about 7 m below the FO of *W. manivitae*, relative to the *Laeviuscula* Zone (ammonite) according to Erba (1990), Cobianchi *et al.* (1992) and Mattioli *et al.* (in press) (Fig. 2). In the Terminilletto section $\delta^{13}C$ values increase from 80 m upwards from the *Laeviuscula* zone on the basis of ammonites recovered (Tonielli, 1991) (Fig. 4). The early Bajocian carbon isotope excursion observed in the UMS Basin correlates with an analogous excursion reported from the Digne area, on the northern Tethyan margin (Corbin, 1994) (Fig. 5). The Chaudon-Norante Section studied by Corbin (1994) yielded an exceptional Bajocian ammonite record (Pavia 1973, 1983) and it was also studied by means of calcareous nannofossils (Erba, 1990). The $\delta^{13}C$ values in the Chaudon-Norante section increase in the lower part of the *Laeviuscula* Zone and reach maximum values in the upper part of the *Sauzei* Zone and then decrease from the upper part of the *Humphresianum* Zone (Corbin, 1994). Sample TM 90.32 falls within the $\delta^{13}C$ value maximum measured in the Terminilletto section (Fig. 4) and CB2 45.00 is situated about 1.5m up the $\delta^{13}C$ value maximum measured in the Colle Bertone Section (Figs. 2 and 4).

- TM 105.50 and TM 109.25 (U.A. 11 and U.A. 12, UAZ. 3) can be attributed to the middle Bajocian by means of an integrated biostratigraphy between ammonites, calcareous nannofossils and positive carbon isotope data. In the Terminilletto Section $\delta^{13}C$ values decrease up to 110 m (Fig. 4). In the Chaudon-Norante section the decrease of $\delta^{13}C$ values is recorded in the ammonite *Humphresianum* Zone (Fig. 4).

- In the interval from 110 m to 163 m of the Terminilletto Section, the absence or rarity of visible chert prevented the recovery of well-preserved radiolarian samples. Our data do not allow us to precisely locate the boundary between middle and upper Bajocian. We do not think that upper Bajocian is entirely missing due to a stratigraphical gap in this section. Sediments with a thickness about 48 m are, in fact, present between the middle Bajocian and lower Bathonian. A stratigraphical gap would be demonstrated by the absence of both sediments and biostratigraphic data.

- TM 163.05 sample (U.A. 24, UAZ. 6) may be attributed to the lower-middle Bathonian interval. Calcareous nannofossil data of the Terminilletto section allow identification of the lowermost Bathonian sediments on the basis of the FO of *Watznaueria barnesae* at 157.40 m.

- TM 164.06-TM 168.15 (U.A. 27-31, UAZ. 7) may be assigned to the late Bathonian. At TM 165.22 *Cyclagelosphaera wiedmannii* first occurs, and it become continuosly present in the assemblages from TM 174.86 upward. Reale & Monechi (1994) found the FO of *Cyclagelosphaera wiedmannii* in the sample (127-2-31-31 cm, Hole 534A in the North Atlantic). This event is calibrated by ammonites in the Quissac Section (SE France) as being basal Callovian. The TM 163.05-TM 168.15 interval can be also correlated with the lowermost part of the DSDP Hole 534A in the North Atlantic by means of radiolarians (Chapter 32). In any case, the correlation with radiolarian U.A. calibrated by ammonites in the Sierra de Ricote, Casa Blanca and La Martina Sections (O'Dogherty *et al.*, this volume), should prove a middle-late Bathonian age. In Tethyan sections *Cyclagelosphaera wiedmannii* seems to become common and occurs continuously from the basal Callovian upwards.

- TM 174.86, TM 174.88 and TM 174. 98 samples (U.A. 41-44, UAZ. 8) fall in a second evident positive shift of the $\delta^{13}C$ curve, which we have referred to a Callovian age by means of radiolarian U.A. correlation. An analogous positive carbon isotope shift was recorded by Jenkyns (in press) in the Camposilvano Section (Southern Alps, Italy), where the carbon-isotope ratios rise through the Callovian to reach a peak in the lower-middle part of the stage and fall

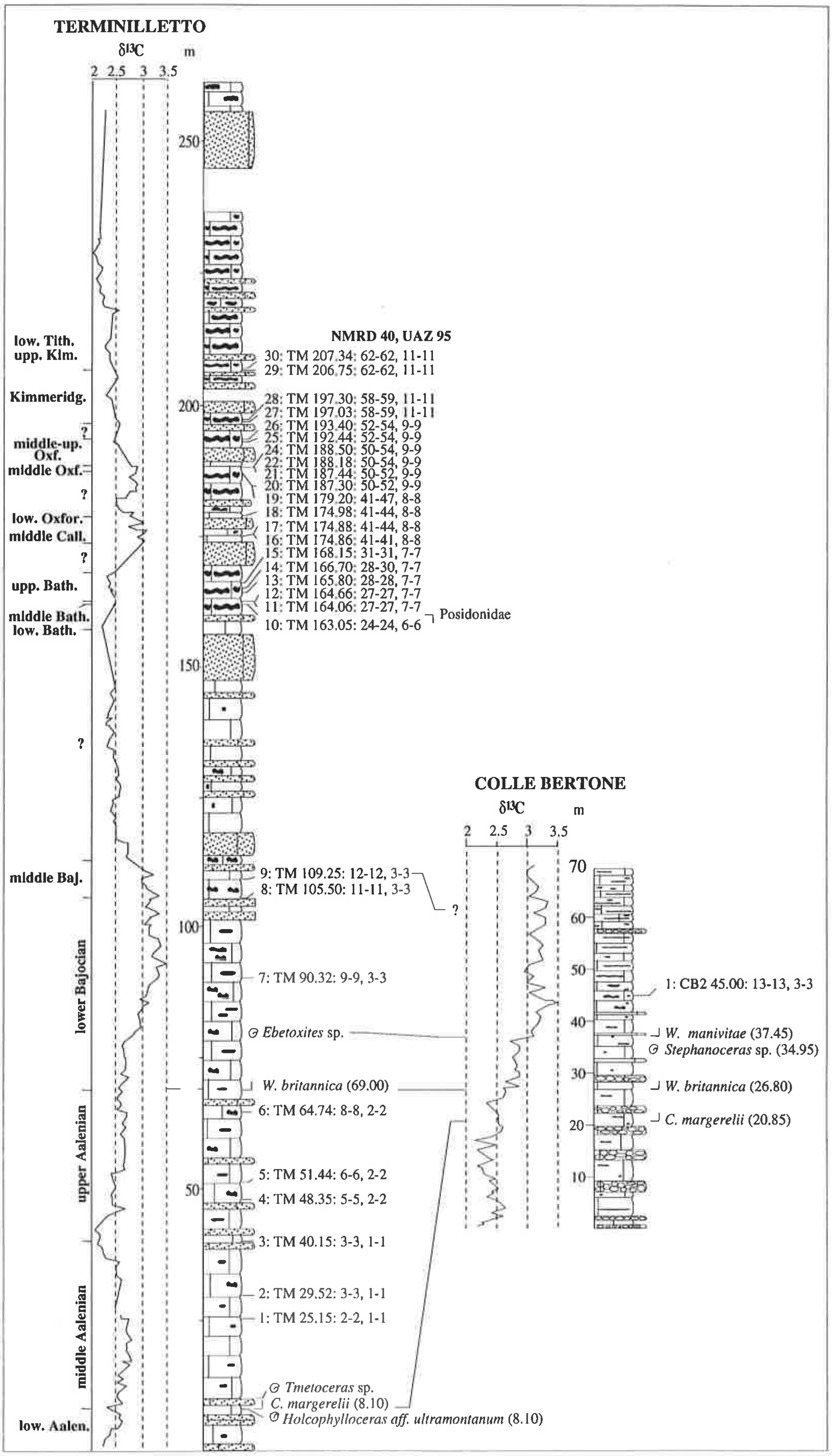


Figure 4. $\delta^{13}C$ curve at Colle Bertone and Terminilletto section. The correlation is based on radiolarians, calcareous nannofossils and ammonites. The main nannofossil events and the radiolarian samples serving for correlation are shown.

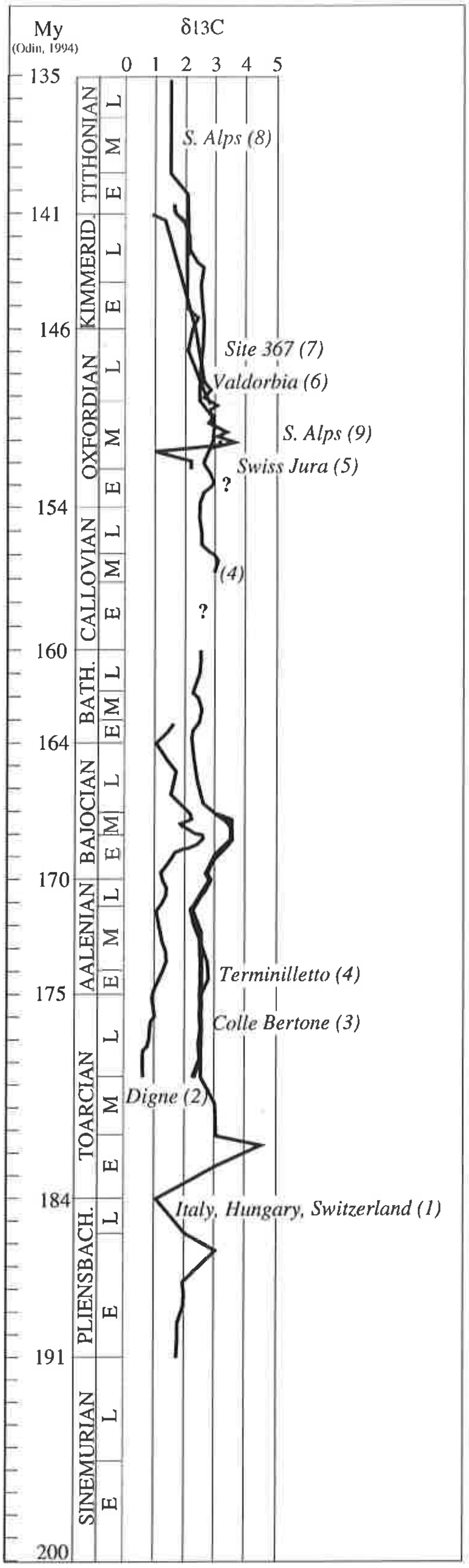


Figure 5. Tentative correlation between the observed carbon isotope events and previously published ones. (1) Jenkyns (1988), Jenkyns *et al.* 1991); (2) Corbin (1994); (3) and (4) this chapter; (5) Bill *et al.* (1995); (6) Haidji (1991); (7) Brenneke (1978); (8 and 9) Weissert & Channell (1989). Timescale after Odin (1994) informal substage division after Gradstein *et al.* (1994).

back slightly in the upper Callovian (*Athleta* Zone). The Camposilvano Section yields abundant early-middle Callovian ammonite fauna, but the high condensation of the sediments does not allow determination of the zonal interval (Clari *et al.* 1984).

- TM 187.30 and TM 187.44 (U.A. 50-52, UAZ. 9) fall in an evident positive shift of the $\delta^{13}C$ curve (Fig. 5), that we have assigned to middle Oxfordian, by radiolarian U.A. correlation. Jenkyns (in press) documents a clear $\delta^{13}C$ positive excursion in the *Transversarium* ammonite Zone from Chabrières Section (Southern France) and Camposilvano and Rovere Veronese Sections (North Italy). Analogous middle Oxfordian *(Transversarium* Zone) $\delta^{13}C$ positive shift was documented by Bill *et al.* (1995) and Weissert & Mohr (in press) in the Swiss Jura mountains and in the Helvetic nappes of eastern Switzerland respectively (Fig. 5).

5. The FO of *Mirifusus* spp.

The FO of *Mirifusus* spp. is one of the most "critical points" to correlate the Middle-Late Jurassic radiolarian zonal scheme proposed for the Nord America by Pessagno and coworkers (Pessagno 1977a; Pessagno et al. 1984, 1987b, 1989, 1993), and that proposed for the low-latitude Tethyan area by Baumgartner (1984, 1987), see *Chapter* 32.

Pessagno et al. (1987b, 1993), Pessagno & Blome (1990) and Pessagno & Mizutani (1992) defined the FO of *Mirifusus* spp. (*Mirifus fragilis* and *Mirifusus guadalupensis*) as primary marker taxa of the boundary between the superzone 1 and zone 2, placed in lower Oxfordian. Baumgartner (1984, 1987) showed the FO of *Mirifusus* spp. (*Mirifusus fragilis*) in zone A0, calibrated in age as late Bajocian and older by O'Dogherty et al. (1989). Tonielli (1991) attributed a late Aalenian (?)-early Bajocian age to the FO of *Mirifusus* spp. (*Mirifusus provus*). The data presented in this work determined that the FO of *Mirifusus* spp. *(M. proavus)* falls in the upper part of upper Aalenian (TM 64.74) and the FO of *Mirifusus fragilis* falls in the middle Bajocian (TM 105.50), on the basis of ammonites, calcareous nannofossils and carbon-isotope data. Pessagno & Blome (1990) insisted in having found the earliest occurrence of *Mirifusus* spp. along the Middle Fork of the Smith River at Harper's locality 1, in volcanopelagic strata 17.60 m (JO 34 sample) above the contact with the Josephine ophiolite. On the basis of the exposed data of the Terminilletto section, the event described by Pessagno & Blome (1990) and Pessagno et al. (1993) does not represent the "absolute" FO of *Mirifusus* spp., because they found the FO of *Mirifusus fragilis* and *Mirifusus guadalupensis* together at the base of zone 2. In the Terminilletto section the FO of *Mirifusus fragilis* (TM 105.50, middle Bajocian) and the FO of *Mirifusus guadalupensis* (TM 163.05, middle Bathonian) are two well differentiated events. Our interpretation of the Smith River section is that the lower end of the ranges of *Mirifusus fragilis* and *Mirifusus guadalupensis* are lacking due to paleobiogeographic, paleoecologic or preservational reasons. Based on the co-occurrence of *Mirifusus fragilis* s.l. and *Mirifusus* *guadalupensis* we correlate the interval between samples JO 34 and JO 73 of the Smith River Section (i.e. the base of zone 2, Pessagno et al. 1993) with the interval from TM 163.05 to TM 179.20 (UAZ. 6-8) of Terminilletto section, consequently this interval would be of middle Bathonian to middle Callovian-early Oxfordian age.

6. Conclusions

By means of an integrated stratigraphic approach in the Terminilletto and Colle Bertone sections we were able to calibrate the radiolarian associations in the Aalenian-Bajocian interval. The Aalenian/Bajocian boundary was especially well defined. Generally, we found a good agreement between biostratigraphic age detemination provided by ammonites and calcareous nannofossils and ages provided by the radiolarian correlation.

The FO of *Mirifusus fragilis* and *Mirifusus guadalupensis* were found as well differentiated events in the Terminilletto section, in the middle Bajocian and in the middle Bathonian, respectively . Based on the co-occurrence of *M. fragilis* and *M. guadalupensis*, JO 34-JO 73 interval of the Smith River Section (subzone 2δ, base of zone 2) of Pessagno et al. (1993) were correlated with TM 163.05-TM 179.20 interval (U.A.Z. 6-8), ranging from middle Bathonian to lower Oxfordian. The zone 2 of Pessagno et al. (1993) would be, therefore, partially overlapping with the superzone 1, as illustrated in figure 11 of the *Chapter* 32, this volume.

Acknowledgements

The first author gratefully acknowledges the fellowship support of CNR/Swiss National Science Foundation (n. 83I-043698).

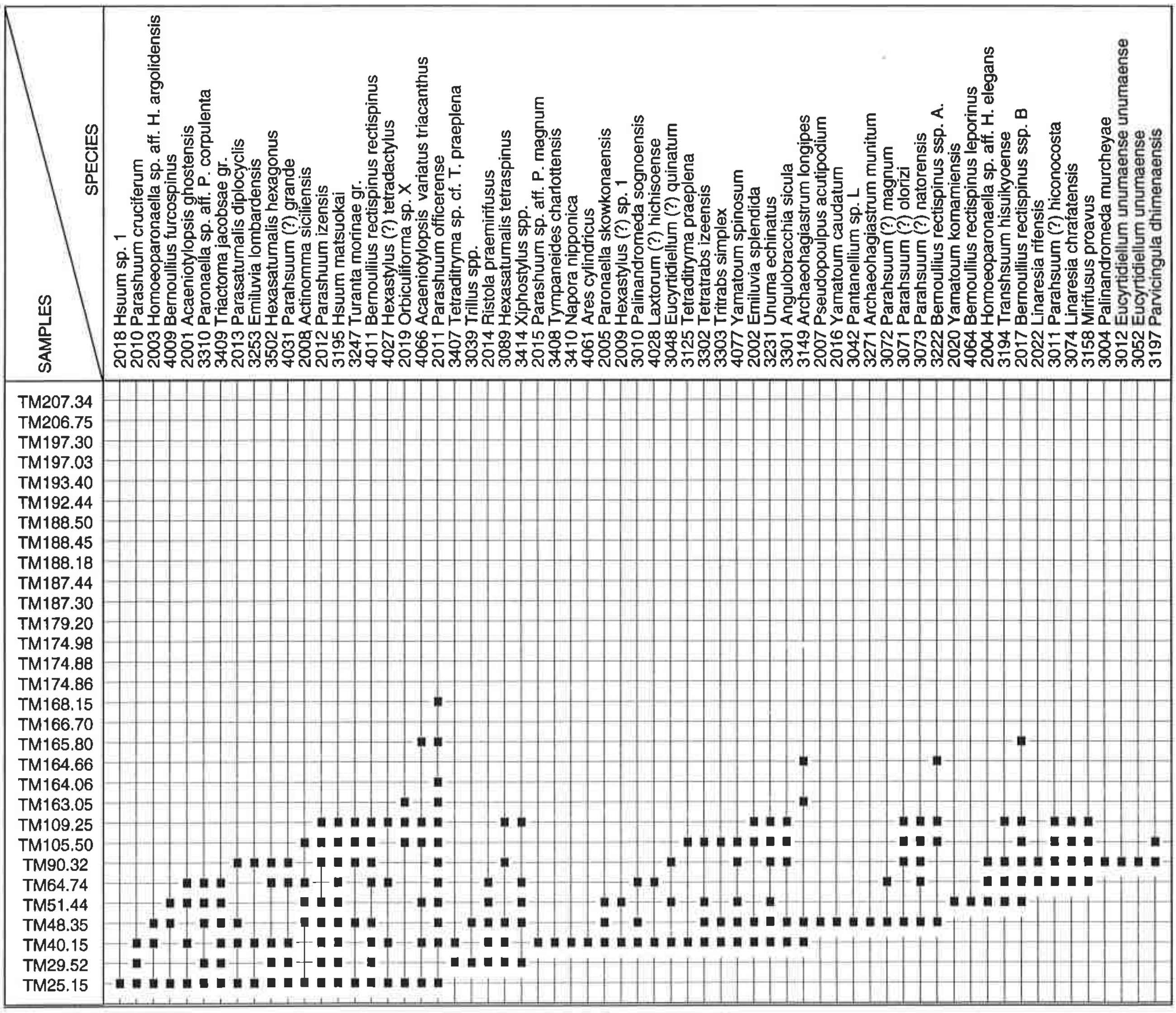


Figure 6. Occurrence of radiolarians species in the Terminilleto Section arranged in order of their first and last occurrences. Correlation to standard chronostratigraphic stages is given in Fig. 3.

References

Baldanza, A., Cresta, S. & Mattioli, E. (1990). Bajocian calcareous Nannofossils from Umbro-Marchean Apennines (Monte Nerone area). *In* Cresta, S. & Pavia, G. Eds. *Proccedings of Meeting on Bajocian Stratigraphy* - Memorie Descrittive della Carta geologica d'Italia. **40**, 225-236.

Baldanza, A. & Mattioli, E. (1992). Biozonazione a Nannofossili Calcarei del Giurassico Inferiore-Medio della Provincia Mediterranea (Dominio Tetideo): revisione ed ampliamento. *Paleopelagos*, **2**, 69-77.

Bartolini, A. (1995). *Stratigrafia isotopica ed evoluzione dei radiolari e dei foraminiferi nel Giurassico dell'Appennino Umbro-Marchigiano-sabino: una nuova chiave di lettura per l'interpretazione delle radiolariti.* Ph.D. Thesis. Università di Perugia (Unpublished)

Bartolini, A., Baumgartner, P.O. & Hunziker, J. (in prep). Middle and Upper Jurassic Carbon stable-isotope stratigraphy and radiolarite sedimentation of the Umbria-Marche basin (Central Italy).

Bill, M., Baumgartner, P.O., Hunziker, J.C. & Sharp, Z.D. (1995). Carbon isotope stratigraphy of the Liesberg Beds Member (Oxfordian, Swiss Jura) using echinoids and crinoids. *Eclogae Geologicae Helvetiae*, **88** (1), 135-155.

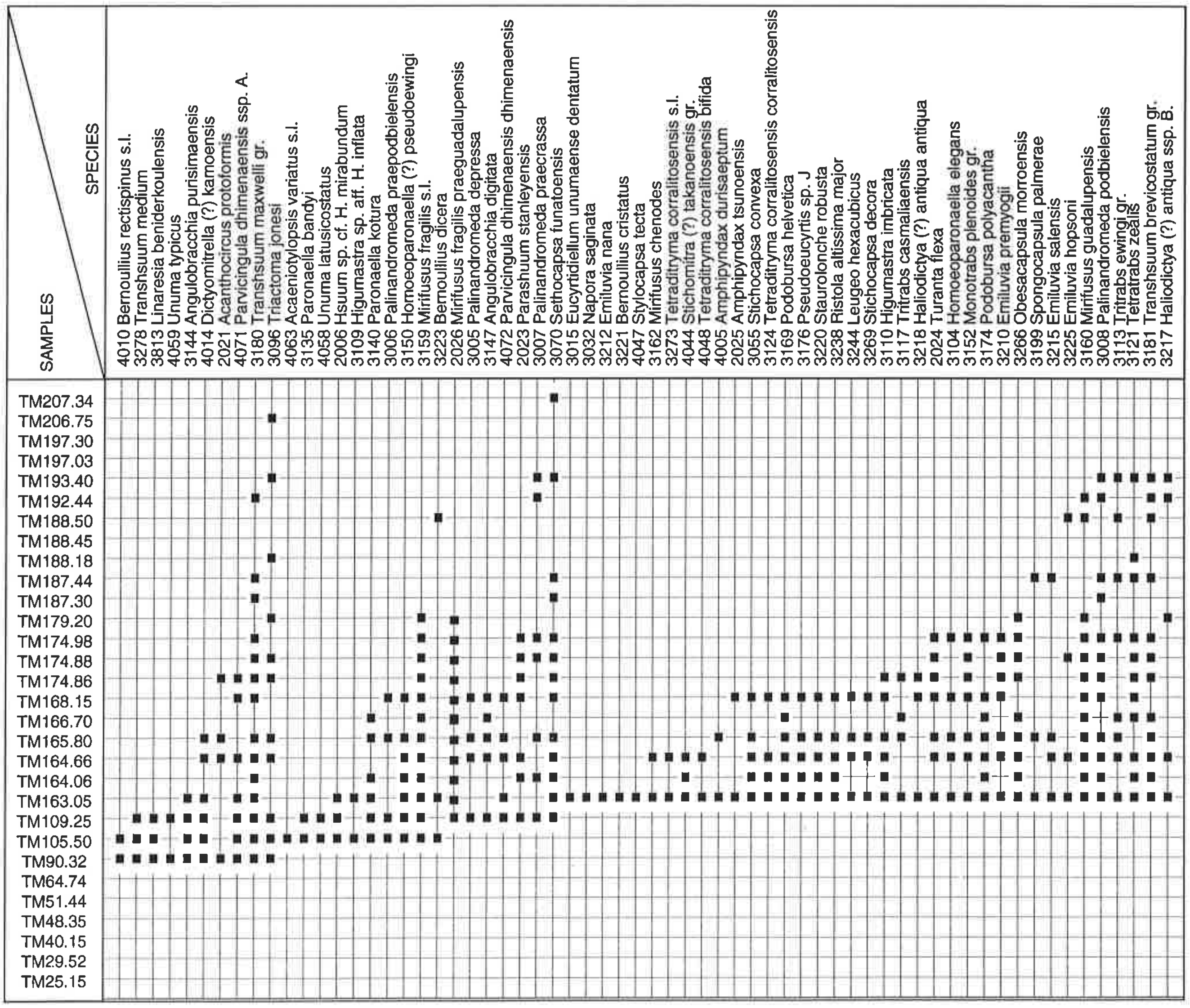


Figure 6. continued

BOWN, P.R. (1987). Taxonomy, Evolution and biostratigraphy of the Late Triassic-Early Jurassic calcareous nannofossils. Paleont. Ass. Special Paper, *Paleontology*, **38**, 118.

Bown, P.R. & Cooper, K.E. (1989). New calcareous nannofossil taxa from the Jurassic. *Journal of Micropaleontology*, **8** (1), 91-96.

BOWN, P.R., COOPER, K.E. & LORD, A.R. (1988). A calcareous nannofossil biozonation scheme for the early to middle Mesozoic. *Newsletters on Stratigraphy*, **20** (2), 91-114.

BOWN, P.R. *et al.* (in press). Recent advances in Jurassic calcareous nannofossil research.

BRENNECKE, J.C. (1978). A comparison of the stable oxygen and carbon isotope composition of the Early Cretaceous and late Jurassic carbonates from DSDP Sites 105 and 367. *In* Lancelot, Y., Seibold, E. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D. C., **41**, 937-955.

CANTELLI, C., CASTELLARIN, A., COLACICCHI, R. & PRATURLON, A. (1982). La scarpata tettonica Mesozoica lungo il settore nord della "linea Ancona-Anzio". *Memorie della Società Geologica Italiana*, **24** (5), 149-153.

CASTELLARIN, A., COLACICCHI, R. & PRATURLON, A. (1978). Fasi distensive, trascorrenze e sovrascorrimenti lungo la linea "Ancona-Anzio" dal Lias medio al Pliocene. *Geologica Romana*, **17**, 161-189.

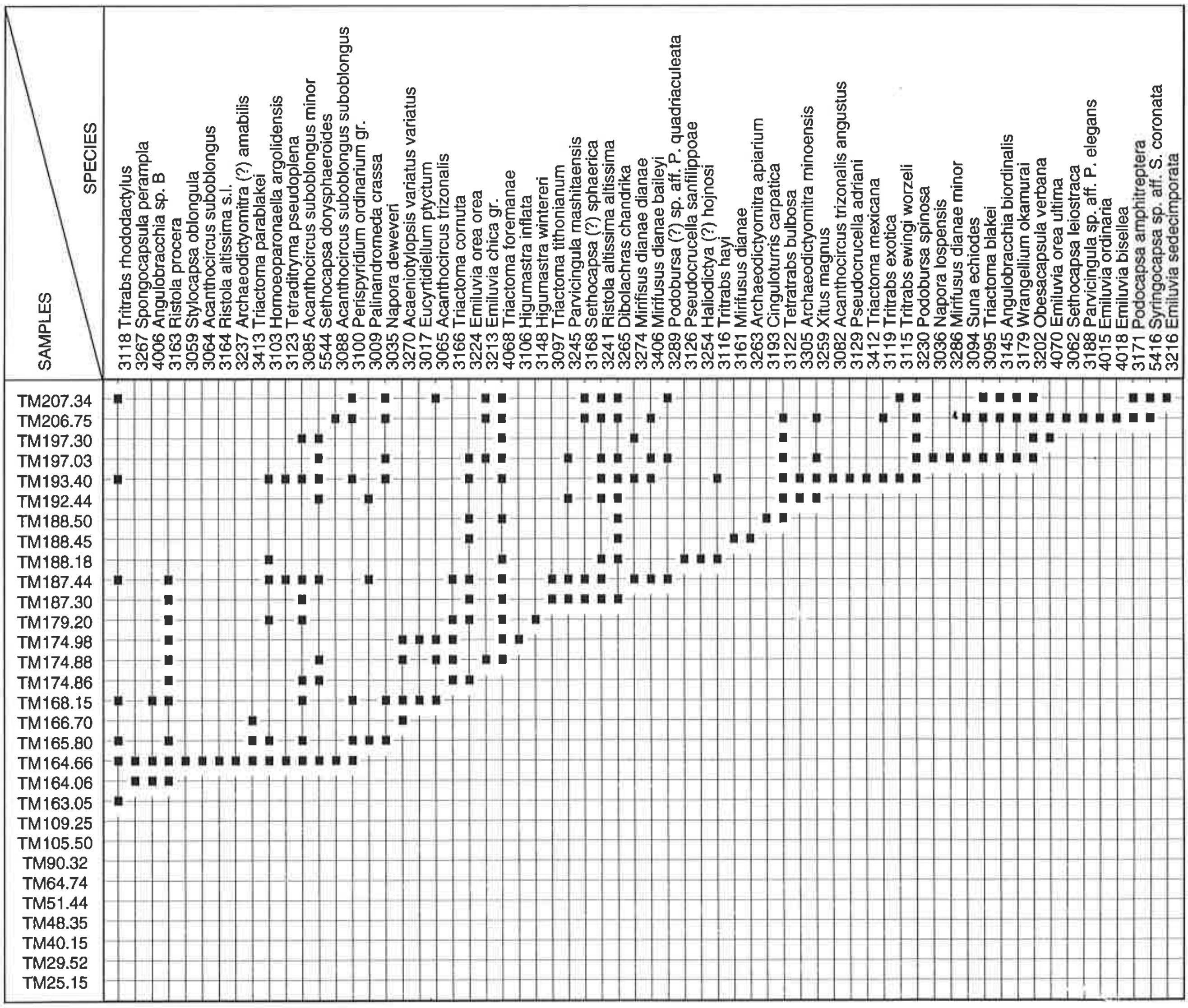


Figure 6. continued

CLARI, P.A., MARINI, P., PASTORINI, M. & PAVIA, G. (1984). Il Rosso Ammonitico Inferiore (Baiociano-Calloviano) nei Monti Lessini Settentrionali (Verona). *Rivista Italiana di Paleontologia e Stratigrafia*, **90** (1), 15-86.

COBIANCHI, M. (1992). Sinemurian-Early Bajocian calcareous nannofossil biostratigraphy of the Lombardy Basin (Southern Calcareous Alps; Northern Italy). *Atti Ticinense di Scienze della Terra*, **35**, 61-106.

COBIANCHI, M., ERBA, E. & PIRINI RADRIZZANI, C. (1992). Evolutionary trends of calcareous nannofossil genera Lotharingius and Watznaueria during the Early and Middle Jurassic. *Memorie di Scienze Geologica, Padova*, **43**, 27-40.

COLACICCHI, R., NOCCHI, M., PARISI, G., MONACO, P., BALDANZA, A., CRESTA, S. & PALLINI, G. (1988). Palaeoenvironmental analysis from Lias to Malm (Corniola to Maiolica Formations) in the Umbro-Marchean Basin, Central Italy (Preliminary report). *In* Rocha, R.B. & Soares, A.F. Eds. *Proceeding of the 2nd International Symposium on Jurassic Stratigraphy*, Lisbon, **2**, 717-728.

COLACICCHI, R., PASSERI, L. & PIALLI, G.P. (1970). Nuovi dati sul Giurese Umbro-marchigiano ed ipotesi per un suo inquadramento regionale. *Memorie della Società Geologica Italiana*, **9**, 838-874.

CORBIN, J.C. (1994). *Evolution géochimique du Jurassique du Sud-Est de la France: influence des variations du niveau marin et de la tectonique*. Ph.D. Thesis (n° 94-12). Département de Géologie sédimentaire. Université Pierre et Marie Curie (Unpublished), Paris, 175 p.

DE KAENEL, E. & BERGEN, J.A. (1993). New Early and Middle Jurassic coccolith taxa and biostratigraphy from the eastern proto-Atlantic (Morocco, Portugal and DSDP Site 547 B). *Eclogae Geologicae Helvetiae*, **86** (3), 861-907.

ERBA, E. (1990). Calcareous nannofossil biostratigraphy of some Bajocian sections from the Digne area (SE France). *Memorie Descrittive della Carta Geologica d'Italia*, **40**, 237-256.

GRADSTEIN, F.M., AGTERBERG, F.P., OGG, J.G., HARDENBOL, J., VAN VEEN, P., THIERRY, J. & HUANG, Z. (1994). A Mesozoic time scale. *Journal of Geophysical Research, Series B, Solid Earth and Planets*, **99** (B12), 24051-24074.

HADJI, S. (1991). *Stratigraphie isotopique des carbonates pelagiques (Jurassic supérieur-Crétacé inférieur) du Bassin d'Ombrie-Marches (Italie)*. Ph.D. Thesis (n° 91-23). Géologie de Bassins Sédimentaires. Université Pierre et Marie Curie (Unpublished), Paris.

HAMILTON, G. (1979). Lower and Middle Jurassic calcareous nannofossils from Portugal. *Eclogae Geologicae Helvetiae*, **72** (1), 1-18.

JENKYNS, H.C. (1988). The Early Toarcian (Jurassic) anoxic event: stratigraphic, sedimentary, and geochemical evidence. *American Journal of Science*, **288**, 101-151.

JENKYNS, H.C. (in press). Relative sea-level change and carbon isotopes: data from the Upper Jurassic (Oxfordian) of central and Southern Europe. *Terra Nova*.

JENKYNS, H.C., GALE, A.S. & CORFIELD, R.M. (1994). Carbon- and oxygen-isotope stratigraphy of the English Chalk and Italian Scaglia and its palaeoclimatic significance. *Geological Magazine*, **131** (1), 1-34.

JENKYNS, H.C., GÉCZY, B. & MARSHALL, J.D. (1991). Jurassic Manganese Carbonates of Central Europe and the Early Toarcian Anoxic Event. *Journal of Geology*, **99**, 137-149.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

MATTIOLI, E. (1995). *Bacino Umbro Marchigiano: Produttività primaria, Preservazione ed effetti della Diagenesi*. Ph.D. Thesis. Università di Perugia (Unpublished)

MATTIOLI, E., ERBA, E. & REALE, V. (in press). Biostratigraphic synthesis of calcareous nannofossil events from Jurassic. *Rivista Italiana di Paleontologia e Stratigrafia*.

MEDD, A.W. (1982). Nannofossil zonation of the English middle and upper Jurassic. *Marine Micropaleontology*, **7**, 73-95.

ODIN, G.S. (1994). Geological Time scale. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **318**, 59-71.

PAVIA, G. (1973). Ammoniti del Baiociano superiore di Digne (Francia SE, Dip. Basses-Alpes). *Bollettino della Società Geologica Italiana*, **10** (2), 75-142.

PAVIA, G. (1983). Ammoniti e biostratigrafia del Baiociano inferiore di Digne (Francia SE, Dip. Alpes-Haute-Provence). *Museo Regionale di Scienze Naturali di Torino, Monografia*, 1-254.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

Reale, V., Baldanza, A., Monechi, S. & Mattioli, E. (1991). Calcareous nannofossil biostratigraphic events from the Early-Middle Jurassic sequences of the Umbria-Marche area. *In* Rio, D. & Proto-Decima, F. Eds. *Procedings of the International Nannofossils Association Meeting* - Memorie della Società Geologica di Padova, Florence, **43**, 41-76.

Reale, V. & Monechi, S. (1994). *Cyclagelosphaera wiedmannii* new species, a marker for the Callovian. *Journal of Nannoplankton Research*, **16** (3), 117-119.

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Scholle, P.A. & Arthur, M.A. (1980). Carbon Isotope Fluctuations in Cretaceous Pelagic Limestones: Potential Stratigraphic and Petroleum Exploration Tool. *Bulletin of the American Association of Petroleum Geologists*, **64** (1), 67-87.

Tonielli, R. (1991). Associazioni a radiolari dei "Calcari e Marne a Posidonia" del Monte Terminilletto (RI). *Paleopelagos*, **1**, 18-37.

Weissert, H. & Channell, J.E.T. (1989). Tethyan carbonate carbon isotope stratigraphy across the Jurassic-Cretaceous boundary: an indicator of decelerated Global Carbon Cycling?. *Paleoceanography*, **4**, 483-494.

Weissert, H. & Mohr, H. (in press). Late Jurassic climate and its impact on carbon cycling. *Palaeogeography, Palaeoclimatology, Palaeoecology.*

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991). Sample numbers are given in parenthesis (see Figs. 2 and 3 for the stratigraphic position of the samples in different sections).

SECTION1_TERMINILLETTO: bottom 1 - top 30
< 30 {TM 207.34}: 3035, 3065, 3070, 3095, 3100, 3115, 3118, 3145, 3168, 3171, 3179, 3202, 3213, 3216, 3230, 3241, 3265, 3289, 4068, 5416
< 29 {TM 206.75}: 3035, 3062, 3088, 3094, 3095, 3096, 3100, 3119, 3122, 3145, 3168, 3171, 3179, 3188, 3202, 3213, 3230, 3241, 3259, 3265, 3406, 4015, 4018, 4068, 4070, 5416
< 28 {TM 197.30}: 3085, 3122, 3202, 3230, 3274, 4068, 4070, 5544
< 27 {TM 197.03}: 3035, 3036, 3094, 3095, 3122, 3145, 3179, 3202, 3213, 3224, 3230, 3241, 3245, 3259, 3265, 3286, 3289, 3406, 4068, 5544
< 26 {TM 193.40}: 3007, 3008, 3035, 3070, 3082, 3085, 3096, 3100, 3103, 3113, 3115, 3116, 3118, 3119, 3121, 3122, 3123, 3129, 3181, 3217, 3224, 3230, 3241, 3259, 3265, 3274, 3305, 3406, 3412, 4068, 5544
< 25 {TM 192.44}: 3007, 3008, 3009, 3122, 3160, 3180, 3181, 3217, 3241, 3245, 3259, 3265, 3305, 5544
< 24 {TM 188.50}: 3113, 3122, 3160, 3181, 3193, 3223, 3224, 3225, 3265, 4068
< 23 {TM 188.45}: 3161, 3224, 3263, 3265
< 22 {TM 188.18}: 3121, 3265, 3096, 3254, 3103, 3241, 4068, 3116, 3126
< 21 {TM 187.44}: 3008, 3009, 3070, 3085, 3097, 3103, 3113, 3118, 3121, 3123, 3163, 3166, 3168, 3180, 3181, 3199, 3215, 3224, 3241, 3245, 3274, 3289, 3406, 4068, 5544
< 20 {TM 187.30}: 3008, 3070, 3085, 3097, 3163, 3168, 3180, 3181, 3224, 3241, 3245, 3265, 4068
< 19 {TM 179.20}: 3085, 3096, 3103, 3148, 3159, 3160, 3163, 3166, 3217, 3224, 3266, 4068
< 18 {TM 174.98}: 2023, 2024, 3007, 3008, 3017, 3065, 3070, 3104, 3106, 3113, 3121, 3152, 3159, 3160, 3163, 3166, 3174, 3180, 3210, 3266, 3270, 4068
< 17 {TM 174.88}: 2023, 2024, 3007, 3008, 3065, 3070, 3096, 3121, 3152, 3159, 3160, 3163, 3166, 3180, 3181, 3210, 3213, 3225, 3266, 3270, 4068, 5544
< 16 {TM 174.86}: 2021, 2023, 2024, 3008, 3070, 3085, 3096, 3110, 3117, 3121, 3152, 3159, 3160, 3163, 3166, 3180, 3181, 3210, 3218, 3224, 3266, 4071, 5544
< 15 {TM 168.15}: 2011, 2023, 2024, 2025, 3005, 3006, 3008, 3017, 3035, 3055, 3065, 3070, 3085, 3100, 3104, 3110, 3117, 3118, 3121, 3124, 3147, 3150, 3152, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3210, 3218, 3220, 3238, 3244, 3269, 3270, 4006, 4071, 4072
< 14 {TM 166.70}: 3113, 3121, 3140, 3147, 3159, 3160, 3169, 3174, 3266, 3270, 3413
< 13 {TM 165.80}: 2011, 2017, 2021, 2024, 3005, 3006, 3007, 3008, 3009, 3035, 3055, 3070, 3085, 3096, 3100, 3103, 3104, 3110, 3113, 3117, 3118, 3140, 3147, 3150, 3152, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3199, 3210, 3215, 3220, 3238, 3244, 3266, 3269, 3413, 4005, 4014, 4066, 4072
< 12 {TM 164.66}: 2021, 2023, 2024, 3005, 3008, 3055, 3059, 3064, 3070, 3085, 3088, 3096, 3100, 3103, 3104, 3110, 3113, 3118, 3121, 3123, 3124, 3147, 3149, 3150, 3152, 3159, 3160, 3162, 3163, 3164, 3169, 3174, 3176, 3180, 3181, 3210, 3215, 3217, 3220, 3222, 3225, 3237, 3238, 3244, 3266, 3267, 3269, 3273, 3413, 4006, 4014,

4044, 4048, 4071, 4072, 5544

< 11 {TM 164.06}: 2011, 2023, 3007, 3008, 3055, 3070, 3110, 3121, 3124, 3140, 3150, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3220, 3238, 3266, 3267, 4006, 4044

< 10 {TM 163.05}: 2006, 2011, 2019, 2024, 2025, 3008, 3015, 3032, 3055, 3070, 3104, 3109, 3110, 3113, 3117, 3118, 3121, 3124, 3140, 3144, 3149, 3150, 3152, 3159, 3160, 3162, 3169, 3174, 3176, 3180, 3181, 3199, 3210, 3212, 3215, 3217, 3218, 3220, 3221, 3223, 3225, 3238, 3244, 3266, 3269, 3273, 4005, 4014, 4044, 4047, 4048, 4071, 4072

< 9 {TM 109.25}: 2002, 2006, 2011, 2012, 2017, 2019, 2023, 2026, 3005, 3006, 3007, 3011, 3070, 3071, 3073, 3074, 3089, 3096, 3135, 3140, 3144, 3147, 3150, 3158, 3159, 3180, 3194, 3195, 3222, 3231, 3247, 3278, 3301, 3414, 3813, 4011, 4014, 4027, 4058, 4059, 4066, 4071, 4072

< 8 {TM 105.50}: 2002, 2006, 2008, 2011, 2012, 2017, 2019, 3006, 3011, 3071, 3073, 3074, 3096, 3109, 3125, 3135, 3140, 3144, 3150, 3158, 3159, 3180, 3195, 3197, 3222, 3223, 3231, 3247, 3278, 3301, 3302, 3303, 3813, 4010, 4011, 4014, 4058, 4063, 4066, 4071, 4077

< 7 {TM 90.32}: 2004, 2011, 2012, 2013, 2017, 2021, 2022, 3004, 3011, 3012, 3048, 3052, 3071, 3073, 3074, 3089, 3096, 3144, 3158, 3180, 3194, 3195, 3197, 3231, 3247, 3253, 3278, 3301, 3502, 3813, 4010, 4011, 4014, 4031, 4059, 4071, 4077

< 6 {TM 64.74}: 2001, 2004, 2008, 2011, 2014, 2017, 2022, 3010, 3011, 3072, 3073, 3074, 3158, 3194, 3195, 3310, 3409, 3414, 4011, 4027, 4028, 4031

< 5 {TM 51.44 }: 2001, 2004, 2005, 2008, 2009, 2011, 2012, 2014, 2017, 2020, 3048, 3194, 3195, 3231, 3302, 3310, 3409, 3414, 4009, 4064, 4066, 4077

< 4 {TM 48.35}: 2002, 2003, 2005, 2007, 2008, 2011, 2012, 2013, 2014, 2016, 3010, 3039, 3042, 3071, 3072, 3073, 3089, 3125, 3149, 3195, 3222, 3231, 3247, 3271, 3301, 3302, 3303, 3310, 3409, 3414, 3502, 4009, 4011, 4077

< 3 {TM 40.15}: 2001, 2002, 2003, 2005, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 3010, 3048, 3089, 3125, 3149, 3195, 3231, 3253, 3301, 3302, 3303, 3407, 3408, 3409, 3410, 3502, 4011, 4027, 4028, 4031, 4061, 4066, 4077

< 2 {TM 29.52}: 2010, 2012, 2014, 3039, 3089, 3195, 3310, 3407, 3409, 3414, 3502, 4011, 4031

< 1 {TM 25.15}: 2001, 2003, 2008, 2010, 2011, 2012, 2013, 2018, 2019, 3195, 3247, 3253, 3310, 3409, 3502, 4009, 4011, 4027, 4031, 4066

SECTION 2_COLLE BERTONE: bottom 1 - top 1

< 1 {CB2 45.00}: 3278, 3813, 3231, 4059, 3158, 3074, 3011, 3194, 3071, 3073, 3301, 2002, 4014.

16. Jurassic Radiolarians from the Campofiorito and Peloritan Zones, Sicily (Italy)

by Norio Kito[1] and Patrick De Wever[2]

[1] Institute of Earth Sciences, College of General Education, Hokkaido University of Education, 1-2 Hachiman-cho, 040 Hakodate, Japan

[2] CNRS-Université Pierre et Marie Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France

ABSTRACT

Middle and Upper Jurassic radiolarian faunas from two sections in Sicily are compared with the previously proposed zonations. The ages of the faunas are estimated by correlation with these zonations and by concurrent range zone. The end of the radiolarite sedimentation is precisely dated as co-inciding with the Kimmeridgian-Tithonian boundary.

1. Introduction

In Sicily several tectonostratigraphic domains are distinguished which are characterised by their structural style, position, age of tectonic activity affecting them, and their stratigraphic succession (Grandjacquet & Mascle, 1978). The domains are classified into three main groups: the external domains underlying the flysch nappes, the flysch nappes themselves, and the Peloritan domain.

These domains are cut by numerous normal faults. The external Sicilian zones present tangential structures (Broquet *et al.*, 1966) in the Sciacca, Campofiorito, Vicari, Sclafani, and Panormide (Fabiani & Trevisan, 1940) Zones. In the Sciacca Zone, thrusts and reverse faults affect the Lower Pliocene. The Campofiorito Zone, in the form of thrust sheets, is thrust over the preceding zone and has several generations of structures between the Middle Miocene and the Middle Pliocene. The Vicari Zone is made of elements of the preceding zone, reworked during the Langhian-Tortonian. The Sclafani Nappe is thrust over the Langhian-Tortonian sequence, and some of the elements are resedimented. The Panormide Zone, thrust over the Sclafani Zone during Oligocene-Aquitanian times, was also involved in the Helvetian-Tortonian structures affecting the Sclafani Zone.

The localities discussed below belong to the Campofiorito-Cammarata Zone (Contrada La Ferta section) and to the Peloritan zone (Galati section).

For a more complete account of the geological setting see the paper on Jurassic radiolarians from Santa Anna, Sicily, *Chapter 17*, this volume).

2. Contrada La Ferta section

2.1. Geological framework

The oldest unmetamorphosed rocks known in Sicily belong to the Campofiorito Domain (Broquet *et al.*, 1966; Mascle, 1970, 1979). In outcrop these rocks resemble a flysch of varicoloured shales with beds of green quartzite which become sandy towards the top (Fabiani & Trevisan, 1937).

Occasionally microbreccias with Lower Permian fusulinids, blocks of productid limestone, and diabase are found. As clearly seen in the field and in drill cores, this sequence is broken up into a series of superposed tectonic slices, the lowest containing at their base limestones assigned to the Carboniferous (Caflisch & Schmidt di Friedberg, 1967). Alternations of variegated shales and finely-banded limestone turbidites with rare horizons of sandstone and limestone microbreccias (Carnian flysch) lie discordantly upon the Permian (Fabiani & Trevisan, 1937). They contain blocks of highly fossiliferous Permian reef limestone (the well-known Permian of Sosio) and a few fragments of Triassic rocks. The succession continues with further finely banded calcareous turbidites containing *Halobia*. Sometimes rich in chert, sometimes dolomitized, these rocks are assigned a Late Triassic, Carnian-Norian age. The Lower Jurassic rocks consist of finely-banded limestones with brachiopods and radiolarians, overlain by marls. In both these lithologies, turbidites and conglomerates of Lower Jurassic reef limestones, probably derived from the Sciacca Zone, occur. The series of tuffs and basaltic pillow-lavas are assigned to the Mid Jurassic, and the silicified limestones (false radiolarites) to the Upper Jurassic. The uppermost Jurassic and Lower Cretaceous are represented by more or less siliceous, light-coloured, ammonitic, nodular limestones. These are overlain by Neocomian blue marls. Part of the sequence is commonly absent, reflecting Cretaceous tectonic activity. The Upper Cretaceous and Eocene successions are incomplete and variable, although homogeneous from a facies standpoint. The section consists of well-bedded, fine-grained, cherty argillaceous limestones (Scaglia facies) with intercalated basalts. The first discordance, rarely seen, occurs below the upper Albian-Cenomanian, and a second in upper Campanian-Maastrichtian (or intra-Maastrichtian), where it is sometimes indicated by the presence of a conglomerate. The Oligocene begins above with basal uncomformity, with a limestone conglomerate, succeeded by argillaceous limestones and sandy marls, the latter passing up into lower Miocene (Aquitanian-Burdigailan) glauconitic, calcareous sandstones. The middle Miocene consists of marls.

Once again, this domain was subjected to several phases of deformation. The Pliocene and Pleistocene strata found along the southern edge of the domain are folded and faulted (normal faults), and rest with unconformity upon structures in which the Trias is thrust over Lower Pliocene. The Messinian phase of movement is marked by the resedimentation of slices of the Jurassic-Oligocene cover. Then, during the tectonic movements of the Langhian-Tortonian, slices of the Campofiorito domain were thrust over each other and some were transported as far as the Sciacca Zone. Prior to these movements the Oligocene, Upper Cretaceous, and Upper Triassic unconformities represent evidence of tectonism whose style is still uncertain.

2.2. Location

The section of Contrada La Ferta is situated on the eastern slope of Mt. Cammarata (Fig. 1A), western Sicily, and belongs to the Campofiorito-Cammarata Zone (Broquet *et al.*, 1966). The section (Lat. 37°30'N, Long. 13°37'E) ranges from Triassic (radiolarians described by De Wever *et al.*, 1979), to Tertiary in age.

2.3. Description and previous dating:

In stratigraphical order from base to top the following lithological groups can be identified (Fig. 1B):

1- White oolitic limestones (1a) overlain by a conglomerate (1b), 15m thick, composed of fragments (various size) of light micritic limestone, of grey Triassic limestones with radiolarians, of crinoidal limestones. The green marly matrix of the conglomerate yielded ostracods, which show some affinities with Lower Jurassic (Sinemurian) ostracods reported from the Paris Basin. White micritic limestone (15-20m thick) rests on the conglomerate followed by oolitic limestone (bed thicknesses are from a few decimeters to several metres) interlayered with green clays.

2- Red and green clays (15 m) with abundant foraminifera and ostracods of Pliensbachian (Carixian) age. Foraminifera identified by J. Sigal include: *Lenticulina* cf. *ruthenensis* ESPITALIE & SIGAL, *Astacolus* cf. *rectalonga* BRAND, *Dentalina sinemuriensis* TERQUEM, *Marginulina* cf. *burbachii* DREYER, *Marginulina* gr. *constricta* TERQUEM & BERTHELIN, *Nodosaria* cf. *setulosa* TERQUEM, *Frondicularia involuta* TERQUEM, *Frondicularia* cf. *procera* BURBACH, *"Frondicularia" thuringica* BURBACH, *Planularia* cf. *filosa* TERQUEM, *Lingulina* gr. *tenuistriata* NÖRVANG, *Lingulina tenera* (BRÖNIMANN), *Lingulina* gr. *occidentalis* (BERTHELIN), *Lingulina tenera carinata* NÖRVANG. Among the ostracods identified by Grekoff are: *Bairdia* aff. *fortis* DREXLER, *Bairdia* cf. *molesta* APOSTOLESCU, *Isobythocypris* sp.

3- Red silicified limestone (3a) with abundant Radiolarians, interbedded with thin red argillites. Some brown-yellow lenses of silicified material are visible. Radiolarians are the only fossil content. The thickness of this level is 5 m. The overlying unit, 20m thick, is made of red chert and red to white siliceous limestone (3b), in beds of 5 to 35 cm. thick, which contain some Upper Jurassic aptychi (Kimmeridgian-Portlandian) (Broquet, 1964).

In spite of the fact that several levels were not formally identified (upper Lower Jurassic, Mid Jurassic, parts of the Upper Jurassic), the sedimentation is probably continuous from Mid Liassic time (2) to Upper Jurassic time (3b) and the sedimentation rate reduced as inferred from the thickness of the unit.

Collected samples come from the upper part of the Jurassic sequence (Fig. 1B).

3. Galati section

3.1. Geological framework

Eastern Sicily is subdivided in several palaeogeographical units and the Peloritan domain is one of them. In the Peloritan and southern Calabrian domains metamorphosed Palaeozoic basement is exposed, and this allows the recognition of basement and cover. The domains were affected by important tectonic movements between Mid and Late Eocene times. Tangential movements were first demonstrated in Sicily and were subsequently noted in Spain and North Africa. They were responsible for the principal structures in the Peloritan domain (Grandjacquet & Mascle, 1978).

The base of the Taormina Unit (Truillet, 1968; Duée, 1969) is formed by the Verrucano Facies over which lie massive oolitic limestones and dolomites with algae and molluscs (Grandjacquet & Mascle, 1978). The base is Sinemurian in age. The Middle Liassic which follows consists of somewhat argillaceous, finely-banded limestones, with oolitic or detrital quartz turbidites. Posidonomya limestones and some beds of red and brown radiolarite represent the Middle-Upper Jurassic, and fine argillaceous limestones with radiolaria, calpionellids, and aptychi form the Tithonian and Neocomian. The Lower Cretaceous ends with radiolarian marls. The varicoloured Scaglia facies of the Upper Cretaceous is incomplete and variable as in the preceding unit. The Paleocene is absent, consistent with the resedimentation of blocks of the Taormina into the Paleocene-Eocene (Ypresian) of the

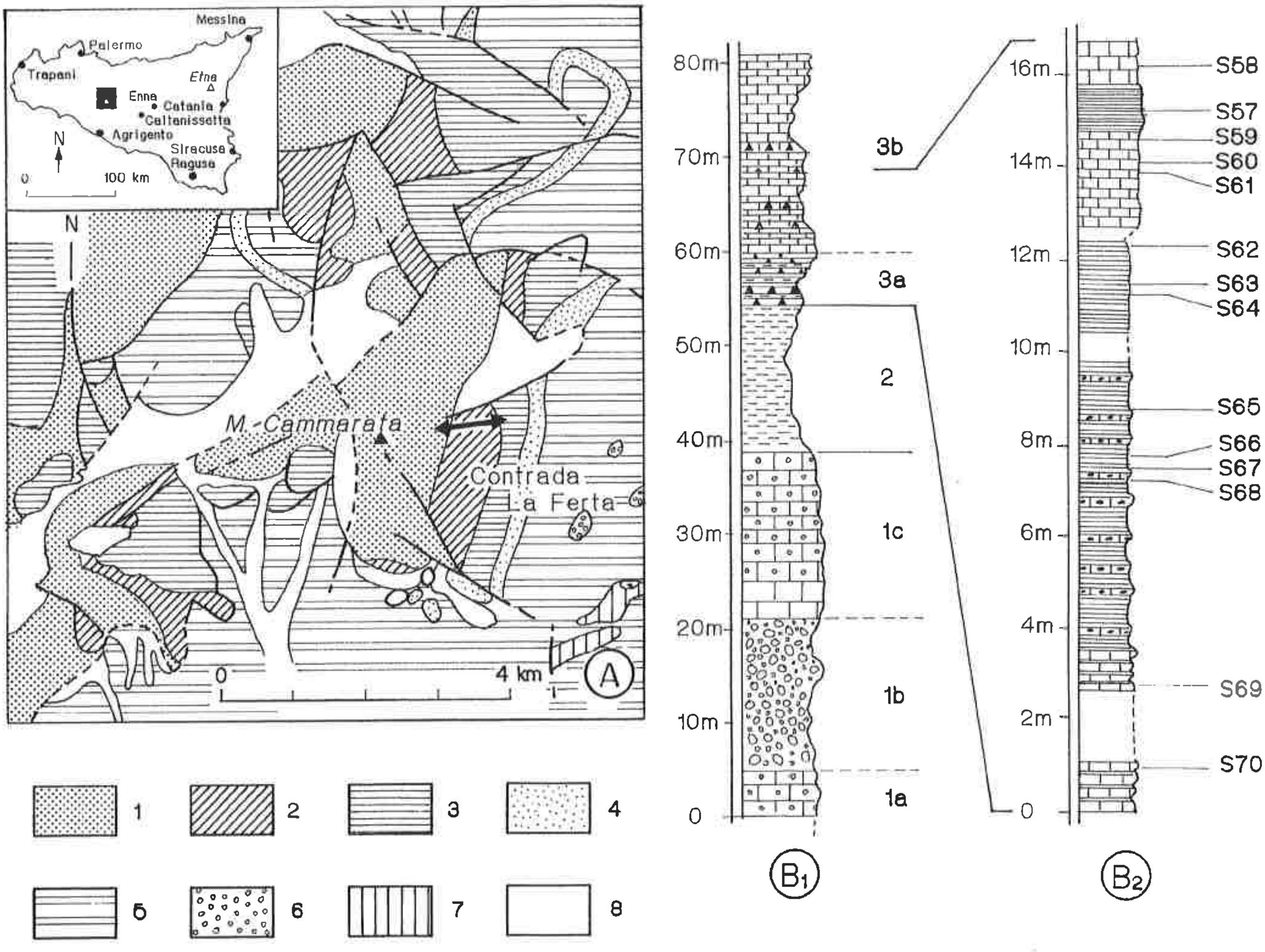


Figure 1.

1A. Geological sketch map showing the location of the Contrada La Ferta section (after Broquet, 1971). **1.** Norian-Hettangian (limestone with chert), **2.** Lower and Middle Liassic (oolitic limestone and conglomerate), **3.** Lower Jurassic to Paleocene, (4) Lower Miocene (sandstone and sandy marls), **5.** Upper Miocene (marls), **6.** Tortonian molasse blocks, **7.** Sedimentary klippes, **8.** Clastic debris and alluvium.

1B. Lithostratigraphic succession of the Contrada La Ferta section and lithologic subdivision by Broquet (1971, p.83). Detailed lithologic column is shown in Figs. 17-19. **1a.** white oolitic limestone, **1b.** Lower Jurassic conglomerate, **1c.** White micritic limestone. **2.** Red and greenish marls, with abundant foraminifera and ostracods of Carixian age, **3a.** Red siliceous limestones with abundant radiolarians (sampled level). **3b.** Red cherts and white siliceous limestones of Kimmeridgian-Tithonian.

Longi Unit. The Ypresian and Lutetian (in part) are represented by foraminiferal calcarenites. The North African equivalent units are found in the Djebel Bou Aded Sebargoud (internal Zone).

3.2. Location

The Galati section is situated 15 km east of Aquedolci (eastern Sicily, Lat. 38°1'N, Long. 15°14'E, Fig. 2A-B), in the "Chaine Calcaire" (Caire *et al.*, 1965). In this area, the Jurassic overlies phyllites of the basement (Calabria-Peloritan Zone) with a fault contact and is covered with Neocomian marly limestone. The sequence, some 140 m thick is composed of siliceous limestone, marly limestone, white limestone, radiolarite and some sandstones.

3.3. Description and previous dating

The samples were collected from the radiolarite and the limestone beds (Fig. 2C). The age of the limestone under the radiolarite is attributed to Bathonian to Callovian? (Maugeri -Patanè, 1932) with *Pentacrinus nodosus*, *Cidaris sublaevis*, *Cidaris* cf. *spinulosa*, *Terebratula laticoxa*, *Avicula* sp., *Posidonomia alpina*, *Nerita* sp., *Sphaeroceras bombur*, *Aptychus flexuosus*, *Perisphinctes triplicatus*,

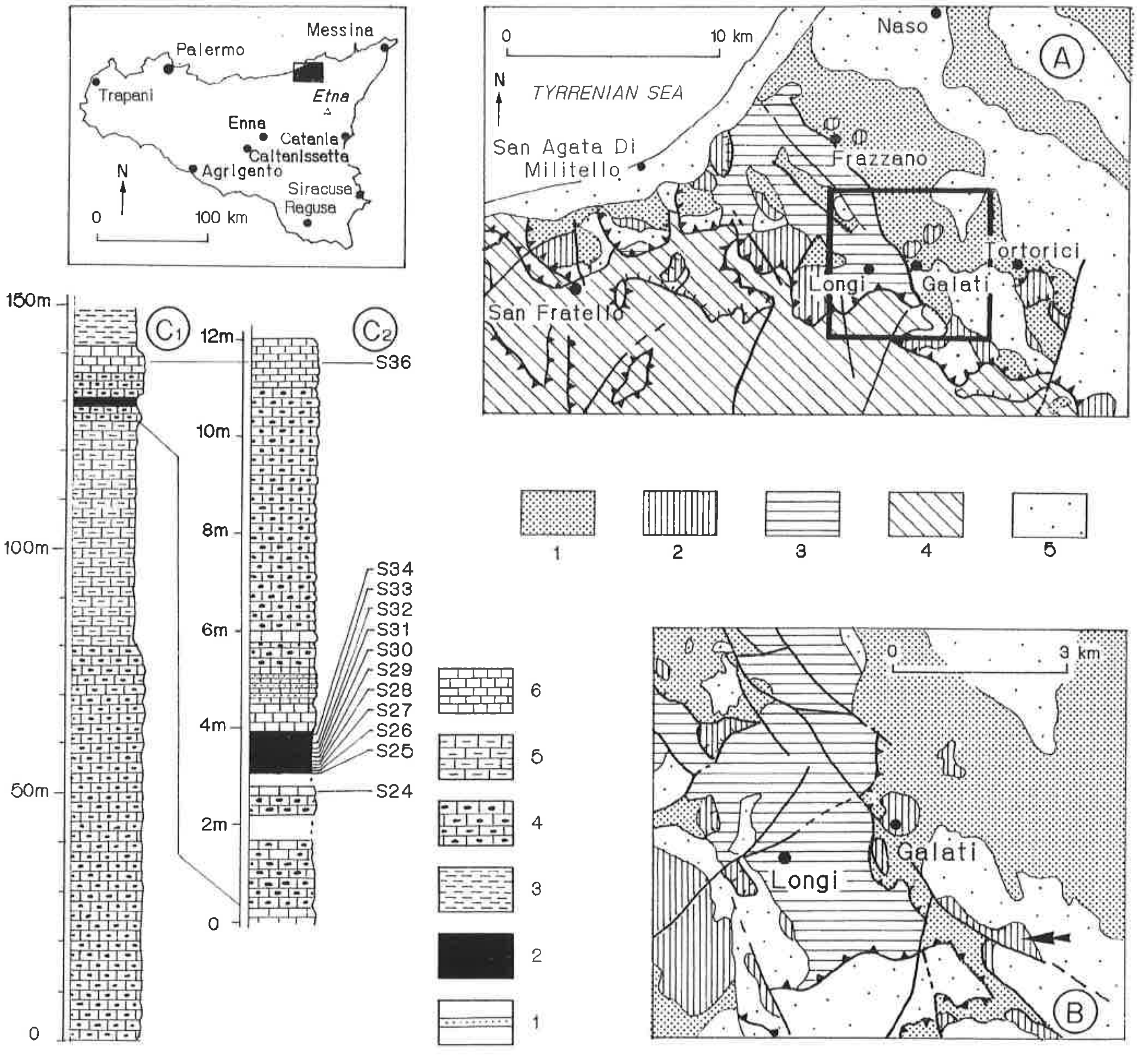


Figure 2.

2A-B. Geological sketch map showing the location of the Galati section (after Duée, 1978). **1.** phyllites, **2.** Taormina Unit (Mesozoic-Eocene), **3.** Longi-Gallodoro Unit, **4.** Oligocene-Miocene.

2C. Jurassic lithological succession of the Galati section (after Duée, 1978). Sampling position column. **1.** Limestone, **2.** Marly limestone, **3.** Siliceous limestone, **4.** Marl, **5.** Radiolarite, **6.** Sandstone.

Phylloceras, Hecticoceras sp., *Lytoceras pygmeus, Belemnites* sp. and *Oppelina fusca*. The limestone above the radiolarite is dated as early Upper Jurassic by *Aptychus sparsilamellosus, Neumayriceras* cf. *trachynotum, Lytoceras* sp., *Perisphinctes rhodanicus, Aspidoceras dornasense, A. tietzei* ?, *Aspidoceras* sp., *Belemnopsis hastatus* and *Belemnopsis pressulus*. Maugeri-Patanè (1932) estimated the age of the radiolarite to be Oxfordian, based on the stratigraphic succession.

References

BROQUET, P. (1964). Remarque sur la géologie de la bordure orientale des monts Sicani (Sicile). *Annales de la Société Géologique du Nord, Lille*, **84**, 303-308.

BROQUET, P. (1971). *Etude géologique de la région des Madonies (Sicile)*. Ph.D. Thesis. Université de Lille, 333 p.

BROQUET, P., CAIRE, A. & MASCLE, G. (1966). Structure et évolutions de la Sicile occidentale (Madonies et Sicani). *Bulletin de la Société Géologique de France, Série VII*, **7**, (8), 994-1013.

CAFLISCH, L. & SCHMIDT DI FRIEDBERG, P. (1967). L'evoluzione paleogeografica della Sicilia e le sue relazioni con la tettonica e la naftogenesi. *Memorie della Società Geologica Italiana*, **6**, 449-474.

CAIRE, A., DUÉE, G. & TRUILLET, R. (1965). La chaîne calcaire des monts Péloritains (Sicile). *Bulletin de la Société Géologique de France, Série VII*, **7**, (7), 881-888.

DE WEVER, P., SANFILIPPO, A., RIEDEL, W.R. & GRUBER, B. (1979). Triassic radiolarians from Greece, Sicily and Turkey. *Micropaleontology*, **25** (1), 75-110.

DUÉE, G. (1969). *Etude géologique des Monts Nebrodi (Sicile)*. Ph.D. Thesis. Université Pierre et Marie Curie, Paris, 369 p.

DUÉE, G. (1978). Nouvelle interprétation du Nord-Est Sicilien. *A.S.A.C., Deptartment de Géologie Structural*, **5**, 5-16.

FABIANI, R. & TREVISAN, L. (1937). Di alcune novità geologiche nel territorio del foglio Termini-Imerese (Palermo). *Bollettino della Società di Scienze Naturali Economica, Palermo*, **19**, 1-8.

FABIANI, R. & TREVISAN, L. (1940). Prove dell'esistenza di uno stile tettonico a falde di ricoprimento nei monti di Palermo. *Atti della Reale Accademia Italiana, Memorie della Classe di Scienze Fisiche, Matematiche e Naturali*, **11**, 435-448.

GRANDJACQUET, C. & MASCLE, G. (1978). The structure of the Ionian Sea, Sicily, and Calabria-Luciana. *In* Nairn, A.E.M., Kanes, W.H. & Stehli, F.G. Eds. *The Ocean Basins and Margins* - Plenum Publ. Comp. **4B**, 257-329.

MASCLE, G. (1970). Geological sketch of Western Sicily. *Geology and History of Sicily* - Petroleum Exploration Society of Lybia, Tripoli. (231-243).

MASCLE, G.H. (1979). Etude géologique des Monts Sicani (Sicile). *Rivista Italiana di Paleontologia e Stratigrafia, Memoria*, **16**, 1-431.

MAUGERI-PATANE, G. (1932). Introduzione allo studio geo-paleontologico del M. Ueina e Dintorni (Prov. Messina). *Memorie della Società Geologica Italiana*, **51**, 115-170.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

TRUILLET, R. (1968). *Etude géologique des Péloritains orientaux*. Ph.D. Thesis. Université Pierre et Marie Curie, Paris, 547 p.

ANNEXE

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION KI2_CONTRADA_LA_FERTA: bottom 1 - top 9

< 9 {S34}: 3083, 3065, 3087, 3090, 3097, 3111, 3113, 3171, 3185, 3193, 3203, 3213, 3225, 3228, 3263, 3287, 3293, 3305, 5607

< 8 {S33}: 3083, 3065, 3087, 3090, 3097, 3113, 3115, 3164, 3171, 3185, 3197, 3203, 3213, 3228, 3241, 3263, 3287, 3292, 3305, 4069, 4072, 5607, 5674

< 7 {S32}: 3083, 3065, 3087, 3097, 3113, 3164, 3171, 3185, 3197, 3203, 3213, 3241, 3263, 3287, 4072, 5426, 5607

< 6 {S31}: 3012, 3052, 3064, 3088, 3089, 3096, 3113, 3144, 3159, 3180, 3197, 3213, 3221, 3223, 3231, 3270, 3303, 4010, 4063, 4064, 4072

< 5 {S30}: 3008, 3012, 3039, 3052, 3055, 3072, 3089, 3096, 3113, 3144, 3159, 3180, 3215, 3231, 3270, 3271, 3301, 3303, 4010, 4063, 4064
< 4 {S29}: 3001, 3006, 3012, 3024, 3033, 3039, 3048, 3050, 3052, 3055, 3072, 3089, 3096, 3104, 3113, 3118, 3123, 3125, 3137, 3144, 3194, {3198, DOES NOT EXIST. ERROR??}3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4061, 4063, 4064
< 3 {S28}: 3001, 3006, 3012, 3033, 3039, 3050, 3052, 3055, 3072, 3089, 3096, 3104, 3113, 3123, 3125, 3137, 3144, 3194, {3198, DOES NOT EXIST ERROR?} 3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064
< 2 {S27}: 3001, 3006, 3012, 3033, 3039, 3050, 3052, 3055, 3072, 3089, 3096, 3103, 3104, 3110, 3113, 3123, 3125, 3137, 3144, 3194, 3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064
< 1 {S25}: 3001, 3006, 3039, 3050, 3066, 3072, 3089, 3096, 3104, 3113, 3116, 3121, 3123, 3125, 3144, 3194, 3215, 3231, 3270, 3301, 3302, 3303, 3502, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064

SECTION KI1_GALATI: bottom 1 - top 9
< 9 {S58}: 3119, 3124, 3210, 3273, 3301
< 8 {S57}: 3096, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3225, 3244, 3273
< 7 {S59}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3244, 3273
< 6 {S63}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3244, 3273
< 5 {S64}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3218, 3243, 3244, 3273
< 4 {S66}: 3095, 3096, 3103, 3110, 3117, 3119, 3121, 3124, 3144, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3303, 2001, 2008
< 3 {S68}: 3090, 3096, 3103, 3110, 3117, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 2008
< 2 {S69}: 3096, 3103, 3110, 3117, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3409 {see Kito's thesis}, 4069, 2009, 2008
< 1 {S70}: 3096, 3103, 3110, 3118, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3302, 3303, 3409, 2001, 2008

17. Radiolarians from the Sciaccia Zone, Santa Anna, Sicily (Italy)

by Patrick De Wever

Patrick De Wever, CNRS-Université Pierre et Marie Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France

ABSTRACT

A combined study of various paleontological groups (ammonites, brachiopods, calpionellids, nannoplankton, radiolarians) has been undertaken on samples from the Santa Anna section (Late Jurassic-Lower Cretaceous of the Sciacca Zone, Sicilian external zones). Previously interpreted age determinations vary depending on the fossil group used. The present study reviews previous contradictory age interpretations and proposes age determinations based on intergrated data from the different fossil group collected. The end of radiolarite deposition in the western Mediterranean region is also very precisely dated by means of this work.

1. Introduction

The Santa Anna section has been described by several authors (Riedel & Sanfilippo, 1974; Mascle, 1973, 1979; Baumgartner *et al*, 1980; De Wever *et al.*, 1986) because of its rich fossil content (ammonites, aptychi, belemnites, brachiopods, calpionellids and nannoplankton associated with radiolarians).

2. Geographical and geological frameworks

Structural framework of the External Sicilian Domains

In Sicily a series of domains, characterised by structural style, position, the age of tectonic activity affecting them, and their stratigraphical succession, can be recognized (Grandjacquet & Mascle, 1978). The domains are classified in three main groups: the external ones underlying the flysch nappes, the flysch nappes themselves, and the Peloritan domain.

The Iblean domain is the most external. Its structure is well-known from exploratory drilling and consists of broad, open folds and normal faults. The chief structural trends are NE-SW, NNE-SSW, and WNW-ESE. The structures were active from Miocene (Tortonian) to Recent times (Mascle, 1974), as shown in Malta where normal faults trending WNW-ESE and NNE-SSW affect a recent erosion surface.

As can be seen on seismic sections in the Sicilian Channel or in the Ionian Sea, these domains are cut by numerous normal faults. Some of them have a major throw, and delimit either the grabens of the Sicilian Channel or the edge of the Malta platform. Some others clearly affect Recent sediments. Excluding the NNW-SSE-oriented faults which limit the Ibleo-Malta plateau to the east, the faults are oriented WNW-ESE to NE-SW, the same trends as those affecting Malta and the Iblean domain. The other external Sicilian zones present tangential structures from the exterior to the interior (Broquet *et al.*, 1966) in the Sciacca, Campofiorito, Vicari, Sclafani, and Panormide Zones (Fabiani & Trevisan, 1937; 1940). In the Sciacca Zone, thrusts and reverse faults affect the Lower Pliocene. The Campofiorito Zone, in the form of thrust sheets, has been emplaced over the preceding zone and has several generations of structures dating from between the Helvetian and the Middle Pliocene. The Vicari Zone is made of elements of the preceding zone, reworked during Langhian-Tortonian time. The Sclafani Nappe is overthrust on the Langhian-Tortonian sequence, and some of the elements of the latter are resedimented. The Panormide units, thrust over the Sclafani Zone during Oligocene-Miocene (Aquitanian) time, were also involved in the Langhian-Tortonian structures affecting the Sclafani Zone. All these deformations occurred above the schistosity front. Fracture cleavage occurs only very locally and is always related to important tectonic fractures.

Among the external zones from Sicily (Mascle, 1973, 1979; Broquet *et al.*, 1966) the Sciacca Zone is the southernmost and occurs in the Monte de Sambuca, one of the Sicani Mountain range (fig. 1). In a general palaeogeographical framework, this section belongs to the northern part of the African plate (Dercourt *et al.*, 1985).

The base of the sequence in the Sciacca domain (Grandjacquet & Mascle, 1978; Broquet *et al.*, 1966; Mascle, 1970, 1973) consists of thick-bedded dolomite (3000m thick), assigned to the Upper Triassic. These sediments are overlain by thick-bedded, Lower Jurassic, algae limestones with megalodont molds. Locally, crinoidal middle Lower Jurassic limestones have been recorded. The upper Lower Jurassic and Middle-Upper Jurassic sometimes form a condensed succession a few metres thick, lying discordantly over an eroded surface. Red, nodular limestones (Ammonitico Rosso), ferruginous beds, manganese crusts and nodules, and occasional trachyandesitic flows are found. The overlying cherty, argillaceous limestones are late Jurassic and Early Cretaceous in age. They are succeeded by Upper Cretaceous sediments sometimes preserved in joints in earlier beds, and by Eocene material represented by fine-grained argillaceous limestones (Scaglia facies). The Oligocene consists of nummulitic limestones also resting discordantly upon the Jurassic. Lower Miocene calcarenites with glauconite and phosphatic debris are found.

Deformation in the Sciacca Zone occurred in several stages, of which the most recent was normal faulting which affects the older Quaternary (Calabrian) (Mascle, 1973, 1974). The principal structures were formed during the Pliocene, with thrust and reverse faults affecting Lower Pliocene beds upon which the Middle-Upper Pliocene rests discordantly. The Lower Pliocene, in turn, rests discordantly upon the Messinian, evidence of further movements during the Miocene (Messinian) and in particular near the Langhian-Tortonian boundary. Deformation at this time resulted in resedimentation in the Miocene basin of some parts of the Sciacca Zone, while at the same time the internal part of the zone was overthrust by units from the Campofiorito Zone. Prior to that there are traces of early deformation, illustrated by the Lower Miocene, Oligocene, and Upper Cretaceous unconformities. The upper Lower Jurassic-Middle Jurassic discordance dates the structures, which are due to an extensional phase.

3. Location

The section is located on the southern flank of Caltabellotta Monte (NE of the village Sciacca, south-western Sicily, Italy) (fig. 1). It is 0,8 km, NE of the village of Santa Anna (province of Caltabellotta), on the north-west road cut (facing a small chapel) on the road to Molino Cifota (sheet 261 ISO, Military Geographic Institute).

4. Description of the outcrop

The following succession is visible up to the section (fig. 1) :

1) 10m of white "radiolarite" with clay interlayers. The rocks are bedded siliceous limestone (with diffuse silica), white to pink (sometimes greenish).

2) 3m of white (greenish) nodular chalky limestone (biomicrites), locally silicified,

3) A few metres of white clayey chalky limestone with cherts.

5. Previous dating

See fig. 2. for positions.

Level 2 :

Mascle (1973, 1979) reported macro- and microfossils ammonites, echinoderms, bivalves and ostracods, with relatively rare *Globochaete alpina* LOMBARD, *Stomiosphaera moluccana* WANNER and saccocomids. The collected macrofauna is mainly represented by ammonites, aptychi, and few belemnites (*Duvalia* sp.) and brachiopods.

Geyssant & Mascle (1970) identified one brachiopod: *Pygope triangulus* (LAMARCK) and several ammonoids : *Phylloceras* sp., *Phylloceras serum* (OPPEL), *Phylloceras* aff. *isotypum* (BENECKE), *Calliphylloceras* (*Ptychophylloceras*) *ptychoicum* (QUENSTEDT), Lytoceratids, the Perisphinctids, *Haploceras elimatum* (OPPEL), *Neochetoceras* sp., ? *Ulhigites* sp., *Aspidoceras rafaeli* (OPPEL), *Physodoceras cyrlotum* (OPPEL), and *Hybonoticeras hybonotum* (OPPEL). Some of these species are restricted in age-range to the early Tithonian, while others range from Kimmeridgian to late Tithonian. Level 2 is at least partly dated as early Tithonian (one can not exclude, at this stage, that its oldest part is Kimmeridgian in age and the youngest part is late Tithonian in age).

Level 3

Mascle (1973, 1979) dated this level as Berriasian based on the presence of calpionellids.

undetermined level:

Riedel & Sanfilippo (1974) reported several nannofossils from this outcrop (without further details on the precise level) dated as Tithonian-early Berriasian (identified by P.H. Roth): *Watznaueria barnesae* (BLACK), *W. communis* REINHARDT, *Ellipsagelosphaera britannica* (STRADNER), *Rhagodiscus rugosus* (NOËL), *Cyclagelosphaera margereli* NOËL, *C. deflandrei* (MANIVIT), *Diazomatolithus lehmani* NOËL, and

Nannoconnus colomi (De Lapparent).

According to Baumgartner *et al.* (1980) ammonites from this section, collected by McGill and identified by O. Renz, are late Oxfordian-Kimmeridgian in age. While the sampled level is not accurately defined, it most probably corresponds to Level 2, being the only one containing ammonites. These authors also state that among the ammonites collected by Riedel are *Katroliceras (Katroliceras)* sp. cf. K. aceroides Geyer and *Orthaspidoceras orthocera* (D'Orbigny) which dated the level as Kimmeridgian. They also comment on the contradictory dates indicated by Riedel & Sanfilippo (1974) who cited nannoplankton and on one hand ammonites, the absence of Calpionellids, on an other hand.

Origlia-Devos (1983), using radiolarian data, proposed a mid Oxfordian-mid Tithonian age for Level 1 and a Berriasian-early Valanginian age for Level 3.

6. Biostratigraphic data

Ammonites

All the ammonites listed are from Level 2.

The oldest association is from the *Hybonotum* zone (base of Tithonian) and comprises (De Wever *et al.*, 1986) :

Hybonoticeras hybonotum autharis (Oppel)
Hybonoticeras hybonotum beneckei Geyssant
Hybonoticeras sp. gr. *hybonotum* (Oppel)
Torquatisphinctes laxus Oloriz
Lithacoceras (Virgalithacoceras) sp. gr. *supremum* (Schneid).

From the Semiforme Zone (lower Tithonian) the following were identified:

Aspidoceras sp. cf. *rogoznicense* (Zeuschner)
Danubisphinctes sp. cf. *echidneus* (Schneid).
Dorsoplanitoides n.sp. A

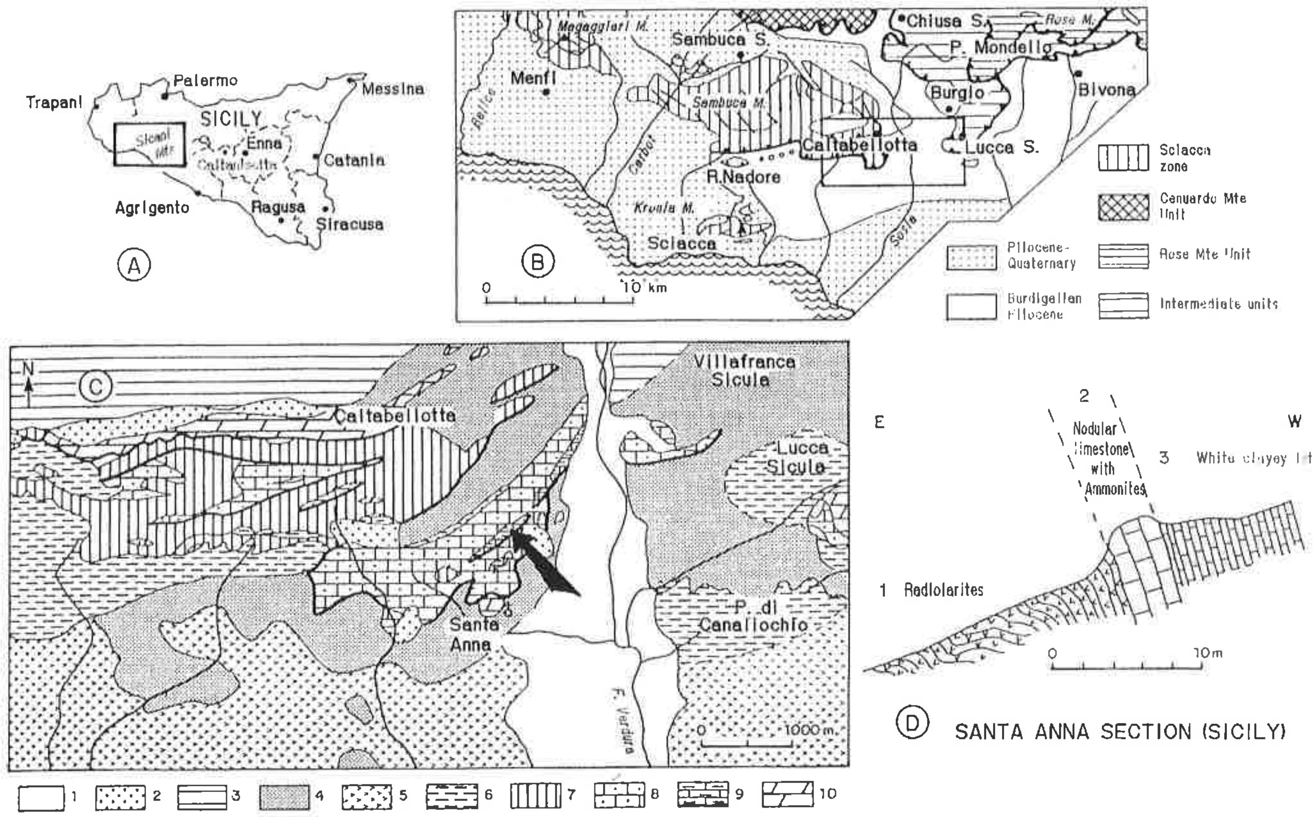


Figure 1. Location of Santa Anna section (from De Wever *et al.*, 1986)

A- General map of Sicily.

B- Structural scheme of Monte Sicani. A rectangle locates the region shown in C.

C- Geological map of the locality (from Mascle, 1979): The locality is shown by an arrow.
1. Alluvium; **2.** Scree; **3.** Marls and sandy clays (Middle-Upper Pliocene); **4.** Marls and white clayish limestones (Lower Pliocene); **5.** Marls, gypsum and limestones (Messinian); **6.** Blue and grey marls (Upper Burdigalian, Langhian to Tortonian); **7.** Numidian facies sandstones; **8.** White to pinky clayish limestones more or less siliceous (Berriasian to Eocene); **9.** Brown and greyish radiolarite, nodular limestone (Jurassic); **10.** Massive dolomites and cherty limestones (Upper Carnian to Rhaetian).

D- Schematic Santa Anna section (from Mascle, 1979). A reconstructed section perpendicular to the road cut.

Lithacoceras (*Pseudodiscosphinctes*) *rhodaniforme* (OLORIZ)
Physodoceras neoburgense (OPPEL)
Sublithacoceras sp. cf. *penicillatum* (SCHNEID)
Subplanitoides contiguus (CATULLO)
Virgatosimoceras rothpletzi (SCHNEID)

The other ammonite zones (specially the *Darwini* and *Fallauxi* Zones) of lower Tithonian horizons are not positively identified but are probably present as the following species were found :

Aspidoceras sp. gr. *rafaeli* (OPPEL)
Aulasimoceras tethysiense GEYSSANT
Neochetoceras paternoi (DI STEFANO)
Neochetoceras sp. cf. *griesbachiforme* (DONZE & ENAY)
Physodoceras cyclotum (OPPEL)
Virgatosimoceras siculum GEYSSANT.

The presence of the *Microcanthum* Zone of Upper Tithonian age is demonstrated by the occurrence of *Corongoceras symbolum* (OPPEL), *Corongoceras savornini* ROMAN.

Other, longer-ranging, and therefore stratigraphically less important, ammonites were also found in association with this assemblage and include *Haploceras* (*Haploceras*) *carachtheis* (ZEUSCHNER) morph. *elimatum* (OPPEL) together with others of several families (Phylloceratidae, Lytoceratidae).

Absence of representative forms for the Ponti Zone is insignificant because characteristic ammonites of this zone are often poorly represented in the Tethyan domain.

Several microfossils were found within the matrix of ammonites: saccocomids, *Globochaete alpina* LOMBARD, *Stomiosphaera moluccana* WANNER.

Level 2 yielded other macrofossils such as aptychi and brachiopods (Pygopidae: *Triangope triangulus* (VALENCIENNES)), which confirm the age indicated by ammonites but do not further refine it.

CALPIONELLIDS

Level 3

The zonation scheme used for calpionellids is that of Remane (1963, 1964, 1971, 1985) and Le Hegarat & Remane (1968).

Sample S97: *Tintinnopsella carpathica* (MURGEANU & FILIPESCU), *T. longa* (COLOM), *Calpionellopsis simplex* (COLOM), *Calpionellopsis oblonga* (CADISCH). This assemblage is from Zone D, probably sub-zones D2-D3,

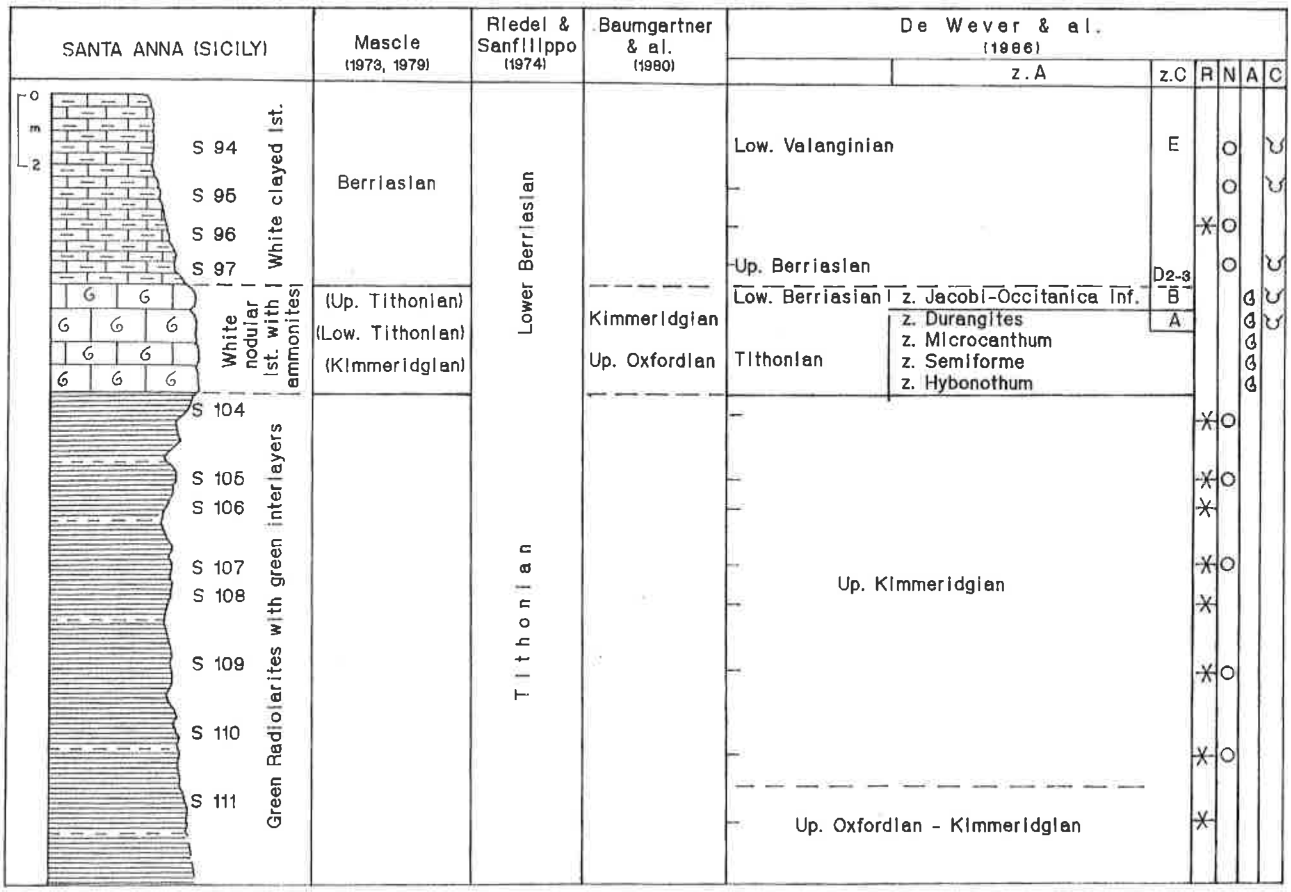


Figure 2. Biostratigraphical synthesis of the Santa Anna section (Sicily). The position of samples is shown along the lithological column (on the left). **z.A.** Ammonite zone, **z.C.** Calpionellid zone, **R.** Presence of radiolarian at this level, **N.** Presence of nannofossils, **A.** presence of ammonites, **C.** Presence of calpionellids. Lines between ammonites zones indicate zones which were demonstrated present in the section. Dots indicates ammonite zones which are possibly present in the section. Between calpionellid Zones B and D2-D3 a dashed line indicates that Zones C and D1 were not formally identified.

which are late Berriasian in age.

Sample S 94: *Tintinnopsella carpathica* (MURGEANU & FILIPESCU), *Remaniella* sp., ? *Calpionellites* cf. *darderi* (COLOM), this assemblage represents Zone E (= early Valanginian).

Ammonites and Calpionellids

Calpionellids were found in the matrix of several ammonites (De Wever *et al.*, 1986) :

a) with *Protacanthodiscus andreaei* (KILIAN) were found : (sample PDW-AR 2)

Globochaete alpina LOMBARD
Stomiosphaera moluccana WANNER
Calpionella alpina LORENZ
Tintinnopsella carpathica (MURGEANU & FILIPESCU)
Crassicollaria massutiniana (COLOM)
Crassicollaria intermedia (DURAND-DELGA)

This association indicates Calpionellid Zone A (more precisely A2-A3 sub-zones, which are the equivalent of the Durangites Zone of latest Tithonian age).

b) with *Timovella* sp. cf. *suprajurensis* (MAZENOT) were found (sample PDW-AR 3):

Globochaete alpina LOMBARD
Stomiosphaera moluccana WANNER
Calpionella alpina LORENZ
Tintinnopsella carpathica (MURGEANU & FILIPESCU)
Crassicollaria parvula REMANE.

This association belongs to calpionellid Zone B (early Berriasian) which is the equivalent of *Jacobi* + *Grandis* + lower *Occitanica-Subalpina* subzone of ammonite zones.

Conclusion

Ammonites and calpionellids date the base of Level 2 as early Tithonian (*Hybonotum* Zone) and the upper part as early Berriasian [Calpionellid Zone B = *Jacobi-Grandis*-lower *Occitanica* ammonites zones. The Tithonian-Berriasian boundary is here accepted as being located between calpionellid Zones A and B , which corresponds to the boundary of *Durangites* and *Jacobi* ammonite Zones, according to the recommendations of the Jurassic-Cretaceous Colloquium (Lyon-Neuchâtel, 1973)].

Nannofossils

Level 1

Samples S110 and S109:

Diazomatolithus lehmani NOËL
Cyclagelosphaera margereli NOËL
Parhabdolithus embergeri NOËL
Conusphera mexicana TREJO

and rare primitive *Nannoconus* which, according to Manivit (in De Wever *et al.*, 1986, p. 147) suggest an age of late Kimmeridgian to early Tithonian.

Sample S107 : similar association as for sample S110 (with rare nannoconids), *Polycostella beckmani* THIERSTEIN was identified; the age is the same.

Samples S105 and S104 : contain similar nannofossils as in S107 with more abundant primitive *Nannoconus*. The age could therefore be restricted to Late Kimmeridgian.

Level 2

In Level 2 the calcareous nannoplankton are relatively poorly-preserved. *Conusphaera mexicana* was identified but neither *C. deflandrei* (MANIVIT), nor *Nannoconus* spp. were observed. A Kimmeridgian-Tithonian age is therefore recognised, but further refinement is not possible

Level 3

Samples S97 and S96 :

Nannoconus bronnimanni TREJO
Nannoconus steinmanni minor KAMPTNER
Nannoconus dolomiticus CITA & PASQUARE
Polycostella senaria THIERSTEIN

this association indicates an early-mid Berriasian (N. colomi Zone, with the first true *Nannoconus*) age. No specimens of *C. crenulatus* were found, (although searched for) therefore, the age is interpreted being no younger than Mid Berriasian.

Sample S95 : several *Nannoconus* spp. are similar to those in S96, with

Nannoconus colomi DE LAPPARENT
Speetonia colligata BLACK (synonym of *Cretaturbella rothi*)
Assipetra infracretacea (THIERSTEIN)
Micrantholithus hoschulzi REINHARDT
Cretarhabdus crenulatus BRAMLETTE & MARTINI.

This association indicates a late Berriasian-early Valanginian age.

Sample S94 : many *Nannoconus ssp.* among which occur:

Nannoconus bronnimanni TREJO
N. colomi DE LAPPARENT
N. quadratus DERES
N. kamptneri BRONNIMANN
Micrantholithus hoschulzi REINHARDT
Cyclagelosphaera margereli NOËL
Discorhabdus ignotus (GORKA)
Vekshinella stradneri ROOD *et al.*
Zeugrhabdotus erectus (DEFLANDRE)
Assiptera infracretacea (THIERSTEIN)
Cretarhabdus crenulatus BRAMLETTE & MARTINI
Polycostella senaria THIERSTEIN
Calcicalathina oblongata (WORSLEY).

The first appearance levels of the latter indicate an Early Valanginian age (*Pertransiens* Zone in Spain and in the Vocontian trough).

7. Synthesis of ages as indicated by the total fossil evidence

Level 1 "radiolarite" :

The base is dated exclusively by radiolarians (as Late Oxfordian-Kimmeridgian), higher up in Level 1 age integrated radiolarian and nannofossil evidence suggests a Late Kimmeridgian age.

Level 2 (nodular limestone) :
This level is condensed. The base is early Tithonian (*Hybonotum* Zone) in age, and the youngest horizons are early Berriasian as indicated by both ammonites and calpionellids (calpionellid Zone B = ammonite zones of *Jacobi, Grandis* and lower *Occitanica* - *Subalpina* subzone). It is likely that sedimentation of these nodular limestones was still active during the early Berriasian.

Level 3 (white clayey limestone):
This level is dated with calpionellids as late Berriasian (Zones D2-D3) for its base and early Valanginian (Zone E) for its top. Radiolarian dating is consistent with these ages and nannofossil dating confirms the early Valanginian age of the upper part.

8. Conclusions

The end of the radiolarite sedimentation is precisely dated as the Kimmeridgian-Tithonian boundary.

References

BAUMGARTNER, P., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BROQUET, P., CAIRE, A. & MASCLE, G. (1966). Structure et évolution de la Sicile occidentale (Madonies et Sicani). *Bulletin de la Société Géologique de France, Série VII,* **7** (8), 994-1013.

Colloque sur la limite Jurassique-Crétacé, Lyon, Neuchâtel, septembre 1973 (1975). *Mémoires du Bureau de Recherches Géologiques et Minières, Paris,* **86**, 393 p.

DE WEVER, P., GEYSSANT, J.R., AZÉMA, J., DEVOS, I., DUÉE, G., MANIVIT, H. & VRIELYNCK, B. (1986). La coupe de Santa Anna (zone de Sciacca, Sicile): Une synthèse biostratigraphique des apports des macro-, micro- et nannofossiles du Jurassique supérieur et Crétacé inférieur. *Revue de Micropaléontologie*, **29**, (5), 141-186.

DERCOURT, J., ZONENSHAIN, L.P., *ET AL.* (1985). Présentation de 9 cartes paléogéographiques au 1.20.000.000e s'étendant de l'Atlantique au Pamir pour la Période du Lias à l'Actuel. *Bulletin de la Société Géologique de France, Série VIII*, **1** (5), 637-652.

FABIANI, R. & TREVISAN, L. (1937). Di alcune novità geologiche nel territorio del foglio Termini-Imerese (Palermo). *Bollettino della Società di Scienze Naturali Economica, Palermo*, **19**, 1-8.

FABIANI, R. & TREVISAN, L. (1940). Prove dell'esistenza di uno stile tettonico a falde di ricoprimento nei monti di Palermo. *Atti della Reale Accademia Italiana, Classe di Scienze Fisiche, Matematiche e Naturali*, **2**, 435-448.

GEYSSANT, J.R. & MASCLE, G.H. (1970). Deux gisements fossilifères du Tithonique des Monts Sicani (Sicile occidentale). *Comptes Rendus Sommaire de la Société Géologique de France*, 213-214.

GRANDJACQUET, C. & MASCLE, G. (1978). The structure of the Ionian Sea, Sicily, and Calabria-Luciana. *In* Nairn, A.E.M., Kanes, W.H. & Stehli, F.G. Eds. *The Ocean Basins and Margins* - Plenum Publ. Comp. **4B**. (257-329).

LE HEGARAT, G. & REMANE, J. (1968). Tithonique supérieur et Berriasien de la bordure cévenole. Corrélations des ammonites et des calpionelles. *Geobios*, **1**, 7-70.

MASCLE, G. (1970). Geological sketch of Western Sicily. *Geology and History of Sicily* - Petroleum Exploration Society of Lybia, Tripoli. (231-243).

MASCLE, G. (1974). Le système de failles de Comiso, bordure nord-occidentale du haut-plateau ibléen (Sicile). *Comptes Rendus Sommaire de la Société Géologique de France*, 134-136.

MASCLE, G.H. (1973). *Etude géologique des Monts Sicani (Sicile).* Thèse de Doctorat d'Etat (Université Pierre et Marie Curie, Paris, 691 p.

MASCLE, G.H. (1979). Etude géologique des Monts Sicani (Sicile). *Rivista italiana di Paleontologia e Stratigrafia, Memoria*, **16**, 1-431.

ORIGLIA-DEVOS, I. (1983).*Radiolaires du Jurassique supérieur-Crétacé inferieur: Taxonomie et révision stratigraphique (zone du Pinde-Olonos, Grèce, zone de Sciacca, Italie, Complexe de Nicoya, Costa Rica et forages du DSDP*. Université Pierre et Marie Curie, Paris (Unpublished), 328 p.

REMANE, J. (1963). Les Calpionelles dans les couches de passage Jurassique-Crétacé de la fosse vocontiènne. *Travaux du Laboratoire de Géologie de la Faculté des Science de l'Université de Grenoble*, **39**, 25-82.

REMANE, J. (1964). Unterschungen zur Systematik und Stratigraphie der Calpionellen in der Jura-Kreide-Grenzschichten des Volcontischen Troges. *Palaeontographica. Abteilung A: Palaozoologie-Stratigraphie*, **123**, 1-57.

REMANE, J. (1971). Les Calpionelles, protozoaires planctoniques des mers mésogéennes de l'époque secondaire. *Annalen Guebhard, Neuchâtel*, **47**, 1-25.

REMANE, J. (1985). Calpionellids. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/ New York/New Rochelle/Melbourne, 555-572.

RIEDEL, W.R. & SANFILIPPO, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles,* 80 (**3**), 317-340.

APPENDIX

Radiolarians were extracted by alternating etching with Hydrofluoric and Hydrochloric acids, then cleaned with H_2O_2 (80 vol., 100°C for 30 minutes) and/or sodium hexametaphosphate (100°C for 30 minutes).

The following radiolarians were identified (see fig. 2 for the stratigraphic position of the samples). Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION DW1_SANTA_ANNA_SICILY: BOTTOM 1 - TOP 10

< 10 {SA94}: 3066, 3065, 3087, 3090, 3092, { 3103,} 3113, 3115, { 3140,} 3213, { 3220,} 3227, 3228, {DENTATA}3281, {RADICUS} 5209

< 9 {SA96}: 3066, 3065, 3078, 3087, 3090, 3092, {3103,} 3113, 3115, { 3137,} { 3140,} 3161, { 3220, 3227, 3228, 3266, 4069,} {RADICUS}5209

< 8 {SA104}: 3036, 3066, 3090, 3092, 3096, 3097, 3100, 3103, 3104, 3106, 3113, 3116, 3117, 3122, 3131, 3137, 3138, 3139, 3147, 3161, 3171, 3185, 3210, 3213, 3215, 3220, 3230, 4069

< 7 {SA105}: 3035, 3036, 3066, 3096, 3097, 3100, 3104, 3113, 3122, 3147, 3164, 3166, 3171, 3185, 3210, 3215, 3230, 3263, 4069

< 6 {SA106}: 3035, 3036, 3066, 3096, 3097, 3103, 3104, 3106, 3113, 3116, 3118, 3119, 3121, 3122, 3140, 3147, 3164, 3166, 3169, 3180, 3185, 3199, 3215, 3230, {3255,} 3263, 3267, 4069

< 5 {SA107}: 3035, 3036, 3063, 3066, 3096, 3097, 3113, 3116, 3118, 3121, 3122, 3129, 3140, 3147, 3161, 3164, 3169, 3180, 3185, 3199, 3210, 3213, 3225, 3230, 3263, 3267, 4069

< 4 {SA108}: 3035, 3036, 3066, 3090, 3096, 3103, 3104, 3113, 3116, 3117, 3119, 3121, 3122, 3126, 3129, 3140, 3161, 3169, 3185, 3210, 3215, 3225, 3230, 3267, 4069, 5003

< 3 {SA109}: 3035, 3036, 3066, 3078, 3090, 3096, 3100, 3103, 3104, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3131, 3139, 3140, 3147, 3160, 3161, 3164, 3169, 3180, 3185, 3210, 3215, 3225, 3230, { 3255,} 3267, 4069

< 2 {SA110}: 3035, 3036, 3066, 3078, 3096, 3100, 3103, 3104, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3129, 3139, 3140, 3147, 3160, 3161, 3162, 3185, 3210, 3225, 3230, { 3255,} 3263, 3267, 3273, 4069

< 1 {SA111}: 3008, 3035, 3036, 3066, 3096, 3103, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3126, 3129, 3140, 3160, 3164, 3180, 3185, 3210, 3213, 3215, 3230, {3255,} 3267, 4069

18. Middle Jurassic to Early Cretaceous Radiolarian Biochronology of the Budva Zone (Dinarides, Montenegro)

by Spela Gorican

Institut de Géologie et Paléontologie, BFSH 2, 1015 Lausanne, Switzerland
Present address: Paleontoloski Institut Ivana Rakovca ZRC SAZU, Gosposka 13, 61000 Ljubljana, Slovenia

ABSTRACT

A local radiolarian zonation for the Aalenian-Early Bajocian to Hauterivian-Barremian time interval is presented. The radiolarian assemblages were obtained from seven sections of the Budva Zone (Dinarides, Montenegro). The zonation was established by means of the Unitary Association Method (Guex, 1977, 1991). The data allowed the recognition of 37 U.A.'s which were merged in 11 chronologically meaningful «zones». The resulting «zones» were calibrated through a correlation with published zonations.

1. Introduction

Radiolarian work in the Budva Zone was initiated in the late 1980's (Obradovic *et al.*, 1986; Gorican, 1987; Obradovic & Gorican, 1989). Lower Jurassic, Middle Jurassic and Middle Cretaceous radiolarian assemblages were obtained from the Gornja Lastva Section near Tivat.

The rather rich assemblages and thick continuous successions of radiolarian-bearing rocks encouraged us to extend the investigation to other sections of the Budva Zone. The hitherto poorly-known Jurassic and Cretaceous stratigraphy of the region, due to the lack of other age-diagnostic fossils, led us to undertake a wider biostratigraphic study based on radiolarian dating. Lowermost Jurassic to Middle Cretaceous formations have now been defined and described (Gorican, 1994). A tentative reconstruction of the sedimentary evolution of the Mesozoic Budva Basin has been proposed. A local radiolarian zonation has been established for the Middle Jurassic to Turonian time interval.

In this paper, the Aalenian-Bajocian to Hauterivian-Barremian radiolarian biochronology is presented. The complete stratigraphic and biochronological results are published separately (Gorican, 1994).

2. Geological setting

Geographically, the Budva Zone comprises a narrow, NW to SE oriented belt, less than 10km wide and about 100 km long, situated in coastal Montenegro between the Albanian border in the south and Hercegnovi in the north (Figs. 1, 2).

Geologically, the Budva Zone (Petkovic, 1956) is a part of the External Dinarides (Fig. 2). Tectonically, the Budva Zone is represented by several thrust units, underlain by the Dalmatian Zone (Aubouin, 1960) in the southwest and overlain by the High Karst Zone (Kossmat, 1924) in the northeast. The nappes were emplaced towards the southwest.

The front of the Budva Zone overthrust can be traced from Bar to Sutomore and from Budva to Hercegnovi (Fig. 2). South of Bar the High Karst Zone was emplaced over the Budva Zone and brought in contact with the Dalmatian Zone. The outcrop of the Budva Zone wedges out near Konavlje north of Kotor Bay (Markovic, 1966). This area marks the northwest termination of an approximately 800km long belt of basinal deposits represented by the Pindos-Olonos Zone in Greece and Krasta-Cukali Zone in Albania.

The Budva Zone itself comprises several thrust sheets (Fig. 2). In the Kotor area two tectonic units are distinguished, the Devesilje Tectonic Unit which is overthrust by the Vrmac Tectonic Unit. The central part between Kotor and Petrovac is more complex, composed of several smaller discontinuous recumbent folds. In general, a subdivision between a lower and an upper tectonic unit is possible.

The present disposition of the tectonic units corresponds approximately to the Mesozoic palaeogeography. The Budva Zone was a narrow basin situated between two carbonate platforms (D'Argenio *et al.*, 1971).

The oldest outcropping formation in the Budva Zone (Fig. 3) is composed of Lower Triassic red marine sandstones, dolomites, and marly limestones. The Middle Triassic is characterized by the "Anisian Flysch" or limestone-dolomite sequence, overlain by a volcano-sedimentary sequence, which consists of volcanic and volcaniclastic rocks alternating with cherts or limestones. The Upper Triassic to Maastrichtian succession displays an alternation of pelagic limestones, radiolarites, and resedimented carbonates which is overlain by flysch deposits of Paleocene to Early Eocene age. The following lithostratigraphic units are recognized in the Triassic-Jurassic to Middle Cretaceous succession (Fig. 3):

- *Halobia* limestone: bedded cherty limestone; Upper Triassic.
- «Passée Jaspeuse»: alternation of calcareous chert and shale beds; Triassic-Jurassic boundary to the Sinemurian - ? lower Pliensbachian.
- Bar Limestone: carbonate gravity-flow deposits

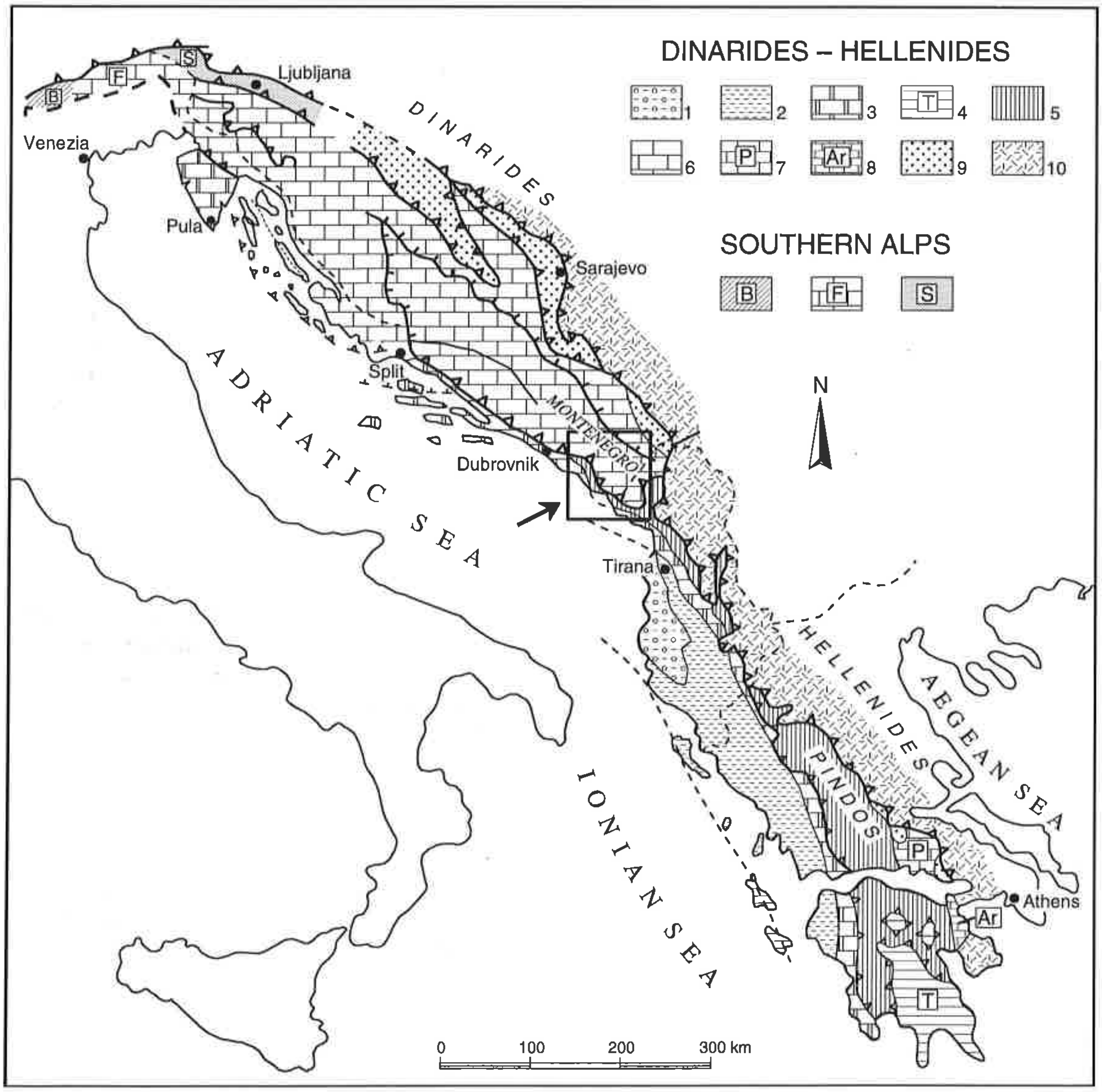


Figure 1. Schematic tectonic map of the Dinarides, Hellenides and Southern Alps showing the position of the Budva Zone (5) and its relationship with the neighbouring tectonic units. The position of the Internal Dinarides (10) comprising the Ophiolitic complex is indicated (after Celet, 1977). **1.** Dalmatian-Albanian Foredeep, **2.** Ionian Zone, **3.** Dalmatian and Gavrovo Zones, **4.** Tripolitza Zone, **5.** Budva-Cukali-Pindos Zone, **6.** High Karst Zone, **7.** Parnassos Zone, **8.** Argolid, **9.** Bosnian and Beotian Zones, **10.** Internal Dinarides and Hellenides, **B.** Belluno, **F.** Friuli, **S.** Slovenian Zone. The framed area is enlarged in Fig. 2.

composed of penecontemporaneous platform debris and remobilized slope sediments; ? upper Sinemurian-lower Pliensbachian to lower Toarcian (Lower Member), upper Toarcian ?-Aalenian to lower Oxfordian (Upper Member).

- Lastva Radiolarite: alternation of chert and shale layers; ? Toarcian to Tithonian.
- Praevalis Limestone: reddish cherty limestone with marls; upper Tithonian to Upper Aptian-Lower Albian.
- Bijela Radiolarite: alternation of shales and cherts; Hauterivian-lower Barremian to Turonian.
- *Globotruncana* limestone: Coniacian? to Maastrichtian.

Locally, pelagic deposits are displaced by resedimented carbonates of Tithonian to Neocomian and Albian to Late Cretaceous age. These resedimented carbonates originated mainly from the erosion of lithified shallow water limestones.

3. Summary description of localities

The location of the sections studied is indicated in Fig. 2. Detailed lithological columns and stratigraphic positions of radiolarian samples are presented in Fig. 4. They are arranged in an axial northwest to southeast direction. The numbering of the sections is the same as in Gorican (1994).

For each locality, its tectonic position within the Budva Zone is indicated. The thrust sheet directly underlying the High Karst Zone is considered the upper tectonic unit.

2. Locality name: **Verige**

Upper tectonic unit

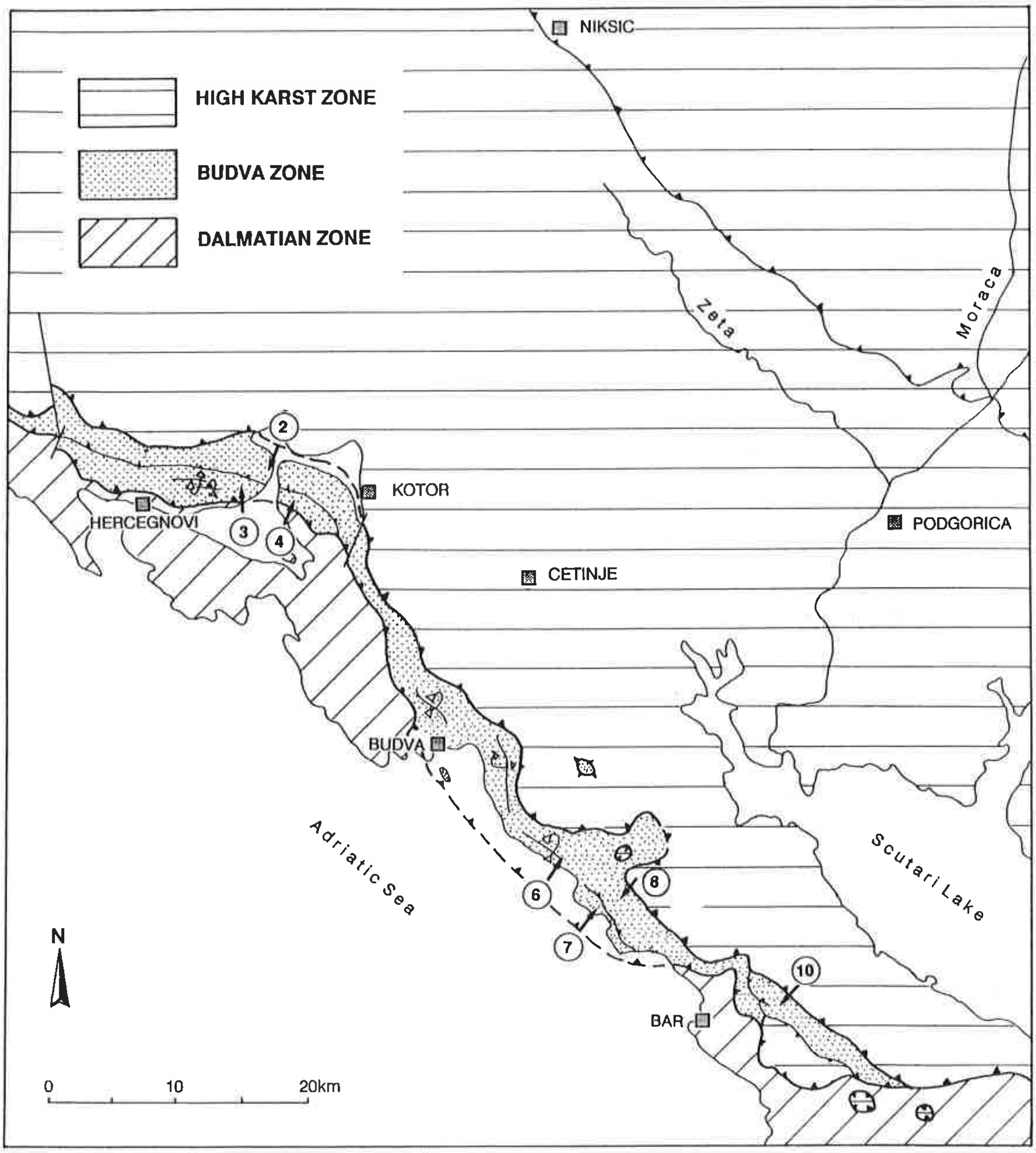


Figure 2. Simplified tectonic map of the Montenegro coast (after Mirkovic, *in press*) and location of the sections studied. **2.** Verige, **3.** Bijela, **4.** Gornja Lastva, **6.** Petrovac, **7.** Canj, **8.** Din Vrh, **10.** Bar.

Location and access: Lat. 42° 28.50'N, Long. 18° 41.00'E. At the Verige isthmus in Kotor Bay, along the coast road, 1km NE of Kamenari.

Stratigraphy: About 70m of the Lastva Radiolarite was sampled.

Previous work: Cadjenovic *et al.* (1988), Radoicic & D'Argenio (1988) under the name Vrmac sequence.

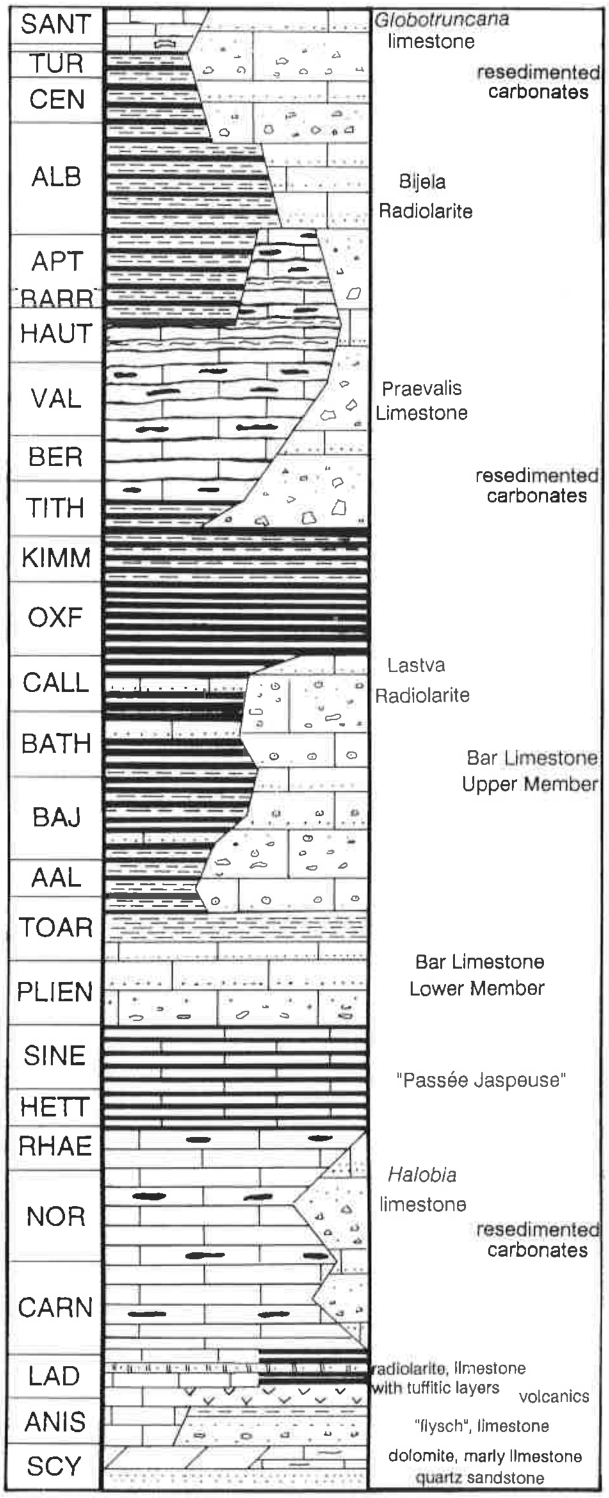


Figure 3. Generalized stratigraphic column of the Budva Zone (redrawn after Gorican, 1994).

3. Locality name: **Bijela**

Lower tectonic unit

Location and access: Lat. 42° 27.80'N, Long. 18° 38.70'E. A small church about 1km NE from Bijela is built on the base of the Bar Limestone Formation. The Jurassic part of the section was sampled on the slope northwards. The Cretaceous formations and the contact with the underlying Lastva Radiolarite are exposed along the road from Kamenari to Krusevice.

Stratigraphy: The radiolarian samples were collected in the Lastva Radiolarite and Bijela Radiolarite formations.

Remarks: The Upper Jurassic part of the Bijela section was divided into three partial sections. The superpositional relationship of strata could not be determined in the field due to tectonic disruption and poor exposure.

4. Locality name: **Gornja Lastva**

Lower tectonic unit

Location and access: Lat. 42° 27.30'N, Long. 18° 42.20'E. Near Tivat, along the road from Donja Lastva to Gornja Lastva.

Stratigraphy: The most complete succession of the Lastva Radiolarite Formation in the Budva Zone is exposed in this section. It is overlain by Praevalis Limestone and Bijela Radiolarite.

Previous work: Cadet (1978), Obradovic *et al.* (1986), Gorican (1987), Radoicic & D'Argenio (1988), Obradovic & Gorican (1989). The samples of Gorican (1987) were re-examined.

6. Locality name: **Petrovac**

Lower tectonic unit

Location and access: Lat. 42° 12.60'N, Long. 18° 56.36'E. Along the road Petrovac - Podgorica. The section starts at the junction with the main coast road Budva - Bar.

Stratigraphy: A 20m thick sequence of the Lastva Radiolarite is overlain by Praevalis Limestone that exhibits slump folding. The section is tectonically inverted.

7. Locality name: **Canj**

Lower tectonic unit

Location and access: Lat. 42° 9.86'N, Long. 18°59.50'E. The section starts on the beach of the small bay of Pecin, 1km NW from Canj south of Petrovac. It is exposed on the slope towards NNE.

Stratigraphy: The radiolarian samples were collected in the Lastva Radiolarite and Praevalis Limestone.

8. Locality name: **Din Vrh**

Upper tectonic unit

Location and access: Lat. 42°11.44'N, Long. 19° 0.50'E. 3.5km in direct line north from Canj between Velja Glava (603m) and the Ilijino Brdo hills. A path goes to the north from the main road about 2km from Misici.

Stratigraphy: The section studied comprises 25m of the Lastva Radiolarite and 15m of Praevalis Limestone.

10. Locality name: **Bar**

Upper tectonic unit

Location and access: Lat. 42° 6.39'N, Long. 19° 9.21'E. Along a mule track from the ruins of the medieval city of Stari Bar toward the NE to the village Mali Mikulici. The Upper Jurassic to Cretaceous part is exposed by a waterfall in a gorge near the path.

Stratigraphy: The Lastva Radiolarite and Praevalis Limestone were sampled for radiolarians.

4. Lithostratigraphy

4.1. Lastva Radiolarite

The Lastva Radiolarite (Fig. 4) is a sequence of rhythmically alternating chert and shale layers. Beds of silicified resedimented carbonates are intercalated. The thickness of the formation varies from about 20 metres (Din Vrh) to 150 metres (Gornja Lastva).

The Lastva Radiolarite conformably overlies the Bar Limestone Formation. At the upper boundary the Lastva Radiolarite is overlain by siliceous reddish limestone (Praevalis Limestone). The increase of carbonate is abrupt (Canj, Bar) except where calcarenites and marls are intercalated (Gornja Lastva, Din Vrh). A part of both pelagic sequences can be displaced by platform-derived resedimented carbonates (Verige, Bijela sections).

Based on the colour, shale content and bedding style the following radiolarite facies can be distinguished from base to top (Fig. 4):

The **variegated** facies is divided in two parts. The first (V1) is characterised by a very high proportion of dark green or brownish shale alternating with thin beds of chert. Most chert beds are about 5 cm thick grey laminated siliceous sandstone consisting of sponge spicules and radiolarians. The high concentration of siliceous organisms and the laminated structure suggest bottom-current redeposition. The preservation of radiolarians is extremely poor. Centimetre-thick layers of dark variegated argillaceous chert are present. These contain rare moderately preserved radiolarians. Chert beds do not exceed 30% of the sequence.

Higher in the sequence (V2) the shale component gradually decreases. Dark reddish-green chert beds are thicker (5 to 10 cm), sometimes nodular, and are progressively less argillaceous. Siliceous sandstone beds disappear. Cherts represent 60% to 90% of the sequence. Moderately preserved radiolarians can be found in all chert beds. The slightly argillaceous chert occasionally contains a very well-preserved and diverse fauna.

Green radiolarite (G) generally consists of thicker (average 10 cm) unevenly bedded, sometimes laminated greyish-green chert. Thin interlayers of slightly argillaceous yellowish-green chert are present along joints. They contain a small percentage of diagenetic pyrite (oxidized to limonite) in the form of scattered euhedral crystals. The content of chert varies from 95% to 100% of the sequence. The uppermost part of the green radiolarite in the Bar and Bijela sections is composed of thin, evenly bedded argillaceous chert with 20% shale interlayers. The average preservation of radiolarians is very poor. Thinner yellowish interlayers, however, can yield pyritized Nassellarian dominated assemblages.

Greenish-red (GR) nodular radiolarite is characterised by 3 to 15 cm thick undulating chert beds alternating with a maximum 5% shale. This facies is a few metres thick and always interstratified between green radiolarite and red nodular radiolarite. Chert beds are red in the middle part and green at the margins. The original colour was probably red, the margins owing their green colour to diagenesis. Radiolarians are abundant, diverse and well-preserved.

Red knobby radiolarite (Rk) facies consists of decimetre-sized nodular chert beds with a high pinch-to-swell ratio. No shale is interlayered. At Canj, where the facies is best exposed, it changes from orange-red through dark red to brick-red upsection. Radiolarians are well-preserved.

Red ribbon (Rr) radiolarite displays a very regular alternation of dark brownish-red argillaceous chert (beds 3 to 6 cm) and centimetre-sized shale interlayers. The content of chert beds varies from 80% to 90% of the sequence. In the Canj section this facies is directly overlain by pelagic cherty limestone, the uppermost portion (3.5 metres) is brick red and contains some dispersed carbonate. Radiolarians are very abundant but moderately preserved and usually compressed because of the compaction of the relatively clay-rich sediment.

In addition to radiolarians, sponge spicules and rhaxes occur through all the radiolarite succession. They are especially abundant in the lower variegated facies, where they predominate over radiolarians.

Carbonate gravity-flow deposits are intercalated throughout the succession. Calcarenite beds are silicified, generally 5-20 centimetres thick, rarely up to 30-40 centimetres. Occasionally thicker, graded turbidites which escaped complete silicification are interstratified. The frequency of calcarenite beds varies from absent to more than 50%.

Age: The Lastva Radiolarite was systematically sampled for radiolarians at 5m to 10 m intervals (Fig. 4). The base of the formation is diachronous. The oldest age determination obtained is Aalenian-Early Bajocian (Gornja Lastva, Bijela). A relatively thick lime-free succession below the lowest radiolarian samples suggests that the accumulation of the Lastva Radiolarite possibly started as early as the Toarcian. The youngest recorded age for the base of the formation is Oxfordian (Din Vrh, Bar). The top is late Tithonian and synchronous in the continuous pelagic succession (Gornja Lastva, Canj, Din Vrh, Bar). When overlain by resedimented carbonates the topmost radiolarites can be as old as Kimmeridgian (Verige, Bijela).

4.2. Praevalis Limestone

The sequence (Fig. 4) is composed of well-stratified marly micrite (beds 10-20 cm) with replacement chert nodules and layers. The general colour of limestone is light red to violet red, rarely white to pale green, cherts are vivid red. Bedding planes are undulating. The amount of visible chert varies between 10 and 50%. In the upper part of the sequence reddish marls are interbedded. Calcarenite beds are also occasionally interlayered.

The limestone beds contain a maximum of 15% calcified radiolarians in a lime-mud matrix. Very rare calpionellids

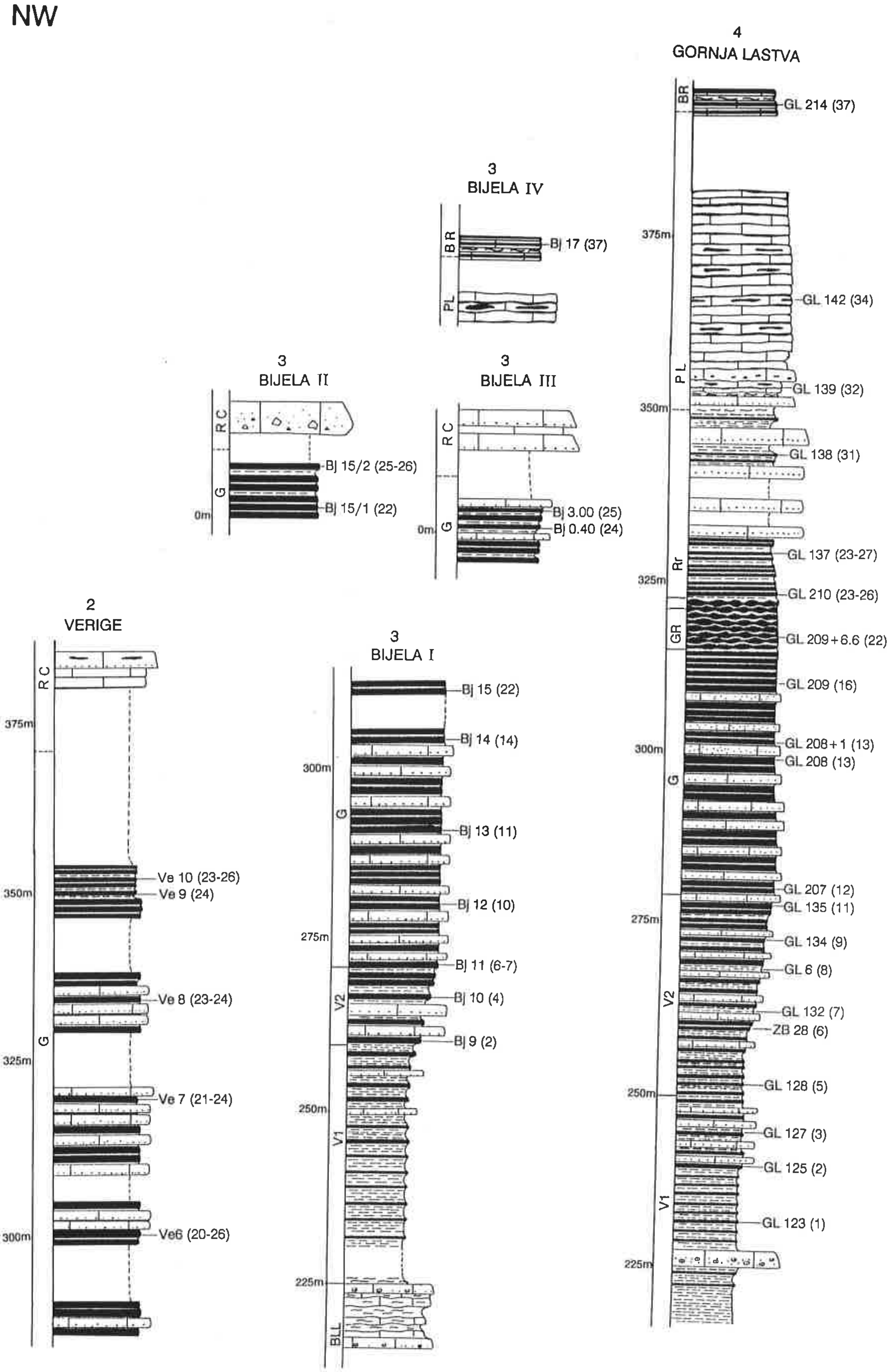
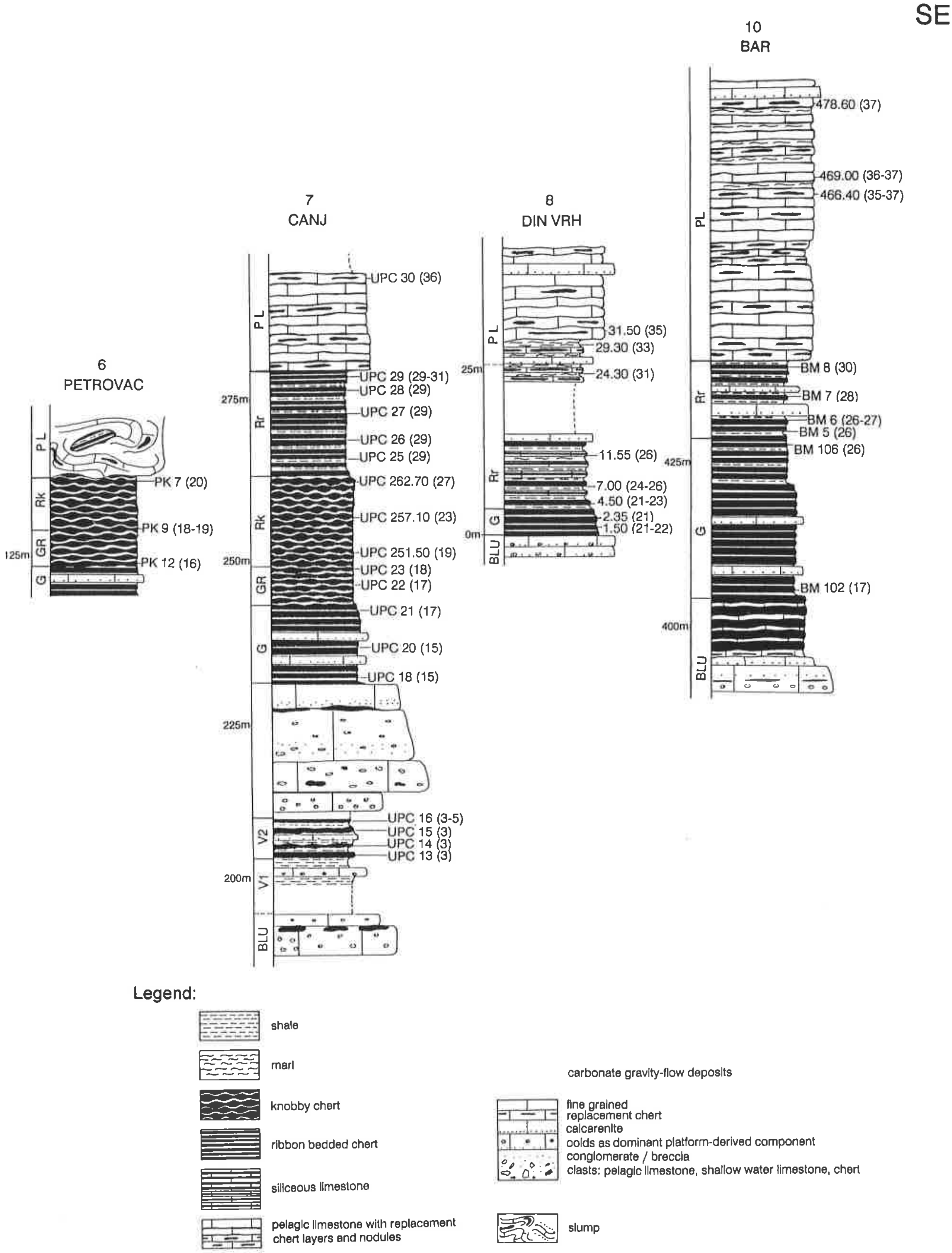


Figure 4. Lithological columns and position of samples. Numbers within brackets refer to corresponding unitary associations. Abbreviations of the lithostratigraphic units: **BLL.** Bar Limestone. Lower Member, **BLU.** Bar Limestone - Upper Member, **BR.** Bijela Radiolarite, **PL.** Praevalis Limestone, **RC.** Resedimented carbonates. Abbreviations of different radiolarite facies of the Lastva



Radiolarite Formation: **V1.** Lower variegated, **V2.** Upper variegated, **G.** Green, **GR.** Greenish red knobby, **Rk.** Red knobby, **Rr.** Red ribbon.

were found in the lower part of the sequence. Relatively abundant and well-preserved radiolarians were extracted from chert nodules.

Age: The Praevalis Limestone lies on the top of the Lastva Radiolarite. Radoicic (in D'Argenio *et al.*, 1971; Radoicic & D'Argenio, 1988) found the upper Tithonian *Calpionella alpina* LORENZ near the base. Our radiolarian evidence is not continuous over all the sequence. Berriasian-lower Valanginian, and upper Valanginian to Hauterivian assemblages were found in different sections. The base of the overlying Bijela Radiolarite is assigned to the Hauterivian-lower Barremian (Bijela, Gornja Lastva sections). Locally, the carbonate sedimentation continued up to the upper Aptian-lower Albian (Gorican, 1994).

The maximum thickness for the upper Tithonian to Hauterivian-Barremian interval does not exceed 50m.

4.3. Bijela Radiolarite

The transition from the underlying siliceous Praevalis Limestone to the Bijela Radiolarite is gradual, marked by a progressive increase in clay and silica content. The base of the radiolarite is defined where the sequence has a typical radiolarite aspect of thin dark red siliceous beds alternating with clayey marls.

The Bijela Radiolarite is predominantly dark red, characterized by a very high proportion of shale layers. Chert beds are thin (1-3cm), generally representing 20-40% of the sequence. In the lower and uppermost part of the succession the chert beds are somewhat thicker (5-8cm); they constitute 50-80% of the sequence. At the base of the succession some carbonate is present, otherwise the overall facies is lime-free. Graded calcarenite beds up to 70 cm thick are interbedded in the sequence. The maximum estimated thickness of the Bijela Radiolarite is 60m.

The samples treated in this paper were collected at the very base of this formation in the Bijela and Gornja Lastva sections (Fig. 4). The siliceous radiolarian-bearing beds still contain some dispersed carbonate. Radiolarian assemblages are poorly-preserved.

Age: The radiolarite succession is overlain either by red *Globotruncana* limestone or by calcareous turbidites. The base of the Bijela Radiolarite is assigned to the Hauterivian-lower Barremian (Bijela, Gornja Lastva). The youngest age obtained for the top is Turonian (Gorican, 1994).

5. Sample preparation

Radiolarians from chert samples were extracted using standard HF methods (Dumitrica, 1970; Pessagno & Newport, 1972; De Wever, 1982b).

The Lower Cretaceous siliceous-limestone samples were first treated with acetic acid to remove the carbonate component. These residues were devoid of determinable radiolarians. Radiolarians were then isolated with diluted hydrofluoric acid.

6. Remarks on systematics

The definition of taxa mainly follows the agreement on systematics accepted by the Jurassic-Cretaceous Working Group (Radiolarian Catalogue this volume). Hence our data can be integrated into a single data base used in generating a globally applicable radiolarian biochronologic scale for low latitudes.

Some of the recorded species (numerical codes within brackets in Appendix) are not included in the Budva Zone radiolarian zonation for the following reasons: 1: They were found only in one section and are therefore of no importance for correlation. 2: The presence of some radiolarians with delicate tests, especially spumellarians, is very discontinuous in our sections. Furthermore, ancestral and descendent forms are often similar in shape and external ornamentation. Such forms were not used for the correlation in order to avoid the introduction of possible homeomorphs. The occurrence of these species is indicated so as to complete the picture of the radiolarian assemblages from the Budva Zone and provide supplementary data for correlation with other regions.

The taxa with numerical codes from 1000 to 2999 (Appendix) are either not included in the Radiolarian Catalogue (this volume) or their definition has been broadened in this paper. The following species are in the latter group:

1. *Guexella nudata* (KOCHER): *Gongylothorax sakawaensis* MATSUOKA is synonymized with *Guexella nudata* (KOCHER) because the preservation of our material does not allow transmitted light study to determine the number of segments.
2. *Napora bukryi* PESSAGNO gr.: forms with a large hemispherical thorax assignable to *Napora bukryi* PESSAGNO, *N. lospensis* PESSAGNO and *N. deweveri* BAUMGARTNER are grouped together.
3. *Tritrabs exotica* (PESSAGNO) gr.: *Tritrabs rhododactylus* BAUMGARTNER is considered a synonym of *Tritrabs exotica* (PESSAGNO).

The radiolarian species found in the Budva Zone are illustrated and discussed in more detail elsewhere (Gorican, 1994).

7. Radiolarian Biochronology

7.1. Introduction

The continuous succession of radiolarian-bearing rocks in the Budva Zone from the beginning of the Middle Jurassic to the Turonian allowed us to establish a local radiolarian zonation for this time interval (Gorican, 1994). The biochronological correlation was accomplished by means of the BioGraph computer program (Savary & Guex, 1991), based on the Unitary Association Method (Guex, 1977, 1991) which has proven to be an efficient tool for the construction of reliable radiolarian zonations (Baumgartner, 1984; Jud, 1994; Carter, 1993).

The radiolarian inventory of 95 samples from eight sections was studied. The species content of the samples included in this paper is listed in the Appendix.

Based on the distribution of 139 taxa, 48 different Unitary Associations were recognized. In this study the Middle Jurassic to Lower Cretaceous (Hauterivian-Barremian) part of the zonation comprising 37 U.A.'s, is presented. The resulting protoreferential is shown in Fig. 5.

Individual Unitary Associations, identified in separate sections, can differ in faunal content due to ecological, taphonomic or documentary factors. These usually have no chronological significance. Some of them must be merged to construct chronologically meaningful «zones». Such zones are characterized by a wide lateral traceability and a good mutual superpositional control (see Guex, 1991 for the details of the procedure). On the basis of the lateral reproducibility (Fig. 6) our U.A.'s were merged into 15 «zones», 11 of them are discussed herein. Faunal differences between the different U.A.'s encompassed in the same «zone» are ignored in the biochronological interpretation.

To enable a biostratigraphic correlation of sections, the assignment of each sample to a corresponding U.A., is indicated in the lithological columns showing the position of samples (Fig. 4).

7.2. Definition and age assignment of biochronologic units. Correlation with other zonations.

The biochronologic units determined here were mostly calibrated through a correlation with published zonations, therefore age assignment and correlations are discussed simultaneously. Species or pairs of species defining individual U.A.'s, as well as mutually exclusive species defining their limits are evident from Fig. 5 and will not be systematically referred to in the text.

The union of **U.A. 1 and U.A. 2** occurs in two sections. U.A. 1 was identified in the Gornja Lastva section, 5m above a calcarenite bed containing *Gutnicella cayeuxi* (LUCAS), which is restricted to the Aalenian and Early Bajocian (Septfontaine *et al.*, 1991).

Tonielli (1991) assigned an assemblage yielding *Parahsuum* (?) *magnum* TAKEMURA and *Ares cylindricus* (TAKEMURA) to the latest Toarcian/Aalenian-earliest Bajocian on the basis of ammonites. *Parahsuum* (?) *magnum* TAKEMURA associated with *Parahsuum* (?) *natorense* (EL KADIRI) and *Hexasaturnalis tetraspinus* (YAO) was found above middle Toarcian ammonites in Morocco (El Kadiri, 1992).

U.A. 2 is correlative with the *Hsuum hisuikyoense* Assemblage Zone (Hori, 1990), based on the co-occurrence of *Transhsuum hisuikyoense* (ISOZAKI & MATSUDA) and *Laxtorum* (?) *jurassicum* ISOZAKI & MATSUDA. The top of this zone is supposed to lie within the late Aalenian to Early Bajocian interval (Hori, 1990).

The coexistence of *Laxtorum* (?) *jurassicum* ISOZAKI & MATSUDA with *Transhsuum hisuikyoense* (ISOZAKI & MATSUDA) and *Unuma echinatus* ICHIKAWA & YAO allows correlation with the late part of the *Laxtorum* (?) *jurassicum* Interval Zone (Matsuoka & Yao, 1986).

U.A. 1 and U.A. 2 are assigned to the Aalenian - Early Bajocian. The superposed U.A. 3 to U.A. 5 not being younger than the early Late Bajocian, an age comprising only the early part of the Early Bajocian is probable.

The union of **U.A. 3 to U.A. 5** was identified in three sections. It is delimited from U.A. 1 and U.A. 2 by LAD of three and FAD of eight taxa, some of them (*Zartus*, *Ares*, *Turanta*) being known from the Liassic (Pessagno & Blome, 1980; De Wever, 1982a; Carter *et al.*, 1988). This faunal change is partly preservation-controlled.

This union can be correlated with the Early Bajocian Zone 7 of Carter *et al.* (1988) on the basis of the coexisting *Emiluvia splendida* CARTER and *Zartus* spp. *Zartus* makes its last appearance in the early part of the Late Bajocian (Zone 1D, Pessagno *et al.*, 1987). The inferred age for U.A. 3 to U.A. 5 is early to early late Bajocian.

U.A.'s 3 to 5 are probably partly time-equivalent with the *Tricolocapsa plicarum* Interval Zone (Matsuoka & Yao, 1986). The absence of the marker taxon and most of the associated taxa in our material does not allow a direct correlation.

Trillus sp. and *Eucyrtidiellum* (?) *quinatum* TAKEMURA are restricted to U.A. 0 in Baumgartner's (1984) zonation, which suggests the correlation of the U.A. 0 with our U.A.'s 1 to 5.

The unions of **U.A. 6 to U.A. 7** and **U.A. 8 to U.A. 12** were identified in two sections.

The limit between these two chronologic units is marked by the mutual exclusion of *Unuma echinatus* ICHIKAWA & YAO with *Hagiastrum munitum* BAUMGARTNER and *Transhsuum maxwelli* (PESSAGNO) among others. It is concluded that the groups U.A. 6 to U.A. 7 and U.A. 8 to U.A. 12 are correlative with Zones A0 and A1 respectively of Baumgartner (1984). The limit between both unions of U.A.'s is placed in the late part of the late Bajocian, according to the updated calibration by O'Dogherty *et al.* (1989).

Both groups of U.A.'s are further correlative with the *Tricolocapsa conexa* Interval Zone (Matsuoka & Yao, 1986), which is defined by the FEAB of the marker species. *Cyrtocapsa mastoidea* YAO, restricted to the underlying *Tricolocapsa plicarum* Zone (Matsuoka & Yao, 1986) coexists with *Tricolocapsa conexa* MATSUOKA in our material.

The union of **U.A. 13 to U.A. 15** was identified in three sections. The faunal content of all the samples assigned to this chronologic unit is characterised by a great many small nassellarians and by the fact that spumellarians rarely occur. Due to different diagnostic pairs of species, a direct correlation with the zonation of Baumgartner (1984) is not possible.

The coexistence of *Stylocapsa* (?) *spiralis* MATSUOKA gr. with *Guexella nudata* (KOCHER) (see also taxonomic remarks on this species), *Stylocapsa catenarum* MATSUOKA and *Stichocapsa naradaniensis* MATSUOKA allows a correlation with the *Stylocapsa* (?) *spiralis* Zone (Matsuoka & Yao, 1986).

Stylocapsa tecta MATSUOKA and *Stylocapsa hemicostata* MATSUOKA have not been found in our material. All specimens of *Stylocapsa* (?) *spiralis* MATSUOKA gr. show an advanced evolutionary stage of surface ornamentation. It is likely that the late part of the *Tricolocapsa conexa* Zone and the early part of the *Stylocapsa* (?) *spiralis* Zone have not been recorded in the Budva Zone due to widely spaced sampling in this interval and not to a stratigraphic gap.

The union of **U.A. 16 to U.A. 18** was identified in four sections. The samples assigned to this chronologic unit generally contain a well-preserved and highly diverse radiolarian fauna which is clearly reflected in the referential by the first appearance of many taxa.

The group U.A. 16 to U.A. 18 is separated from the underlying chronologic unit by mutually exclusive *Emiluvia orea* BAUMGARTNER with *Guexella nudata* (KOCHER) or *Higumastra imbricata* (OZVOLDOVA) among others. On the basis of these species the boundary can be correlated to the limit between the A2 and B Zones of Baumgartner (1984). It is assigned to the Callovian-Oxfordian according to O'Dogherty *et al.* (1989).

The superposed **U.A. 19 to U.A. 22** were identified in six sections. The following group of U.A. 23 to U.A. 27 is assigned to the late Oxfordian and Kimmeridgian. It is concluded that U.A. 16 to U.A. 18 and U.A. 19 to U.A. 22 lie within the Oxfordian.

The *Cinguloturris carpatica* Zone (Matsuoka & Yao, 1986) defines the interval between the LAD of *Tricolocapsa conexa* MATSUOKA and FAD of *Pseudodictyomitra primitiva* MATSUOKA & YAO, the latter

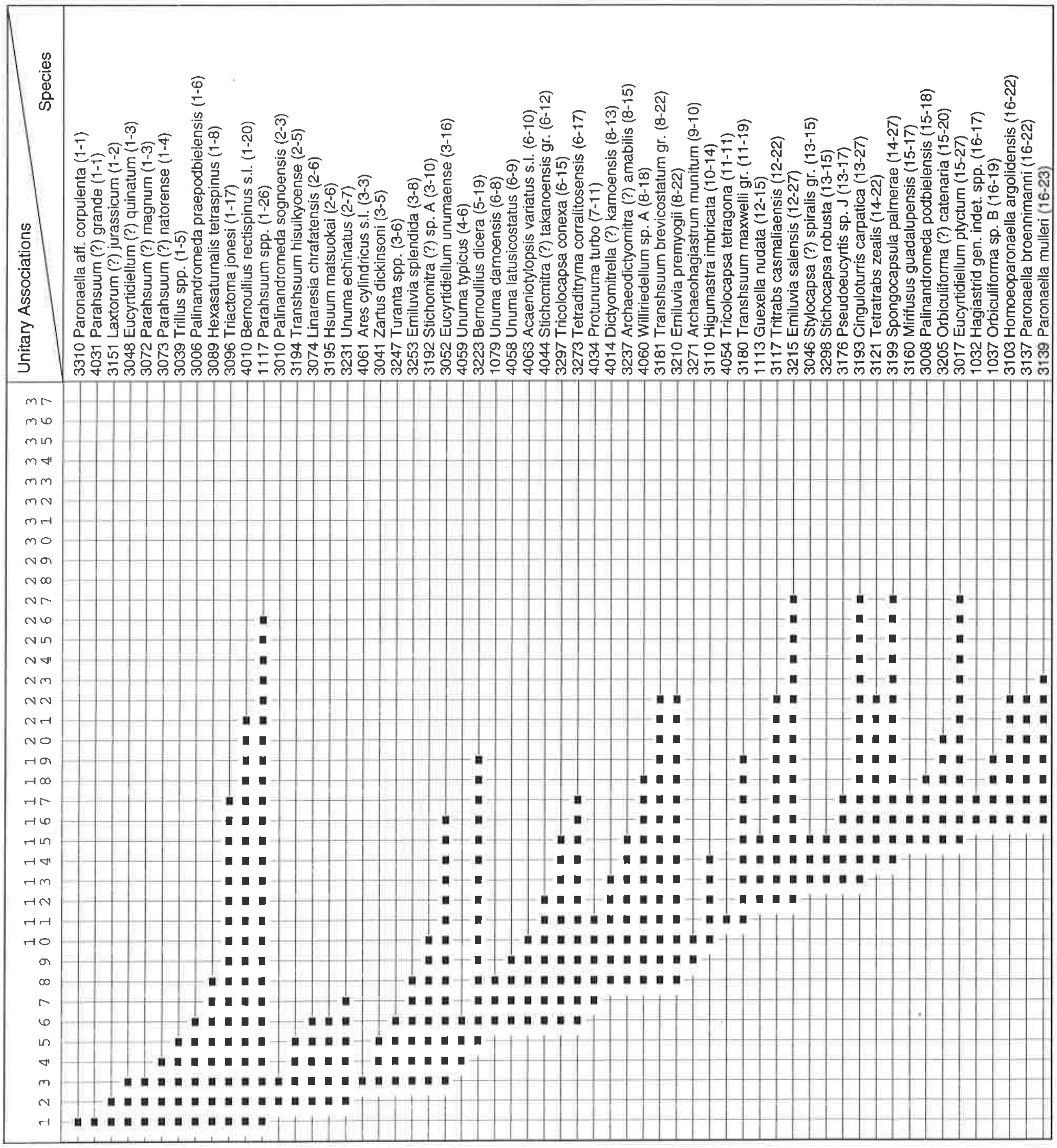
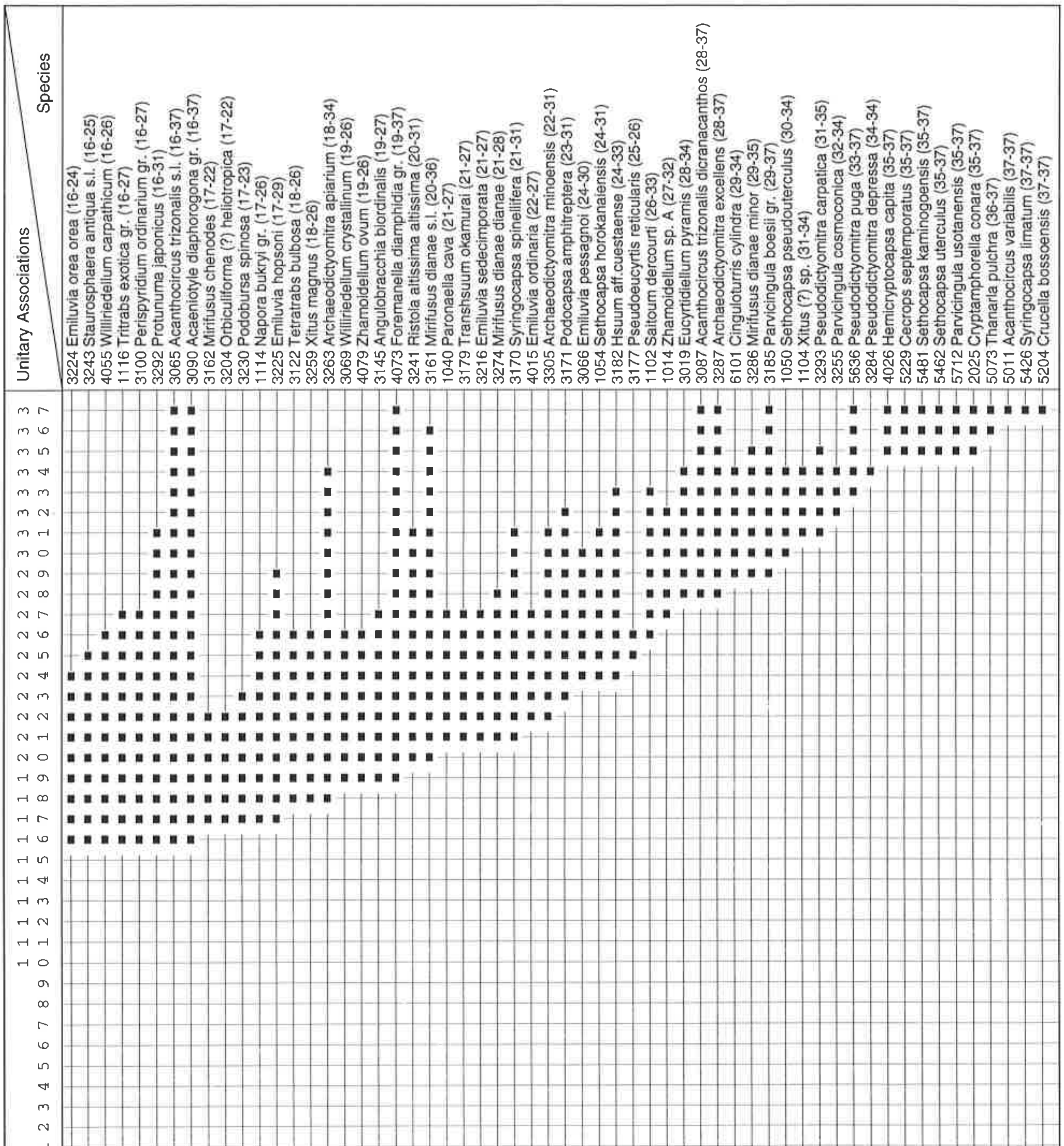


Figure 5. Middle Jurassic to Lower Cretaceous radiolarian protoreferential (in brackets the ranges are presented numerically) (output of BioGraph program version 2.02, Savary & Guex, 1990). For each species its numerical code is indicated. The systematics of taxa

being very rare in our material. On the basis of supplementary species like *Williriedellum carpathicum* DUMITRICA associated with *Williriedellum* sp. A *sensu* MATSUOKA and *Transhsuum maxwelli* (PESSAGNO) we correlated the *Cinguloturris carpatica* Zone to the interval of our U.A. 16 to U.A. 22.

The union of **U.A. 23 to U.A. 27** is well represented in seven sections. *Podocapsa amphitreptera* FOREMAN makes its first appearance in this chronologic unit. The oldest datum known for this species is late Oxfordian based on aptychi (Widz, 1991). *Pseudoeucyrtis reticularis* MATSUOKA & YAO is restricted to this unit. It is a common species in the Kimmeridgian ammonite-bearing sequence of Sierra de Ricote (O'Dogherty, personal communication). The age for U.A. 23 to U.A. 27 is estimated to be late Oxfordian-Kimmeridgian.

The union of U.A.'s 23 to 27 is correlative to the *Pseudodictyomitra primitiva* Interval Zone (Matsuoka &



coded from 1000 to 2999 is discussed in Gorican, 1994. Correlation to standard chronostratigraphic stages is given in Fig. 6.

Yao, 1986) on the basis of the following species common to both assemblages and defining U.A. 23 to U.A. 27: *Pseudoeucyrtis reticularis* MATSUOKA & YAO, *Podocapsa amphitreptera* FOREMAN, *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO) and *Cinguloturris carpatica* DUMITRICA. The top of the *Pseudodictyomitra primitiva* Interval Zone is defined with the FEAB of *Pseudodictyomitra carpatica* (LOZYNYAK) (Matsuoka, 1992), which first appears in U.A. 31. The ancestral species *Pseudodictyomitra primitiva* MATSUOKA & YAO was found in U.A. 29. The two species have not been observed in the same sample. Although, on the basis of our data, the above mentioned U.A.'s belong to the same «zone», we cannot exclude a minor age difference between them. The upper limit of the *Pseudodictyomitra primitiva* Zone is thus placed within the interval of U.A. 28 to U.A. 31.

Baumgartner (1984) defined the boundary between B and C1 Zones on the basis of mutually exclusive *Bernoullius dicera* BAUMGARTNER or *Transhsuum maxwelli* (PESSAGNO) with *Acanthocircus dicranacanthos*

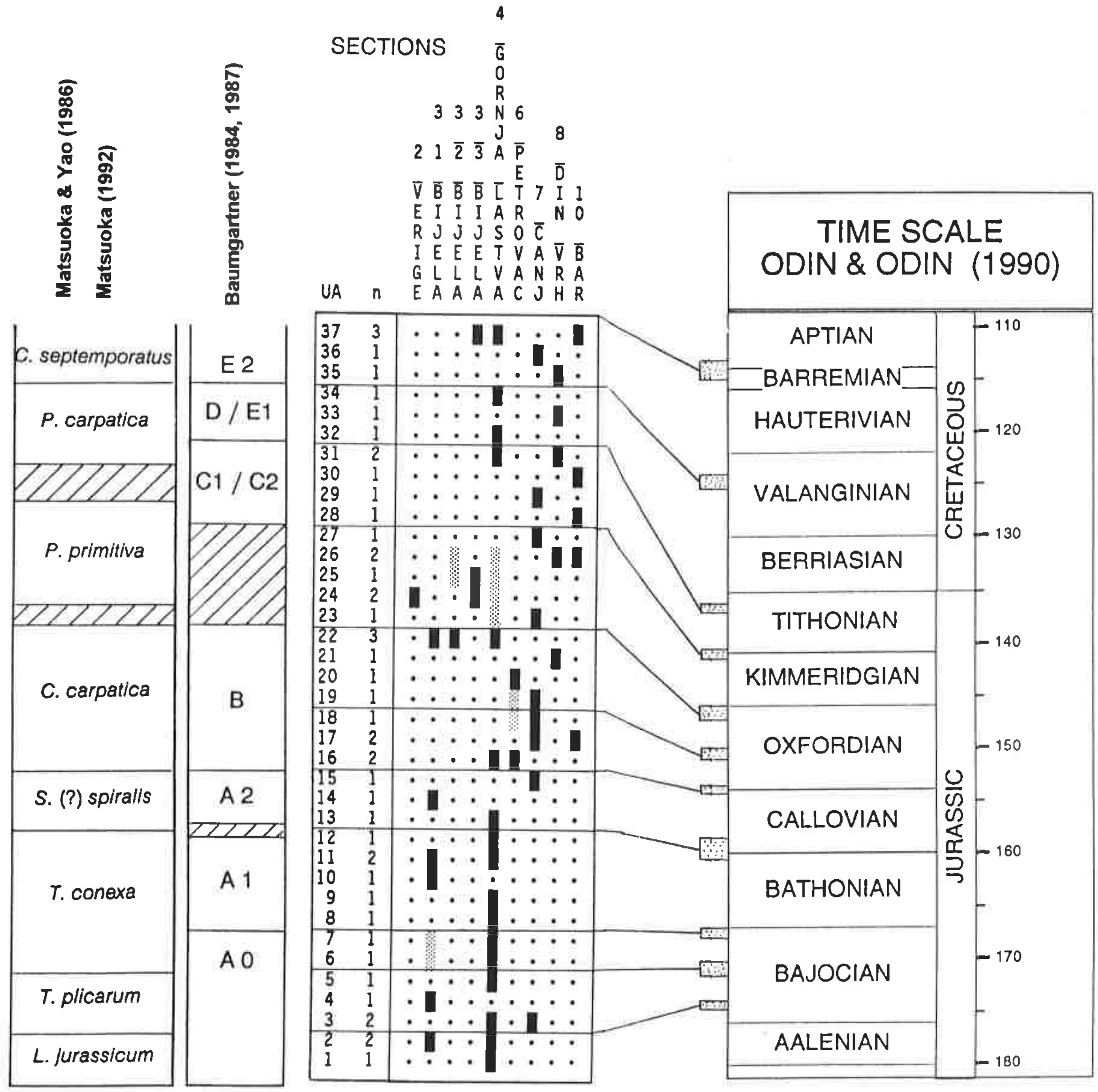


Figure 6. Reproducibility table (output of BioGraph program version 2.02, Savary & Guex, 1990). Black and grey rectangles represent U.A.'s and unions of U.A.'s respectively, identified in the sections studied. The proposed local «zones» are correlated to standard chronostratigraphic stages and radiolarian zonations proposed by Matsuoka & Yao (1986), Matsuoka (1992), and Baumgartner (1984, 1987). Cross-hatched fields indicate uncertain correlation.

(Squinabol). The same superposition was recorded in the Budva Zone; it is delimited with U.A. 23 to U.A. 27, where none of these species has been found.

U.A. 28 to U.A. 31 were identified in four sections. The samples assigned to this union of U.A.'s represent the top of the Jurassic radiolarite. The assemblage was in addition compared to sample 89B-312R (sample courtesy of L. O'Dogherty) from the Betic Cordillera, dated as early Tithonian by ammonites. The following species defining U.A. 28 to U.A. 31 have been determined: *Cinguloturris cylindra* Kemkin & Rudenko and *Acanthocircus dicranacanthos* (Squinabol) associated with *Archaeodictyomitra minoensis* (Mizutani), *Syringocapsa spinellifera* Baumgartner and *Protunuma japonicus* Matsuoka & Yao. An early-middle Tithonian age seems reasonable for U.A. 28 to U.A. 31.

Zones C1 and C2 of Baumgartner (1984) could not be distinguished in the Budva Zone.

U.A.'s 28 to 31 are differentiated from the underlying unit by the absence of a great number of taxa. The lack of some morphotypes is certainly related to preservation (which is only moderate) and the smaller numbers of sections examined in the upper unit. On the other hand, the disappearance of some dissolution-resistant forms, especially genera like *Parahsuum*, *Transhsuum* and *Tetratrabs* implies an extinction event. Whether or not this extinction is correlative to the high extinction rate detected in the C1 and C2 Zones of Baumgartner (1984) could not be ascertained. For the time being, the observed faunal turnover is interpreted as local as it coincides with one of the major changes in sedimentary evolution of the Budva Basin (Goričan, 1994).

The Cretaceous assemblages from the Budva Zone are generally characterised by a small number of identifiable taxa per sample. U.A.'s 32 to 36 comprise a long time interval from the late Tithonian to possibly Hauterivian and, in addition, demonstrate a low lateral reproducibility and weak superpositional control because only very rare productive samples could be obtained from this sequence. Our own data are not sufficient to establish a chronologically meaningful subdivision. Dating and delineation among unitary associations is based on Jud's (1994) zonation.

Pseudodictyomitra puga (Schaaf) in association with *Cinguloturris cylindra* Kemkin & Rudenko allow the placing of **U.A. 33 and U.A. 34** in the Berriasian-early Valanginian. **U.A. 32** lacking *Pseudodictyomitra puga* (Schaaf) can be as old as the late Tithonian.

U.A. 35 and U.A. 36 are defined by the co-occurrence of *Mirifusus dianae* (Karrer) with *Cecrops septemporatus* (Parona), which implies a late Valanginian-Hauterivian age. The other species starting in U.A. 35 or U.A. 36 are either known from older strata in other regions or their stratigraphic ranges have not yet been well established, as is the case for *Hemicryptocapsa capita* Tan. U.A. 36 actually lacking *Cecrops septemporatus* (Parona) is disconnected from the underlying U.A. 31 in the section and could be of Berriasian to Hauterivian age.

The presence of *Acanthocircus variabilis* (Squinabol) in the following **U.A. 37** suggests that U.A. 37 is not younger than early Barremian.

Acknowledgements

I wish to thank Peter O. Baumgartner, Elisabeth Carter, Pascale Dalla Piazza, Jean Guex and Luis O'Dogherty for helpful discussions, useful suggestions and critical comments. I am truly grateful to Mirko Mirkovic for his guidance in the field. The financial aid was provided by the Centre of Scientific Research of the Slovenian Academy of Sciences and Arts, Ministry of Science and Technology of Slovenia and University of Lausanne.

References

Aubouin, J. (1960). Essai sur l'ensemble italo-dinarique et ses rapports avec l'arc alpin. *Bulletin de la Société géologique de France, Série VII*, **2**, (4), 487-526.

Baumgartner, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77**, (3), 729-841.

Baumgartner, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80**, (3), 831-879.

Cadet, J.-P. (1978). Essai sur l'évolution alpine d'une paléomarge continentale: les confins de la Bosnie-Herzégovine et du Monténégro (Yougoslavie). *Mémoires de la Société Géologique de France*, **133**, 1-84.

Cadjenovic, D., Stijovic, V. & Mirkovic, M. (1988). Kredni alohtoni karbonati, Budva zona. *In* Mirkovic, M. & Vujisic, P. Eds. *Vodic ekskurzije 6. skupa sedimentologa Jugoslavije* - Crnogorsko geolosko drustvo, Titograd, 26-32.

Carter, E.S. (1993). Biochronology and paleontology of uppermost Triassic (Rhaetian) radiolarians, Queen Charlotte Islands, British Columbia, Canada. *Mémoires de Géologie (Lausanne)*, **11**, 1-175.

Carter, E.S., Cameron, B.E.B. & Smith, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

Celet, P. (1977). The Dinaric and Aegean arcs: the geology of the Adriatic. *In* Nairn, A.E.M., Kanes, W.H. & Stehli, F.G. Eds. *The ocean basins and margins* - Plenum Press, New York / London, 215-261.

D'Argenio, B., Radoicic, R. & Sgrosso, I. (1971). A Paleogeographic Section through the Italo-dinaric External Zones during Jurassic and Cretaceous Times. *Nafta*, **22** (4-5), 195-207.

De Wever, P. (1982a). Nassellaria (Radiolaires Polycystines) du Lias de Turquie. *Revue de Micropaléontologie*, **24** (4), 189-232.

De Wever, P. (1982b). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

Dumitrica, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14** (1), 45-124.

El Kadiri, K. (1992). Description de nouvelles espèces de radiolaires jurassiques de la Dorsale calcaire externe (Rif, Maroc). *Revista Española de Paleontología*, **Núm. Extra.**, 37-48.

Gorican, S. (1987). Jurassic and Cretaceous radiolarians from the Budva zone (Montenegro, Yugoslavia). *Revue de Micropaléontologie*, **30** (3), 177-196.

Gorican, S. (1994). Jurassic and Cretaceous radiolarian biostratigraphy and sedimentary evolution of the Budva Zone (Dinarides, Montenegro). *Mémoires de Géologie (Lausanne)*, **18**, 1-120.

Guex, J. (1977). Une nouvelle méthode d'analyse biochronologique. *Bulletin de la Société Vaudoise des Science Naturelles*, **73**, 309-322.

Guex, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

Hori, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 562-586.

Jud, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

Kossmat, F. (1924). Geologie des zentralen Balkan Halbinsel. (Mit einer Übersicht des dinarischen Gebirgsbaues). *Die Kriegschauplätze 1914-1918. Geologisch dargestellt*, Berlin, **12**, 1-198.

Markovic, B. (1966). Osnovna geoloska karta 1:100'000, list Dubrovnik. *Savezni Geoloski Zavod, Beograd.*

Matsuoka, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

Matsuoka, A. & Yao, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

Mirkovic, M. (in press). Lithofacies and tectonic characteristics of Montenegro. *Geoloski glasnik, Titograd.*

O'Dogherty, L., Sandoval, J., Martin-Algarra, A. & Baumgartner, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

Obradovic, J. & Gorican, S. (1989). Siliceous deposits in Yugoslavia: occurrences, types and ages. *In* Hein, J.R. & Obradovic, J. Eds. *Siliceous Deposits of the Tethys and Pacific Regions* - Springer-Verlag, New York, 51-64.

Obradovic, J., Mirkovic, B., Mirkovic, M., Gorican, S. & Vujisic, P. (1986). Siliceous rocks from Mesozoic carbonate complex, Budva Zone, Montenegrin littoral. *Posebna izdanja Crnogorske Akademije Nauka i Umjetnosti, posv. Zariji Besicu*, Titograd, **2**, 317-343.

Odin, G.-S. & Odin, C. (1990). Echelle numérique des temps géologiques. *Géochronique*, **35**, 12-22.

Pessagno, E.A. & Blome, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26** (3), 225-273.

Pessagno, E.A., Blome, C., Carter, E.S., MacLeod, N., Whalen, P. & Yeh, K.Y. (1987). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, 1-18.

Pessagno, E.A. & Newport, R.L. (1972). A technique for extracting Radiolaria from radiolarian cherts. *Micropaleontology*, **18** (2), 231-234.

Petkovic, K.V. (1956). Yougoslavie. *Lexique stratigraphique international, Centre National de la Recherche Scientifique*, Paris, **1** (Europe), 12a (Yougoslavie), 1-54.

Radoicic, R. & B., D.A. (1988). *Geology and Mesozoic - early Tertiary Facies of External Dinarids (Southern sector).* Guidebook, 74 Congresso Nazionale - Sorrento - Societa Geologica Italiana. 79 p.

Savary, J. & Guex, J. (1990). BioGraph, version 2.02. *Institute of Geology and Paleontology, University of Lausanne.*

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SEPTFONTAINE, M., ARNAUD-VANNEAU, A., BASSOULLET, J.-P., GUSIC, I., RAMALHO, M. & VELIC, I. (1991). Les foraminifères imperforés des plates-formes carbonatées jurassiques: état des connaissances et perspectives d'avenir. *Bulletin de Géologie de Lausanne*, **312**, 255-277.

TONIELLI, R. (1991). Associazioni a radiolari dei «Calcari e Marne a Posidonia» del Monte Terminilletto (RI). *Paleopelagos*, **1**, 18-37.

WIDZ, D. (1991). Les Radiolaires du Jurassique supérieur des radiolarites de la zone des Klippes de Pieniny (Carpathes occidentales, Pologne). *Revue de Micropaléontologie*, **34** (3), 231-260.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991). Codes starting with 3, 4, 5 or 6 correspond to the taxa of the Radiolarian Catalogue (this volume), the systematics of taxa with codes starting with 1 or 2 are discussed in Gorican (1994). Species within brackets were not treated in constructing the protoreferential. Sample numbers are given in parenthesis (see Fig. 4 for the stratigraphic position of the samples in different sections).

SECTION 2_VERIGE: bottom 1 - top 5
< 5{Ve 10}: 1114,{ 3164,} 3170, 3171, 3216, 3241, 3292, 4015, 4073
< 4{Ve 9 }: 1040, 1054, 3017, 3145, 3161,{ 3164,} 3170, 3171, 3182, 3224, 3241, 3263,{ 3267,} 3274, 3292, 4015{, 4069}
< 3{Ve 8}: 1040, 1114, 1116, 3017, 3065, 3069, 3145, 3161,{ 3164,} 3170, 3171, 3241, 3263, 3274, 3292
< 2{Ve 7}: 3161,{3164,} 3224, 3241,{3267,} 3274{ ,4069}
< 1{Ve 6}: 3069,{ 3164,} 3241, 3292, 4073

SECTION 3_1_BIJELA_I: bottom 1 - top 7
< 7{Bj 15}: 3065, 3069, 3090, 3122,{ 3164,} 3181, 3193, 3199, 3224, 3241, 3263, 3292, 3305, 4055,{ 4069,} 4079
< 6{Bj 14}: 3046, 3110, 3117, 3121, 3176, 3180, 3199, 3210, 3215, 3297, 3298
< 5{Bj 13}: 3237, 3273, 4044, 4054, 4060
< 4{Bj 12}: 1117, 3096, 3110, 3181, 3192,{ 3197,} 3210, 3237, 3271, 4010, 4034, 4044, 4063
< 3{Bj 11}: 1079, 3052, 3089, 3192,{ 3197,} 3231, 4010, 4044, 4058
< 2{Bj 10}: 1117, 3039, 3041, 3073, 3074, 3089, 3096, 3194, 3195, 3253, 4059
< 1{Bj 9}: 3006, 3010, 3048, 3072, 3074, 3151, 3194, 3195

SECTION 3_2_BIJELA_II: bottom 1 - top 2
< 2{Bj 15/2}: 3161,{ 3164,} 3171, 3177, 3241, 3274
< 1{Bj 15/1}: 1116, 3017, 3065, 3069, 3100, 3137, 3181, 3193, 3210, 3224, 3243, 3305, 4055,{ 4069,} 4079

SECTION 3_3_BIJELA_III/IV: bottom 1 - top 3
< 3{Bj 17}: 3087, 3185, 4026, 5073, 5229, 5426, 5462, 5481, 5636, 5712
< 2{BjIII 3.00}: 1114, 1117, 3069, 3161,{ 3164,} 3170, 3171, 3177, 3182, 3216, 3241, 3243,{ 3267,} 3274, 3292, 4015, 4055, 4073, 4079
< 1{BjIII 0.40}: 1054, 1114, 1116, 3017, 3066, 3122, 3161,{ 3164,} 3170, 3171, 3182, 3216, 3224, 3241, 3274, 3292,{ 4069,} 4073

SECTION 4_GORNJA_LASTVA: bottom 1 - top 20
< 20{GL 214}: 3087, 3090, 3185, 4026, 5011, 5229
< 19:{GL 142}: 1050, 1104, 3019, 3065, 3087, 3090,{ 3092,} 3185, 3255, 3263, 3284, 4035, 6101
< 18{GL 139}: 1014, 1104, 3065, 3087, 3171, 3255, 3263, 3287
< 17{GL 138}: 1014, 1050, 1054, 1104, 3019, 3065, 3087, 3161,{ 3164,}{ 3165,} 3170, 3171, 3185, 3241, 3263, 3286, 3287, 3292,{ 3294,} 3305, 4035, 6101
< 16{GL 137}: 3145, 3161, 3170, 3171, 4015
< 15{GL 210}: 1114, 1116, 3145, 3161, 3170, 3171, 3216, 3274, 3292, 4073
< 14{GL 209+6.60}: 1040, 1114, 1116, 1117, 3017, 3065, 3069, 3090,{ 3095,} 3103, 3117, 3121, 3122,{ 3129,}{ 3133,} 3137, 3139,{ 3140,} 3145, 3161, 3162,{ 3164,} 3170, 3181, 3193,{ 3197,} 3199, 3204, 3210, 3215, 3216, 3224, 3225, 3230, 3241, 3243, 3263,{ 3267,} 3274, 3292, 3305, 4015, 4055,{ 4069} 4073, 4079
< 13{GL 209}: 1032, 1037, 1116, 3008,{ 3014,} 3017, 3052,{ 3095,} 3100, 3103, 3117, 3121, 3137, 3139, 3193, 3205, 3210, 3215, 3223, 3224, 3243,{ 3279,} 3292, 4055, 4060{ 4069}
< 12{GL 208+1.00}: 1113, 1117, 3046, 3052, 3176, 3180, 3193, 3297, 3298, 4014, 4060
< 11{GL 208}: 3117, 3273, 3298
< 10{GL 207}: 1113, 3110, 3117, 3180, 3181,{ 3197,} 3210, 3215,{ 3221,} 3223, 3273,{ 3277,}{ 3279,} 3297,

4010, 4014, 4044

< 9{GL 135}: 1117, 3052, 3180, 3181,{ 3197,} 3237, 4014, 4034, 4044, 4054

< 8{GL 134}: 3052, 3096, 3181,{3197,} 3210, 3223, 3271, 3273, 4010, 4034, 4044, 4058

< 7{GL 6}: 1079, 3089, 3096, 3181, 3192,{3197,} 3210, 3237, 3253, 4014, 4044, 4058, 4060

< 6{GL 132}: 1079, 3052, 3192,{3197,} 3231, {3558,} { 4009,} 4010, 4034, 4044

< 5{ZB 28}: 1079, 1117, 3006, 3052, 3074, 3089, 3096,{ 3123,}{ 3129,} 3192, 3195,{ 3197,} 3231, 3247, 3253, 3273, 3297,{ 3307,}{ 3413,}{ 3558,}{ 4009,} 4010, 4044,{ 4049,} 4058, 4059, 4063

< 4{GL 128}: 1117, 3039,{ 3040,} 3041, 3052, 3192, 3194, 3223, 3231, 3253

< 3{GL 127}: 1117, 3010, 3039, 3041, 3048, 3052, 3072, 3074, 3089, 3096, 3192, 3194, 3195,{ 3197,} 3231, 3253, 4010, 4061

< 2{GL 125}: 1117, 3010, 3039, 3048, 3072, 3074, 3151, 3194, 3195, 3231, 4010

< 1{GL 123}: 1117, 3006, 3039, 3048, 3072, 3073, 3089, 3096, 3151, 3310, 4010, 4031

SECTION 6_PETROVAC: bottom 1 - top 3

< 3{PK 7}: 1114, 1117, 3145, 3161,{ 3164,} 3181, 3199, 3205, 3224, 3230, 3241, 3263, 3292{ 4069,}

< 2{PK 9}: 1037, 1116,{ 3014,} 3017, 3065, 3100, 3103, 3117, 3121,{ 3133,} 3181, 3193, { 3197,} 3199, 3204, 3223, 3224, 3243, 3263, 3292{ 4069,}

< 1{PK 12}: 1117, 3052, 3065, 3090, 3096, 3103, 3117, 3181, 3193, 3223, 3292, 4060

SECTION 7_CANJ: bottom 1 - top 18

< 18{UPC 30}: 2025, 3065, 3087,{3092,} 3161, 3287,5073, 4026, 5462, 5636

< 17{UPC 29}: 1014, 3065, 3087, 3161,{3165,} 3170, 3263, 3286

< 16{UPC 28}: 1014, 1102, 3019, 3065, 3087,{ 3164,} 3170, 3171, 3225, 3241, 3263, 3305, 6101

< 15{UPC 27}: 1014, 1054, 1102, 3019, 3065, 3066, 3087, 3161,{ 3164,} 3171, 3185,{ 3189,} 3241, 3263, 3286, 3287, 3292, 3305,{ 3911}

< 14{UPC 26}: 1014, 3065, 3087,{3164,} 3171, 3241, 3263

< 13{UPC 25}: 1014, 1054, 3019, 3065, 3161,{ 3164,} 3170, 3171, 3241, 3292, 6101

< 12{UPC 262.70}: 1014, 1040, 1054, 1102, 1116, 3017, 3090, 3100, 3145, 3161,{ 3164,} 3170, 3171, 3179, 3182,{ 3189,} 3193, 3199, 3215, 3216, 3241, 3263, 3274, 3292, 4015, 4073

< 11{UPC 257.10}: 1116, 1117, 3017, 3069, 3139, 3161,{ 3164,} 3171, 3179, 3215, 3216, 3224, 3230, 3241, 3263, 3274, 4055,{ 4069,} 4079

< 10{UPC 251.50}: 1037, 1116, 1117, 3017, 3065, 3069, 3090, 3100, 3117, 3121, { 3133,} 3137, 3145, 3180, 3181, 3193,{ 3197,} 3199, 3205, 3210, 3223, 3224, 3243, 3259, 3263, 3292, 4055,{ 4069,} 4073, 4079

< 9{UPC 23}: 1037, 1114, 3008, 3065, 3100, 3103,{ 3104,} 3117, 3122,{ 3127,}{ 3129,}{ 3133,} 3137, 3139,{ 3140,} 3180, 3181, 3193, 3199, 3205, 3223, 3224, 3243, 3259, 3263, 4055, 4060{ 4069}

< 8{UPC 22}: 1032, 3017,{ 3095,}{ 3133,} 3137, 3139,{ 3140,} 3180, 3181, 3199, 3205, 3223, 3224, 3243, 4055{ 4069,}

< 7{UPC 21}: 1116, 3096, 3100, 3117, 3121, 3139, 3180, 3181, 3193,{ 3197,} 3199, 3205, 3215, 3223, 3224, 3225, 3243, 3273{ 4069,}

< 6{UPC 20}: 1113, 1117,{3044,} 3046,{3197,} 3297, 3298

< 5{UPC 18}: 1113, 1117, 3008, 3017,{ 3044,}{ 3045,} 3046, 3121, 3160, 3176, 3180, 3181, 3193, 3199, 3205, 3210, 3237, 3297, 3298,{ 3413,} 4060

< 4{UPC 16}: 1117, 3041, 3096,{ 3197,} 3231

< 3{UPC 15}: 3006, 3039, 3041, 3073, 3074, 3096, 3194, 3195, 3253, 4061

< 2{UPC 14}: 1117, 3010, 3048, 3072, 3073, 3074, 3194, 3195, 3253

< 1{UPC 13}: 1117, 3006, 3010, 3048, 3072, 3195, 3247, 3253, 4061

SECTION 8_DIN_VRH: bottom 1 - top 8

< 8{DIN 31.50}: 2025, 3065, 3087, 3090, 3161, 3286, 4026, 4035, 5229, 5462, 5481, 5636, 5712

< 7{DIN 29.30}: 1102, 1104, 3019, 3182, 3185, 4035, 5636, 6101

< 6{DIN 24.30}: 1014, 1050, 3019, 3065, 3161, 3171, 3182, 3263, 3287, 3292, 3305,{ 3911,} 4035, 4073

< 5{DIN 11.55}: 1054, 1102, 1114, 3017, 3066, 3069,{ 3123,} 3161, 3171, 3177, 3182, 3216, 3259, 3263, 3274, 3292,{ 3294,} 3305, 4055, 4079

< 4{DIN 7.00}: 1054, 3171, 4015, 4055

< 3{DIN 4.50}: 3017, 3069,{ 3164,} 3224, 3230, 3241, 4055{ 4069,}

< 2{DIN 2.35}: 1040, 1114, 1116, 1117, 3069, 3100, 3103, 3117, 3121, 3122, 3139, 3145, 3161,{ 3164,} 3170, 3179, 3181, 3199, 3210, 3215, 3216, 3224, 3230, 3241, 3243, 3263, 3274, 4010 { 4069,}

< 1{DIN 1.50}: 3017, 3117, 3122, 3161,{ 3164,} 3181, 3193, 3241, 3274, 3292

SECTION 10_BAR: bottom 1 - top 9

< 9{BM 478.60}: 2025, 3087, 3185, 3287, 4026, 4073, 5011, 5073, 5204, 5229, 5426, 5462, 5481,{ 5532,} 5636, 5712

< 8{BM 469.00}: 3087, 3287, 4026, 5073, 5229, 5462, 5636

< 7{BM 466.40}: 2025, 3065, 3087, 4026, 4073, 5229, 5462, 5481

< 6{BM 8}: 1014, 1050, 3065, 3066, 3087, 3161, 3170, 3171, 3185, 3263, 3286, 3287, 3292, 4073, 6101

< 5{BM 7}: 1014, 1102, 3019, 3065, 3087, 3161,{ 3164,} 3170, 3171, 3241, 3263, 3274, 3287, 3292

< 4{BM 6}: 3017, 3065, 3161,{ 3164,} 3170, 3171, 3241, 3263, 3274, 3292, 4015

< 3{BM 5}: 1054, 1114, 3069, 3161,{ 3164,} 3171, 3177,{ 3197,} 3241, 3274, 4015

< 2{BM 106}: 1040, 1054, 1102, 1116, 1117, 3065, 3066, 3122, 3145, 3161, 3170, 3171, 3177, 3182,

3193,{ 3197,} 3199, 3215, 3274, 3292, 4015, 4079
< 1{BM 102}: 1032, 1037, 1114, 1116, 1117, 3008,{ 3014,} 3017, 3065, 3090,{ 3095,} 3096, 3100,{ 3104,} 3117, 3121,{ 3123,}{ 3127,}{ 3129,} 3137, 3139,{ 3147,} 3160, 3162, 3176, 3180, 3181, 3193,{ 3197,} 3199, 3204, 3205, 3210, 3215, 3223, 3224, 3225, 3230, 3243, 3273, 3292, 4010, 4055 { 4069}

19. Middle to Upper Jurassic Radiolarian Biostratigraphy of the Ionian and the Maliac Zones (Greece)

by Taniel Danelian

Department of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Road, Edinburgh EH9 3JW, UK

ABSTRACT

The Ionian Zone is regarded paleogeographically as a trough created during the Liassic when part of a large carbonate platform, situated at the southern margin of Tethys, collapsed. Pelagic sediments accumulated in a depositional environment starved of any major siliciclastic input as the Ionian Zone was flanked, and thus protected, by the remains of the previously continuous platform (Paxos-Zanthe and Gavrovo-Tripolitza Zones). Synsedimentary faulting introduced intrabasinal differentiation which resulted in basinal sequences with continuous sedimentation and reduced sequences associated with stratigraphic gaps. Although the main lithostratigraphic framework of Jurassic sedimentation was established by the 1960's, chronostratigraphic correlations were inhibited until the recent progress achieved in studies of Mesozoic Radiolaria. Middle and Late Jurassic Radiolarian assemblages from seven sections are presented here.

In the Othris mountains of Greece typical ribbon radiolarites cap the carbonate sequence of the Pyrgaki unit which, for the Late Triassic-Jurassic period, is regarded as the proximal part of the Pelagonian Platform's slope to the abyssal/ocean-floor Maliac sequences. Radiolarian assemblages extracted from these ribbon cherts provide important evidence in the understanding of overlying chaotic siliciclastic sediments, the development of which is closely related to the "eo-hellenic orogenesis".

1. Geological Framework

1.1. Ionian Zone

The Ionian Zone, which crops out in north-western Greece and southern Albania (Fig. 1), belongs to the external zones of the Hellenides, which are defined mainly with respect to their Mesozoic facies development. It has many similarities with the Umbrian-Marchean Zone in Italy. The metamorphic series (Plattenkalk) which crop out in tectonic windows in the Peloponnese and Crete (Greece) have also been attributed to the Ionian Zone.

Structurally, the Ionian Zone is thrusted westward onto the Paxos-Zanthe Zone, which crops out in the Ionian islands in Greece (Fig. 1). Eastward, in Greece and Albania, it is thrust over, in turn, by the Gavrovo-Tripolitza or the Pindos Zones. The Ionian Zone has been sheared off its substratum along Triassic evaporites present at the base of its sedimentary sequence.

Palaeogeographically, the Ionian Zone was part of the southern continental margin of Tethys and developed during the Mesozoic in the interior of the Apulian microplate (Dercourt *et al.*, 1985). During the Triassic-lower Liassic, the Ionian Zone together with the Paxos-Zanthe and Gavrovo-Tripolitza Zones, were covered by an extensive carbonate platform, on which evaporites and shallow marine carbonates accumulated. Part of this neritic realm was submitted to an extensional regime during the middle-late Liassic and affected by block-faulting. The Ionian trough was then established and flanked on both sides by

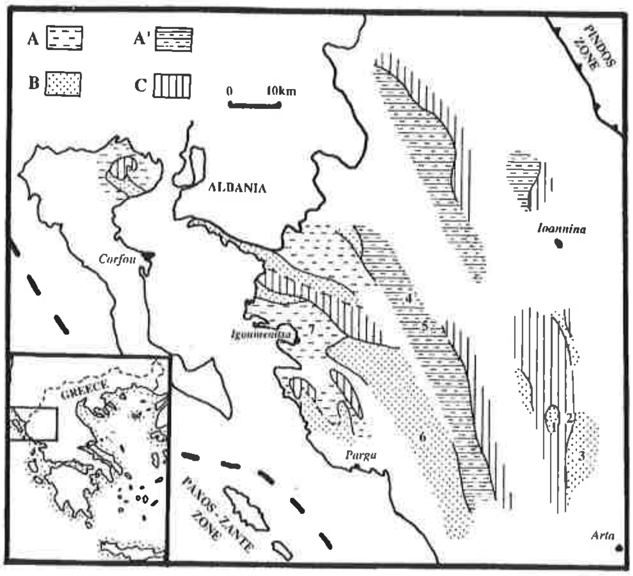


Figure 1.- Jurassic facies distribution map in Epirus (after IGRS-IFP, 1966). The distinguished areas (A, A', B and C) present the following lithostratigraphic successions: **A.** Lower "Posidonia" beds, pelagic Lamellibranch limestones, upper "Posidonia" beds. **A'.** Lower and upper "Posidonia" beds. Pelagic Lamellibranch limestones are not well-developed. **B.** Ammonitico Rosso, pelagic Lamellibranch limestones, upper "Posidonia" beds. **C.** Palaeogeographical highs. Reduced sequences with major stratigraphical gaps. Numbers (1 to 7) indicate the location of the studied sections: **1.** Ano Kouklessi, **2.** Kato Kouklessi, **3.** Vathi, **4.** Khionistra, **5.** Paliambela, **6.** Skandhalon and **7.** Varathi.

Bahamian-type carbonate platforms of the Paxos-Zanthe and Gavrovo-Tripolitza Zones. Pelagic sediments (essentially calcareous, partly argillo-siliceous) occurred and persisted in the Ionian trough until the Late Eocene, while sedimentation of shallow-water carbonates persisted on the adjacent platforms. Lime turbidites from the adjacent carbonate platforms were intercalated within the pelagic sediments of the Ionian trough during the Upper Senonian and the Eocene. Within the Oligocene to the lower Miocene orogenic flysch was deposited before the structural deformation of the Ionian realm (Aquitanian-Burdigalian).

While the main lithostratigraphic elements of the Ionian Zone in Western Greece are well known (Renz, 1955; Aubouin, 1959; Bornovas, 1964; IGRS-IFP, 1966; Bernoulli & Renz, 1970; B.P. Co Ltd, 1971), the chronostratigraphic correlation of the Jurassic sediments was still problematic, because of the absence of fossilised material (with the exception of Ammonites restricted to a few facies and to Calpionellids restricted to the Jurassic-Cretaceous boundary). Radiolarians were noted out by many authors but have not been studied until the recent advances were made in this field.

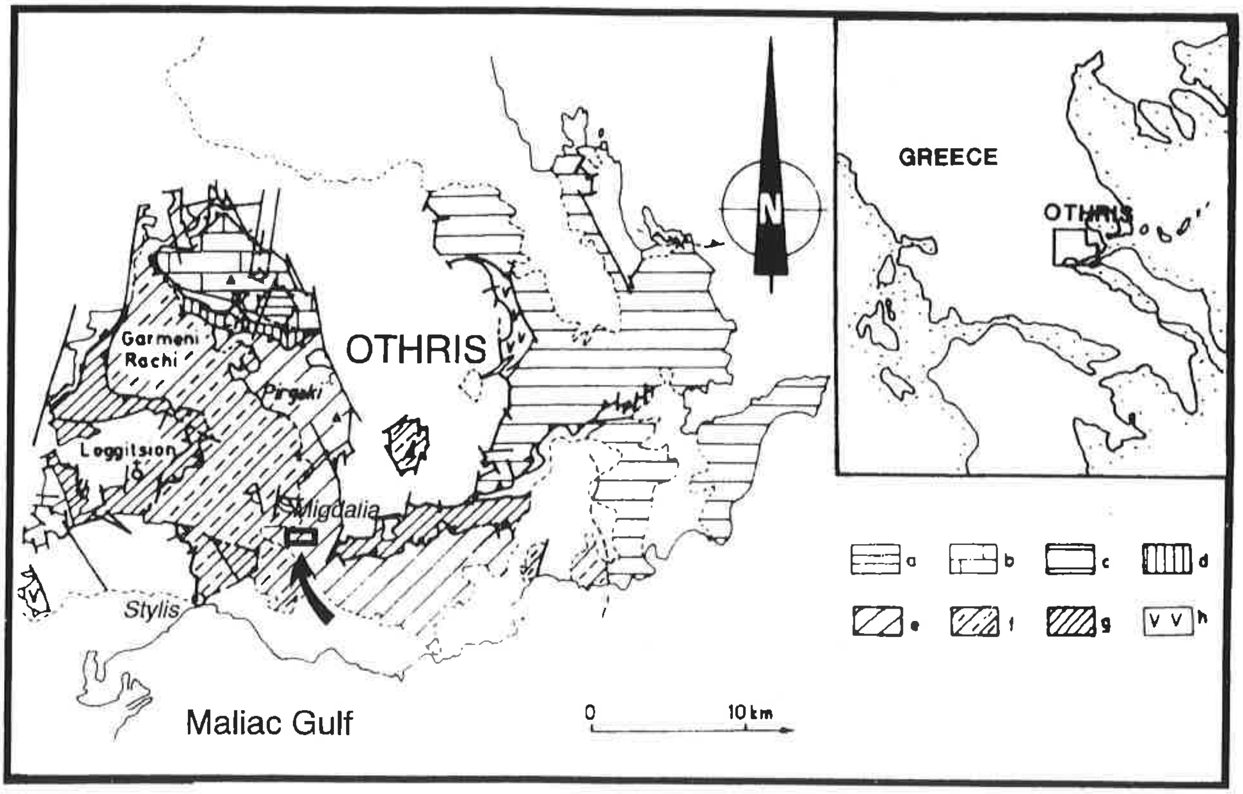


Figure 2.- Geological map of the main structural units of Orthis (after Ferrière, 1982). Inset : map of Greece with location area **(a-c).** Pelagonian units, **a.** of Prosilia, **b.** of Messovouni, **c.** of Oriental Orthis. **(d-g).** Maliac units, **d.** of Chatala, **e.** of Pirgaki, **f.** of Garmeni Rachi, **g.** Loggitsion lower unit, **h.** ophiolites. The area indicated by the arrow shows the location of the studied section

1.2. Maliac Zone of Othris

The Othris area (central Greece, Fig. 2) exposes the Triassic-Jurassic passive margin sequences of the Pelagonian Platform to the basinal/ocean floor sequences of the Maliac or Sub-Pelagonian Zone. There is also evidence of the destruction of this margin during the Mid-Late Jurassic tectonic phase of the "internal" Hellenides, associated with ophiolite emplacement.

An accurate chronostratigraphy of the sedimentary sequences of the Othris continental margin is crucial to interpret its tectono-sedimentary evolution. In the marginal Maliac (Sub-Pelagonian) units of Othris (Pirgaki and Garmeni-Rachi, Fig. 2) pelagic sedimentation was established during the Late Triassic (Smith *et al.*, 1975; Ferrière, 1982). During the Jurassic, calciturbidites of shallow-water derived material intercalated with the background calcareous pelagic sediments. A major change of the sedimentary record from calcareous to siliceous deposits then took place. As few data are available for the Othris area regarding the radiolarite sedimentation on this continental margin, it was decided to undertake detailed biostratigraphic studies using radiolarians. This paper will present preliminary data, focusing on the radiolarites of the **Pirgaki unit** of Ferrière (= Poulia sequence *pro parte* of Smith *et al.*, 1975), which crops out in southern and central Othris (Fig. 2).

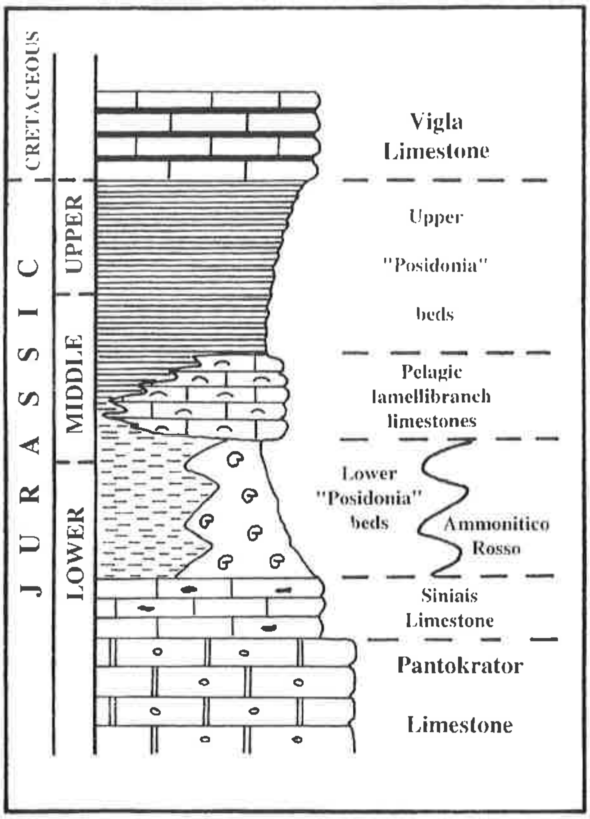


Figure 3: Simplified litho-chronostratigraphy of the main Jurassic formations.

2. Stratigraphic framework

2.1. Ionian Zone

IGRS & IFP (1966) have proposed, in a formal way, a stratigraphic framework for the Jurassic sediments of Epirus (Fig. 3). Since this milestone work, Bernoulli & Renz (1970), Karakitsios & Tsaila-Monopolis (1988) and Danelian & Baudin (1990) have improved this framework with additional lithostratigraphic elements.

Variations in the thickness and facies of Jurassic formations indicate a significantly irregular topography for the Ionian basin, due to the intrabasinal differentiation involved with the Early Jurassic syn-sedimentary block-faulting. Single basins and swells were limited to a few, or some tens of kilometres, across.

Between the two relatively homogeneous formations, the Pantokrator Limestone at the base and the Vigla Limestone at the top, the Jurassic outcrops present either complete stratigraphic successions (Fig. 3) which correspond to *basinal* sequences with continuous deposition, or stratigraphically reduced series which can be attributed to palaeogeographical *highs* (intrabasinal swells; C areas of Fig. 1). Reduced Jurassic sequences differ from their basinal equivalents (complete successions) by their small thicknesses, the reduced clay content and the absence of cherts (Bernoulli, 1972). They are marked by interrupted sedimentation and stratigraphic gaps of variable amplitudes (in extreme cases, the Vigla rests directly on the Pantokrator), that have been interpreted either as the result of local emergence and subaerial erosion (IGRS-IFP, 1966) or as the result of non-deposition and/or submarine erosion of swells in a pelagic environment ("sea-mounts"; Bernoulli & Renz, 1970).

Pantokrator Limestone. Two facies, more or less associated with each other, have been distinguished in this formation, representing a carbonate platform: (i) a white, massive pack- to grainstone, rich in dasyclad and codiacean Algae, (ii) a pelletal/intraclast lime grainstone and pelleted lime mudstone. Ooids and stromatolite lime boundstones may occur. The formation is particularly thick and some outcrops measure more than 1100 metres. It is affected by dolomitization, mainly in its lower levels. An upper Triassic to lower Liassic age is indicated by the reported Bivalves, Gastropods and especially Algae (Aubouin, 1959; Bornovas, 1964; IGRS & IFP, 1966; Bernoulli & Renz, 1970).

Siniais Limestone. Greyish well-bedded lime wackestones containing frequent bands and lenses of replacement chert and intercalations of thin beds of dark grey marls indicate a significant deepening of the previous platform environment to a pelagic open-sea one. Radiolarians are present but calcitized. Several intercalations of slump conglomerates have been observed in some sections. The thickness of this limestone may vary laterally rapidly, from a few to over 200 metres. The age of this sequence is not well established as yet, but the Siniais Limestone can be considered as having been deposited during the middle Liassic, probably including part of the lower Toarcian (Renz, 1955; Kottek, 1966; IGRS-IFP, 1966; Danelian, 1989). A lateral equivalent of the Siniais Formation, the **Louros Limestone**, considered as having been deposited ina shallower environment (external carbonate platform) than the latter, has been described by Karakitsios & Tsaila-Monopolis (1988). It is made by pelletal-intraclast lime packstone/grainstone and contains foraminifera, small ammonites, brachiopods, gastropods, and ostracods. Cherts are completely absent.

Ammonitico Rosso. Two facies may be distinguished: one *marly*, occurring mainly at the lower levels and composed of grey to greenish marls, marly shales and slightly siliceous lime wackestones, while the second facies is *calcareous* and comprise red, nodular bedded, marly lime mud- to wackestone with red marly interbeds. Redeposited pelagic sediments (slump conglomerates, associated with graded calcarenites and calcisiltites) may occur in some basinal sequences. The thickness of the formation varies significantly from a few to over 300 meters. Its age, Toarcian to Aalenian, is quite well established by Ammonites (Renz, 1955; Aubouin, 1959; Bornovas, 1964; Kottek, 1966; IGRS-IFP, 1966; B.P. Co Ltd, 1971; Dalipi *et al.*, 1971; Galbrun *et al.*, 1994). Calcitized Radiolarians and Lamellibranch also occur.

The **lower "Posidonia" beds** are the lateral and more basinal equivalent facies of the Ammonitico Rosso, as slumped complexes (pebbly mudstones) of the latter have been observed in them. They are made up generally by well laminated dark grey-bluish marls and marly shaly limestones, interbedded by thin chert and siliceous argillite levels. Lime turbidites and debris-flow sediments may occur in some sections. Contrary to the limestones, marls and shaly argillites are rich in organic content which is mainly of marine origin (Baudin & Lachkar, 1990). Vertical and lateral facies' variations are common throughout the Ionian Zone. Nevertheless, some correlatable horizons can be traced out (Walzebuck, 1982; Baudin *et al.*, 1988): Marls are dominant in the lower levels. The median part is more argillaceous and brecciated levels may occur. In the upper levels, the siliceous facies become abundant due to a rapid radiolarian increase. "Posidonia" (= *Bositra*) appear only in the upper levels. The thickness of the lower "Posidonia" beds varies generally from a few to 100 metres. The age range of the formation is not well known as yet. Lower Toarcian calcareous nannofossils have been recorded in Greece (Baudin, 1989) and middle and upper Toarcian ammonites in Albania (Dalipi *et al.*, 1971).

Pelagic lamellibranch limestones. Well-bedded greyish lime mud- to wackestone with thin marl interbeds and bands or lenses of replacement chert. Pelagic Lamellibranch (*Bositra*), calcitized radiolarians and coccoliths occur in abundance. Intraformational slump breccias and associated graded calcarenites and calcisiltites may be present in some sections. Its thickness varies laterally from a few to 60 metres. The formation was deposited during the Middle Jurassic, but its age is not well established as yet. Ammonites of lower Aalenian and lower Bajocian age have been discovered in Albania (Dalipi *et al.*, 1971) and Greece (Aubouin, 1959), respectively. Radiolaria indicate a latest Bajocian-middle Bathonian age for the youngest levels (Danelian *in* Baumgartner *et al.*, 1993).

Upper "Posidonia" beds. These represent a radiolaritic sequence composed ofan alternation of yellowish to greenish ribbon cherts (beds of 5 to 20 cm thick) and thin levels of siliceous argillites. Some bedded siliceous limestones may be present, especially near the base of the formation. Radiolarians and pelagic Lamellibranch ("Posidonia"= *Bositra*) are abundant, the latter being present in the lower part only. The formation is dated mainly by its Radiolarian fauna (Danelian, 1989). Its sedimentation covers the upper part of the Middle Jurassic (Bathonian, Callovian) and the whole of the Upper Jurassic. Its thickness varies from a few to over 250 metres and it may present rapid lateral variations. A calcareous equivalent, composed of laminated grey-bluish wackestones, rich in Radiolaria and pelagic Lamellibranch has been observed locally by Danelian & Baudin (1990) and described as the **Paliambela Limestone.** These limestones are very siliceous, slightly argillaceous and rich in organic matter. Dark grey bands and lenses of replacement chert occur in abundance. Extracted radiolarians indicate that its deposition took place during the late Middle (Callovian) and Upper Jurassic (Danelian *in* Baumgartner *et al.*, 1993).

In many outcrops the pelagic Lamellibranch limestones are not developed as a distinct formation between the upper and lower "Posidonia" beds. Even if the dominance of marly facies at the lower part and siliceous at the upper can be distinguished, the stratigraphical limit between the two "Posidonia" formations is not clear. Palaeogeographically, these sections are attributed to the deepest areas of the Ionian basin, where the carbonate material of the pelagic Lamellibranch limestones was largely dissolved in descent through the water column (A' areas of Fig. 1).

Bio-lithoclast lime wacke- to grainstones of upper Oxfordian-lower Kimmeridgian age, containing mainly small Ammonites, pelagic Lamellibranches and calcitized radiolarians have been observed locally by Bernoulli & Renz (1970; **pelagic Cephalopod limestones**) between the pelagic Lamellibranch limestones and the Vigla formation. Ferruginous stained horizons, corroded Ammonite shells, features of early lithification and subsequent solution indicate a current-swept seamount environment of deposition. Intraformational conglomerates and breccia (probably representing a product of local reworking in small depressions of a seamount) and sedimentary dykes occur frequently.

The **Vigla Limestone** is a Maiolica-type facies comprising well-bedded (5-20 cm thick), white to light grey lime mud- to wackestone, together with bands and nodules of replacement chert. Cherty beds may become abundant in the upper levels. The formation is rich in planktic microfossils (Radiolarians, Tintinnids near the base, Foraminifera in the upper part). Coccoliths make up the largest part of the fine lime sediment. The thickness of this facies varies considerably throughout the Ionian basin, from a few tens to over 2000 metres. Its age covers most of the Cretaceous: uppermost Tithonian-lower Berriasian (dated by Calpionellids) at the base to Lower Senonian (dated by planktic Foraminifera) at the top (Aubouin, 1959; IGRS & IFP, 1966; Bernoulli & Renz, 1970; B.P. Co Ltd, 1971; Dalipi *et al.*, 1971; Karakitsios *et al.*, 1988; Danelian, 1989).

2.2. Maliac Zone of Othris

Smith *et al.* (1975) formally proposed a stratigraphic framework for the Othris Mountains, defining sixteen formations which are divided into three Groups. They mentioned radiolarians extracted from the **Anavra Chert formation** (Poulia and Karolina Sequences of the Othris Group), which were studied by Riedel and Pessagno, and considered indicative of an upper Tithonian to Valanginian age.

Ferrière (1982) and Ferrière *et al.* (1988) coined the term "formations **pré-ophiolitiques**" for the uppermost sediments of the Othris Jurassic sequences. They considered their age as Late Jurassic, based on foraminifera and *Cladocoropsis* sp. identified in the uppermost levels of the Maliac (Sub-Pelagonian) and Pelagonian limestones, respectively, and mainly as Kimmeridgian-Tithonian, based on extracted Radiolarians. They distinguished the "formation **pré-ophiolitique de base**", represented by radiolarites and shales, overlain stratigraphically by the "formation **volcano-détritique**", which displays siliciclastic sediments of a chaotic aspect, containing resedimented blocks of diverse nature, some of which were derived from ophiolitic units (i.e. gabbros and peridotites). The development of this latter formation is closely related to the paleotectonic compressional events of the Hellenides and the obduction of ophiolites onto the Pelagonian microcontinent (Ferrière, 1982; Baumgartner, 1985; Ferrière *et al.*, 1988; Robertson, 1991).

During Late Triassic-Jurassic times, the Pirgaki unit represented the proximal part of the slope, situated between the Pelagonian Platform and the abyssal Maliac units (Ferrière, 1982). The sedimentary sequence comprises Anisian platform carbonates, overlain by Late Triassic-Jurassic siliceous limestones. The latter were intercalated, during the Jurassic, with clastic carbonates of shallow-water derived material (calcarenites, calcirudites; see Meterizia formation of Smith *et al.*, 1975). These limestones are overlain by red ribbon radiolarites, which then pass upwards into the "volcano-detritic" formation (Fig. 4).

Ferrière (1982, p. 252) assumed that the radiolarites of the Pirgaki unit are of Late Jurassic age, based on Foraminifera (Trocholines and *Protopeneroplis striata* WEYNSCHENK), identified in the underlying limestones, and indicating a Middle to Late Jurassic age. Radiolarian data obtained recently (Danelian, in press) suggested an earlier age (late Middle Jurassic), based on the biozonations of Baumgartner (1984), Matsuoka & Yao (1986) and Aita (1987).

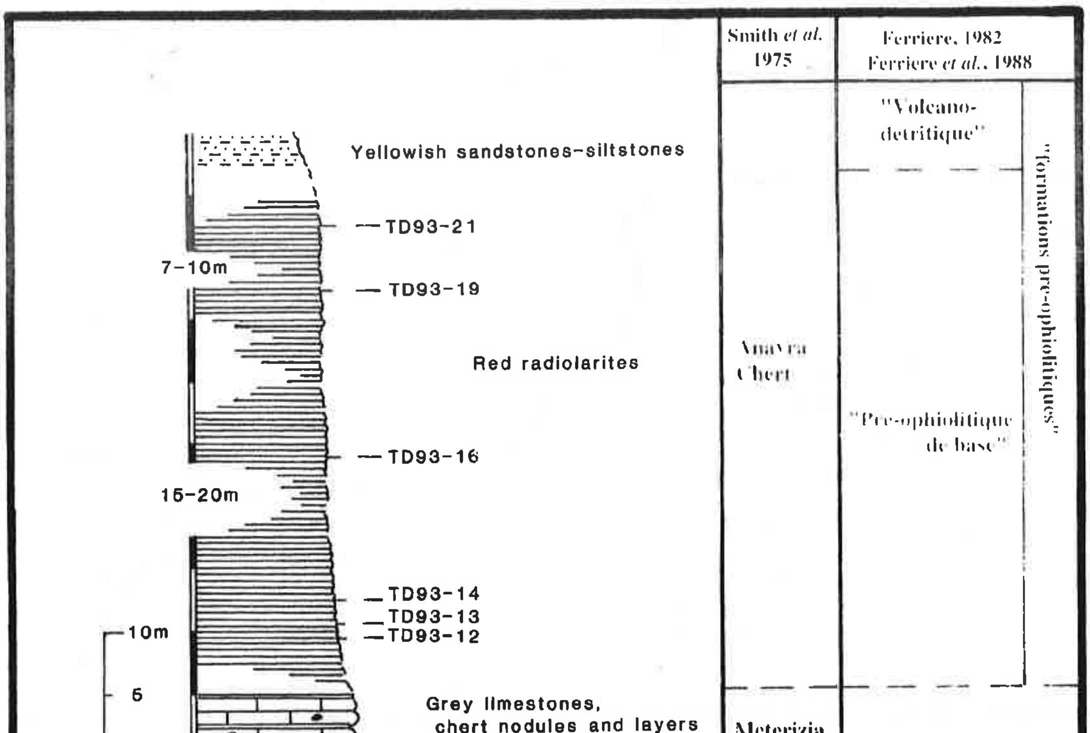


Figure 4: Lithostratigraphic log of the studied Migdalia section

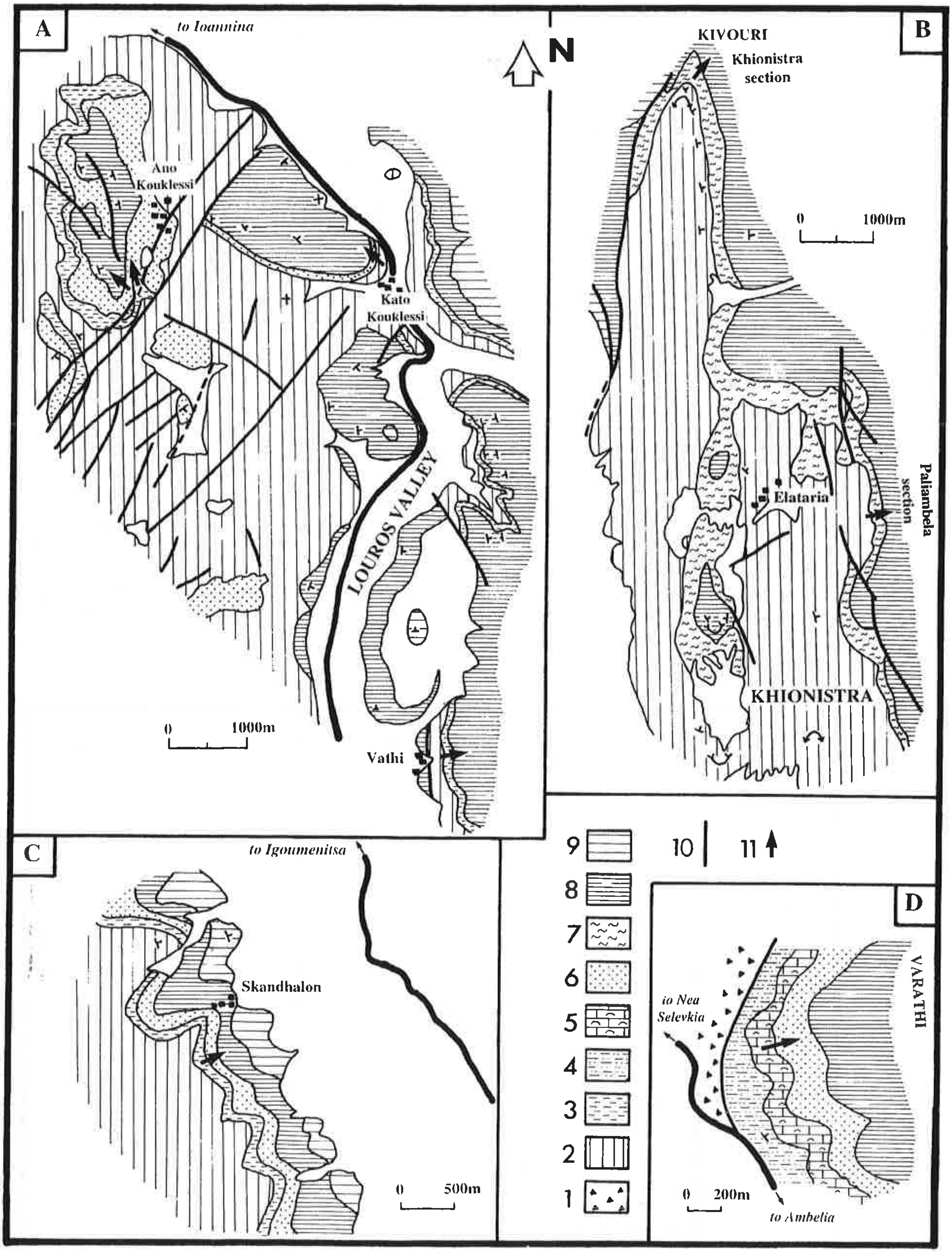


Figure 5.- Geological sketch-maps of the studied areas (after the maps published by I.G.R.S., Athens, 1:50.000). **A.** Louros, **B.** Khionistra, **C.** Skandhalon and **D.** Varathi. **1.** Triassic evaporitic breccia, **2.** Pantokrator and Siniais Limestones (undifferentiated), **3.** Ammonitico Rosso and pelagic lamellibranch limestones (undifferentiated), **4.** Lower "Posidonia" beds, **5.** Pelagic lamellibranch limestones, **6.** Upper "Posidonia" beds, **7.** Undifferentiated "Posidonia" beds, **8.** Vigla Limestone, **9.** Upper Senonian and Eocene brecciated limestones, **10.** Fault, **11.** Location of the studied section.

3. Description of the studied sections and radiolarian data

3.1. Ionian Zone

The studied sections are grouped around four areas (Figs. 1 and 5): Louros, Khionistra, Skandhalon and Varathi areas.

A- Louros area

Three sections, situated in the Louros valley, have been investigated (Fig. 5A). Palaeogeographically, the area is characterised by a Jurassic high and a gap of almost the entire Jurassic sediments overlying the massive Pantokrator limestones, as is the case of the Kato Kouklessi section.

Ano Kouklessi section. The outcrop is situated in the Gorbiteri ravine, SE of Ano Kouklessi village (Fig. 5A; 20°8'46'' E - 39°36'9'' N). The sedimentary sequence here represents a small basin created by a tilted block aside the Jurassic high (Fig. 1). The studied levels of this section are thus parts of a basinal sequence characterised by continuous sedimentation from the Pantokrator to Vigla Limestone, through Siniais, Ammonitico Rosso, pelagic Lamellibranch limestones and upper "Posidonia" beds. At the area of our section the pelagic Lamellibranch limestones are intercalated with a few lime-breccias, containing pelagic limestone elements. The last lime-breccia bed, over 1.5 m thick, is overlain by an alternation of thin bedded (2-10 cm) dark grey marly limestones, yellowish or black cherts and a few fine argillaceous levels, which represent either the top of the pelagic Lamellibranch limestones or their passage to the upper "Posidonia" beds (Fig. 6). Sample ASAx-4 comes from a ribbon chert level. The following Radiolarians have been identified:

Linaresia chrafatensis El Kadiri
Parvicingula dhimenaensis dhimenaensis Baumgartner
Stichocapsa convexa Yao
Transhsuum maxwelli gr. (Pessagno)

The sample 587, which represents a chertified band coming from the base of the Vigla Limestone (Karakitsios *et al.* 1988), yielded the following assemblage:

Acaeniotyle diaphorogona gr. Foreman sensu Baumgartner
Acaeniotyle umbilicata (Rüst)
Acanthocircus suboblongus suboblongus(Yao)
Alievium helenae Schaaf
Angulobracchia (?) *portmanni* s.l. Baumgartner
Cyclastrum infundibuliforme Rüst
Cyclastrum rarum (Squinabol)
Ditrabs sansalvadorensis (Pessagno)
Mirifusus dianae minor Baumgartner
Obesacapsula verbana (Parona)
Parvicingula cosmoconica (Foreman)
Parvicingula longa Jud
Syringocapsa limatum Foreman

Kato Kouklessi section. The outcrop is exposed along a pathway leading from the church of Kato Kouklessi village to Ano Kouklessi village (Fig. 5A; 20°8'83'' E - 39°37'1'' N). The section is located on the Jurassic high (Fig. 1). A few metres of "Posidonia" beds (well-bedded, varicoloured -dark blue, reddish, greenish, yellowish- cherts or chertified limestones, alternating with laminated, siliceous argillites) overlie the massive Pantokrator limestones (Fig. 6). The contact between the two formations is covered by scree at the locality of our section but it has been observed by IGRS-IFP (1966) and Bernoulli & Renz (1970) nearby: the top of the Pantokrator Limestone is brecciated and intruded by sedimentary dykes of the overlying sediments.

The Vigla Limestone comprises white, well-bedded, lime mud- to wackestones. Studied in cathodoluminescence they present an homogeneous facies which is due to recrystallization. Grey to bluish cherts occur as interbeds with irregular surfaces (e.g. samples ASB1-6 and ASB1-7) or as nodules/lenses.

The following Calpionellid assemblages have been recognised by Dr.J.Azema (Paris) in two limestones situated near the base of the Vigla formation (more precisely, the sample AB1-3a corresponds to the first limestone bed, and was taken 30-40 cm above the last cherty bed -ASB1-4- of the upper "Posidonia" formation).

AB1-3a: *Calpionella alpina* Lorenz and *Remaniella ferasini* (Catalano).

AB1-4: *C.alpina*, *R.ferasini* and *Tintinnopsella carpathica* (Murgeanu & Fillipescu). Both of the assemblages characterise the lower Berriasian (Remane *et al.*, 1986).

Vathi section. At the eastern flank of the Louros valley (Fig. 5A), the Jurassic sequences are relatively reduced, but complete and continuous until the late Middle Jurassic. The Pantokrator Limestone is overlain by the Louros Limestone, the nodular lime facies of the Ammonitico Rosso and finally the pelagic Lamellibranch limestones. The Upper Jurassic sediments are extremely reduced to a few metres of yellow-greenish ribbon cherts with argillaceous intercalations (as it is the case in our section, Fig. 6) or of pelagic Cephalopod limestones (Bernoulli & Renz, 1970). Sample 3A comes from a yellow siliceous level at the top of the pelagic Lamellibranch limestones, near the village of Vathi (Karakitsios *et al.*, 1988). The following assemblage has been identified:

Bernoullius cristatus Baumgartner
Bernoullius furcospinus Kito, De Wever, Danelian & Cordey.
Bernoullius rectispinus delnortensis Pessagno, Blome & Hull
Emiluvia chica s.l. Foreman
Emiluvia premyogii Baumgartner
Podobursa helvetica (Rüst)
Tetraditryma corralitosensis corralitosensis (Pessagno)
Triactoma jonesi (Pessagno)
Tritrabs casmaliaensis (Pessagno)

B.- Khionistra area

In this area the pelagic Lamellibranch limestones are reduced to a few beds or they are practically absent (A' area of Fig. 1). The two following sections, even if they are situated close one to the other, represent two adjacent but

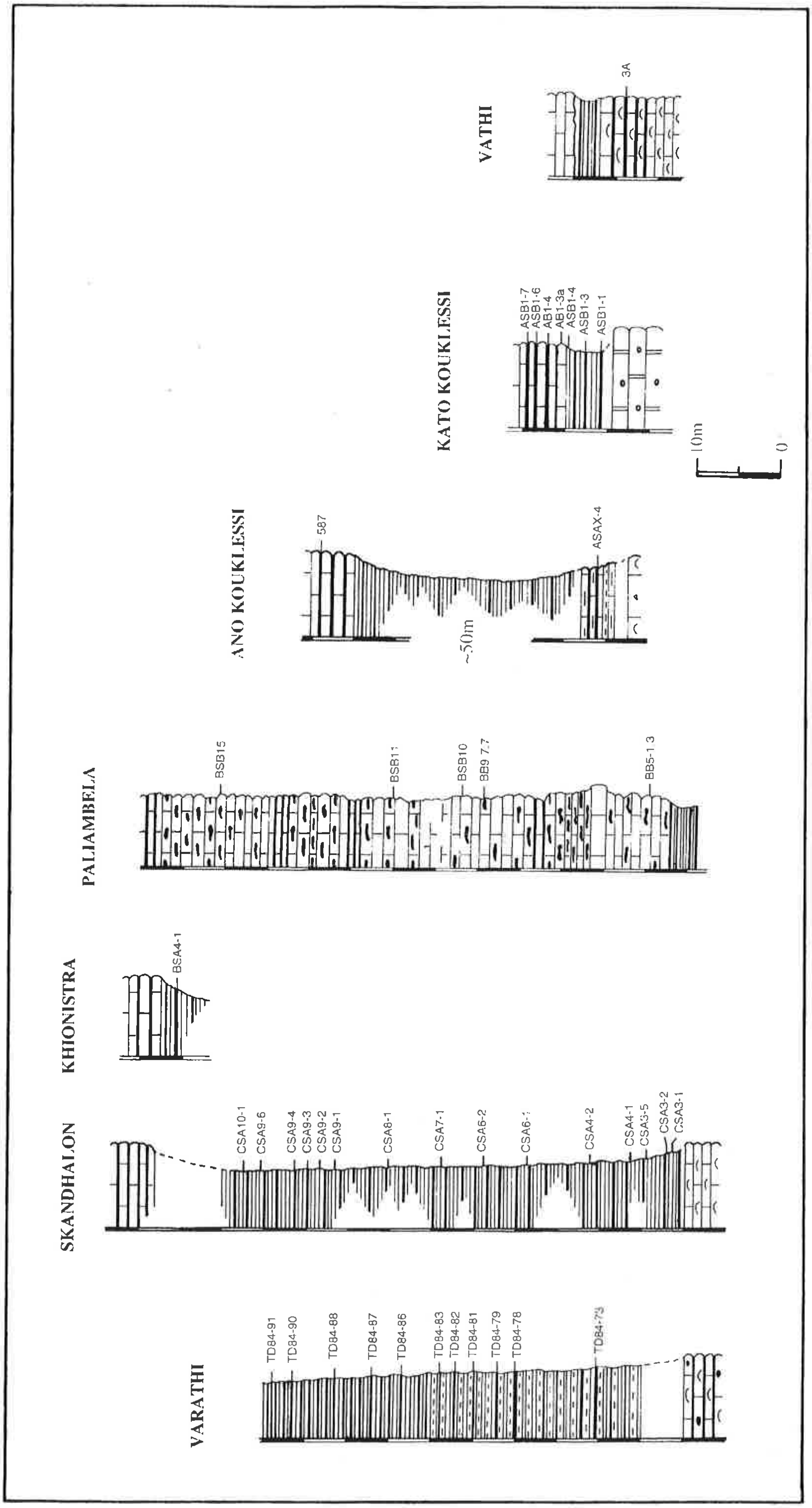


Figure 6.- Lithostratigraphic logs and sampling points of the studied sections.

distinct palaeoenvironmental settings during the Middle to Upper Jurassic.

Khionistra section : At the western part of the Khionistra massif (Fig. 5B) "Posidonia" beds are over 150 m thick. Pelagic Lamellibranch limestones, though reduced to a few metres, clearly separate a lower marly sequence (lower "Posidonia" beds) from an upper radiolaritic one (upper "Posidonia " beds). At the northern part of the Khionistra massif, along a pathway near the Kivouri hill (Fig. 3B; 20°50'6''E - 39°58'8° N), the passage of the latter formation to the Vigla Limestone is interesting. The upper "Posidonia" beds are characterised in this section by alternations of varicoloured (yellowish or greenish) bedded (a few cm thick) cherts and argillaceous levels. The Vigla Limestone essentially comprises well-bedded, decimetric pelagic limestones with radiolarians and is intercalated with cherty irregular bands, 10 to 20 cm thick (Fig. 6). The following assemblage has been extracted from sample BSA4-1:

Triactoma tithonianum RÜST
Podocapsa amphitreptera FOREMAN
Obesacapsula cetia (FOREMAN)
Archaeodictyomitra apiarium (RÜST)
Angulobracchia (?) *portmanni portmanni* BAUMGARTNER.

Paliambela section: In the eastern part of the Khionistra Massif (Fig. 5B) the "Posidonia" beds are less than 100 m thick. The upper "Posidonia" are represented by a calcareous sequence containing abundant cherty nodules or lenses that sometimes form bands; the Paliambela Member. The outcrop is situated in the Paliambela torrent, at the east of Elataria village (Fig. 5; 20°53'5''E - 39°54'2'' N). This section has been already described in detail by Danelian & Baudin (1990). A few metres of radiolarites (alternation of ribbon cherts and argillaceous levels) are overlain by dark grey to bluish, thin bedded and laminated lime wackestones (Fig. 6). Laminated microfacies, rich in lamellibranch, radiolarians and rare sponge spicules, prevail and are quite uniform along the section. However, they are some variations of the texture, the proportion or the origin of the constituents (rare phosphatic pellets, fish scales, small Foraminifera) can be observed. beds are generally poorly-distinguishable, because their joints are discontinuous. At the top of the sequence, the limestone beds become lighter (white) and thicker-bedded (30 cm in average), with more abundant and thicker (15 to 20 cm) cherty levels and they are attributed to the Vigla Limestone.

C.- Skandhalon area

The Jurassic sequence is complete in this area from the Pantokrator Limestone to Vigla, through Siniais, Ammonitico Rosso, pelagic Lamellibranch limestones and upper "Posidonia" beds (Fig. 5C). It resembles the Ano Kouklessi section. The thickness of the Ammonitico Rosso and the pelagic Lamellibranch limestones is however much reduced. The former formation is more calcareous (slightly marly nodular limestones, with a few marly interbeds). The latter presents a remarkable absence of cherty material. No slump conglomerates or turbidites are present.

The studied section outcrops 500 m south of the Skandhalon village, along a path leading to an abandoned quarry (Fig. 5C; 20°53'4''E - 39°36'1''N). The passage between pelagic Lamellibranch limestones and upper "Posidonia" beds is quite abrupt (rapid lithological change). The latter formation is constituted uniformly by alternated centimetric thick cherty beds and argillaceous interbeds (Fig. 6). The dominant colour of cherts is yellowish, but blue, green and red cherts are also present. Radiolarians are abundant and observable only in laminated cherty beds, contrary to the "vitreous" ones. Along the section some parts are folded. The formation's top and its passage to the Vigla Limestone is covered by scree.

D.- Varathi area

In the surroundings of Igoumenitsa the lower and upper "Posidonia" beds are clearly separated by the well-developed pelagic Lamellibranch limestones. The studied section is situated NE of Igoumenitsa, almost 2km east of the Igoumenitsa-Ioannina road and near the mountain road leading to the abandoned village of Ambelia (Fig. 5D; 20°28'2'' E, 39°51'8'' N). Diapiric intrusions of Triassic evaporitic breccia locally cut the lower "Posidonia" beds. The upper part of them, the pelagic Lamellibranch limestones, as well as the lower-median part of the upper "Posidonia" beds have been sampled, but only the latter have yielded radiolarians (Fig. 6). They are composed by grey-brown-greenish ribbon cherts, alternating with laminated brown-greenish siltstones, which are abundant in the lower 25 metres of the sequence. The cherts become thicker and abundant upwards.

3.2. Maliac Zone of Othris

The studied section is situated at the margin of the western flank of Mount Migdalia (Fig. 2) and corresponds to the upper part of the Migdalia section described by Ferrière (1982, p. 229, the northern section only; his fig. 92A). The outcrop shows a reasonably good stratigraphic continuity from the limestones to the siliciclastic chaotic formation, with good exposure of the intervening radiolarites. Reasonably well preserved radiolarian faunas have been extracted from ribbon cherts in the radiolarite sequence (Fig. 4). The assemblages are quite diverse, but are dominated by nassellarians.

References

AITA, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

AUBOUIN, J. (1959). Contribution à l'étude géologique de la Grèce septentrionale : les confins de l'Epire et de la Thessalie. *Annales Géologiques du Pays Helléniques*, **1**,(9), 1-483.

BAUDIN, F. (1989). *Caractérisation géochimique et sédimentologique de la matière organique du Toarcien Tethysien (Méditerranée, Moyen-Orient), Significations Paléogéograpohiques*. Ph.D. Thesis (n° 89-30). Département de Géologie sédimentaire. Université Pierre et Marie Curie (Unpublished), Paris, 246 p.

BAUDIN, F., DERCOURT, J., HERBIN, J.P. & LACHKAR, G. (1988). Le Lias supérieur de la zone ionienne (Grèce): une sédimentation riche en carbone organique. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **307**, 985-990.

BAUDIN, F. & LACHKAR, G. (1990). Géochimie organique et palynologie du Lias supérieur en zone ionienne (Grèce). Exemple d'une sédimentation anoxique conservée dans un paléosillon. *Bulletin de la Société Géologique de France, Série VIII*, **6** (1), 123-132.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1985). Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). *Mémoires de la Société Helvétique des Sciences Naturelles*, **99**, 1-111.

BAUMGARTNER, P.O., DANELIAN, T., DUMITRICA, P., GORICAN, S., JUD, R., O'DOGHERTY, L., CARTER, B., CONTI, M., DE WEVER, P., KITO, N., MARCUCCI, M., MATSUOKA, A., MURCHEY, B. & URQUHART, E. [INTERRAD Jurassic - Cretaceous Working Group] (1993). Middle Jurassic - Early Cretaceous Radiolarian biochronology of Tethys: implications for the age of radiolarites in the Hellenides (Greece). *Bulletin of the Geological Society of Greece*, **28** (3), 13-23.

BERNOULLI, D. (1972). North Atlantic and Mediterranean Mesozoic Facies: a comparison. *Initial Reports of the Deep Sea Drilling Project* - U. S. Government Printing Office, Washington, D.C., **11**, 801-871.

BERNOULLI, D. & RENZ, O. (1970). Jurassic Carbonate Facies and New Ammonite Faunas from Western Greece. *Eclogae Geologicae Helvetiae*, **63** (2), 573-607.

BORNOVAS, J. (1964). *Geological Study of Leukas Island.* Athens, **10** - Institute of Geology Subsurface Research. 142 p. *(in Greek)*

BP CO. LTD. (1971). *The geological results of petroleum exploration in western Greece*, **10** - Institute of Geology Subsurface Research Edition, Athens. 73 p.

DALIPI, H., KONDO, A., PEJO, I., IKONOMI, J. & MECAJ, B. (1971). Stratigraphy of the deposits of the Mesozoic in southern and western Albania (outer Albanids). *Nafta*, **22**, 227-253.

DANELIAN, T. (1989). *Radiolaires jurassiques de la zone Ionienne (Epire, Grèce). Paléontologie-Stratigraphie implications paléogéographiques*. Ph.D. Thesis (n° 89-25). Département de Géologie sédimentaire. Université Pierre et Marie Curie (Unpublished), Paris, 269 p.

DANELIAN, T. (in press). Palaeo-oceanographic significance of Mid-Jurassic Radiolarites on the Maliac (Sub-Pelagonian) margin of Othris (Greece). *Bulletin of the Geological Society of Greece.*

DANELIAN, T. & BAUDIN, F. (1990). Découverte d'un horizon carbonaté, riche en matière organique, au sommet des radiolarites d'Epire (zone ionienne, Grèce): le Membre de Paliambela. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **311**, 421-428.

DERCOURT, J., ZONENSHAIN, L.P., *ET AL.* (1985). Présentation de 9 cartes paléogéographiques au 1.20.000.000e s'étendant de l'Atlantique au Pamir pour la Période du Lias à l'Actuel. *Bulletin de la Société géologique de France, Série VIII*, **1** (5), 637-652.

FERRIÈRE, J. (1982). Paléogéographies et tectoniques superposées dans les Hellénides internes au niveau de l'Othrys et du Pelion (Grèce). *Société Géologique du Nord, Publication*, **8**, 1-970.

FERRIÈRE, J., BERTRAND, J., SIMANTOV, J. & DE WEVER, P. (1988). Comparaison entre les formations volcano-détritiques ("melanges") du Malm des Hellênides internes (Othrys, Eubée); implications géodynamiques. *Bulletin of the Geological Society of Greece*, **20**, 223-235.

GALBRUN, B., MOUTERDE, R., BAUDIN, F., DANELIAN, T. & DERCOURT, J. (1994). L'Ammonitico-Rosso Toarcien de la zone ionienne (Epire, Grèce) : Magnétostratigraphie et biostratigraphie. *Eclogae Geologicae Helvetiae*, **87** (1), 91-111.

IGRS-IFP [Institut de Géologie et Recherches du Sous-sol, Athènes & Institut Francais du Petrole, Mission Grèce] (1966). *Etude géologique de l'Epire (Grèce nord-occidentale)* - Technip Edition, Paris. 306 p.

KARAKITSIOS, V., DANELIAN, T. & DE WEVER, P. (1988). Datations par les Radiolaires des Calcaires à Filaments, Schistes à Posidonies supérieurs et Calcaires de Vigla (zone ionienne, Epire, Grèce) du Callovien au Tithonique terminal. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **306**, 367-372.

KARAKITSIOS, V. & TSAILA-MONOPOLIS, S. (1988). Données nouvelles sur les niveaux supérieurs (Lias inférieur-moyen) des Calcaires de Pantokrator (zone ionienne moyenne, Epire, Grèce continentale). Description des Calcaires de Louros. *Revue de Micropaléontologie*, **31** (1), 49-55.

KOTTEK, A.V. (1966). Die Ammonitenabfolge des Griechischen Toarcium. *Annales Géologiques du Pays Helléniques*, **1** (17), 1-157.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

REMANE, J., BAKALOVA-IVANOVA, D., BORZA, K., KNAUER, J., NAGY, I., POP, G. & TARDI-FILACZ, E. (1986). Agreement on the subdivision of the Standard Calpionellid Zones defined at the IInd Planktonic Conference, Roma 1970. *Acta Geologica Hungarica*, **29** (1-2), 5-14.

RENZ, C. (1955). *Die vorneogene Stratigraphie der normal-sedimentären formationen Griechenlands* - Institute of Geology Subsurface Research, Athens. 637 p.

ROBERTSON, A.H.F. (1991). Origin and emplacement of an inferred late Jurassic subduction-accretion complex, Euboea, eastern Greece. *Geological Magazine*, **128** (1), 27-41.

SMITH, A.G., HYNES, A.J., MENZIES, M., NISBET, E.G., PRICE, I., WELLAND, J. & FERRIÈRE, J. (1975). The Stratigraphy of the Othris Mountains, Eastern Central Greece: a Deformed Mesozoic Continental Margin Sequence. *Eclogae Geologicae Helvetiae*, **68** (3), 463-481.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

WALZEBUCK, J.P. (1982). Bedding Types of the Toarcian Black Shales in NW Greece. *In* Einsele, G. & Seilacher, A. Eds. *Cyclic and Event Stratification* - Springer-Verlag, New York, 512-525.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION 1_Ano Kouklessi: bottom 1 - top 1
< 1 {ASAx-4}: 3055, 3074, 3180, 4072

SECTION 2_Ano Kouklessi: bottom 1 - top 1
< 1 {587}: 3083, 3090, 3092, 3202, 3227, 3228, 3255, 3286, 5261, 5290, 5426, 5578, 6121

SECTION 3_Kato Kouklessi: bottom 1 - top 5
< 5 {ASB1-7} : 3087, 3090, 3092, 3112, 3203, 3228, 3255, 3263, 3285, 3286, 5607, 6121
< 4 {ASB1-6} : 3087, 3090
< 3 {ASB1-4} : 3090, 3096, 3104, 3118, 3121, 3125, 3137, 3139, 3147, 3161, 3168, 3171, 3189, 3199, 3205, 3215, 3224, 3230, 3254, 4015, 4068
< 2 {ASB1-3} : 3139, 3168, 4015, 4069
< 1 {ASB1-1} : 3062, 3064, 3090, 3092, 3096, 3103, 3118, 3122, 3125, 3137, 3139, 3145, 3147, 3161, 3171, 3199, 3215, 3216, 3230, 3241, 3243, 3254, 3263, 4015, 4018, 4069

SECTION 4_Vathi: bottom 1 - top 1
< 1 {3A}: 3096, 3117, 3124, 3169, 3210, 3213, 3221, 3222, 4009

SECTION 5_Khionistra: bottom 1 - top 1
< 1 {BSA4-1}: 3097, 3171, 3203, 3263, 3285

SECTION 6_Paliambela: bottom 1 - top 5
< 5 {BSB15} : 3171, 3263
< 4 {BSB11} : 3215, 3216
< 3 {BSB10} : 3096, 3137, 3139, 3215, 3254, 4015, 4068
< 2 {BB9-7.7} : 3121, 3122, 3215, 3230, 3241, 4070
< 1 {BB5-1.3} : 3020, 3035, 3055, 3061, 3062, 3085, 3088, 3096, 3100. 3103, 3110, 3113, 3116, 3117, 3118, 3121, 3124, 3144, 3152, 3166, 3169, 3210, 3215, 3216, 3225, 3230, 3244

SECTION 7_Skandhalon: bottom 1 - top 15
< 15 {CSA10-1}: 3087, 3097, 3171, 3225, 3263, 3286
< 14 {CSA9-6} : 3087, 3090, 3092, 3097, 3171, 3193, 3225, 3263, 3286
< 13 {CSA9-4} : 3082, 3097, 3171, 3225, 4015
< 12 {CSA9-3}: 3082, 3097, 3171, 3225
< 11 {CSA9-2} : 3082, 3092, 3097, 3171, 3177, 3202, 3203, 3225, 3227, 3241, 3263, 3285, 3406, 4015, 5674
< 10 {CSA9-1} : 3097, 3171, 3203, 3263
< 9 {CSA8-1} : 3171, 3177, 3215, 3216
< 8 {CSA7-1} : 3090, 3118, 3137, 3168, 3147, 3171, 3193,

3243, 3292, 4015, 4018, 4070, 4073
< 7 {CSA6-2} : 3085, 3088, 3090, 3161, 3171, 3215, 3230, 3241, 4015, 4018, 4070, 5199
< 6 {CSA6-1} : 3082, 3085, 3088, 3095, 3118, 3139, 3147, 3215, 3241, 3263, 4069, 4070
< 5 {CSA4-2} : 3085, 3215, 4069
< 4 {CSA4-1} : 3104
< 3 {CSA3-5} : 3008
< 2 {CSA3-2} : 3005, 3008, 3020, 3055, 3085, 3103, 3121, 3169, 3180, 3197, 3238, 3244, 3277, 3298
< 1 {CSA3-1} : 3005, 3008, 3012, 3020, 3033, 3055, 3061, 3085, 3088, 3096, 3103, 3110, 3124, 3169, 3195, 3210, 3221, 3225, 3238, 3244, 3270, 3271, 3276, 3277, 3290, 3297, 3413, 4014, 4072

SECTION 8_Varathi: bottom 1 - top 10
< 10 {TD 84-91} : 3160
< 9 {TD 84-90} : 3008, 3017, 3020, 3055, 3062, 3078, 3085, 3095, 3096, 3104, 3110, 3117, 3118, 3121, 3124, 3131, 3133, 3135, 3139, 3140, 3144, 3160, 3166, 3169, 3180, 3199, 3202, 3204, 3205, 3210, 3215, 3220, 3222, 3223, 3224, 3230, 3243, 3244, 3254, 3298, 4063
< 8 {TD 84-88} : 3180
< 7 {TD 84-87} : 3088, 3117, 3121, 3133, 3210, 3215, 3221, 3222, 3243, 3254, 4009
< 6 {TD 84-86} : 3008, 3117, 3180, 3210
< 5 {TD 84-83} : 3238
< 4 {TD 84-81} : 3085
< 3 {TD 84-79} : 3005, 3008, 3085, 3147, 3169, 3411
< 2 {TD 84-78} : 3117, 3124, 3197, 3199, 3222
< 1 {TD 84-73} : 3222

SECTION 9_maliac: bottom 1 - top 6
< 6 {TD93-21} : 3012, 3055, 3180, 3221, 3277, 3297, 3298
< 5 {TD93-19} : 3298
< 4{TD93-16} : 3052
< 3 {TD93-14} : 3052, 3277
< 2 {TD93-13} : 3052, 3277
< 1 {TD93-12} : 3012, 3197, 3276, 3277, 3298, 4014

20. Radiolarians Overlying Ophiolites of the Almopias Domain (Macedonia, Greece)

by Patrick De Wever

CNRS-Université Pierre et Marie Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France

ABSTRACT

Chert beds from the Almopias area have been dated with radiolarian remains: some of these chert beds such as the previously undescribed Vrissi Unit are Triassic, whilst others, such as the chert and volcanic beds from Mavrolakkos Unit are Jurassic or early Neocomian (probably Upper Jurassic). These results provide some information on the previously geological history of this area during Triassic-Jurassic times. They support the hypothesis of the existence of a Jurassic oceanic crust basin east of the Pelagonian Zone, initiated during Triassic times. Finally, they modify the data used to discuss the existence of an Upper Cretaceous oceanic crust in the Almopias area.

1. Geological framework

The Almopias sub-zone has been defined by J. Mercier (1968) and since then it has been considered as a depression (trough or basin). This interpretation, however, is solely based on the analysis of the Cretaceous series which are the subject of a long established stratigraphical interpretation and are only weakly metamorphosed.

This zone was later described as a basin formed when oceanic crust was obducted during the Middle Jurassic on the western zones (Bernoulli & Laubscher, 1972; Dercourt, 1972; Aubouin, 1973; Ferrière, 1982; Vergely, 1984; Dercourt *et al.*, 1985).

On the Edessa geological map, the chert and volcanic series of the Mavrolakkos Unit are shown as Upper Cretaceous (dating of the base of these series with pithonellids). It has recently (Stais *et al.*, 1990) been shown that, in contrast to the previously suggested age (Late Cretaceous), the chert series (radiolarites) were of Jurassic-early Neocomian age in the Mavrolakkos Unit and of Triassic age in the Vrissi Unit.

The Mavrolakkos Unit was defined by Mercier (1968) and reviewed by Bijon (1982). It is composed of (from the base to the top):

- Red radiolarite, often pelitic, with intercalations of basic lavas and diabases (MV1, on fig.1).
- Red and yellow shale with rare recrystallised calcarenite beds becoming more typical of a flysch upwards.

From to the presence of pithonellids in the carbonate beds, a Late Cretaceous age is indicated for the base of the unit on the 1/50000 Edessa geological map. It is now established that this part of the unit belongs to the Vrissi Unit. The radiolarian remains from the radiolarites give a Jurassic-early Neocomian age (*Praeconocaryomma* sp., *Ristola* sp. and *Pseudodictyomitra apiarium* (RÜST), ? *Parvicingula dhimenaensis* BAUMGARTNER) or an undoubted Jurassic (probably Callovian-Oxfordian) age for a boulder sample (*Archaeospongoprunum bipartitum* PESSAGNO, *Pseudodictyomitra* sp., *Podobursa* sp., ? *Spongocapsula palmerae* PESSAGNO, *Homoeoparonaella argolidensis* BAUMGARTNER, ? *Tetratrabs zealis* (OZVOLDOVA) and ? *Eucyrtidiellum ptyctum* (RIEDEL). It is possible that these series could have been deposited during Jurassic to Neocomian times, but it is more probable that the sedimentation occurred during the Late Jurassic.

2. Radiolarians

Radiolaria were only recovered from two samples both of which yielded a poor fauna, including the following specimens:

Sample ALM1: *Parvicingula dhimenaensis* s.l. BAUMGARTNER and *Archaeodictyomitra apiarium* (RÜST)
Sample ALM2: *Homoeoparonaella argolidensis* BAUMGARTNER and *Spongocapsula palmerae* PESSAGNO

References

AUBOUIN, J. (1973). Des tectoniques superposées et de leur signification par rapport aux modèles géophysiques: l'exemple des Dinarides; paléotectonique, tectonique, tarditectonique, néotectonique. *Bulletin de la Société Géologique de France, Série VII*, **15**, 426-460.

BERNOULLI, D. & LAUBSCHER, H. (1972). The Palinspatic problem of the Hellenides. *Eclogae Geologicae Helvetiae*, **65** (1), 107-118.

BIJON, J. (1982). *Géologie et géochimie des formations volcano-sédimentaires d'âge jurassique supérieur et crétacé de la région d'Edessa (Grèce, Province de Pella)*. Ph.D. Thesis. Université d'Orsay, 192 p.

DERCOURT, J. (1972). The canadian Cordillera, the Hellenides and the Sea-floor spreading theory. *Canadian Journal of Earth Science*, **9** (6), 709-743.

DERCOURT, J., ZONENSHAIN, L.P., *ET AL.* (1985). Présentation de 9 cartes paléogéographiques au 1.20.000.000e s'étendant de l'Atlantique au Pamir pour la Période du Lias à l'Actuel. *Bulletin de la Société Géologique de France, Série VIII*, **1** (5), 637-652.

FERRIÈRE, J. (1982). Paléogéographies et tectoniques superposées dans les Hellénides internes au niveau de l'Othrys et du Pelion (Grèce). *Société Géologique du Nord, Publication*, **8**, 1-970.

MERCIER, J. (1968). Etude géologique des zones internes des Hellénides en Macédoine centrale (Grèce). *Annales Géologiques du Pays helléniques*, **1** (20), 1-720.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

STAIS, A., FERRIÈRE, J., CARIDROIT, M., DE WEVER, P., CLEMENT, B. & BERTRAND, J. (1990). Données nouvelles sur l'histoire ante-obduction (Trias-Jurassique) du domaine d'Almopias (Macédoine, Grèce). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **310**, 1475-1480.

VERGELY, P. (1984). *Tectonique des ophiolites dans les Hellénides internes (déformations, métamorphismes et phénomènes sédimentaires). Conséquences sur l'évolution des régions téthysiennes occidentales*. Ph.D. Thesis (n° 250). Université d'Orsay, 411 p.

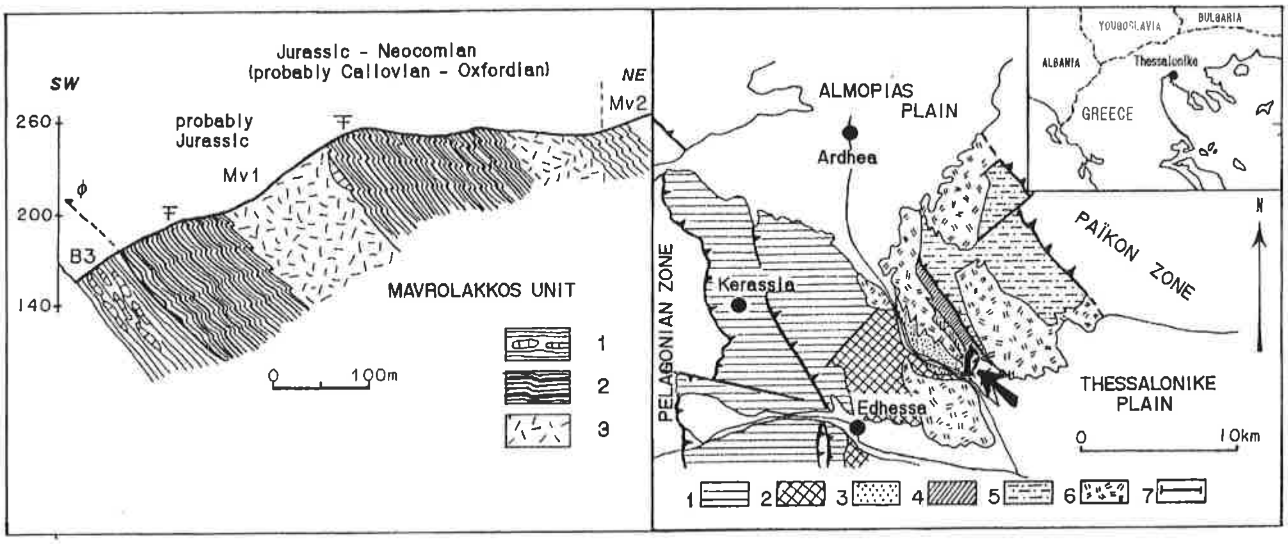


Figure 1.

RIGHT : Location (upper corner) and sketch map of the Almopias area (Greece).**1-5.** Almopias Units, **1.** Western units; **2.** Ophiolitic mélanges of Klissochori; **3.** Nea Zoi Unit ; **4.** Mavrolakkos Unit ; **5.** Eastern units; **6.** Pliocene volcanic rocks; **7.** Location of the cross-section.

LEFT: Geological cross-section across the Mavrolakkos Unit (**C**) **1.** Shales with lenses of limestones (Late Cretaceous); **2.** Red pelitic radiolaritic rocks (Jurassic-Neocomian, probably Middle-Late Jurassic); **3.** Dolerite and mafic lavas.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION DW7_GRECE_ALMOPIAS_UNIVRI: bottom 1 - top 1
< 1 {ALM1}: 3197, 3263

SECTION DW8_GRECE_ALMOPIAS_UNIVRI: bottom 1 - top 1
< 1 {ALM2}: 3103, 3199

21. Radiolarians from the Radiolarites Formation (s.s.), Pindos-Olonos Zone (Greece): Bajocian (?) to Tithonian

by Patrick De Wever[1] and Fabrice Cordey[2]

[1] CNRS-URA 1315, Université Pierre et Marie Curie, Laboratoire de Stratigraphie, 4 Place Jussieu, 75230 Paris Cedex 05 (France)
[2] 311 - 1080 Pacific Street, Vancouver B.C., V6E 4C2, Canada

ABSTRACT

Radiolarians have been extracted from the Radiolarite Formation (s.s.) of the Pindos Olonos Zone (Karpenission area, Evritanie, continental Greece). Eighteen assemblages are recorded and permit continuous dating of the formation from possible Bajocian to Tithonian (excluding the Oxfordian). From age determinations in different sections, we can calculate an average "sedimentation rate" of 1.8-2 mm 10^{-3} yr for the whole formation.

1. Introduction

Radiolarians have been extracted from the Radiolarite Formation (s.s.) of the Pindos-Olonos Zone (Karpenission area, Evritania, mainland Greece). Eighteen assemblages are recorded and permit continuous dating of the formation from possible Bajocian to Tithonian (excluding the Oxfordian)(De Wever & Cordey, 1986).

2. Geological setting

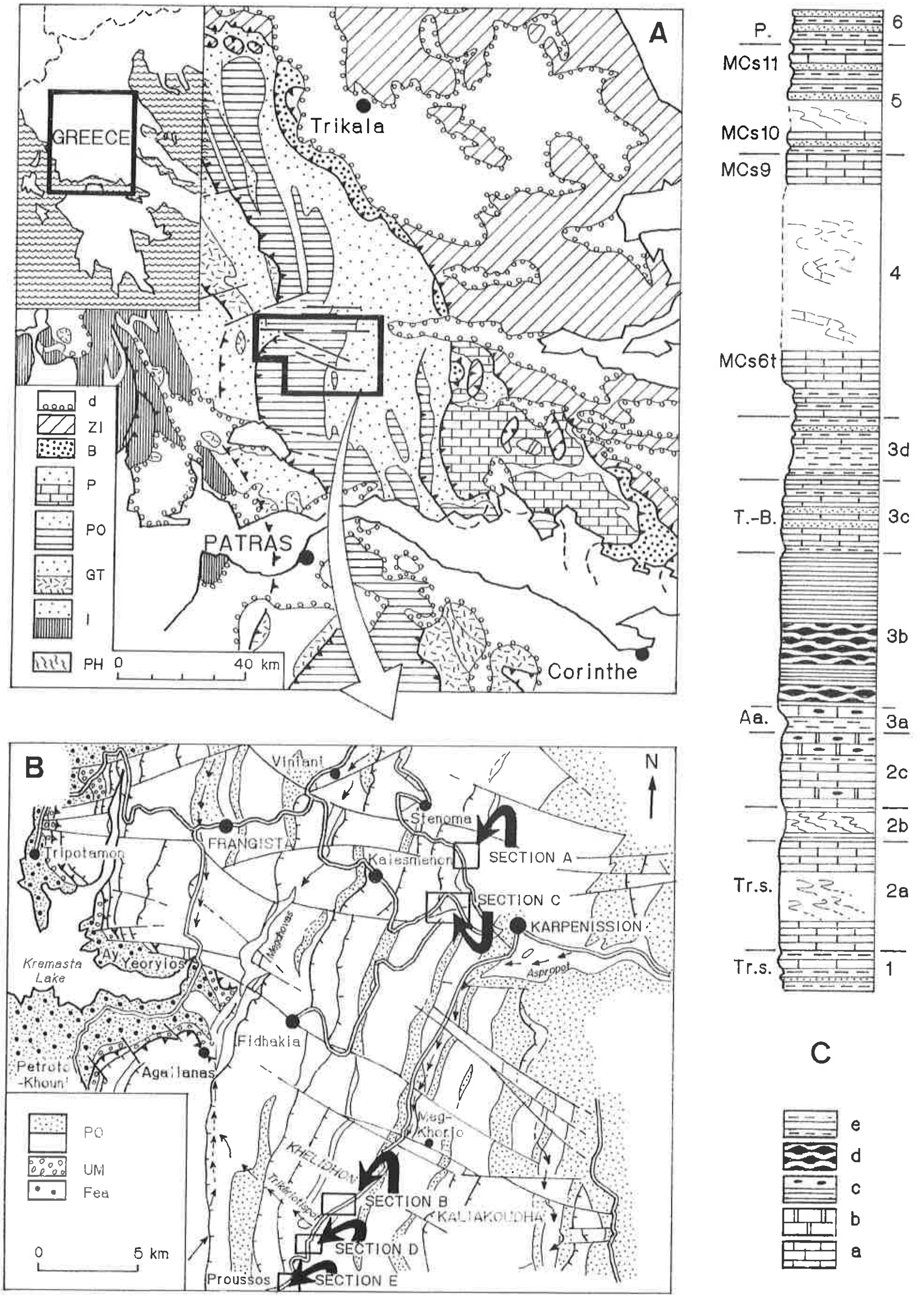
In the Hellenides mountain range the Pindos-Olonos Series, composed mainly of pelagic sedimentary rocks, is overthrust over the Gavrovo-Tripolitza sedimentary pile, consisting of neritic limestones and a flysch (in the Epireous-Akarnania syncline, Fig. 1.B). The Pindos-Olonos sequence is in turn overlain by the Parnassos overthrust northwards to the Corinth Gulf, and by the ophiolitic nappe in northern Greece. Eastern contacts between these piles are locally covered by molasse of the Albano-Thessalian trough (Upper Eocene-Miocene) or by the large Quaternary plain of Trikala.

From base to top, the Pindos-Olonos Series consists of (Fleury, 1980) (Fig. 1C):

1- Triassic detrital sediments, (?) Ladinian-Norian in age.

2- Drimos Limestones which, are subdivided into
(a) Lower Drimos Limestones, dated as Late Triassic (Carnian-Norian) by conodonts (Fleury, 1980);
(b) a chert horizon dated as Early Jurassic by radiolarians (De Wever & Origlia-Devos, 1982b),
(c) Upper Drimos Limestones.

3- The Radiolarite Formation is subdivided into four parts which are, from base to top :
(a) Pélites de Kasteli Formation, these shales are dated as Aalenian-early Bajocian with *Lucasella cayeuxi* LUCAS (Dercourt *et al.*, 1973);
(b) Radiolarite *s.s.* dated as Bajocian to Tithonian by radiolarians (De Wever & Origlia-Devos, 1982a; De Wever & Cordey, 1986) - in the southern Peloponnessos the base of the Radiolarites *s.s.* has been previously interpreted as Bathonian? in age based on microfauna (*Protopeneroplis striata, Trocholina* cf. *palastiniensis,*


A
GREECE
Trikala
PATRAS
Corinthe
d
ZI
B
P
PO
GT
I
PH
0
40 km
B
N
Viniani
Stenoma
FRANGISTA
Tripotamon
Kalesmenon
SECTION A
SECTION C
KARPENISSION
Megdhovas
Kremasta Lake
Ay. Yeoryios
Aspropot
Fidhakia
Petroto -Khouni
Agailanas
PO
UM
Fea
0
5 km
Meg-Khorio
KHELIDHON
Trikeriotis
SECTION B
KALIAKOUDHA
SECTION D
Proussos
SECTION E
P.
MCs11
MCs10
MCs9
MCs6t
T.-B.
Aa.
Tr.s.
Tr.s.
6
5
4
3d
3c
3b
3a
2c
2b
2a
1
C
e
d
c
b
a

Mesoendothyra croatica, Valvulina cf. *lugeoni*) found in a silicified calcarenite bed within the base of that level (Thiébault *et al.*, 1981) ;

(c) Calcaires à Calpionelles Formation dated as late Tithonian-Berriasian (possibly early Valanginian) by calpionellids. The detailed dates provided by Fleury (1980, p. 322) are as follows:

- *Calpionella alpina* LORENZ "type-like" (older than mid Berriasian) near the base; *C. alpina*, *C.* cf. *alpina, C.* gr. *elliptica* CADISH "short" (late Tithonian) very close to previous sample ;
- *C.* cf. *alpina*, *Tintinopsella* sp., *Stomiosphaera moluccana* WANNER, "*Stomiosphaera*" *misozensis* (VOGLER), *Nannoconus* (Cretaceous, at least early Berriasian) - 15 m above previous sample
- *C. alpina*, *C.* sp. gr. *elliptica, C.* cf. *elliptica* "middle", *S. moluccana* (Berriasian, no younger than mid Berriasian).- 20 m above previous sample ;
- *C. alpina* , *C.* sp. gr. *elliptica*, *C.* cf. *elliptica* ?, *Tintinopsella* sp., *T. carpathica* (MURGEANU & FILIPESCU) ?, *Calpionellopsis* sp., *C. oblonga* (CADISH), *Nannoconus* (late Berriasian) - 5 m above previous sample ;
- *Calpionellopsis* sp., *C.* cf. *oblonga, Nannoconus* - 5 m above previous sample.

One early Valanginian age was reported by Lybéris (1978) based on the occurrence of *Calpionellites darderi* (COLOM).

(d) the Marnes Rouges à Radiolaires Formation, which ranges in age from Valanginian to late Albian-Turonian as indicated by radiolarians (De Wever & Origlia-Devos, 1982a).

4- Calcaires en Plaquettes Formation. These platy limestones are dated by globotruncanids and were deposited from Coniacian to Maastrichtian (Fleury, 1980, p. 345);

5- Couches de Passage au Flysch Formation is made of alternating limestones and shales of mid to late Maastrichtian age (Fleury, 1980, p. 349);

6- Flysch du Pinde Formation, ranges in age from Paleocene to Eocene (Fleury, 1980, p. 360).

3. Description of Sections

Five sections were sampled in the vicinity of Karpenission (Fig.1 A,B).

SECTION A

Location (Figs. 1.B and 2.A): 10 km NW of Karpenission at the "Kokkino Diaselo", along the road to Stenoma (Karpenission sheet, 1/50'000, X = 21°45'30", Y = 38°57'10").

Description (Fig. 3): The contact between the Pélites de Kasteli Formation (3a) and the Radiolarite Formation s.s. (3b) occurs at a road junction, the base of 3b is not exposed. The lower part of the radiolarites (12m) shows centimetric beds of green and red chert interlayered with red shale horizons, while its upper part (23m) is made of nodular beds [called "Jaspes amygdalaires" by Dercourt (1964) and Fleury (1980)] near the base, but with red chert in beds of several centimetres which thicken towards the top. A fault marks the top of the succession.

Samples (Fig. 3): among 25 samples collected along this section, four of them yielded identifiable radiolarians: FC3, FC5, FC10, and FC19.

Figure 1. Location of sections in mainland Greece and a general lithological column (from Fleury, 1980).

A- Geological sketch (the studied area is framed) (upper centre)

PH. Phyllades; **I.** Ionian Zone (Mesozoic series and Cenozoic flysch are distinguished); **GT.** Gavrovo-Tripolitza Zone (Mesozoic series and Cenozoic flysch are distinguished); **PO.** Pindos-Olonos Zone (Mesozoic series and Cenozoic flysch are distinguished); **P.** Parnassos Zone (Mesozoic series and Cenozoic flysch are distinguished); **B.** Beotian Zone; **ZI.** Undifferentiated Internal Zones; **d.** Unconformable post-tectonic formations.

B- Structural sketch of the Karpenission-Frangista area (from Fleury, 1980) and location of the sections (lower centre). Only the main slices corresponding to upthrusts of Triassic strata over Upper Cretaceous-Eocene formations are drawn.

Fea. Flysch of the Epireous-Akarnanian syncline; **UM.** Megdhovas Unit; **PO.** Pindos-Olonos Zone (Mesozoic series and Cenozoic flysch are distinguished).

C- Lithological column of the Pindos-Olonos series in the Karpenission area (from Fleury, 1980).
The numbers correspond to the following units.

1. Triassic detrital formation; **2.** Drimos Formation; **2a.** Limestones of the lower part; **2b.** Cherty level; **2c.** Limestones of the upper part; **3.** Radiolarite *s.l.* Formation; **3a.** Pélites de Kasteli Fm; **3b.** Radiolarite *s.s.* Fm; **3c.** Calcaires à Calpionelles Fm; **3d.** Marnes Rouges à Radiolaires Fm; **4.** Calcaires en Plaquettes Fm.; **5.** transitional beds to the flysch; **6.** Flysch.

Age assignments (Fleury, 1980) are located on left of the column:

Tr.s. Late Triassic (Carnian, Norian); **Aa.** Aalenian. **T.-B.** Late Tithonian-Berriasian; **MCs6t.** Santonian-Campanian boundary; **MCs9**. Early Maastrichtian; **MCs1O.** Maastrichtian p.p.; **MCs11.** latest Maastrichtian; **P.** Paleocene.

Lithologic caption: **a.** Micritic limestones; **b.** Microbrecciated limestone; **c.** Ribbon cherts and siliceous nodules; **d.** Nodular ribbon cherts; **e.** Sandstones and pelites.

Section B

Location (Figs. 1.B et 2.B): 20 km S of Karpenission, along the road to Proussos (Frangista sheet, 1/50000, X= 21°42'20", Y= 38°47'40")

Description (Fig. 3): The boundary between levels 3a and 3b is obscured by scree. Within level 3b (here 60m thick) three lithological divisions are recognisable : (1) the lower part (13 m thick) is made of nodular beds and centimetric beds of red chert separated by red shales; (2) the middle part (23 m thick) shows nodular beds and centimetric beds of red and green chert; then scree obscures the outcrop for 10m; (3) the upper part (14m thick) is composed of nodular chert (which disappears upwards) and multidecimetric beds of red chert; a brecciated limestone bed represents the beginning of the Calcaires à Calpionelles Formation (3c).

Samples (Fig. 3): 20 samples were collected; two of them yielded identifiable radiolarians: FC 35 and FC 47.

Section C

Location (Fig. 1B and 2C): 2.5 km W of Karpenission, (Karpenission sheet, 1:50'000, X= 21°45'10", Y= 38°55'46"); it has also been described as the "Coupe de Karpenission" by Fleury (1980).

Description (Fig. 3): A microbreccia limestone bed with cherty nodules underlies the boundary between levels 3a and 3b (Fleury, 1980). Level 3b (65 m thick) can be subdivided into three parts:

1- a lower part (22m thick) composed of nodular chert (near the base) and multidecimetric beds of red chert with interlayered red shales;

2- a middle part (20 m thick) made of nodular cherts (which disappear upwards) and multidecimetric beds of green and red chert;

3- an upper part (21 m thick) with centimetric beds of red chert.

A red brecciated limestone bed, including green fragments, represents the beginning of the Calcaires à Calpionelles Formation (3c)

Samples : 40 samples were collected, 9 of them yielded identifiable radiolarians: FC120, FC121, FC127, FC133, ID93 and FC144 (Fig. 4); ID96, ID98 and ID99 (Fig. 5).

Section D

Location (Fig. 1B and 2D): 2 km SW of section B, 22 km from Karpenission (Frangista sheet, 1:50'000, X= 21°41'00", Y= 38°47'10").

Description (Fig. 3): Only the upper part of level 3b is visible, consisting of a 20 m thick alternating sequence of red cherts and shales, which are overlain by the Calcaires à Calpionelles Formation (3c).

Samples (Fig. 3): 10 samples were collected, only one (ID 214) yielded identifiable radiolarians.

Section E

Location (Fig. 1B. et 2E): 4 km S of section D, to Proussos (Frangista sheet, 1:50'000, X= 21°40'20", Y= 38°46'10").

Description (Fig. 3): The lower part of level 3b is covered by scree. The sampled part is made of a succession

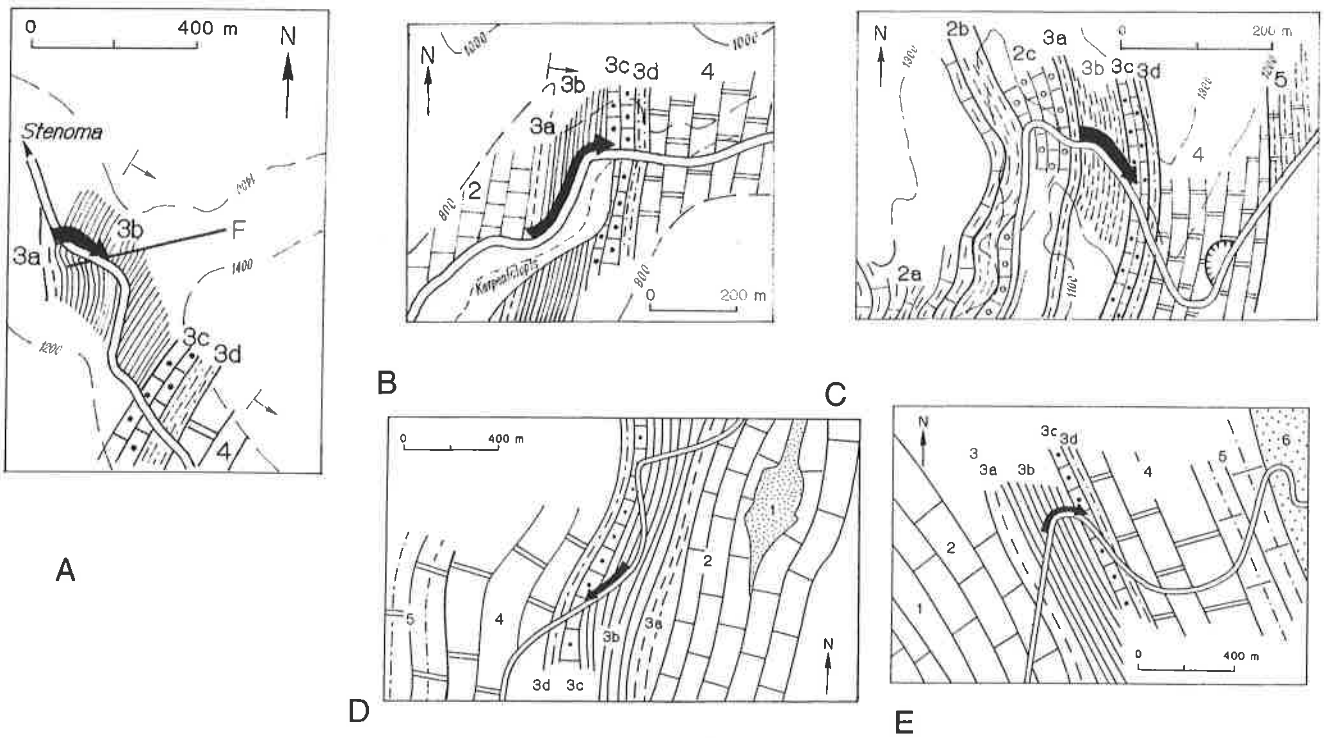


Figure 2. Geological sketch and location of sections (indicated by a thick arrow). Numbers as for Fig. 1C. **A.** Section A, **B.** Section B, **C.** Section C, **D.** Section D, **E.** Section E.

of red and green cherty levels progressively becoming an alternation of red chert beds and thin shales over a 30m thickness. These red cherts are overlain by the first limestones beds belonging to the Calcaires à Calpionelles Formation (3c).

Samples (Fig. 3): 8 samples were collected, 2 of them yielded identifiable radiolarians: ID192 and ID200.

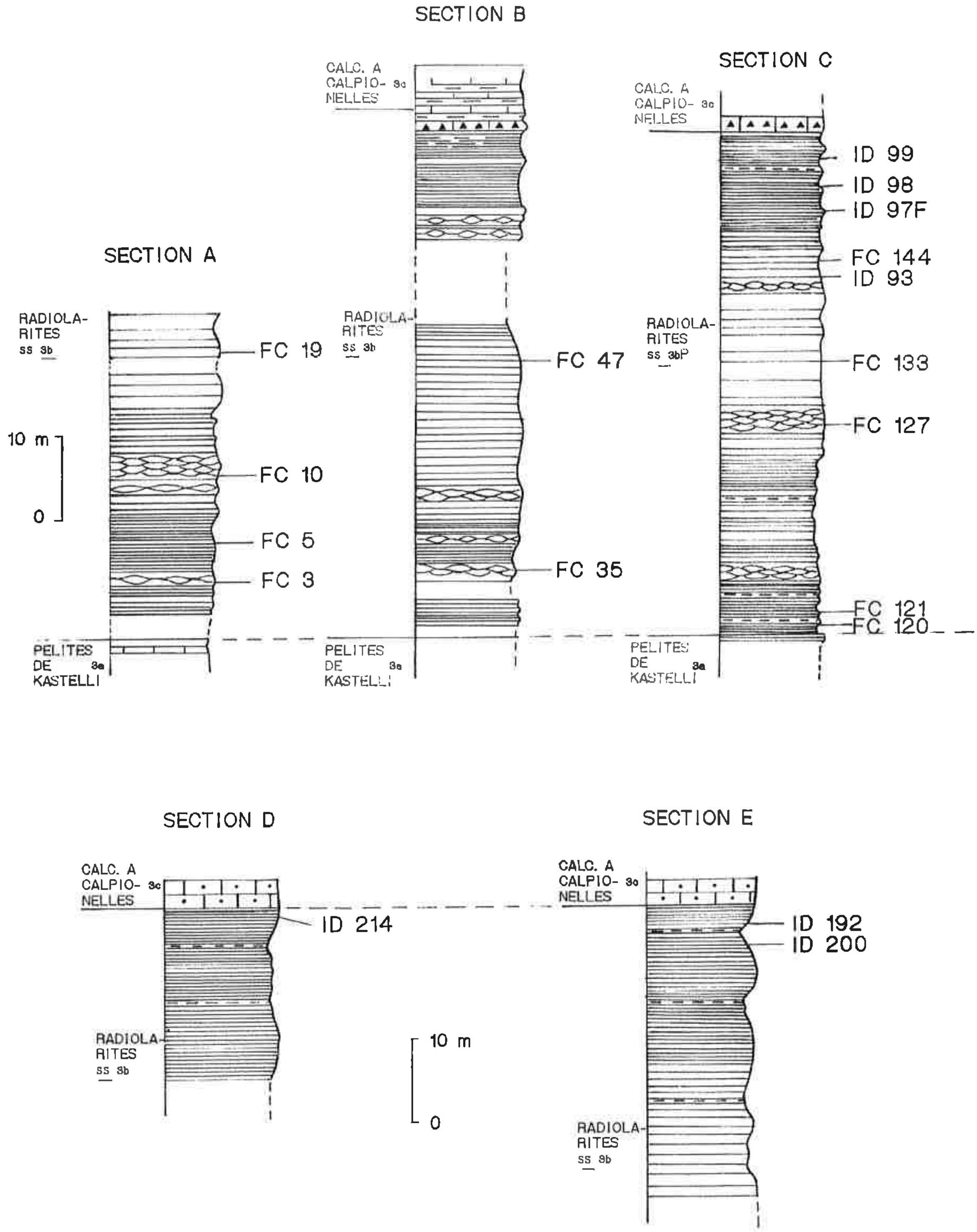


Figure 3 : Position of samples on the lithological column for each section. The general position of each formation name is presented on Fig. 1.

References

De Wever, P. (1982). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

De Wever, P. & Cordey, F. (1986). Datation par les Radiolaires de la Formation des Radiolarites s.s. de la Série du Pinde-Olonos (Grèce): Bajocien (?)-Tithonique. *Marine Micropaleontology*, **11**, 113-127.

De Wever, P. & Origlia-Devos, I. (1982a). Datations nouvelles par les radiolaires de la série des radiolarites S.P. du Pinde-Olonos (Grèce). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **294**, (Série II), 399-404.

De Wever, P. & Origlia-Devos, I. (1982b). Datation par les radiolaires des niveaux siliceux du Lias de la série du Pinde-Olonos (formation de Drimos, Peloponnèse et Grèce continentale). *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **294** (19), 1191-1198.

De Wever, P., Riedel, W.R., Baumgartner, P., Dumitrica, P., Bjørklund, K.R., Caulet, J.P., Drobne, K., Granlund, A. & Kocher, A.R. (1979). Recherches actuelles sur les Radiolaires en Europe. *Annales de la Société Géologique du Nord, Lille*, **96**, 205-222.

Dercourt, J. (1964). Contribution à l'étude géologique d'un secteur du Péloponnèse septentrional. *Annales Géologiques du Pays Helléniques*, **15**, 1-417.

Dercourt, J., Flament, J.M., Fleury, J.J. & Meilliez, F. (1973). Stratigraphie des couches situées sous les Radiolarites de la zone du Pinde-Olonos (Grèce): Le Trias supérieur et le Jurassique inférieur. *Annales géologiques du Pays helléniques*, **25**, 397-406.

Dumitrica, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14**, (1), 45-124.

Fleury, J.J. (1980). Les zones du Gavrovo-Tripolitza et du Pinde-Olonos (Grèce continentale et Péloponnèse du Nord). Evolution d'une plateforme et d'un bassin dans leur cadre alpin. *Société Géologique du Nord, Publication*, **6**, 1-608.

Kishida, Y. & Sugano, K. (1982). Radiolarian zonation of Triassic and Jurassic in outer side of southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 271-300.

Lybéris, N. (1978). *Etude géologique de la partie méridionale des montagnes d'Agrapha (Euritanie, Grèce)*. Ph.D. Thesis. Université Pierre et Marie Curie (Unpublished), Paris.

Pessagno, E.A. & Newport, R.L. (1972). A technique for extracting Radiolaria from radiolarian cherts. *Micropaleontology*, **18** (2), 231-234.

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Thiébault, F., De Wever, P., Fleury, J. & Bassoulet, J.P. (1980). Précisions sur la série stratigraphique de la nappe du Pinde-Olonos de la presqu'île de Koroni (Péloponnèse méridional, Grèce): l'âge des radiolarites (Dogger - Crétacé Supérieur). *Annales de la Société géologique du Nord, Lille*, 91-105.

Yao, A., Matsuoka, A. & Nakatani, T. (1982). Triassic and Jurassic radiolarian assemblages in southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 27-43.

APPENDIX

From a total of 103 samples (selected with field etching), from 5 sections, 19 yielded identifiable radiolarians. The extraction technique (Dumitrica, 1970; Pessagno & Newport, 1972; De Wever *et al.*, 1979; De Wever, 1982) used very dilute Hydrofluoric acid (1-2% for several days),

The following radiolarians were recognized (see Fig. 3 for stratigraphic position of the samples in the different sections). Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION DW9_GRECE_PINDE_OLONOS_COUPE_A: bottom 1 - top 4
< 4 {fc19}: 3110, 3117, 3118, 3215
< 3 {fc10}: 3135, 3197, 3231
< 2 {fc5}: 3041, 3231
< 1 {fc3}: 3231

SECTION DW1O_GRECE_PINDE_OLONOS_COUPE_B: bottom 1 - top 2
< 2 {fc47}: 3117, 3118
< 1 {fc35}: 3231, 3197, 4072

SECTION DW14_GRECE_PINDE_OLONOS_COUPE_C1: bottom 1- top 5
< 5 {fc144}: 3022, 3103, 3122, 3164, 3180
< 4 {id93}: 3008, 3017, 3022, 3078, 3105, 3126, 3163, 3199
< 3 {fc133}: 3123, 3180, 3213, 3215, 3273
< 2 {fc127}: 3006, 3096, 3103, 3197, 3231
< 1 {fc121}: 3115, 3113, 3231

SECTION DW13_GRECE_PINDE_OLONOS_COUPE_C2: bottom 1- top 3
< 3 {id99}: 3036, 3092, 3103, 3104, 3113, 3118, 3121, 3133, 3139, 3161, 3164, 3185, 3230, 3255, 3919, 4069, 5003, 5426
< 2 {id98}: 3020, 3022, 3062, 3066, 3078, 3096, 3100, 3106, 3117, 3118, 3121, 3126, 3137, 3139, 3180, 3230, 3266, 4004, 4069
< 1 {id96}: 3017, 3022, 3023, 3036, 3180, 3185, 4004

SECTION DW11_GRECE_PINDE_OLONOS_COUPE_D: bottom 1 - top 1
< 1 {id214}: 3022, 3036, 3161, 3164, 3171, 3185, 3255, 4069

SECTION DW12_GRECE_PINDE_OLONOS_COUPE_E: bottom 1- top 2
< 2 {id192} : 3017, 3020, 3022, 3066, 3078, 3103, 3113, 3117, 3126, 3199, 3210, 3215, 3255
< 1 {id200}: 3062, 3090, 3117, 3185, 3210, 3255, 3263, 4069

22. Biostratigraphy of Upper Jurassic Radiolarites in the Pieniny Klippen Belt, Carpathians

by Krzysztof Birkenmajer and Daniel Widz

Institute of Geological Sciences, Polish Academy of Sciences, Senacka 1, 31002 Krakow, Poland

ABSTRACT

Jurassic radiolarites from the Pieniny Klippen Belt of Poland, yielded determinable radiolarians indicating mainly Oxfordian, or Upper Oxfordian-Kimmeridgian ages of the radiolarite complex in the Klippen successions. Oxfordian to Kimmeridgian ages were established by radiolarians obtained from the radiolarite complex in the Grajcarek Unit (Magura Succession).

1. Geological setting

The Pieniny Klippen Belt in the Carpathians is some 600 km long, but only a few hundred metres to about 20 km wide (Fig. 1). This is one of the most complex structural units of the Carpathian Foldbelt, strongly deformed as a result of Late Cretaceous to Early Palaeogene nappe thrusting, and Late Palaeogene to Miocene compressional and transpressional movements. As a result of these deformations, the Pieniny Klippen Belt is a heterogeneous unit. It consists of: (1) the Klippen Successions proper deposited in the Pieniny Klippen Basin (Triassic to Cretaceous), and their sedimentary cover (Upper Cretaceous and Palaeogene); (2) Inner Carpathian tectonic units (Jurassic-Lower Cretaceous) and their sedimentary cover (Upper Cretaceous and Palaeogene), deposited in the Magura Basin, and its Palaeogene sedimentary cover (Birkenmajer *et al.*, 1985, 1986, 1988).

2. Jurassic radiolarite complexes

The Jurassic radiolarite complexes occur in all three groups listed above, being best developed in the deepest part of the original Pieniny Klippen Basin, and in the southern part of the Magura Basin: the Grajcarek Unit (Figs. 2, 3). In the Klippen Basin, the radiolarites are thickest in the Pieniny Succession which originally occupied a near-central position, thinning out to the south (Haligovce Succession), and to the north (Branisko-, Niedzica-, and Czertezik successions). No radiolarites were formed in the Czorsztyn Succession which was deposited on a submarine ridge separating the Klippen Basin from the Magura Basin. The radiolarites reappear in the latter basin.

The succession of radiolarites in the deepest parts of the basin starts with greenish-grey spotty lithologies (Sokolica Radiolarite Formation), passing upward into green and red radiolarite units (Czajakowa Radiolarite Formation). A symmetric arrangement in the sequence of the latter formation is expressed in the Niedzica Succession, with lower red radiolarites (Kamionka Radiolarite Member), and upper red radiolarites (Buwald Radiolarite Member) marking a gradual subsidence of the basin down to about CCD (green radiolarites), followed by shallowing (Fig. 3).

3. Litho- and biostratigraphy of radiolarites

The lithostratigraphy and biostratigraphy of the radiolarite complex in the Pieniny Klippen Belt of Poland have been the subjects of many studies to date (Birkenmajer 1953, 1958, 1960, 1963; Birkenmajer & Gasiorowski, 1960, 1961; Gasiorowski, 1959, 1962). Formal lithostratigraphic units were introduced by Birkenmajer (1977), and correlation of *Aptychus* zonation with standard ammonite zones was proposed by Gasiorowski (1959) and modified by Durand Delga & Gasiorowski (1970). The age of the Sokolica Radiolarite Formation was established indirectly as Upper Bajocian?-Callovian (and Lower Oxfordian?), based on fossils found in underlying and overlying strata; that of the Czajakowa Radiolarite Formation (both indirectly and directly, based on *Aptychus* faunas, as mainly Upper Oxfordian, sometimes Upper Oxfordian-Lower Kimmeridgian). Geometric relationships between radiolarite formations and members, and their relation to underlying and overlying strata are shown in Fig. 4.

4. Upper Jurassic radiolarian database

Forty three samples of radiolarites have been analysed which were collected from four field sections in the Pieniny Klippen Belt: Czajakowa Skala section (4 samples); Podmajerz section (5 samples); Szaflary section (21 samples); and Szczawnica Wyzna section (13 samples), yielded determinable siliceous radiolarians. The collection

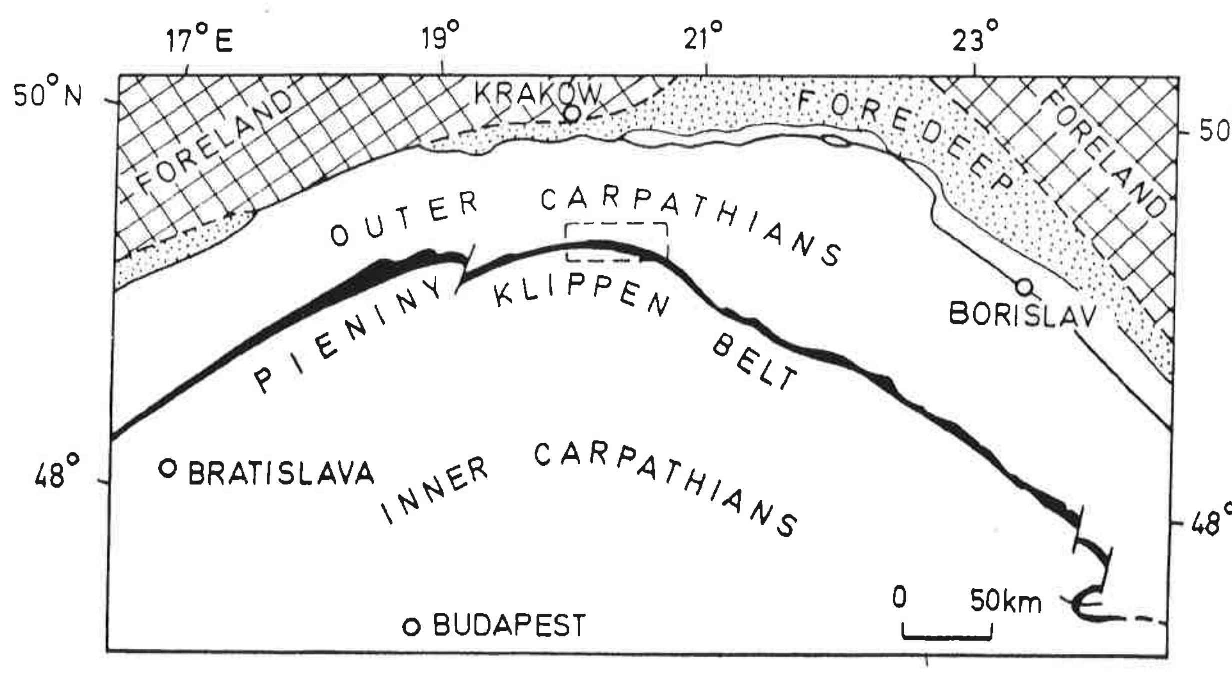


Figure 1. Location of the sampled radiolarite sequences in the Pieniny Klippen Belt of Poland (B) against simplified geological structure of the Carpathians.

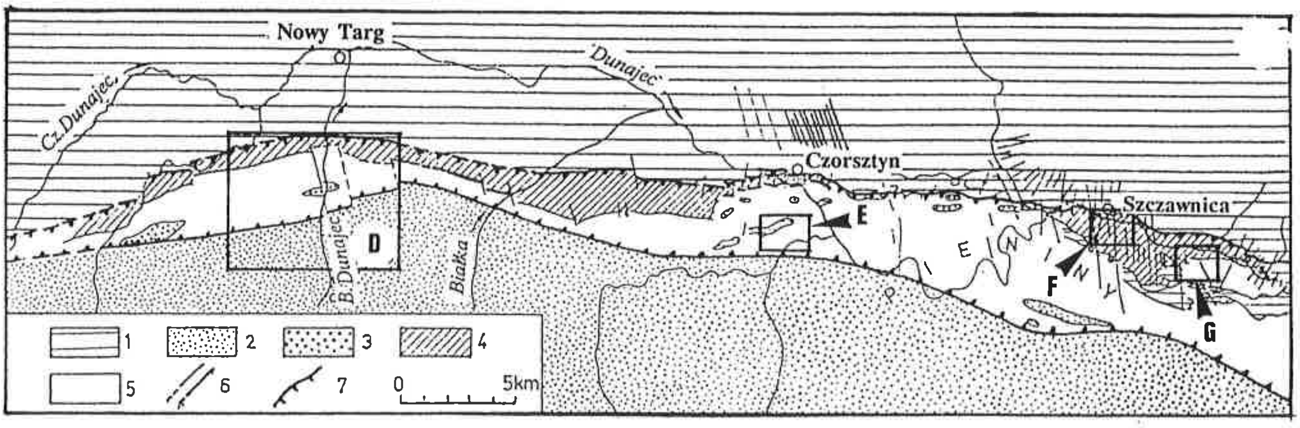


Figure 2. Geological sketch-map of the Polish sector of the Belt showing location of studied section **D.** Szaflary, **E.** Podmajerz, **F.** Szczawnika Wyzna, **G.** Czajakowc Skala. **1.** Magura Palaeogene; **2.** Odhale Palaeogene; **3.** Upper Cretaceous mantle in the Klippen Belt; **4.** Grajcarek Unit (Magura Succession); **5.** Jurassic-Cretaceous (locally also Triassic) elements of the Klippen successions; **6.** selected Tertiary faults; **7.** boundary overthrusts.

was initially evaluated micropalaeontologically and stratigraphically by Widz (1991). A re-examination of the samples, yielded a list of 58 radiolarian species identifiable with those presented in the Catalogue of Jurassic and Cretaceous Radiolaria *(Chapter* 4). Local range charts of particular species are shown in Fig. 4. (see also Appendix). The location of field sections sampled is given in Figure 2. Age of samples was correlated to the UAZones established in the *Chapter* 32.

5. Listing of localities included in the database

5.1. Czajakowa Skala

Skala section (Fig. 5), Niedzica Succession, Pieniny Klippen Belt, West Carpathians, Poland: 1.

References.-
Birkenmajer (1958; 1977, fig. 7A, loc. 24C; 1979, excursion 19, loc. 131); Gasiorowski (1962, p. 113, loc. 111); Birkenmajer & Myczynski (1984); Widz (1991, loc. 3).
Lithology and sample location.-
Birkenmajer (1958; 1977, fig. 7A, loc. 24C; 1979, excursion 19, loc. 131); Widz (1991, loc. 3).
Biostratigraphy.-
Gasiorowski (1962, p. 113, loc. 111); Birkenmajer & Myczynski (1984); Widz (1991, loc. 3).
Radiolarian data.-
Widz (1991): Kamionka Radiolarite Member (Czajakowa Radiolarite Formation):Sample 2/15: UAZ. 8-9, middle Callovian-early Oxfordian to middle-late Oxfordian.
Samples 2/11, 2/9-10, 2/2: UAZ. 8-10, middle Callovian-early Oxfordian to late Oxfordian-early Kimmeridgian.

5.2. Podmajerz

Podmajerz section (Fig. 6), Niedzica Succession, Pieniny Klippen Belt, West Carpathians.

References.-
Birkenmajer & Znosko (1955); Birkenmajer (1958; 1977, fig. 7K, loc. 24A; 1979, excursion 11, loc. 72); Gasiorowski (1962, p. 114, loc. 28); Birkenmajer & Myczynski (1984); Widz (1991, loc. 2).
Lithology and sample location.-
Birkenmajer & Znosko (1955); Birkenmajer (1958; 1977, fig. 7K, loc. 24A; 1979, excursion 11, loc. 72); Widz (1991, loc. 2).
Biostratigraphy.-
Birkenmajer & Znosko (1955); Birkenmajer & Myczynski (1984); Widz (1991).
Radiolarian data.-
Widz (1991): a) Podmajerz Radiolarite Member (Czajakowa Radiolarite Formation):
Sample 1/34:UAZ. 8-11, middle Callovian-early Oxfordian to late Kimmeridgian-early Tithonian.
Samples 1/37, 1/57: UAZ. 9-10, middle-late Oxfordian to late Oxfordian-early Kimmeridgian.
Samples 1/39-40, 1/45: UAZ. 9-11, middle-late Oxfordian to late Kimmeridgian-early Tithonian.

5.3. Szaflary

Szaflary section (Fig. 7), large radiolarite olistolith from the Branisko Succession in the Upper Cretaceous Jarmuta

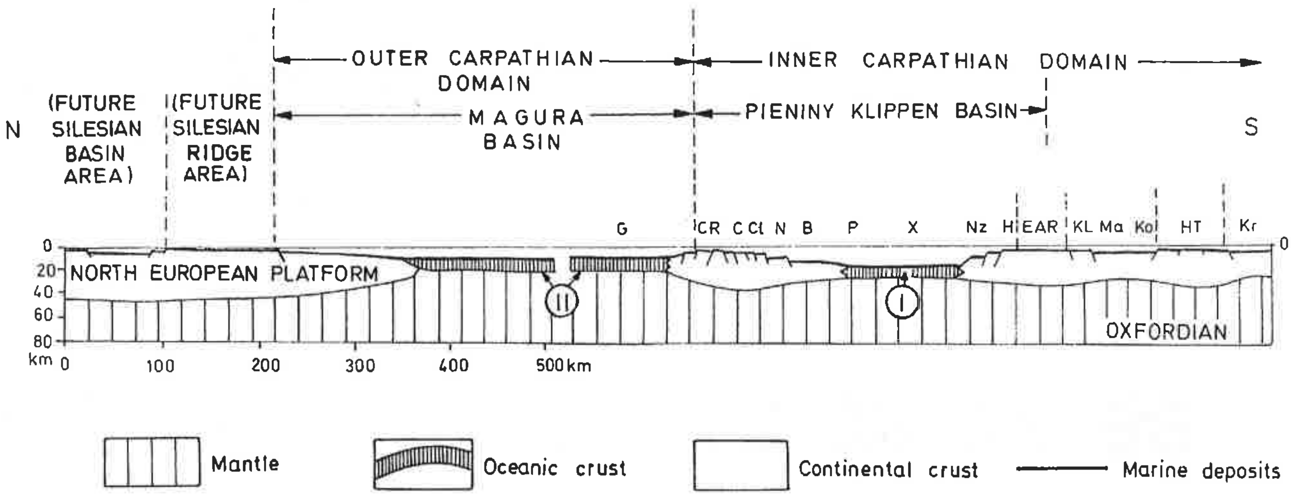


Figure 3. Palinspastic reconstruction of Outer and Central West Carpathian basins during Oxfordian (after Birkenmajer, 1988). **I.** Triassic oceanic crust in the Pieniny Klippen Basin ; **II.** Lower Jurassic oceanic crust in the Magura Basin; **G.** Grajcarek Succession; **CR.** Czorsztyn Ridge; **C.** Czorsztyn Succession; **Ct.** Czertezik Succession; **N.** Niedzica Succession; **B.** Branisko Succession; **P.** Pieniny Succession; **X.** Hypothetical Ultra-Pieniny Succession; **Nz.** Nizna Succession; **H.** Haligovce Succession; **EAR.** Exotic Andrusov Ridge; **KL.** Klape Succession; **Ma.** Manin Succession; **Ko.** Kostelec Succession; **HT.** Hightatric Succession; **Kr.** Krizna Succession.

Formation, Pieniny Klippen Belt, West Carpathians.

References.-
Birkenmajer (1958; 1977, fig. 7R, loc. 40A; 1979, excursion 3, loc. 15); Gasiorowski (1962, p. 113, loc. 4); Widz (1991, loc. 1).
Lithology and sample location.-
Birkenmajer (1958; 1977, fig. 7R, loc. 40A; 1979, excursion 3, loc. 15); Widz (1991, loc. 1).
Biostratigraphy.-
Gasiorowski (1962, p. 113, loc. 4); Widz (1991).

Radiolarian data.-
Widz (1991): Czajakowa Radiolarite Formation: Samples 4/71-4/79 : UAZ. 8-11, middle Callovian-early Oxfordian to late Kimmeridgian-early Tithonian.
Samples 4/3-4/69: UAZ. 9-10, middle-late Oxf. to late Oxf.-early Kimm
Sample 4/1: UAZ. 9-9, middle-late Oxf. to middle-late Oxf.

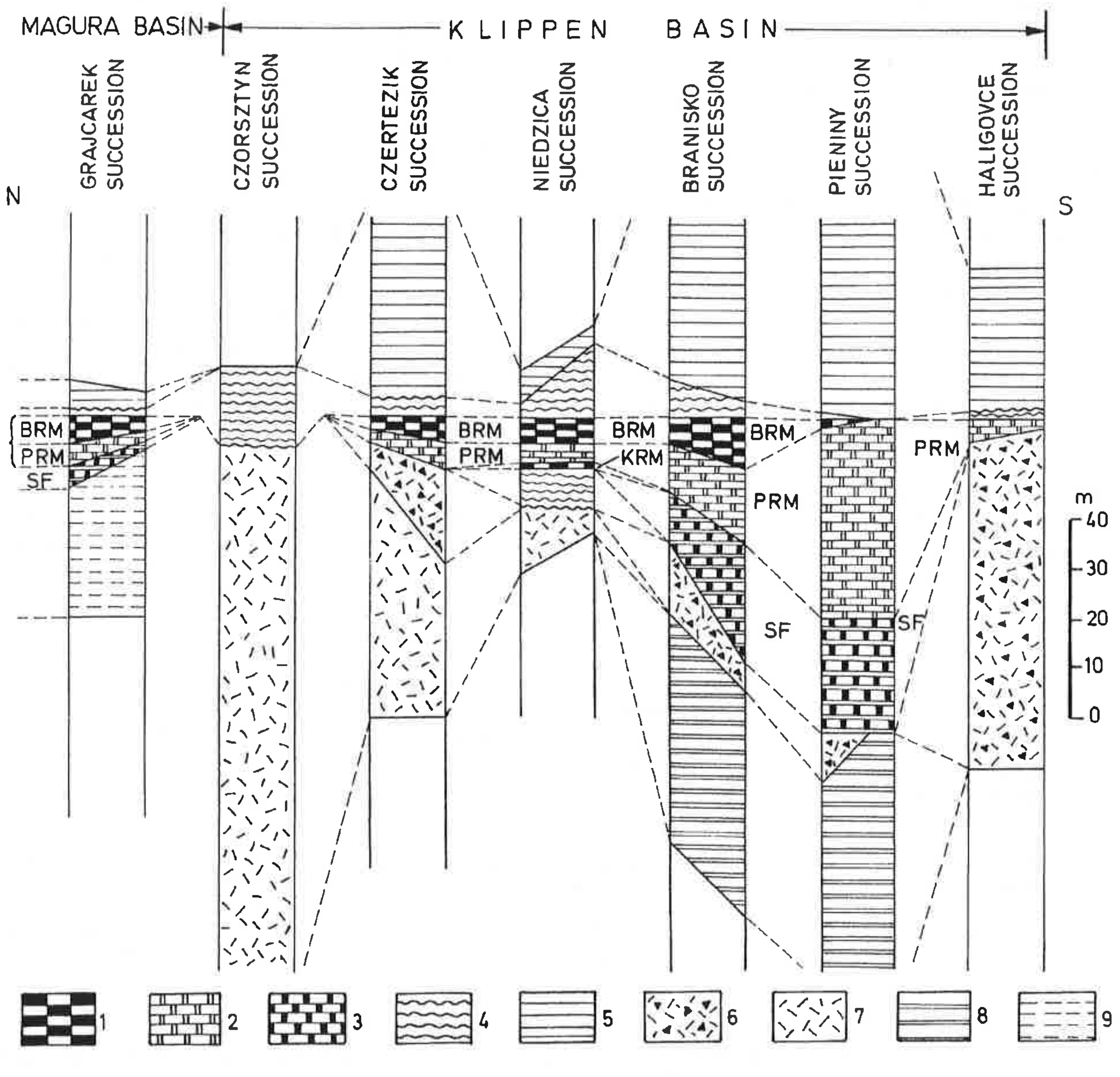


Figure 4. Lithostratigraphic correlation of Jurassic radiolarite complex between the Pieniny Klippen Belt Basin and the Magura Basin. **1-3.** Radiolarite complex (**1.** Spotty manganese radiolarites; **2.** Green radiolarites; **3.** Red radiolarites); **4.** Red nodular limestones *(ammonitico rosso* facies); **5.** Cherty limestone *(biancone* or *majolica* facies); **6.** Grey crinoid limestone with cherts; **7.** White and red crinoid limestones; **8.** Dark spotty limestones and marls; **9.** Dark shales. Radiolarite complex: SF Sokolica Radiolarite Formation; Czajakowa Radiolarite Formation: KRM. Kamionka Radiolarite Member; PRM. Podmajerz Radiolarite Member; BRM. Buwald Radiolarite Member (lithostratigraphic data from Birkenmajer, 1977).

5.4. Szczawnica Wyzna

Szczawnica Wyzna section (fig. 8), Grajcarek Unit (Succession), Pieniny Klippen Belt, West Carpathians.

References.-
Gasiorowski (1962, p. 117, loc. 80); Nowak (1971); Birkenmajer (1977, fig. 7E, loc. 26B; 1979, excursion 18, loc. 118); Obermajer (1986a, b); Birkenmajer & Dudziak (1987); Widz (1991, loc. 4; 1992).

Lithology and sample location.-
Birkenmajer (1977, fig. 7E, loc. 26B; 1979, excursion 18, loc. 118); Birkenmajer & Dudziak (1987); Widz (1991, loc. 4).

Biostratigraphy.-
Gasiorowski (1962, p. 117, loc. 80); Nowak (1971); Obermajer (1986a, b); Birkenmajer & Dudziak (1987); Widz (1991, loc. 4).

Radiolarian data.-
Widz (1991): a) Sokolica Radiolarite Formation: Samples 3/47-3/43:UAZ. 8-10, middle Callovian-early Oxfordian to late Oxfordian-early Kimmeridgian.
Samples 3/47-3/21-23: UAZ. 8-10, middle Callovian-early Oxfordian to late Oxfordian-early Kimmeridgian.

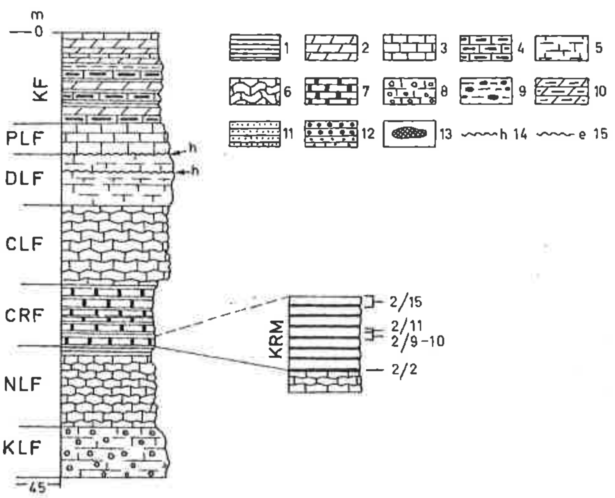


Figure 5. Location of sampled section of the Czajakowa Radiolarite Formation, Niedzica Succession at Czajakowa Skala (lithostratigraphy after Birkenmajer, 1977). Abbreviations: **KMF.** Krempachy Marl Fm.; **SSF.** Skrzypny Shale Fm.; **SLF.** Smolegowa Limestone Fm.; **KLF.** Krupianka Limestone Fm.; **NLF.** Niedzica Limestone Fm.; **CRF.** Czajakowa Radiolarite Fm.; **CLF.** Czorsztyn Limestone Fm.; **DLF.** Dursztyn Limestone Fm.; **PLF.** Pieniny Limestone Fm.; **KF.** Kapusnica Fm.

1. Shales, marly shales; **2.** Marls; **3.** Limestones; **4.** Cherty limestones; **5.** Massive limestones; **6.** Nodular limestones; **7.** Radiolarites; **8.** Crinoid limestones; **9.** Shales with spherosiderites; **10.** Marly limestones; **11.** Sandstones; **12.** conglomerates; **13.** Olistoliths; **14.** Sedimentary hiatus; **15.** Erosional unconformity.

Sample 3/11-13:UAZ. 9 - 11-13, middle-late Oxfordian to late Kimmeridgian-early Tithonian.

References

Birkenmajer, K. (1953). Preliminary revision of the stratigraphy of the Pieniny Klippen Belt series in Poland. *Bulletin de l'Academie Polonaise des Sciences, Classe III*, **1** (6), 271-274.

Birkenmajer, K. (1958). Pieniny Klippen Belt of Poland. Geological guide. *Wydawnictwa Geologiczne, Warszawa.*, 1-4. (*in Polish*)

Birkenmajer, K. (1960). Geology of the Pieniny Klippen Belt of Poland (A review of latest researches). *Jahrbuch der Geologischen Bundesanstalt. Wien*, **103** (1), 1-36.

Birkenmajer, K. (1963). Esquisse de la stratigraphie du Mésozoïque et du Paléogène dans la Zone des Klippes Pienines en Pologne. *Instytut Geologiczny (Warszawa), Biuletyn*, **182**, 207-223.

Birkenmajer, K. (1977). Jurassic and Cretaceous lithostratigraphic units of the Pieniny Klippen Belt, Carpathians, Poland. *Studia Geologica Polonica*, **45**, 1-159.

Birkenmajer, K. (1979). Pieniny Klippen Belt of Poland. Geological guide. *Wydawnictwa Geologiczne, Warszawa.* (*in Polish*)

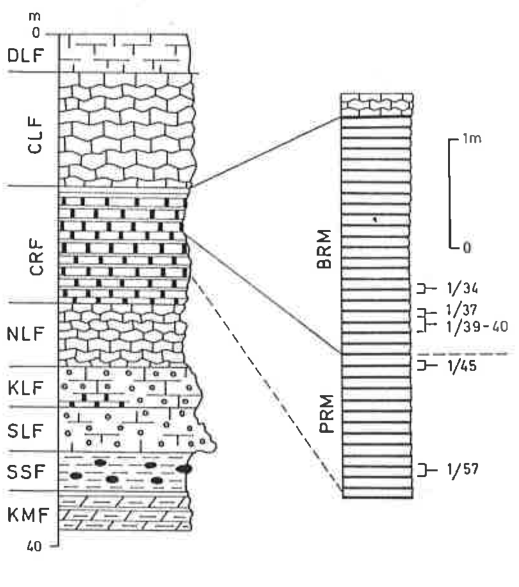


Figure 6. Location of sampled section of the Czajakowa Radiolarite Formation, Niedzica Succession, at Podmajerz (lithostratigraphy after Birkenmajer, 1977). For explanations see Fig. 5.

BIRKENMAJER, K. (1986). Stages of structural evolution of the Pieniny Klippen Belt, Carpathians. *Studia Geologica Polonica*, **88**, 7-32.

BIRKENMAJER, K. (1988). Exotic Andrusov Ridge: its role inplate-tectonic evolution of the West Carpathian Foldbelt. *Studia Geologica Polonica*, **91**, 7-37.

BIRKENMAJER, K. & DUDZIAK, J. (1987). Age of the Wronine Formation (Albian) of the Grajcarek Unit in the Pieniny Klippen Belt, Carpathians, based on calcareous nannoplankton. *Studia Geologica Polonica*, **92**, 87-106.

BIRKENMAJER, K., *et al.* EDS. (1985). *Main geotraverse of the Polish Carpathians (Cracow-Zakopane). Guide to Excursion 2, XIIIth Congress of the Carpatho-Balkan Geological Association*, Cracow, Poland. 188 p.

BIRKENMAJER, K. & GASIOROWSKI, S.M. (1960). Stratigraphy of the Malm of the Niedzica and Branisko Series (Pieniny Klippen Belt, Carpathians), based on Aptychi. *Bulletin de l'Academie Polonaise des Sciences, Classe III*, **8** (2), 137-143.

BIRKENMAJER, K. & GASIOROWSKI, S.M. (1961). Sedimentary character of radiolarites in the Pieniny Klippen Belt, Carpathians. *Bulletin de l'Academie polonaise des Sciences, Classe III*, **9** (3), 175-180.

BIRKENMAJER, K. & MYCZYNSKI, R. (1984). Fauna and age of Jurassic nodular limestones near Niedzica and Jaworki (Pieniny Klippen Belt, Carpathians, Poland). *Studia Geologica Polonica*, **83**, 7-24.

BIRKENMAJER, K. & ZNOSKO, J. (1955). Contribution to the stratigraphy of the Dogger and Malm in the Pieniny Klippen Belt, Central Carpathians. *Annales Societatis Geologorum Poloniae*, **23**, 3-36.

DURAND-DELGA, M. & GASIOROWSKI, S.M. (1970). Les niveaux à Aptychus dans les pays autour de la Méditerranée occidentale et dans les Carpathes. *Comptes Rendus de l'Académie des Sciences de Paris, Série II*, **270**, 767-770.

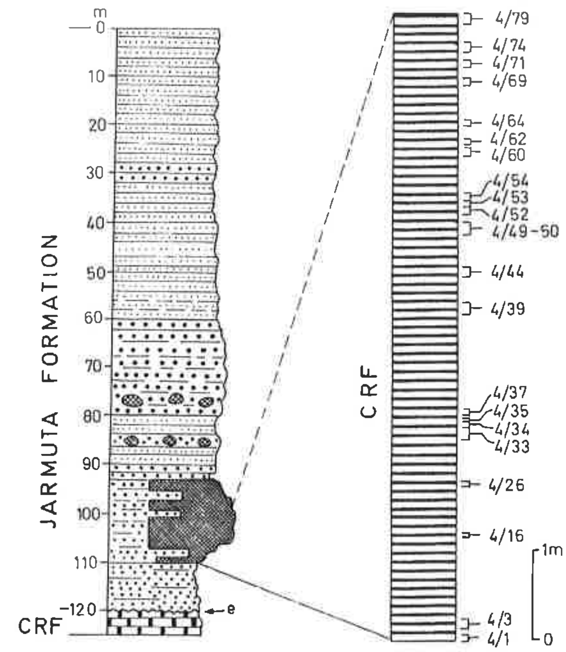


Figure 7. Location of sampled section of the Czajakowa Radiolarite Formation occurring as olistolith of the Branisko Succession at Szaflary (lithostratigraphic column after Birkenmajer, 1977, 1986). For explanations see Fig. 5.

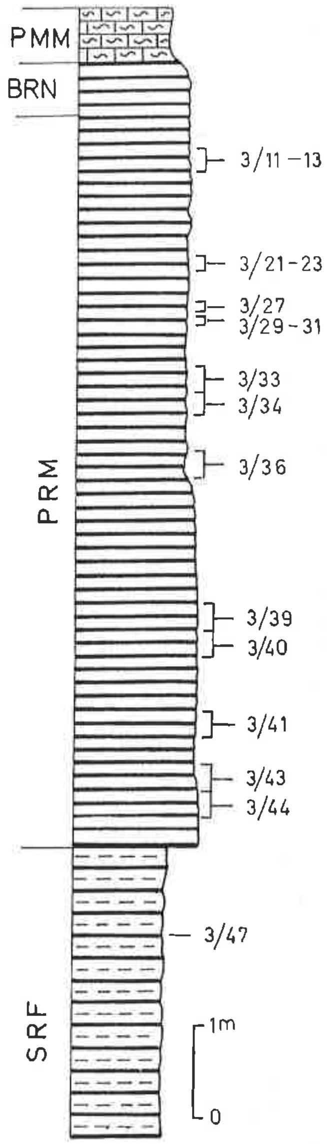


Figure 8. Sampled section of the Sokolica Radiolarite Formation and the Czajakowa Radiolarite Formation, Grajcarek Succession at Szczawnica Wyzna.

GASIOROWSKI, S.M. (1959). Succession of Aptychi faunas in the Western Tethys during the Bajocian-Barremian time. *Bulletin de l'Academie Polonaise des Sciences, Classe III*, **7** (9), 715-722.

GASIOROWSKI, S.M. (1962). Aptychi from the Dogger, Malm and Neocomian in the Western Carpathians and their stratigraphical value. *Studia Geologica Polonica*, **10**, 1-151.

NOWAK, W. (1971). Results of microfacies studies in the Szczawnica Zabaniszcze section, Pieniny Klippen Belt of Poland. Guidebook of the 43 Meeting of the Geological Society of Poland, 12-14 Sept. 1971. *Geological Survey of Poland, Warszawa*, 225-232. *(in Polish)*

OBERMAJER, M. (1986a). Grajcarek Valley: microfacies and age of the Pieniny Limestone Formation. *In* Birkenmajer, K. & Poprawa, D. Eds. *Guidebook of the 57 Meeting of the Geological Society of Poland, 18-20 Sept. 1986*, Kraków. (147-149). *(in Polish)*

OBERMAJER, M. (1986b). Microfacies and age of the Pieniny Limestone Formation (Tithonian - Barremian) of the Grajcarek Unit, eastern part of the Pieniny Klippen Belt, Carpathians. *Przeglad Geologiczny*, **6**, 317-323.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80,** (3) 317-340.

WIDZ, D. (1991). Les Radiolaires du Jurassique supérieur des radiolarites de la zone des Klippes de Pieniny (Carpathes occidentales, Pologne). *Revue de Micropaléontologie*, **34**, (3), 231-260.

WIDZ, D. (1992). Datation par les radiolaires des radiolarites jurassiques de l'Unité de Grajcarek (Zone des Klippes de Pieniny, Carpathes occidentales, Pologne). *Bulletin of the Polish Academy of Sciences, Earth sciences*, **40**, (2), 115-124.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION:1_CZ.SKALA: bottom 1 - Top 4
< 4: {2/15} 3083, 3088, 3263, 3224, 3216, 3215, 3180, 3205, 3230, 3174, 3241, 3122, 3121, 3117, 3113
< 3: {2/11} 3090, 3083, 3088, 3263, 3224, 3216, 3215, 3103, 3181, 3180, 3185, 3230, 3241, 3122, 3121, 3117, 3113, 3119
< 2: {2/9-10} 3083, 3088, 3263, 3224, 3216, 3215, 3103, 3181, 3180, 3230, 3241, 3122, 3121, 3117, 3113, 3119
< 1: {2/2} 3083, 3088, 3009, 3263, 3224, 3215, 3181, 3406, 3169, 3230, 3241, 3121, 3117, 3113

SECTION:2_PODMAJ: bottom 1 - Top 5
< 5: {1/34} 3088, 3216, 3215, 3230
< 4: {1/37} 3083, 3088, 3009, 3216, 3215, 3406, 3230, 3171
< 3: {1/39-40} 3083, 3088, 3224, 3216, 3215, 3406, 3230, 3171
< 2: {1/45} 3083, 3088, 3224, 3216, 3215, 3406, 3230, 3171, 3241, 3022, 3113
< 1: {1/57} 3090, 3263, 3193, 3131, 3224, 3210, 3216, 4018, 3406, 3204, 3205, 3230, 3117, 3119

SECTION:3_SZAFL: bottom 1 - Top 21
< 21: {4/79} 3224, 3181, 3113
< 20: {4/74} 3225, 3224, 3181, 3406, 3230, 3113, 3259
< 19: {4/71} 3193, 3225, 3224, 3181, 3406, 3230, 3241, 3113
< 18: {4/69} 3009, 3147, 3193, 3225, 3224, 3111, 3103, 3181, 3406, 3139, 3133, 3185, 3169, 3230, 3241, 3122, 3121, 3117, 3113
< 17: {4/64} 3088, 3009, 3147, 3193, 3131, 3225, 3224, 3215, 3017, 3111, 3103, 3181, 3406, 3204, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3122, 3121,-3117, 3113, 3119
< 16: {4/62} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3215, 3017, 3111, 3103, 3181, 3406, 3204, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3122, 3121, 3117, 3113, 3119
< 15: {4/60} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3022, 3218, 3123, 3122, 3121, 3117, 3113, 3119
< 14: {4/54} 3088, 3009, 3147, 3263, 3193, 3131, 3225,

3224, 3210, 3215, 3017, 3111, 3103, 3181, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3022, 3218, 3122, 3121, 3117, 3113, 3119

< 13: {4/53} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3022, 3218, 3122, 3121, 3117, 3113, 3119

< 12: {4/52} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3180, 3406, 3204, 3140,3139, 3138, 3133, 3185, 3245, 3169, 3230, 3241, 3022, 3218, 3122, 3121, 31i7, 3113, 3119

< 11: {4/49-50} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3241, 3022, 3199, 3218, 3122, 3121, 3117, 3113, 3119

< 0: {4/44} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3122, 3121, 3117, 3113, 3119

< 9: {4/39} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3215, 3017, 3111, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3122, 3121, 3117, 3113, 3119

< 8: {4/37} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3216, 3215, 3017, 3111, 3076, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3121, 3117, 3113, 3119

< 7: {4/35} 3088, 3009, 3147, 3263, 3193, 3131, 3225, 3224, 3210, 3216, 321S, 3017, 3111, 3076, 3103, 3181, 3180, 3406, 3204, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3121, 3117, 3113, 3119

< 6: {4/34} 3088, 3009, 3147, 3263, 3223, 3193, 3131, 3225, 3224, 3210, 3216, 3215, 3017, 3111, 3076, 3103, 3181, 3180, 3406, 3204, 3205, 3140, 3139, 3138, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3121, 3117, 3113, 3119

< 5: {4/33} 3088, 3009, 3147, 3263, 3223, 3193, 3131, 3224, 3210,3216, 3215, 3017, 3111, 3076, 3103, 3181, 3180, 3406, 3204, 3205, 3140, 3139, 3133, 3185, 3169, 3230, 3022, 3199, 3218, 3121, 3117, 3113, 3119

< 4: {4/26} 3090, 3088, 3009, 3147, 3263, 3223, 3193, 3131, 3224, 3210, 3216, 3215, 3017, 3111, 3076, 3103, 3104, 3181, 3180, 3406, 3204, 3205, 3135, 3140, 3139, 3133, 3185, 3169, 3126, 3022, 3199, 3218, 3121, 3117, 3113, 3119

< 3: {4/16} 3088, 3009, 3263, 3193, 3131, 3224, 3210, 3111, 3103, 3181, 3180, 3406, 3185, 3218, 3121, 3113, 3119

< 2: {4/3} 3088, 3009, 3193, 3131, 3224, 3111, 3103, 3181, 3180, 3406, 3185, 3218, 3121, 3113, 3119

< 1: {4/1} 3083, 3088, 3009, 3193, 3131, 3224, 3111, 3103, 3181, 3180, 3406, 3185, 3163, 3218, 3121, 3113, 3119, 3069

SECTION:4_SZCZWYZ: bottom 1 - Top 13

< 13: {3/11-13} 3083, 3263, 3193, 3216, 3406, 3185, 3171, 3170, 3094

< 12: {3/21-23} 3083, 3145, 3263, 3193, 3224, 3216, 3215, 3111, 3108, 3406, 3185, 3171, 3177, 3170, 3094

< 11: {3/27} 3092, 3083, 3145, 3263, 3193, 3224, 3216, 3215, 3112, 3111, 3108, 3406, 3185, 3171, 3177, 3199, 3170, 3122, 3094

< 10: {3/29-31} 3145, 3263, 3193, 3224, 3216, 3215, 3112, 3111, 3108, 3406, 3185, 3171, 3177, 3170, 3122, 3094

< 9: {3/33} 3145, 3263, 3193, 3224, 3216, 3215, 4018, 3112, 3111, 3108, 3180, 3406, 3185, 3171, 3177, 3170, 3122

< 8: {3r/34} 3145, 3263, 3193, 3224, 3216, 4018, 3017, 3108, 3180, 3406, 3185, 3171, 3177, 3170, 3122

< 7: {3/36} 3145, 3263, 3193, 3224, 3216, 3108, 3180, 3406, 3185, 3171, 3241, 3170, 3122

< 6: {3/39} 3145, 3263, 3193, 3224, 3180, 3406, 3185, 3230 , 3171, 3241, 3122

< 5: {3/40} 3009, 3145, 3263, 3193, 3224, 3180, 3406, 3185, 3230, 3241, 3122, 3113

< 4: {3/41} 3090, 3088, 3009, 3I45, 3263, 3193, 3224, 4017, 3103, 3181, 3180, 3406, 3140, 3185, 3230, 3241, 3122, 3121, 3113, 3119, 3069

< 3: {3/43} 3088, 3009, 3263, 3193, 3224, 3103, 3181, 3180, 3230, 3241, 3122, 3I21, 3113, 3119, 3069

< 2: {3/44} 3088, 3009, 3263, 3193, 3224, 3.103, 3181, 3180, 3122, 3117, 3113, 3119

< 1: {3/47} 3224, 3103, 3180, 3169, 3113

23. Upper Jurassic and Lower Cretaceous Radiolarians at Svinita (Romania)

by Paulian Dumitrica

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
Mailing address: Könizstrasse 39, 3008 Bern, Switzerland

ABSTRACT

At a locality in Svinita which is on the eastern side of the Danube River at the western end of the South Carpathians, moderately to well-preserved radiolarian faunas occur at two stratigraphic levels. The older assemblage is Upper Oxfordian-lowermost Kimmeridgian in age and occurs in the Jasper beds or Cherty limestones. The younger fauna occurs in the Murgucěva Formation in the Upper Berriasian-Middle Hauterivian interval, and is represented by both silicified and pyritized tests. Both assemblages are studied and their biostratigraphic value discussed.

1. Geographical and geological framework

Situated on the left side of the Danube Valley, at a distance of about 45 km upstream from the town of Orsova (Fig. 1), is the village of Svinita which has been known in the paleontological literature since the middle of the last century (Raileanu, 1953) due to its rich Jurassic and Lower Cretaceous fossil faunas. Geologically, the deposits at Svinita are part of the so-called Sirinia Zone (Codarcea, 1940), the Svinita-Fata Mare Zone (Raileanu, 1953, 1960), or the Svinita Sillon of the Danubian autochthone of South Carpathians (Pop, 1973). In recent years, after the synthesis by Raileanu (l. cit.), more detailed stratigraphic and paleontological investigations of the Upper Jurassic and Lower Cretaceous deposits from Svinita have been undertaken by Rusu (1970), Avram (1976), Antonescu & Avram (1980), Melinte (1992) and by others.

According to Raileanu (loc. cit.) who published the only geological synthesis of this zone of the South Carpathians the Jurassic overlies transgressively the Permian and the crystalline basement and comprises all its three subdivisions. With the Liasic transgression a second sedimentary cycle stared in this region, a cycle that lasted until the Lower Albian.

The Liassic deposition is represented in the Gresten facies by conglomerates, sandstones and coal-bearing sediments in the lower part, and neritic calcareous sandstones with *Gryphea* and large pectens in the upper part.

The Middle Jurassic is represented by grey spathic limestones (Bajocian), cherry-coloured spathic limestones (Lower Bathonian) and, in the upper part, by a bank, some 40 cm thick, of ferruginous oolithic limestone with a very rich condensed ammonite fauna (Raileanu, l. cit.). This bank, considered an equivalent of the Klaus Beds, comprises the upper Bathonian, the lower Callovian (*Macrocephalus* Zone) and the middle Callovian (the equivalent of the *Anceps* Zone) (Raileanu & Nastaseanu, 1960).

The Upper Jurassic is well represented at Svinita, and comprises, from bottom to top, the following lithostratigraphic units:

a) *Lower nodular limestones* (5-10 m). The formation consists of red nodular micrites and biomicrites with nodular cherts and bioclasts of planktonic organisms (calcified radiolarians, globigerinids, calcispheres, filamentous bivalves, etc.) (Gr. Pop, pers. comm.). This member was considered to represent the upper Callovian (Raileanu & Nastaseanu, 1960) or the upper Callovian and the lower part of the Oxfordian (Raileanu, 1953) on the basis of the few ammonite species encountered: *Sowerbiceras tortisulcatum* (D'ORBIGNY), *Calliphylloceras zignodianum* (D'ORBIGNY), *Ptychophylloceras feddeni* (WAAGEN), *Macrocephalites macrocephalus canizzaroi* (GEMMELLARO) and *Hibolites hastatus* BLAINVILE. Recent microfacies studies at Svinita (Gr. Pop, pers. comm.) show that in the upper third of this member *Colomisphaera fibriata* (NAGY) makes its first appearance. This microfossil has previously been recovered in late lower Oxfordian and younger sediments and especially in the upper Oxfordian, where it marks the "*Fibriata* Zone" (Nagy, 1966; Borza & Michalik, 1986). If these data are correct and can be applied at Svinita then the upper part of this member comprises also the lower part, and probably also a part of the Middle Oxfordian, as Raileanu (loc. cit.) had already suggested.

b) *Cherty limestones* (*Jasper Beds* of Raileanu, 1953) (about 15 m thick). The formation consists of typically basinal micrites and biomicrites with repeated intercalations of allodapic calcirudites and calcarenites (turbidites Ta-c, Tbc, Tc), usually 5-10 cm thick. The allodapic limestones render a character of calcareous flysch to this member and are partly or totally silicified, forming beds or lenses of chert (Gr. Pop, pers. comm.). Macrofauna of this formation is very poor, a single ammonite species - *Calliphylloceras manfredi* (OPPEL) being identified. According to Raileanu & Nastaseanu (1960) this species was cited by Neumayr (1871) in the *Cordatum* and *Transversarium* Zones from

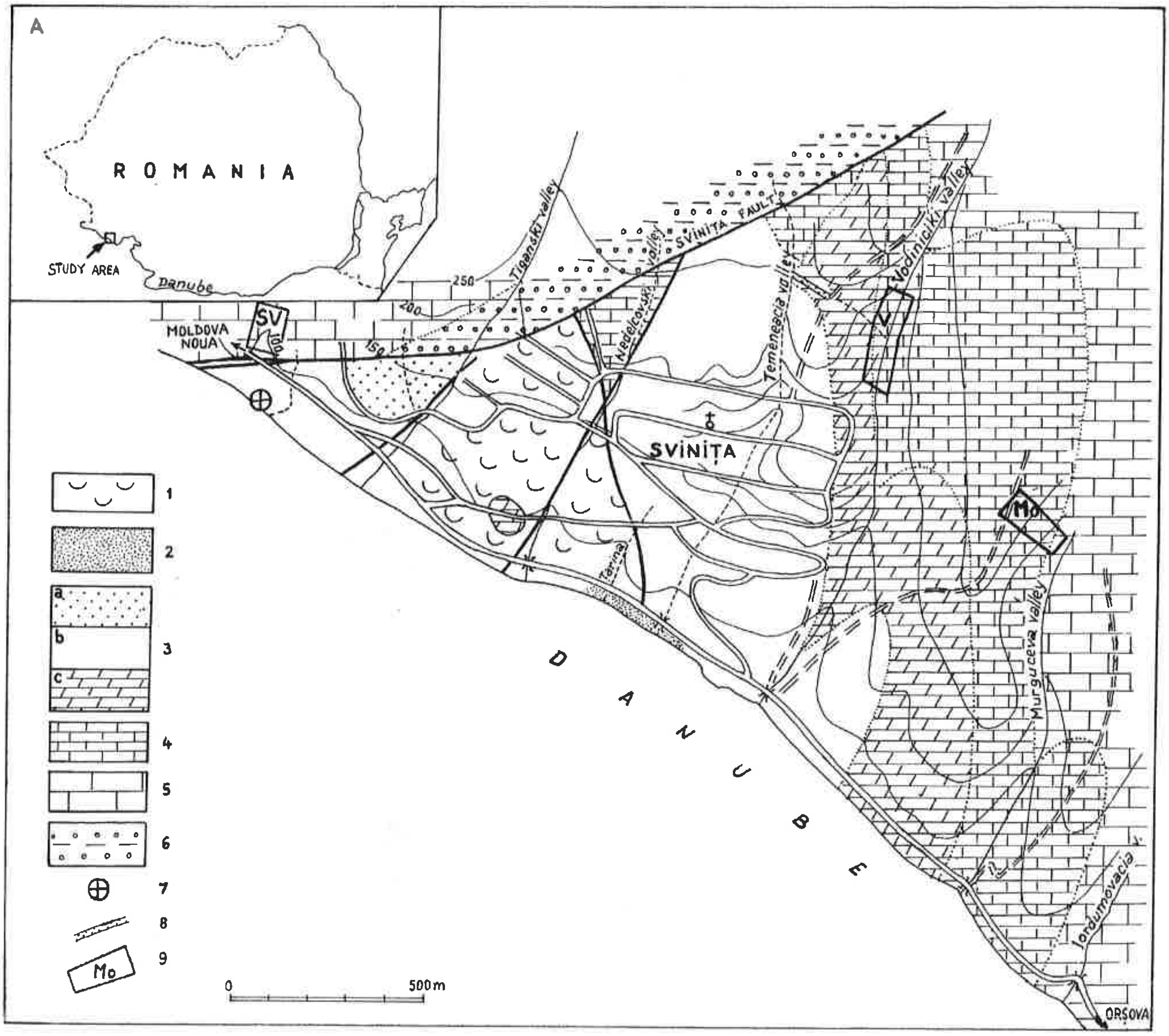


Figure 1. Geological map of Svinita with position of sampling sections (after E. Avram, unpublished). **1.** Earth slides; **2.** Middle Miocene (Badenian); **3.** Svinita Formation: **a.** Upper Aptian-Albian; **b.** Barremian; **c.** Upper Hauterivian; **4.** Murguceva Formation; **5.** Upper Jurassic; **6.** Pre-Upper Jurassic; **7.** Old church; **8.** Ditch; **9.** Sampled sections: **Mo** - Murguceva section; **V** - Vodiniciki section; **SV** - Svinita section.

Czetechowitz, in the Pienniny Klippen Zone. Accordingly, this member was considered to represent the Oxfordian and probably also a part of the lower Kimmeridgian. If we take into account the possibility, as discussed above, that the age of the lower nodular limestone comprises also the lower Oxfordian the age established by Raileanu seems much more probable.

In the lower part of the member a rich belemnite fauna occurs. Unfortunately this fauna has not yet been analysed and therefore it is not know whether it is useful for more precise dating of this member.

c) *Upper nodular limestones*. The cherty limestones pass gradually up-section to nodular limestones similar in lithology and thickness to the lower nodular limestones. They consist of more or less argillaceous micrites or biomicrites, sometimes with thin intercalations of marls, bluish compact micrites, allodapic calcirudites (turbidites) and rare beds of chert. The limestones are fossiliferous, containing ammonites, belemnites, brachiopods and especially aptychi. The species identified to date allow a correlation of this member to the "Acanthicum Beds" (Kimmeridgian) and it is possible to recognize the *Streblites tenuilobatus* Zone and the *Hibonoticeras beckeri* Zone. The *pseudomutabilis* Zone of Arkell was also supposed to exist although the index fossil has not yet been found (Raileanu & Nastaseanu, 1960). In the middle part of the upper nodular limestones *Parastomiosphaera malmica* (NOVAK) is recorded (Gr. Pop, pers. comm.). This microfossil identifies a zone in the lower Tithonian (in the *Hybonotum* Zone), above the base of the stage (Novac, 1976).

A more recent lithostratigraphic and paleontologic study of all these Upper Jurassic formations based on ammonites, that might permit more precise age determinations, is unfortunately missing in this region. Conversely the Upper Tithonian and Lower Cretaceous deposits at Svinita, have been more intensively studied for ammonites (Avram, 1976), calpionellids (Rusu, 1970; Avram, 1976), dinoflagellates (Antonescu & Avram, 1980), nannoplankton (Melinte, 1992). According to Avram (1976) these deposits are represented by two formations: the Murguceva Formation (upper Tithonian-upper Hauterivian) and the Svinita Formation (upper Hauterivian-lower Albian).

d) *The Murguceva Formation* is a pelagic deposit of the Maiolica type (Fig. 2), consisting of a monotonous sequence of dm-bedded white-grey limestones with chert and limestone nodules. It rests on the upper nodular limestones. At the stratotype, which was established on the right side of the Murguceva creek, the basal part of the formation consists of 1m. of slightly nodular and cherty greyish limestone, 1m. of relatively fine, white, compact cherty limestone and 4m. of detrital limestone with sparse chert. In the upper part of the formation, that is some 100m. above its base, the white-grey limestones pass gradually to dark grey marly limestones, and the cherty nodules gradually disappear. Accordingly, the boundary between the Murguceva and the Svinita Formations coincides with the disappearance of these nodules.

At the lower part of the Svinita Formation, within the Tithonian-Berriasian interval, slumps and sedimentation gaps, marked by sudden lithological change or sudden appearance or disappearance of some calpionellid zonal associations, are frequent in all sections. Similar discontinuities, or at least stratigraphic condensations, seem to exist in the lower Hauterivian interval which has a very reduced thickness relative to that of the upper Hauterivian (Avram, 1976).

2. Sections studied

Although in thin sections radiolarian remains are frequent in most part of the Upper Jurassic and Lower Cretaceous sequence at Svinita, well or moderately preserved radiolarians occur at only two levels: in the Oxfordian cherty limestones and in the Murguceva Formation.

2.1. Oxfordian cherty limestones

The cherty limestones are very well exposed from bottom to top in two sections.

One section is situated above the village of Svinita, along the country road leading up from the village, on the right side of the Vodiniciki Valley. A sample of red chert (SV 1635 in Dumitrica, 1978) collected by E. Avram probably from the upper part of this section provided a well-preserved assemblage of radiolarians. Other samples collected later contained very poorly-preserved radiolarians, but a detailed sampling of this section was never made.

The other section is situated at the west side of Svinita village in a small quarry opened just above the highway to the town of Moldova Noua, about 100m. north and above the old village church, now ruined and partly submerged in the waters of the Danube (Fig. 1, 2). The formation overlies the lower nodular limestone, the upper part of which is well-exposed in the eastern part of the quarry where it is apparent that the transition between the two formations is gradual. The western side of the quarry show a good exposure of cherty limestones (Fig. 2). The formation is up to 17m. thick. 15m. of which is represented by grey cherty limestones with greenish grey radiolarian limestone intercalations, 4-13 cm thick. Cherts are disposed irregularly or in centimetric beds. At the upper part of the formation the colour of limestones tends to become brown, and the cherts occur in rare beds, 20-30 cm thick.

As previous investigations had proved that radiolarians are very-poorly preserved in these chert levels and nodules new samples were collected in September 1992 from the greenish grey limestone intercalations or nodules. Almost all such intercalations showed numerous radiolarian remains on weathered surfaces. However, after treating with acetic acid, a single bed (SV 19), collected some 3 m above the base of the formation, has proved to contain a very rich and moderately-preserved radiolarian fauna. In the other samples the residues obtained after treatment with acetic acid were either barren or contained very poorly-preserved radiolarian remains. For this reason it is impossible at present to recognize the changes of radiolarian assemblages up section. Possibly future sampling could be more successful. It is interesting to note that just below the sample SV 19, at the level of samples SV 17 and 18, a rich

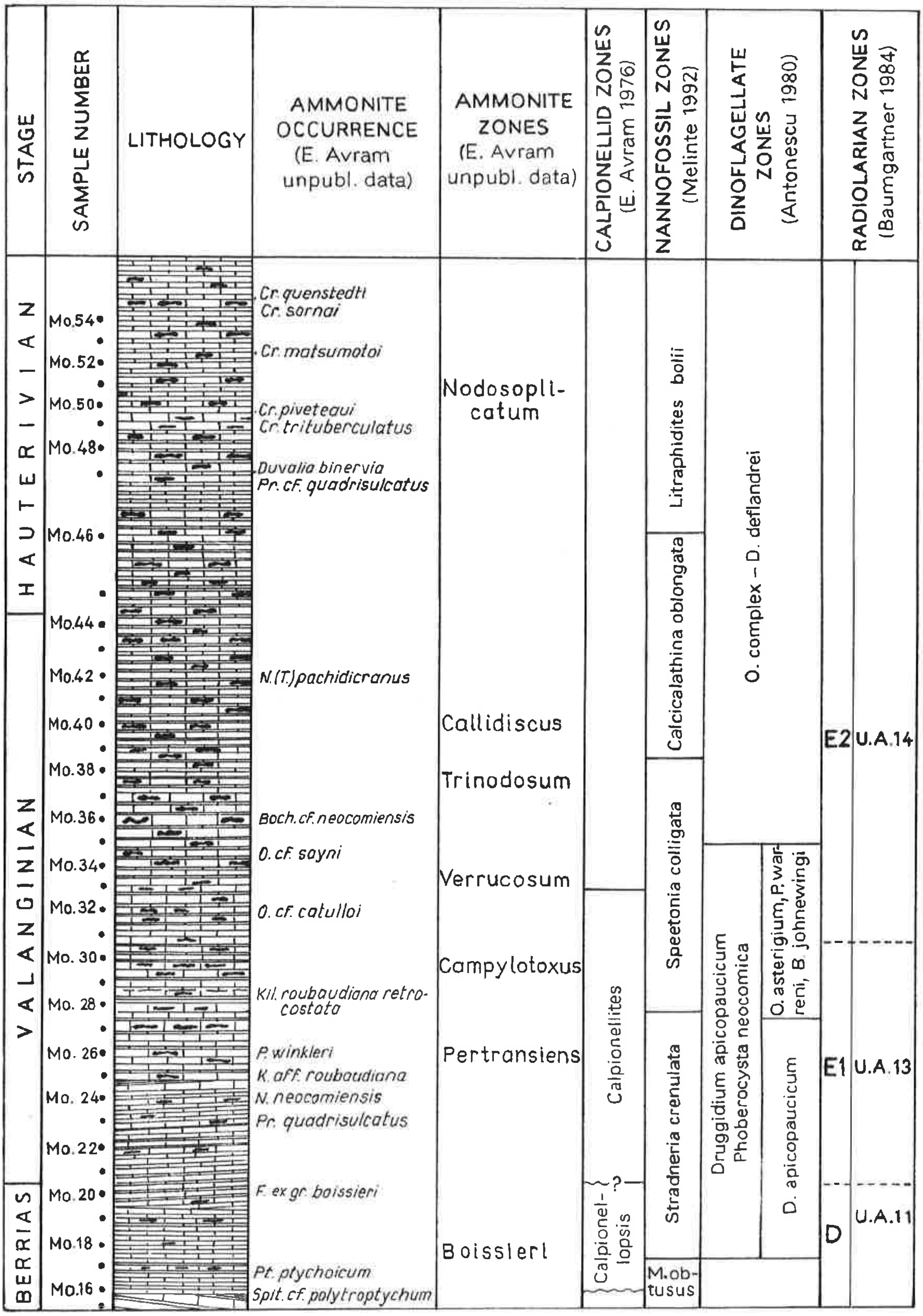


Figure 2. Integrated biostratigraphy of the type section of the Murguceva Formation (Mo), Svinita, with location of samples. The lithologic column is after Avram (1976), and the Unitary Associations recognized correspond to those established by Jud (1994).

belemnite fauna occurs. A number of specimens have been collected but they have yet identified.

Micropaleontological results

Besides several new taxa and taxa not included in the Catalogue (this volume, *Chapter* 4), the radiolarian assemblage of the sample SV 19 contains the following species:

Acaeniotyle diaphorogona gr. FOREMAN sensu BAUMGARTNER, *Acanthocircus suboblongus minor* BAUMGARTNER, *A. suboblongus suboblongus* (YAO) , *A. trizonalis angustus* BAUMGARTNER, *Deviatus diamphidius hipposidericus* (FOREMAN), *Emiluvia orea ultima* BAUMGARTNER & DUMITRICA., *E. pessagnoi multipora* STEIGER, *E. salensis* PESSAGNO, *Haliodictya* (?) *antiqua* ssp.B, *Higumastra coronaria* OZVOLDOVA, *H. wintereri* BAUMGARTNER & KITO, *Hsuum* sp. aff. *H. cuestaense* PESSAGNO, *Mirifusus chenodes* (RENZ), *M. dianae baileyi* PESSAGNO, *Napora deweveri* BAUMGARTNER, *Orbiculiforma* (?) *heliotropica* BAUMGARTNER, *O.*(?) sp. aff. *O. mclaughlini* PESSAGNO, *Palinandromeda crassa* (BAUMGARTNER), *Paronaella kotura* BAUMGARTNER, *Parvicingula mashitaensis* MIZUTANI, *Perispyridium ordinarium* gr. (PESSAGNO), *Podobursa helvetica* (RÜST), *P. spinosa* (OZVOLDOVA), *Protunuma* (?) *ochiensis* MATSUOKA, *Quinquecapsularia megasphaerica* DUMITRICA & BAUMGARTNER, *Ristola altissima altissima* (RÜST), *Sethocapsa* (?) *sphaerica* (OZVOLDOVA), *S. funatoensis* AITA, *Suna echiodes* (FOREMAN), *Tetratrabs bulbosa* BAUMGARTNER, *T. zealis* (OZVOLDOVA), *Triactoma* blakei (PESSAGNO), *T. jonesi* (PESSAGNO), *Triactoma tithonianum* RÜST, *Tritrabs casmaliaensis* (PESSAGNO), *T. ewingi* s.l. (PESSAGNO)

Among the other taxa occurring in this sample one can cite: *Birkenmajeria cometa* (PANTANELLI) sensu WIDZ & DE WEVER, *Podobursa triacantha* (FISCHLI), *Spongocapsula* spp., *Transhsuum* sp., *Parvicingula* sp., *Lanubus* n.sp., *Bistarkum* sp., *Paronaella* n.sp., *Angulobracchia* n.sp., *Hagiastrum plenum* RÜST, *Tritrabs* n. sp., *Paronaella cava* (OZVOLDOVA), *Paronaella* n.sp., *Archaeospongoprunum imlayi* PESSAGNO, *A. elegans* WU, *Orbiculiforma ? lowreyensis* PESSAGNO, *Archaeocenosphaera* sp., *Praeconocaryomma* ? sp., *Spongocapsula* spp., etc.

This assemblage suggests the Zone B of Baumgartner (1984). A characteristics of this assemblage as compared to the Oxfordian fauna from the East Carpathians is the presence of numerous specimens of *Emiluvia orea ultima*, *Andromeda crassa* with a spiney last segment, *Higumastra coronaria*, *Quinquecapsularia megasphaerica*, *Podobursa spinosa*, etc. Besides other new taxa reminiscent of some Tithonian species these species prove that the assemblage of the sample SV 19 is younger than the uppermost levels of the Callovian-Oxfordian radiolarite at Pojorita (Rarau syncline) or the Upper Jurassic Jasper Beds from the East Carpathians.

2.2. Murguceva Formation

Two parallel and nearby sections (Fig. 1) have been sampled in several stages for radiolarians, a section on the right side of the Murguceva creek (samples Mo) and a section on the Vodînicichi (Morilor) creek (samples V), but only the former has been studied in detail. Both sections were also sampled for ammonites, calpionellids, dinoflagellates and nannoplankton (Avram, 1976; Antonescu & Avram, 1980; Melinte, 1992). Biostratigraphic results of these studies are summarised in Figure 3.

The Murguceva section is well-exposed on the right side of the Murguceva Valley from its base to its top, of which the latter corresponds approximately to the top of the hill separating this valley from the Vodîncitchi (Morilor) Valley. The formation is about 100 m. thick. From bottom to top 54 samples have been taken (Mo.1-54). The samples Mo.1-16 were taken only for calpionellids at an interval of 1m. each as they contained only calcified radiolarians. In this interval of 16m. radiolarian-bearing nodules of chert or limestone are absent and the limestone is white in colour. The samples Mo.17-45 were taken for both calpionellids and radiolarians at stratigraphic intervals of 2m. the samples Mo.46-47 at intervals of 5m. and Mo.48-54, from the top of the hill, at intervals of about 1m. Over the whole sampled interval (16.5-54) the limestone is grey and radiolarian-bearing nodules of chert or limestone are frequent. The nodules are aligned along beds or form more or less regular beds.

Radiolarians are preserved in pyrite or in silica. Pyritized radiolarians occur in the interval of the samples Mo.22-54, in the mass of grey limestone. The degree of preservation in pyrite varies across section and along the same bed. Silicified radiolarians are preserved in limestone nodules or in the central, calcareous part of chert nodules. Their preservation is also very variable. As a rule, radiolarian frequency and diversity are much greater in nodules than in the mass of limestones. Some species, and especially the saturnalids and hagiastrids are also usually much more frequent in nodules. The cherts are black or grey in colour and contain very poorly-preserved radiolarians.

All limestone samples have been treated with dilute acetic acid in order to also recover holothurian sclerites, foraminifers or other calcareous fossil remains when present in addition to radiolarians.

Micropaleontological results

Although to date there are no publications on the radiolarian fauna from the Murguceva Formation a series of pyritized specimens have been already illustrated by Baumgartner (1984) from samples previously collected by us. These specimens as well as a large number of other specimens illustrated in the Catalogue (this volume) give a good impression of the excellent preservation of radiolarians in some samples. Baumgartner also recognized here two zones of his zonation based on Unitary Associations, namely Zone E1 (U.A. 13) and E2 (U.A. 14), both of them at the level of the Valanginian.

A comprehensive study of the whole radiolarian fauna of the Murguceva Formation is in progress. Due to its good, or very good, the aims of this study are as follows: a) a good understanding of all species occurring in the fauna, which includes good illustrations and the comprehensionof the morphological limits of each taxon, and b) the zonation and correlation of the zones recognized with those established by Baumgartner (1984) and especially by Jud (1994).

The list of species and biostratigraphic data so far obtained are shown in Figure 3. They bracket the stratigraphic interval comprised between the upper Berriasian (samples Mo.16.5-21) and upper Hauterivian (samples Mo.52-54). On the whole the range chart of the species occurring in the Murguceva section (Fig. 3) is practically comparable with that established by Jud (1994) on the basis of Unitary Associations. There are certainly a number of contradictions, some species appearing here a little earlier or disappearing a little later than her range chart shows. These contradictions are probably caused by: a) a different concept of some radiolarian species, b) incompleteness of the paleontological record, c) repetition by slumping undetected in the field, or d) paleogeographic or paleoenvironmental causes.

References

ANTONESCU, E. & AVRAM, E. (1980). Corrélation de dinoflagellés avec les zones d'ammonites et des calpionelles du Crétacé inférieur de Svinita (Banat). *Anuarul Institutului de Geologie si Geofizica*, **56**, 98-132.

AVRAM, E. (1976). La succession des dépôts tithoniques supérieures et crétacés inférieurs de la région de Svinita (Banat). *Dari de Seama ale Sedintelor, Institutul de Geologie si Geofizica*, **62** (4), 53-71.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

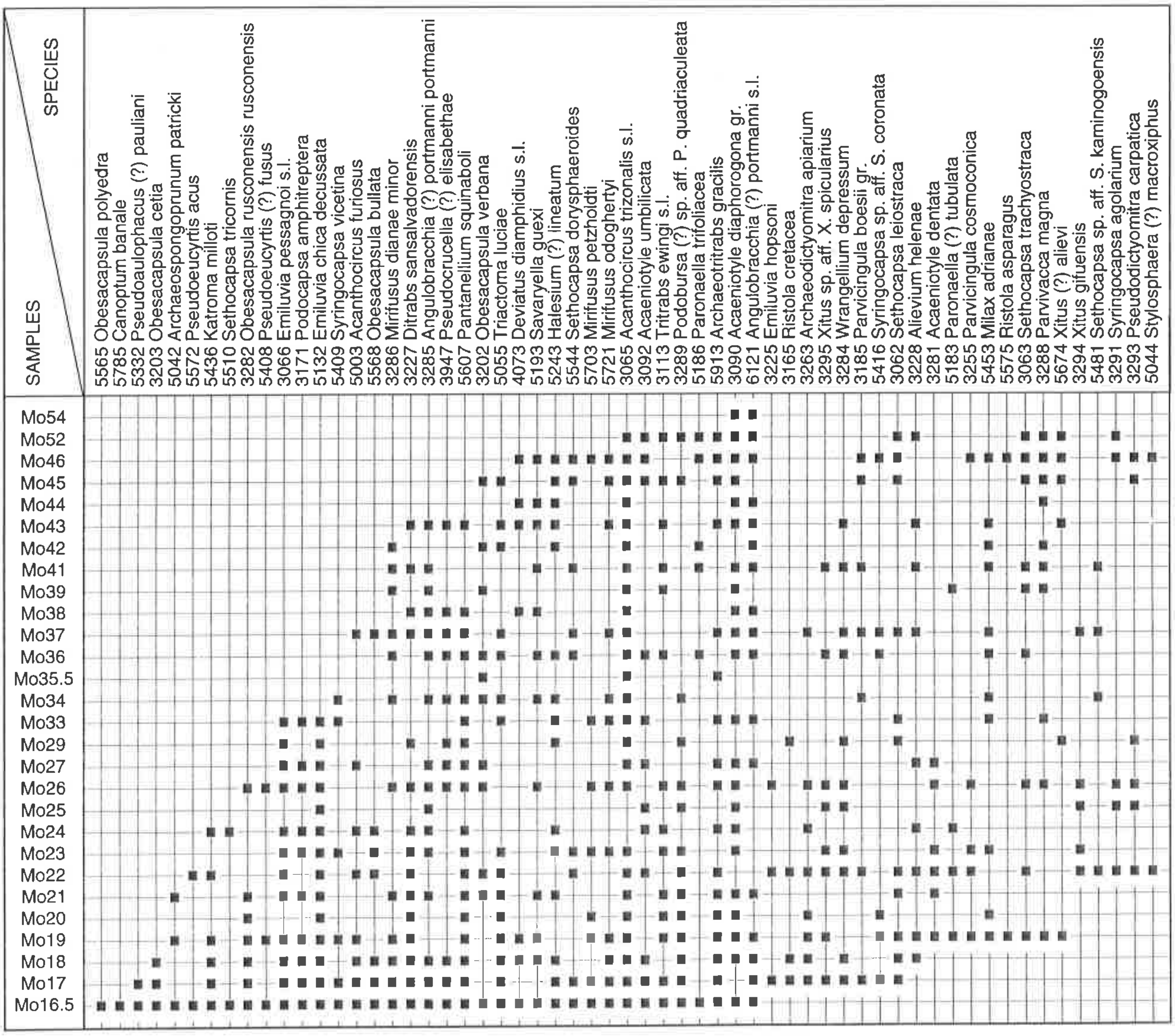


Figure 3. Occurrence of radiolarian species in the Murguceva section, Svinita arranged in order of their first and last occurrence.

BORZA, K. & MICHALIK, J. (1986). Problems with delimitation of the Jurassic/Cretaceous boundary in the Western Carpathians. *Acta Geologica Hungarica*, **29** (1-2), 133-149.

CODARCEA, A. (1940). Vues nouvelles sur la tectonique du Banat méridional et du Plateau de Mehedinti. *Annuaire de l'Instutut Géologique de Roumanie*, **20**, 1-74.

DUMITRICA, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14** (1), 45-124.

JUD, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

MELINTE, M. (1992). Nannofossil biostratigraphy across the Jurassic-Cretaceous boundary from the Southern and Eastern Carpathians (Rumania). *In* Hamrsmid, B. & Young, J. Eds. *Proceedings of the 4th. INA Conference* - Nannoplankton Research, Prague, **1**, 143-163.

NAGY, J. (1966). Sur le rôle stratigraphique des genres Stomiosphaera et Cadosina dans le Jurassique supérieur de la Montagne Mecsek. *Földtani Közlöny*, **96** (1), 86-104.

NOVAC, W.A. (1976). Parastomiosphaera malmica (Borza) from the Polish Carpathians and their stratigraphical value for Lower Tithonian deposits. *Annales Societatis Geologorum Poloniae*, **46** (1-2), 89-134.

POP, G. (1973). Depozitele mezozoice din muntii Vîlcan (The Mesozoic sedimentary formations from the Vîlcan Mts. area - South Carpathians). *Editura Academiei R. S. Romania*, **115**, 1-36.

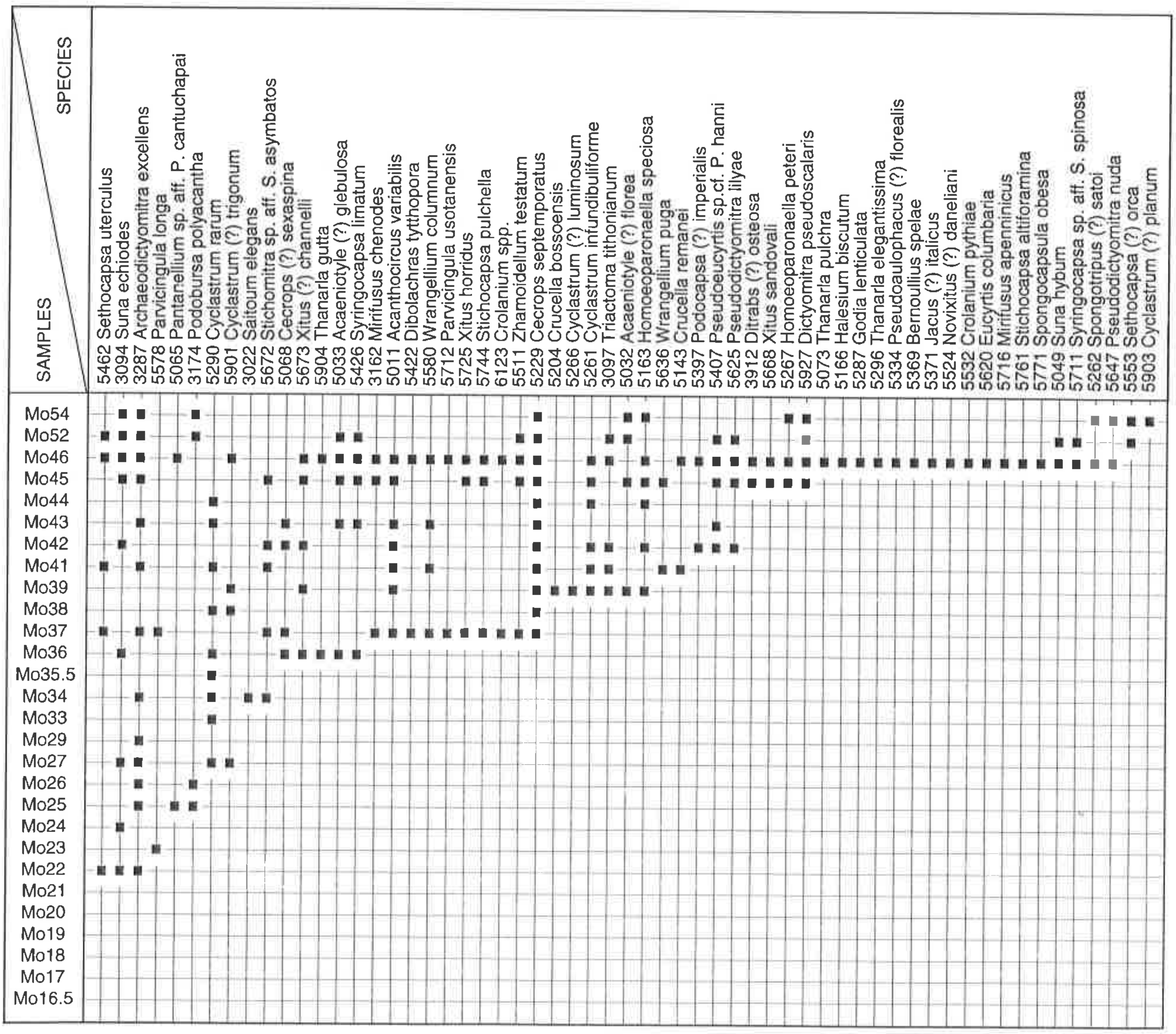


Figure 3. continued

RAILEANU, G. (1953). Cercetari geologice în regiunea Svinita-Fata Mare. *Buletinul Stiintific, Sectia de Stiinte Biologice, Agronomie, Geologie si Geografie*, **5** (2), 307-408.

RAILEANU, G. (1960). Recherches géologiques dans la région Svinita - Fata Mare. *Annuaire du Comité Géologique*, **26-28**, 347-383.

RAILEANU, G. & NASTASEANU, A. (1960). Contributii la cunoasterea faunei de amoniti din Jurasicul superior de la Svinita (Banat). *Studii si Cercetari de Geologie*, **5** (1), 7-38.

RUSU, A. (1970). Biozonele de calpionele din Tithonic-Neocomianul zonei Svinita (Banat). *Studii si Cercetari de Geologie, Geofizica si Geografie, Serie Geologie*, **15** (2), 489-497.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

APPENDIX

Radiolarian inventory of the samples studied in the Svinita section. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991)

SECTION 1_SVINITA: bottom 1 - top 28

< 28 {mo.54}: 3090, 3094, 3174, 3287, 5032, 5163, 5229, 5262, 5267, 5553, 5647, 5903, 5927, 6121

< 27 {mo.52}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3174, 3228, 3287, 3288, 3289, 5032, 5033, 5049, 5186, 5229, 5407, 5426, 5462, 5511, 5553, 5625, 5674, 5711, 5913, 5927, 6121

< 26 {mo.46}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3255, 3287, 3288, 3291, 3293, 3912, 4073, 5011, 5033, 5044, 5049, 5065, 5073, 5143, 5163, 5166, 5186, 5193, 5229, 5243, 5261, 5262, 5267, 5287, 5296, 5334, 5369, 5371, 5397, 5407, 5416, 5422, 5426, 5453, 5462, 5511, 5524, 5532, 5544, 5575, 5580, 5620, 5625, 5647, 5668, 5673, 5674, 5703, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5771, 5901, 5904, 5913, 5927, 6121, 6123

< 25 {mo.45}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3162, 3185, 3202, 3287, 3288, 3289, 3291, 3293, 3912, 5011, 5032, 5033, 5055, 5163, 5229, 5243, 5261, 5267, 5407, 5426, 5511, 5544, 5625, 5636 5668, 5672, 5673, 5674, 5721, 5725, 5744, 5913, 5927

< 24 {mo.44}: 3065, 3090, 3097, 3288, 4073, 5163, 5193, 5229, 5243, 5261, 5290, 6121

< 23 {mo.43}: 3065, 3090, 3113, 3227, 3228, 3284, 3285, 3287, 3947, 4073, 5011, 5033, 5055, 5068, 5193, 5229, 5243, 5290, 5407, 5426, 5453, 5580, 5607, 5674, 5721, 5913, 6121

< 22 {mo.42}: 3065, 3094, 3097, 3202, 3286, 3288, 5011, 5055, 5068, 5163, 5186, 5229, 5243, 5261, 5397, 5407, 5453, 5625, 5672, 5673, 6121

< 21 {mo.41}: 3063, 3065, 3090, 3097, 3113, 3185, 3227, 3228, 3284, 3285, 3286, 3287, 3288, 3295, 5011, 5143, 5186, 5193, 5229, 5261, 5290, 5453, 5462, 5481, 5544, 5580, 5636, 5672, 6121

< 20 {mo.39}: 3063, 3065, 3090, 3097, 3113, 3202, 3285, 3286, 3288, 5011, 5032, 5163, 5183, 5204, 5229, 5261, 5266, 5673, 5901

< 19 {mo.38}: 3065, 3090, 3227, 3285, 3947, 4073, 5193, 5229, 5290, 5607, 5901, 6121

< 18 {mo.37}: 3062, 3065, 3090, 3162, 3185, 3227, 3228, 3263, 3284, 3285, 3286, 3287, 3294, 3947, 5003, 5011, 5055, 5068, 5229, 5416, 5422, 5453, 5462, 5481, 5511, 5544, 5568, 5578, 5580, 5607, 5672, 5712, 5721, 5725, 5744, 5913, 6121, 6123

< 17 {mo.36}: 3063, 3065, 3090, 3092, 3094, 3113, 3202, 3284, 3285, 3286, 3295, 3947, 5033, 5055, 5068, 5186, 5193, 5243, 5290, 5416, 5426, 5453, 5544, 5607, 5673, 5904, 6121

< 16 {mo.35.5}: 3065, 3202, 5290, 5913

< 15 {mo.34}: 3022, 3065, 3185, 3202, 3285, 3286, 3287, 3289, 3947, 5055, 5193, 5243, 5290, 5409, 5453, 5481, 5607, 5672, 5721.

< 14 {mo.33}: 3062, 3065, 3066, 3090, 3092, 3171, 3288, 5055, 5132, 5243, 5290, 5409, 5453, 5607, 5703, 5721, 5913, 6121

< 13 {mo.29}: 3062, 3065, 3066, 3165, 3227, 3284, 3287, 3289, 3293, 3947, 5132, 5243, 5607, 5674

< 12 {mo.27}: 3065, 3066, 3090, 3092, 3094, 3171, 3202, 3228, 3281, 3285, 3287, 3947, 5003, 5132, 5290, 5408, 5607, 5901, 5913, 6121

< 11 {mo.26}: 3063, 3065, 3066, 3090, 3113, 3171, 3174, 3202, 3225, 3227, 3255, 3263, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3289, 3291, 3293, 3294, 3295, 3947, 5132, 5193, 5607, 5703, 5721, 5913

< 10 {mo.25}: 3090, 3092, 3174, 3184, 3263, 3284, 3289, 3291, 3293, 3294, 3295, 5065, 5132

< 9 {mo.24}: 3066, 3090, 3092, 3094, 3113, 3171, 3227, 3228, 3263, 3285, 5003, 5132, 5183, 5243, 5436, 5510, 5568, 5607, 5913

< 8 {mo.23}: 3065, 3066, 3090, 3113, 3171, 3227, 3255, 3281, 3284, 3285, 3289, 3294, 3295, 5055, 5132, 5243,

5409, 5453, 5544, 5568, 5578, 5607, 5703, 5721

< 7 {mo.22}: 3062, 3063, 3065, 3066, 3092, 3094, 3165, 3185, 3202, 3225, 3227, 3228, 3255, 3263, 3281, 3284, 3289, 3291, 3293, 3294, 3295, 5003, 5044, 5055, 5132, 5183, 5432, 5436, 5462, 5481, 5544, 5568, 5572, 5607, 5913

< 6 {mo.21}: 3062, 3065, 3066, 3090, 3113, 3171, 3202, 3227, 3281, 3282, 3285, 3286, 3289, 5042, 5055, 5132, 5193, 5243, 5607, 5913, 6121

< 5 {mo.20}: 3065, 3090, 3113, 3227, 3263, 3282, 3289, 5055, 5132, 5416, 5453, 5607, 5703, 5913

< 4 {mo.19}: 3062, 3063, 3065, 3066, 3090, 3113, 3171, 3227, 3228, 3255, 3263, 3281, 3282, 3286, 3288, 3289, 3295, 4073, 5003, 5042, 5055, 5132, 5183, 5193, 5408, 5409, 5416, 5436, 5453, 5575, 5607, 5674, 5703, 5721, 5913, 6121

< 3 {mo.18}: 3062, 3065, 3066, 3090, 3092, 3165, 3171, 3203, 3227, 3228, 3263, 3282, 3284, 3285, 3286, 3289, 3947, 4073, 5003, 5055, 5132, 5193, 5243, 5436, 5568, 5607, 5721, 5913, 6121

< 2 {mo.17}: 3062, 3065, 3066, 3092, 3113, 3165, 3171, 3185, 3203, 3225, 3227, 3263, 3282, 3284, 3285, 3286, 3289, 3295, 3947, 5003, 5055, 5132, 5243, 5332, 5409, 5416, 5436, 5544, 5568, 5607, 5703, 5721, 5913, 6121

< 1 {mo.16.5}: 3065, 3066, 3090, 3092, 3113, 3171, 3202, 3203, 3227, 3282, 3285, 3286, 3289, 3947, 4073, 5003, 5042, 5055, 5132, 5186, 5193, 5243, 5332, 5408, 5409, 5436, 5510, 5544, 5565, 5568, 5572, 5607, 5703, 5721, 5785, 5913, 6121

24. Biostratigraphy of the Radiolarites at Pojorita (Rarau Syncline, East Carpathians)

by Paulian Dumitrica

Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
Mailing address: Könizstrasse 39, 3008 Bern, Switzerland

ABSTRACT

The Upper Jurassic radiolarites or Jasper Beds at Pojorita represent part of an almost uninterrupted band on the western slope of the Rarau syncline, in the northern part of the East Carpathians. Radiolarites are well-exposed in an old quarry and contain two distinct assemblages: a *Ristola altissima major* - *Stylocapsa* ? *catenarum* assemblage, in the lower part, and a *Ristola altissima altissima* - *Emiluvia orea* assemblage, in the upper part. The beds or blades of white limestone or breccias occurring in the radiolaritic sequence are interpreted as allochthonous elements emplaced during the deposition of radiolarian sediments.

1. Geographical and geological frameworks

The radiolarites at Pojorita, or the Jasper Beds, as they are frequently called in the geological literature, are part of the Mesozoic deposits which fill the Rarau Syncline. This syncline, extending some 40 km in length and 1-8 km in width, represents the northern segment of a much longer synclinal zone situated on the external side of the so-called Crystalline Mesozoic Zone that forms the central area of the Romanian East Carpathians (Fig. 1A).

The deposits that fill the Rarau Syncline belong tectonically and palaeogeographically to the Bucovinian series which represent autochthonous formations. They rest on crystalline basement and, from bottom to top, consist of (Fig. 1B):

- sandstones and conglomerates (Seisian);
- massive dolomites and *Diplopora*-bearing limestones (Campilian-Anisian);
- sandy or oolithic limestones (Dogger);
- radiolarites or Jasper Beds (middle Callovian-Oxfordian);
- Aptychus Beds (upper Oxfordian-?Berriasian or Tithonian - Valanginian) and Pojorita Beds (Tithonian -Berriasian);
- Muncelu conglomerates (Hauterivian-Lower Barremian?)
- Wildflysch formation (upper Barremian?-Albian)

The radiolarites occur as an almost uninterrupted band on the western limb of the syncline, where they represent a good stratigraphical guide. On the eastern limb their occurrence is less frequent because the deposits of the syncline are in tectonic contact with the Lower Cretaceous flysch. On this limb they occur only in places where the Triassic dolomites also occur (Mutihac, 1968).

2. Age of the jasper beds

The close association between Anisian age dolomites and the jaspers was the main argument of many authors for a Ladinian age of the latter (Preda & Ilie, 1940; Bancila & Corvin Papiu, 1953; Popescu & Patrulius, 1964; Sandulescu, 1973, 1976). The same association was also an argument for an Upper Permian age for Ilie (1957) who assigned the dolomites to the Permian. Kräutner (1929) was the first who attributed an Callovian-Oxfordian age to some radiolarites of the Rarau Syncline. Later, Mutihac (1965, 1968), Stanoiu (1966, 1967) and Turculet (1971, 1978) demonstrated this age for all radiolarites that border the Rarau Syncline, and correlated them with the radiolarites occurring in the central and southern parts of the East Carpathians, where, as well as here, they are among the most characteristic rocks of the Lower Malm, and whose Callovian-Oxfordian age was for the first time determined by Jekelius (1922) and later by Patrulius (1960, 1969).

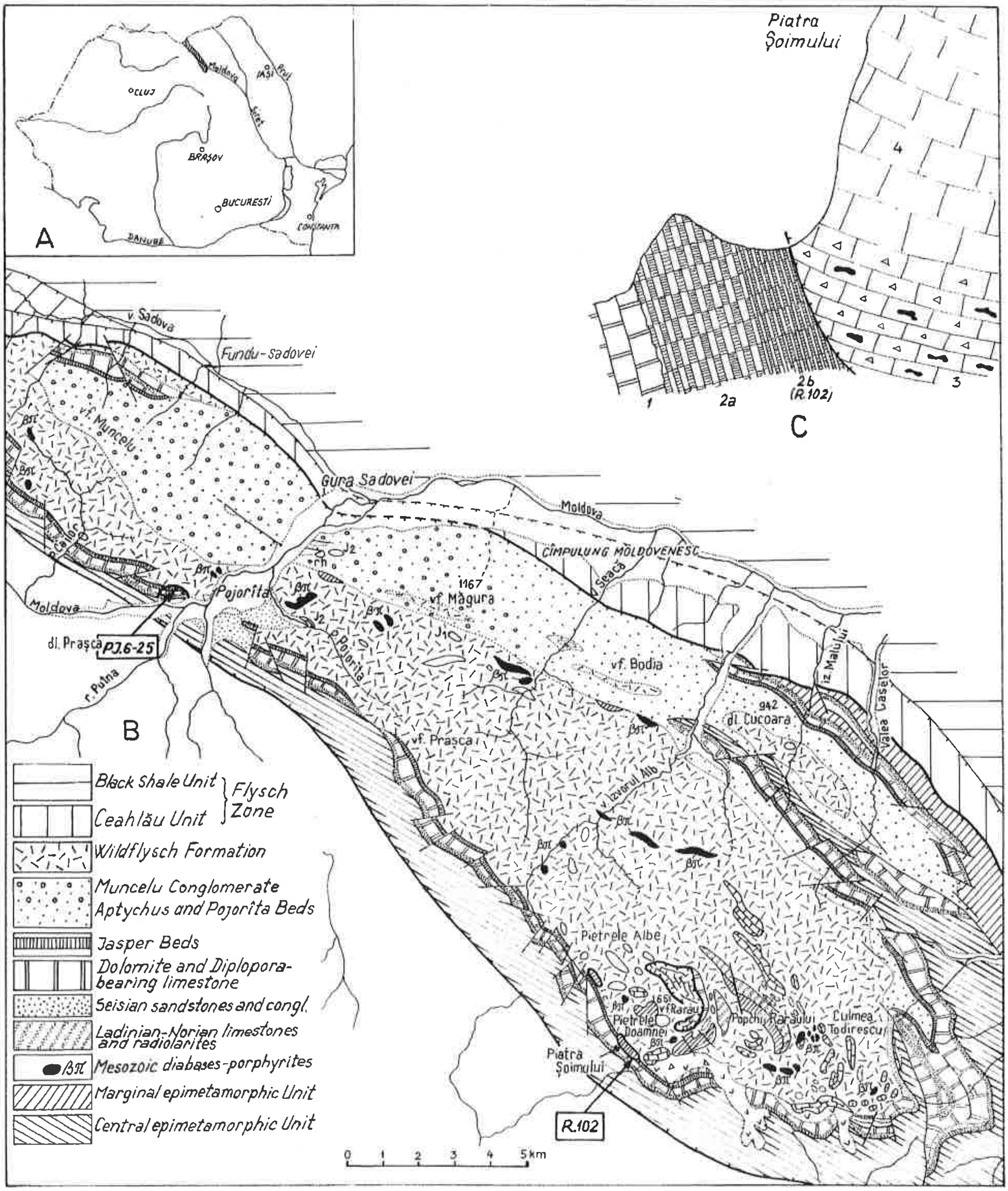


Figure 1.

1A: Location of the Rarau Syncline (hatched) on Roumanian territory.

1B: Geological map of part of the Rarau Syncline (after Mutihac, 1968) with location of the Pojorita and Piatra Soimului sections.

1C: Rarau Mt., Piatra Soimului section: **1-** Anisian dolomite; **2a** - Callovian-Oxfordian grey glassy radiolarite; **2b** (R.102) - Oxfordian slightly silicified reddish argillite; **3** - Ladinian chert-bearing limestone; **4** - Carnian-Norian limestone of the Piatra Soimului klippe.

Relative to the age of the radiolarites suggested it is to say that Triassic (Ladinian and Carnian) radiolarites or jaspers do exist in the Rarau Syncline (Popescu & Patrulius, 1964; Mutihac, 1968; Dumitrica, 1982) but they occur as exotic klippes belonging to the Transylvanian Nappes and have a different lithological aspect.

The radiolarites or jasper beds at Pojorita, considered initially to be Triassic in age (Bancila & Corvin Papiu, 1953) due to their close association with the Anisian dolomites, provide no macrofossil evidence for their age. However evidence was found by Mutihac (1965, 1968), Stanoiu (1966, 1967) and Turculet (1971, 1978) 20-25 km to NW, in their studiesHere, in the area of the Tatarca and Lucava rivers, tributaries of the Moldova river that runs along the syncline, they found that the boundary between the Anisian dolomites and radiolarites follows a palaeorelief surface. At the contact between the two formations a breccia (Tatarca Breccia) occurs, formed by fragments of the underlying dolomites and *Diplopora*-bearing limestones cemented by a red feldspathic sandy oolitic limestone. This limestone deeply fills the fissures and karstic relief of the Triassic deposits and contains a rich fauna of bivalves, brachiopods, belemnites, ammonites (*Entolium demissum* PHIL., *E. spathulatus* ROEMER, *E.* aff. *renevieri* OPPEL, *Camptonectes lens* SOWERBY, *Chlamys subtextorius* (GOLDF.), *Chlamys* cf. *ambiguus* (MNSTR.), *Ostrea calceola* (ZIET), *Bositra buchi* (ROEM.), *Oxytoma munsteri* BRONN, *Waldheimia biappendiculata* DESL., *Rhynconella dumortieri* SAJN., *Belemnopsis* sp., *Phylloceras* sp., *Bullatimorphites* sp. etc.) proving a Middle Jurassic age. Stanoiu (1967) proposed that the presence of *Bullatimorphites* sp. indicates late Bathonian-early Callovian age for this limestone. He also mentioned that in places where this limestone is missing (the left side of the Lucava valley, for instance) that the red radiolarites mould a preexisting relief cut in the Triassic limestones. Moreover he reported from the Jasper Beds *Bositra buchi* (ROEMER), a fossil ranging from Aalenian to Oxfordian and which seems to be the only macrofossil found in these beds.

Based on these faunas, on the relationships between the Jasper Beds and the underlying formations, and on the analogy with similar regions from the East Carpathians, Stanoiu (1967), Mutihac (1968) and Turculet (1971, 1978) assigned the Jasper Beds from the Rarau Syncline to the middle Callovian-Oxfordian. The same authors underlined the strongly transgressive character of this formation that rests not only on Anisian dolomites and limestones, and Middle Jurassic limestones, where preserved, but also on crystalline schists. This would suggest a sedimentary gap corresponding to the upper Bathonian-lower Callovian a large part of the Middle Jurassic sediments having been removed by erosion. A similar situation was observed in the southern part of the East Carpathians, the Bucegi Massif respectively, where the radiolarites rest locally on an indurated surface of the Dogger (Patrulius, 1960).

Even although the lower boundary of the Jasper Beds occurring in the Rarau Syncline can be more or less established, their upper boundary is still disputable because in most parts they are covered by the Lower Cretaceous wildflysch. Turculet (1971) mentioned that the Callovian-Oxfordian jaspers are in some places concordantly overlain by the Aptychus Beds, the age of which is considered as upper Oxfordian-Tithonian. However other authors (Sandulescu, 1976) considered that the lower boundary of these beds is no older than the Kimmeridgian-Tithonian boundary. Moreover, the latter author remarked that the Aptychus Beds are cut at the base by faults so that the contact between them and the underlying formation is nowhere exposed. It seems, however, that Turculet is correct in establishing the upper boundary of the radiolarite facies somewhere within the upper Oxfordian and not at the end of this stage. Similarly Patrulius (1960), in a synthesis of the Mesozoic cover of the crystalline massifs of the East Carpathians, established the upper boundary of the Callovian-Oxfordian radiolarites below the *Bimammatum* Zone of the upper Oxfordian. The Jurassic radiolarite facies of the East Carpathians, the Rarau Syncline included, would accordingly occupy the interval between the *Anceps* Zone of the Callovian and the *Transversarium* Zone of the Oxfordian.

A Kimmeridgian age for the Jasper Beds supposed by Pessagno *et al.* (1984) after an analysis of the relations between these beds and the underlying and overlying deposits is impossible to support because the Kimmeridgian has a different facies in the East Carpathians (Patrulius, 1960).

Before closing this introduction it is important to mention and discuss the presence of some thick (up to 15m) beds or blades of white limestone or breccias in some sections of the radiolarite sequence. Such a blade occurs in the Pojorita quarry towards the upper part of the sequence which is thus divided into two parts. Similar situations (Sandulescu, 1973) are known on the left side of the Tatarca valley, on Dealul Timpa, etc. They have been interpreted by the supporters of the Callovian-Oxfordian age of the radiolarites (Mutihac, 1968; Turculet, 1978) as a repetition of the Anisian limestones and Jurassic radiolarites along a fault. However Sandulescu (1973) has seen a normal succession in them (considered of Landinian age) and this is the best argument for the Triassic age of most radiolarites from the Rarau Syncline. In his interpretation the radiolarites occurring below these limestones (between them and the Anisian dolomites and limestones) would be of Ladinian age, whereas those above may be either Upper Jurassic or Lower Cretaceous. In order to solve this problem I sampled, from several sections where such intercalations occur, both the underlying and overlying radiolarites. The results have been similar in all cases: the assemblages of both sequences were similar. As, on the one hand, a repetition by faulting is not evident in the field and, on the other hand it would have had as result the presence of a younger assemblage below the blade of limestone and of an older assemblage above it, these limestones and breccias should be interpreted as allochthonous blades emplaced during the deposition of the radiolarian sediments.

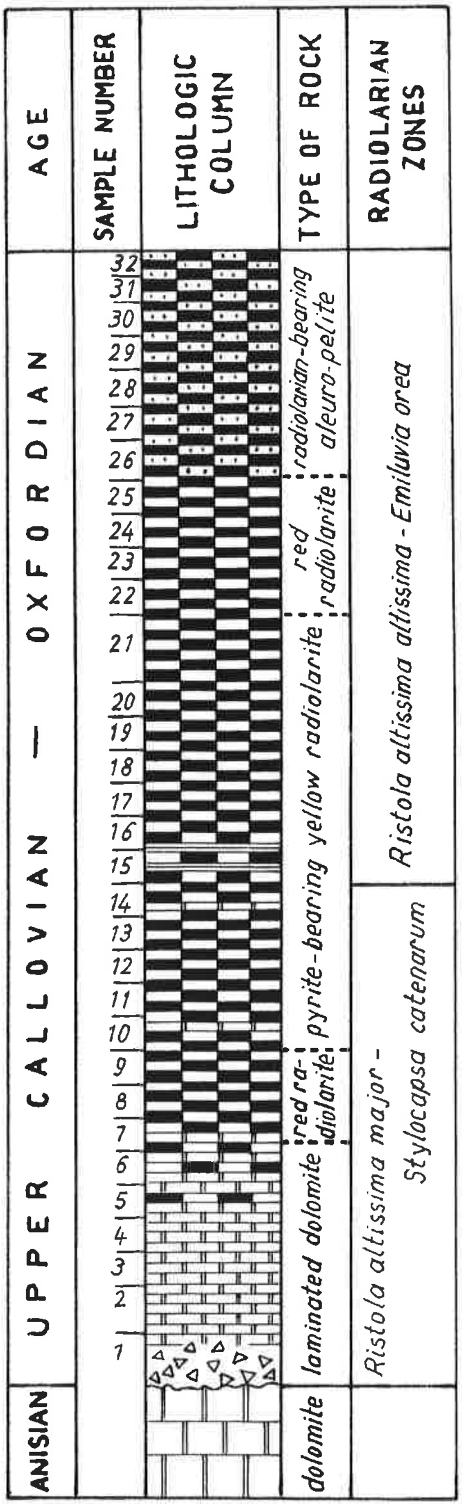


Figure 2. Pojorita section with location of samples. Except PJ. 1,2 and 21 sampling interval is 1 m.

3. Radiolarite section at Pojorita

The band of radiolarites developed on the western slope of the Rarau Syncline is best exposed and reaches its greatest thickness in an old dolomite quarry at Pojorita, a large village situated at 7-8 km west of the town of Campulung Moldovenesc, along the Transcarpathian highway to the town of Vatra Dornei and further on towards Transylvania. The quarry is also known as Pecistea quarry, a name borrowed from the Pecistea Hill at the foot of which it is situated. More precisely, it is located at the periphery of Pojorita village, on the left side of the Moldova valley, at its confluence with the Putna valley. It is highly visible from the highway due to its large size and the red colour of the radiolarites. On the geological map 21b POJORITA, 1:50.000, published in 1975, the quarry is located at a distance of 51 mm from the right border of the map and 61 mm from the lower border (because of the secrecy characteristic of the communist regime of Romanian at the time when the map was published it has no co-ordinates). It is notable that on this map the Callovian-Oxfordian radiolarites are mapped as Ladinian.

The radiolarites from this section have been studied in detail from mineralogical and genetical points of view by Bancila & Corvin Papiu (1953) who considered them in a hemipelagic organogenous deposit with a low terrigenous content. The detrital material is of crystalline origin and proves limited transport and weak alteration processes for the continental area in which they originated. From bottom to top one can recognise the following lithological levels (Fig. 2):

1. Laminated dolomite (3-5 m). The rock is represented by dark grey (light grey weathered) laminated dolomite (60-70% granular or recrystallised dolomite) with detrital material. It has a perfect fine stratification and breaks in quadrangular fragments. Although the authors had signaled the sudden transition between this rock and the white massive dolomite, due to the high content of dolomite they interpreted it as continuous sedimentation. It is to remark however that this level has at its base a breccia and rests on a palaeorelief surface of the dolomites, a fact also presented by Mutihac (1968) and Turculet (1978). Radiolarians are present but very poorly-preserved.

2. Hard red radiolarite (4 m). The thickness of this level, not mentioned by Bancila & Corvin Papiu (loc. cit.), is difficult to establish because of the gradual transition between it and the laminated dolomite. Radiolarians are present, their preservation increasing up section.

3. Pyrite-bearing, yellow radiolarite (13 m). The radiolarite is hard, glassy, in beds 2-5 cm thick, and its colour varies from yellow to grey or brown, light yellow on weathered surfaces. The pyrite is frequent, especially in the lower half of the level. Radiolarians are frequent but their preservation is variable.

4. Red radiolarite (4-5 m or more). The rock is a brown red radiolarite with red clay intercalations, and is less silicified than the underlying level. This type of rock is the most common for the Callovian-Oxfordian radiolarites of the Rarau Syncline. Radiolarians are abundant and well-preserved but many of them are strongly compressed.

5. Radiolarian-bearing aleuro-pelitic shale (6-7 m). The rock is grey, brown or reddish in colour and rich in detrital material (muscovite). Radiolarians are less frequent and very poorly-preserved.

6. White allochthonous limestone or dolomite of probably Triassic age (7-8 m).

7. Highly folded (slumped ?) red, brown and green radiolarite (some 10 m). Because of these disturbances, the sequence was sampled only at the upper part (PJ.40), where the radiolarites, red and slightly silicified, are less folded. At the top they are in contact with the upper Barremian-Albian wildflysch.

4. Micropalaeontological results

The section at Pojorita was first studied for radiolarians almost 25 years ago (Dumitrica, 1970) when several new cryptocephalic and cryptothoracic nassellarian taxa were described from residues obtained by means of dilute HF infill. Ten years later it was sampled and studied by us from a biostratigraphical point of view but the results were never published. The results presented here are based on the samples collected at that time. The detailed study of the radiolarians of the Pojorita section from both systematic and biostratigraphical points of view is important because the section is very well-exposed, complete and radiolarians are relatively well-preserved. It could therefore be a reference section for all the Callovian-Oxfordian radiolarites of the East Carpathians.

Radiolarians occur throughout the length of the section but only in the samples PJ.6-25 and PJ.40 does their preservation permit specific determinations. Well-preserved specimens occur in the lower and upper levels of red radiolarite (levels 2 and 4) and in the upper part of the yellow radiolarite (level 3).

From sample PJ.6 to PJ.9, corresponding to the lower level of red radiolarite, a steady and rapid increase in the diversity of the radiolarian assemblages can be observed (Fig.3). This could be due either to an increase in the degree of preservation or, more probably, to a continuous immigration of species in this area as the transgression advanced.

Due to poor preservation the radiolarian assemblages of samples PJ.10-14 are less diverse but they maintain the general aspect of the previous samples. Irrespective of preservation the assemblages of samples PJ.6-14 are characterised by the presence of the species: *Ristola altissima major* n.ssp. BAUMGARTNER & DE WEVER, *Stylocapsa ? catenarum* MATSUOKA, *Stichocapsa convexa* MATSUOKA and *Gongylothorax sakawaensis* MATSUOKA, although the last species also occurs in sample PJ.15 where its last occurrence in the section is recorded. *Mirifusus guadalupensis* PESSAGNO was also recorded within the interval of these samples.

Briefly the assemblage of the interval PJ.6-14 can be designated as *Ristola altissima major-Stylocapsa (?) catenarum* assemblage. Its lower boundary cannot be defined but its top corresponds with the last occurrence of the two species. The assemblage can be correlated with the *Stylocapsa* (?) *spiralis* zone of Matsuoka (1983) and Matsuoka & Yao (1986) although the nominal species of the zone has never yet been found in the Jurassic radiolarites of the Carpathian region. A correlation with the zonation of Baumgartner (1984) based on Unitaty Associations is difficult because many species recorded in this section do not find a correspondent in his zonation.

Between samples PJ.14 and PJ.15 there is a drastic change in the assemblages, some 20 species making their first occurrence and half this number their last occurrence. Among the former the appearances of *Ristola altissima altissima* (RÜST), *Mirifusus dianae* (KARRER), *Williriedellum crystallinum* DUMITRICA, *Gongylothorax favosus* DUMITRICA, *Archaeodictyomitra minoensis* (MIZUTANI), *A. apiarum* (RÜST), *Xitus magnus* n.sp. BAUMGARTNER, *Emiluvia orea* BAUMGARTNER, *E. salensis* PESSAGNO, etc. are notable. Although no remarkable change in lithology or colour could be observed between samples PJ.14 and PJ.15 such a drastic change may suggest a sedimentation gap.

An assemblage similar to the latter but much richer and better preserved was also recorded many years ago in sample R.102 (Fig. 1B, 1C) which came from the southern part of the syncline. The sample was collected from the upper part of a condensed section exposed in the Rarau Mt., at the base and southern part of the Piatra Soimului klippe, a large olistolith of Ladinian and Carnian-Norian limestone belonging to the Transylvanian Nappes. The radiolarites here rest directly on the Anisian dolomites and are very condensed. They are exposed for about 4 m of which the lower 3 m (2a) are represented by grey glassy radiolarites with very poorly preserved radiolarians, and the upper metre (2b = sample R.102) by slightly silicified reddish argillite.

The assemblage of the samples PJ.15-40 and R.102 can be designated as *Ristola altissima altissima-Emiluvia orea* assemblage. Its lower boundary would correspond with the first appearances of the two species, which probably are not absolutely synchronous, and its upper boundary with the first appearance of *Podocapsa amphitreptera.* FOREMAN This species has not been found to date in the Upper Jurassic radiolarites from the East Carpathians. Widz (1991) records it from the upper Oxfordian of the Pieniny Klippen Belt (West Carpathians). This is in agreement with the age assigned by Patrulius (1960) to the jaspers beds of the East Carpathians which do not correlate with the last ammonite zone of the Oxfordian. This faunas assemblage corresponds to the U.A. 7 of Baumgartner (1984).

Correlation of the two assemblages with the zonation of Baumgartner (1984) based on Unitary Associations is difficult because many species recorded here, and especially those of the lower assemblage, are not included in his zonation.

References

BANCILA, I. & CORVIN-PAPIU, V. (1953). Jaspurile triasice dela Pojorîta. *Buletin Stiintific, Setiunea de Stiinte Biologice, Agronomie, Geologice si Geografice,* **5** (4), 675-694.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

DUMITRICA, P. (1970). Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. *Revue Roumaine de Géologie, Géophysique et Géographie (Série Géologie)*, **14** (1), 45-124.

DUMITRICA, P. (1982). Triassic Oertlisponginae (Radiolaria) from Eastern Carpathians and Southern Alps. *Dari de Seama ale Sedintelor, Institutul de Geologie si Geofizica*, **67**, 57-74.

ILIE, M.D. (1957). Cercetari geologice în regiunea Rarau - Cîmpulungul Moldovei - Pîrîul Cailor. *Anuarul Comitetului Geologic,* **30**, 107-211.

JEKELIUS, E. (1922). Die mittlere und obere Jura im Gebiet des Haghimasu Mare in Siebenbürgen. *Buletinul Sectiei Stiintifice al Academiei Romane,* **7**.

KRÄUTNER, T.H. (1929). Cercetari geologice în cuveta marginala mezozoica a Bucovinei cu privire speciala asuprgga regiunii Raraului. *Anuarul Institului Geologic al Romaniei,* **14**.

MATSUOKA, A. (1983a). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and adjacent areas Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **26** (1), 1-48.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

MUTIHAC, V. (1965). Consideratii asupra doggerului din siclinalul marginal (Rarau-Breaza). Comunicare preliminara. *Studii si cercetari de Geologie, Geofizica si Geografie, Serie Geologie*, **10**, 1.

MUTIHAC, V. (1968). *Structura geologica a compartimentului nordic din sinclinalul marginal extern (Carpatii Orientali)* - Editura Academiei R.S.R., Bucarest. 127 p.

PATRULIUS, D. (1960). La couverture mésozoïque des massifs cristallins des Carpates Orientales. *Annales Instituti Geologici Publici Hungariae*, **49** (1), 123-154.

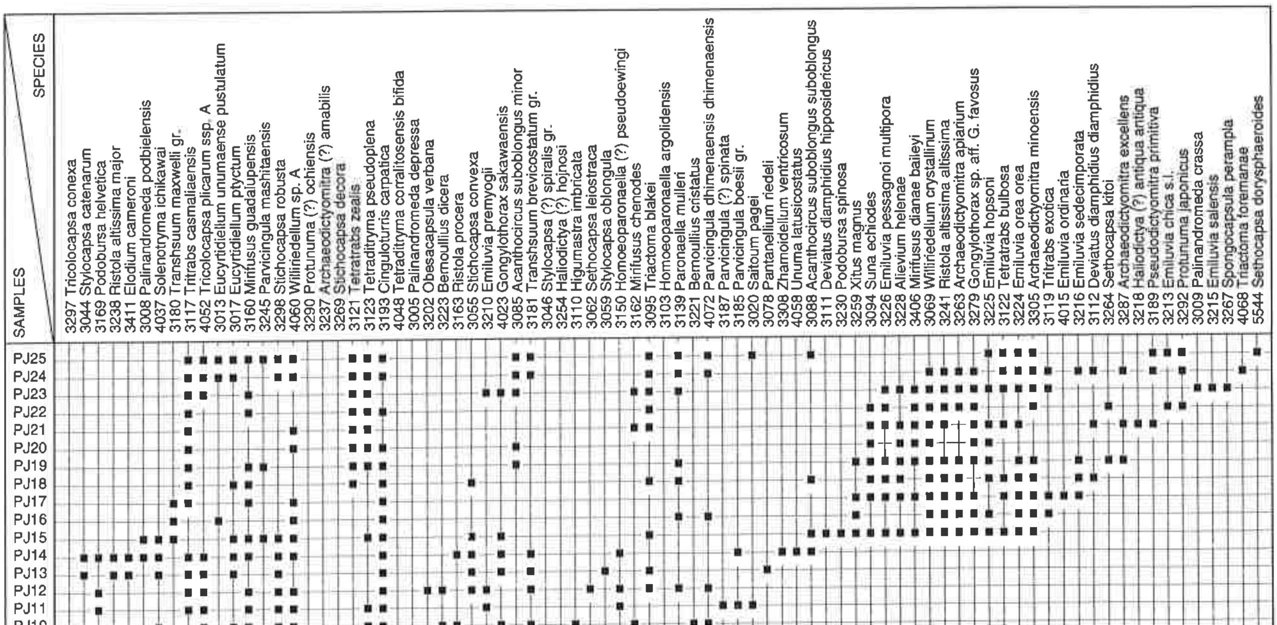


Figure 3. Occurrence of radiolarian species in the Pojorita section arranged in order of their first and last occurences.

PATRULIUS, D. (1969). *Geologia masivului Bucegi si a culoarului Dîmbovicioara* - Editura Academiei R.S.R., Bucarest. 321 p.

PESSAGNO, E.A., BLOME, C. & LONGORIA, J. (1984). A revised radiolarian zonation from Upper Jurassic of western North America. *Bulletins of American Paleontology*, **87** (320), 1-51.

POPESCU, G.R. & PATRULIUS, D. (1964). Stratigrafia Cretacicului si a klippelor exotice din Rarau (Carpatii Orientali). *Anuarul Comitetului Geologic,* **34** (2), 73-130.

PREDA, D.M. & ILIE, M.D. (1940). Nouvelles contributions à la géologie de la cuvette des Carpates de Bucovine. *Compte Rendue de l'Institut Géologique de Roumanie,* **24.**

SANDULESCU, M. (1973). Contributii la cunoasterea structurii geologice a sinclinalului Rarau (sectorul central). *Dari de Seama ale Sedintelor, Institutul Geologic*, **59** (5), 59-92.

SANDULESCU, M. (1976). Contributii la cunoasterea stratigrafiei si pozitei tectonice a seriilor mezozoice din bazinul superior al vaii Moldovei (Carpatii Orientali). *Dari de Seama ale Sedintelor, Institutul geologic*, **62** (5), 149-176.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles,* **80** (3), 317-340.

STANOIU, I. (1966). Asupra prezentei unor calcare liasice în succesiunea depozitelor mezozoice din flancul vestic al sinclinalului Rarau. *Dari de Seama ale Sedintelor, Institutul Geologic*, **52**, 341-352.

STANOIU, I. (1967). Noi date stratigrafice asupra Jurasicului din regiunea valea Tatarca - valea Lucava (partea de nord a sinclinalului Rarau; Carpatii Orientali). *Dari de Seama ale Sedintelor, Institutul Geologic*, **53**, 465-470.

TURCULET, I. (1971). Cercetari geologice asupra depozitelor jurasice si eocretacice din cuveta Rarau - Breaza. *Studii Tehnice si Economice, Institutul Geologic, Serie J.*, **10**, 1-42.

TURCULET, I. (1978). Unele aspecte privind jaspurile din sinclinalul Rarau. *Anuarul Muzeului de Stiinte Naturale din Piatra Neamt, Serie Geologie-Geografie.*, **4**, 81-91.

APPENDIX

Radiolarian inventory of the samples studied in the Pojorita and Piatra Soimului sections. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991)

SECTION 1_POJORITA : bottom 1 - top 21

< 21 {PJ.40}: 3017, 3034, 3069, 3095, 3139, 3160, 3181, 3193, 3224, 3240, 3241, 3305, 3406

< 20 {PJ.25}: 3017, 3020, 3085, 3088, 3095, 3117, 3122, 3189, 3193, 3213, 3224, 3225, 3292, 3305, 4052, 4060, 5544

< 19 {PJ.24}: 3069, 3078, 3085, 3095, 3112, 3119, 3122, 3181, 3189, 3193, 3216, 3224, 3241, 3245, 3263, 3279, 3287, 3292, 3298, 3305, 4052, 4060, 4068, 4072

< 18 {PJ.23}: 3009, 3013, 3017, 3069, 3085, 3095, 3119, 3122, 3139, 3162, 3210, 3215, 3224, 3225, 3226, 3228, 3241, 3263, 3267, 3279, 3305, 3406, 4023

< 17 {PJ.22}: 3017, 3069, 3094, 3095, 3193, 3213, 3226, 3241, 3263, 3264, 3279, 3292, 3305, 3406, 4072

< 16 {PJ.21}: 3069, 3094, 3095, 3112, 3122, 3162, 3189, 3218, 3224, 3226, 3241, 3279, 3287, 3406, 4060

< 15 {PJ.20}: 3069, 3085, 3094, 3122, 3193, 3224, 3226, 3241, 3279, 3406, 4060

< 14 {PJ.19}: 3017, 3069, 3085, 3094, 3117, 3123, 3139, 3193, 3216, 3224, 3226, 3241, 3259, 3263, 3264, 3279, 3287, 3305, 3406

< 13 {PJ.18}: 3017, 3055, 3069, 3088, 3094, 3095, 3112, 3121, 3122, 3139, 3193, 3216, 3224, 3226, 3241, 3263, 3298, 3305

< 12 {PJ.17}: 3017, 3069, 3094, 3119, 3122, 3180, 3193, 3216, 3224, 3226, 3241, 3259, 3263, 3279, 3305, 3406, 4015, 4060

< 11 {PJ.16}: 3069, 3119, 3139, 3193, 3224, 3225, 3241, 3245, 3259, 3263, 3279, 3305, 4060, 4072

< 10 {PJ.15}: 3008, 3017, 3055, 3069, 3088, 3094 3095, 3111, 3117, 3122, 3123, 3193, 3224, 3225, 3226, 3228, 3230, 3241, 3259, 3263, 3279, 3298, 3305, 3406, 4023, 4037, 4052, 4060

< 9 {PJ.14}: 3008, 3013, 3017, 3044, 3055, 3088, 3150, 3160, 3163, 3169, 3180, 3181, 3185, 3193, 3238, 3298, 3308, 3411, 4023, 4052, 4058, 4060

< 8 {PJ 13}: 3008, 3013, 3044, 3055, 3059, 3078, 3095, 3169, 3180, 3181, 3193, 3238, 3298, 4023, 4052

< 7 {PJ.12}: 3013, 3017, 3055, 3062, 3095, 3139, 3150, 3160, 3180, 3181, 3193, 3202, 3210, 3223, 4052, 4060, 4072

< 6 {PJ.11}: 3013, 3017, 3020 3123, 3150, 3160, 3180, 3185, 3187, 3193, 3210, 4052, 4060
< 5 {PJ.10}: 3008, 3013, 3017, 3110, 3123, 3162, 3163, 3181, 3193, 3221, 3223, 3298, 4023, 4052, 4060, 4072
< 4 {PJ. 9}: 3005, 3008, 3013, 3017, 3044, 3046, 3055, 3059, 3062, 3085, 3095, 3103, 3110, 3121, 3123, 3139, 3150, 3160, 3162, 3180, 3181, 3193, 3210, 3237, 3238, 3254, 3269, 3298, 4052, 4060
< 3 {PJ. 8}: 3005, 3008, 3013, 3017, 3044, 3055, 3085, 3160, 3163, 3169, 3180, 3181, 3202, 3210, 3223, 3238, 3298, 3411, 4023, 4048, 4052, 4060
< 2 {PJ. 7}: 3008, 3013, 3044, 3117, 3121, 3123, 3160, 3169, 3180, 3193, 3237, 3238, 3269, 3290, 3298, 3411, 4037, 4052, 4060
< 1 {PJ. 6}: 3008, 3013, 3017, 3044, 3117, 3160, 3169, 3180, 3238, 3245, 3297, 3298, 3411, 4037, 4052, 4060

SECTION 2_PIATRA-SOIMULUI: bottom 1 - top 1
< 1 {R.102}: 3013, 3017, 3069, 3070, 3085, 3095, 3100, 3103, 3118, 3119, 3121, 3122, 3123, 3129, 3137, 3139, 3160, 3161, 3163, 3181, 3182, 3187, 3193, 3210, 3224, 3241, 3245, 3259, 3263, 3267, 3279, 3292, 3298, 3305, 4023, 4060, 4072

25. Jurassic-Lower Cretaceous Radiolarians from the Caucasus and the Carpathians

by Valentina S. Vishnevskaya

Institute of Litosphaera, Staromonethyiper. 22, Moskova, 109017, Russia

ABSTRACT

The Mesozoic radiolarian fauna of the Caucasus (Russia, Armenia, Azerbaijan, Georgia) and Carpathians (Ukraine) are of stratigraphic interest because radiolarians, calpionellids, ammonites and aptychi occur together in the same beds. This Pliensbachian-Albian radiolarian fauna belongs to the Tethyan Realm. The discovery of radiolarian-bearing sediments in non-ophiolite successive sequences in the Caucasus (Vishnevskaya, 1984) permitted both a more precise determination of radiolarite age from ophiolitic complexes and also the opportunity to make an important contribution to the development of a global radiolarian correlation.

1. Introduction

Mesozoic radiolarian faunas of the Koryak mountains, Kamchatka and Sikhote-Alin (Russia, NE Asia) range in age from Hettangian to Maastrichtian and are distinguished by belonging to the Tethyan and Boreal Realms. Radiolarians are often closely associated with buchias, and more rarely they are found with ammonites. In the Pacific region, radiolarian data represent an important tool not only for age determination but also for interpreting paleoenvironments and faunal provinces. Moreover, radiolarians play a major role in identifying and positioning the tectonic plates which, although presently amalgamated and juxtaposed in the north and Far East of Russia, may have been far from one another and from continental Northwest Pacific at the time of their formation.

The study of the Mesozoic radiolarian biostratigraphy of the former USSR has advanced rapidly during the past two decades. In the former USSR, a pioneer study of Mesozoic radiolarians was made by Lipman (1952), as well as by Zhamoida *et al.* (1963) in the Koryak mountains. At that time each radiolarian was investigated in thin sections without using either chemical preparation techniques or the scanning electron microscope. Since then numerous researchers have described many radiolarian assemblages and data is summarised by Vishnevskaya & Kazinova (1989), Vishnevskaya (1990, Basov & Vishnevskaya (1991) and Vishnevskaya & Filatova (1992).

The faunas documented in this paper include only part of the afore-mentioned published summaries. All the radiolarian faunas were extracted from pelagic cherty limestone, chert and jasper by means of treating chemically with hydrofluoric and other acids.

2. Regional and local tectonic setting

Three types of radiolarian-bearing rock sequences are identified based on their sedimentological and tectonic setting: (1) the marginal type, with chert successions always associated with carbonate rocks; (2) the island-arc type, with jasper often associated with tuff or terrigenous tuffaceous sediments; (3) the oceanic (possibly near spreading centres) type, with pelagic or hemi-pelagic ribbon chert and jasper alternating with siliceous argillite, more rarely pelagic limestone and frequently associated with pillow basalts. This sequence may be occasionally associated with distal turbidites or arc-related rocks.

The first type is best represented in the Great Caucasus and in the framing of the Lesser Caucasus ophiolitic belt. The second type occurs in places in the Caucasus but is more widespread in the north east of Russia where it may be a part of prisms or of an accretionary wedge. The third type is well represented both in the Lesser Caucasus, where it can be joined with ophiolite successions or involved in a mélange zone, and in the Koryak mountains where it comprises discrete tectono-stratigraphic terranes.

3. Lithostratigraphy

In the Tethyan region of the former USSR, the radiolarian-bearing rocks of the Greater and Lesser Caucasus belong to the northern branch of the Alpine orogenic fold-belt which stretches from the Apennines through the Alps into the former Yugoslavia and then Greece. It then extends further eastwards along the southern boundary of the Pontides of Turkey, into Georgia, Armenia, Azerbaijan and the southern part of Russia (Fig. 1).

The Jurassic-Lower Cretaceous siliceous limestones with chert nodules or chert inter-layered with clay were deposited in the pelagic open-ocean and marginal basins (sections: 1. Gagomys River, 2. Tuapse River, 4. Koshuni River, 5. Mt. Susuzlukh) and on seamounts, where they are associated with basalt and turbidites (section 3. Mt. Karawul). In the eastern Tethyan area they were studied for radiolarians.

In total, more than 1000 samples (including 42 from the above-mentioned sections) were examined. These were recovered from 25 land sections in Russia (three sections including those of Tuapse and Dagomys rivers), Georgia (2 sections), Armenia (three sections including Koshuni River), Azerbaijan (seventeen sections including Karawul and Susuzlukh mountains). About 200 taxa (species) have been identified.

The data on the detailed geological interpretations of the sections (Fig. 1) and samples (Fig. 2) as well as an outline of the associated problems can be obtained by referring to

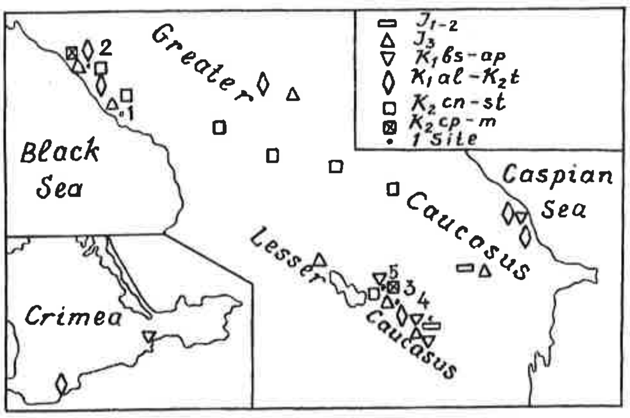


Figure 1. Map showing the location of simplified columnar sections represented in Fig. 2.

Vishnevskaya (1975, 1992).

The oldest Jurassic radiolarian associations in the Caucasus were found in the southern part of the Lesser Caucasus. The first discovery was made at the bottom of the cored hole at Site 22, drilled in the Koshuni River valley of Armenia (Fig. 2). The radiolarian-bearing strata are represented by grey cherts interbedded with siliceous argillite. Based on radiolarians, these strata can be placed in the interval from the Pleinsbachian to Toarcian (Sample 3430 T). Lithologically similar horizonswith the same radiolarian assemblages are widespread in the Alaverdi area of Armenia where these strata are overlain by argillites containing rare ammonites such as *Aegoceras henley* SOWERBY and *Dactylioceras commune* SOWERBY.

Younger Middle Jurassic Bajocian-early Callovian strata occur in the overlying middle part of the Koshuni River sections (samples 3429-3421, the interval is 60 m thick). They are composed of chert inter-layered with siliceous and tuffaceous aleurolite (siltstone) and sandstone. In the Alaverdi area (the Vascepar River section) of Armenia, the strata with the same radiolarian assemblages are represented by the alternation of siliceous argillites with tuffs containing abundant well-preserved ammonite faunas: *Parkinsonia parkinsoni* SOWERBY, *Oppelia subradiata* SOWERBY, *Posidonia buchi* ROEM.

The middle Callovian-Oxfordian siliceous deposits (chert and siliceous limestone) are exposed in the western part of the Greater Caucasus (Dagomys River, stratigraphic section 1, Sample 1076-1B, Fig. 2), and in the eastern part of the Lesser Caucasus (Mt. Karawul, stratigraphic section 3, Fig. 2). They are represented by alternations (from 40 to 100 metres) of chert or siliceous limestone with chert nodules, with turbidite limestone, spiculite or siliceous aleurolite. These sediments have yielded the ammonites *Helticoceras pseudopunctatum* LAH., *Ptychophylloceras mediterraneum* NEUMAYR, *Neoticoceras lumula* (ZITTEL), *Sowerbyceras tortisulcatum* D'ORBIGNY. Upwards, the late Oxfordian chert radiolarite sediments give way to limestone with chert, and then these pelagic facies are progressively replaced by shallow-water sediments. In the Mt. Karawul section the uppermost Oxfordian sediments are absent and the existence of a stratigraphical gap has been confirmed. Towards the Bagirsakh section (Vishnevskaya, 1984), calciturbidites and carbonate breccias containing reef organisms are present in this interval, and are subsequently replaced by reef coral limestones. The Kimmeridgian radiolarian-bearing siliceous limestones and chert (stratigraphic section 1: Sample 1077-2; 3: 139-37; 5: 121-7; Fig. 2) form an extended horizon about 50-250 km thick that yields, in places, the ammonite faunas: *Ochetoceras canaliculatum* BUCH., *Peltoceras transversarium* QUENSTED and rare single corals: *Dermosmilia laxata* (ETALLON), *Epistreptophyllum bonjori* (ETALLON), *Callamorphilia kurvakensis* BABAEV. Siliceous limestones are represented here and there by shallow-water varieties, often highly mixed up with volcanic materials.

The Tithonian radiolarian fauna was recovered from micritic and detrital cherty limestone with chert nodules which is followed by thin layers of limestone and rarely aleurolite turbidites of the lowermost part of Mt. Sasuzlukh (stratigraphic section 5, Fig. 2) in the Lesser Caucasus. The limestones often contain the aptychi: *Lamelaptychus lamellosus* (PARKINSON), *L. mortilleti* (PICTET & LORIOL), *Aptychus Lamellosus* QUENSTED and others as well as abundant radiolaria associated with siliceous sponge spicules. The entire siliceous limestone sequence of the Dagomys River in the Greater Caucasus, illustrated as stratigraphic section 1 (Fig. 2) Sample 1079-1E, contains Tithonian radiolarians. In the Mt. Karawul section, the Tithonian interval is represented by highly siliceous limestone altered with aleurolite chert.

The Mt. Susuzlukh section shows nearly continuous exposures ranging in age from Late Kimmeridgian to Early Turonian. According to our field work along the Agchey and Tekjkayachay Creeks, the Berriasian-mid Valanginian interval (section 5, Sample 065-59, Fig. 2) includes about 100-200 m of light-grey siliceous limestone with numerous siltstone interbeds. Chert nodules and lenses with impure limestone or rimmed by a band of limestone, often containing abundant radiolaria and sponge spicules, predominate. Ammonites and their aptychi from the limestone of this interval include *Berriasella pauyannei* (POM.), *Punctaptychus punctatus* (VOLTZ), *Lamellaptychus beyrichi* (OPPEL).

The overlying Upper Valanginian to Hauterivian strata at Mt. Susuzlukh are about 200 m thick and include a succession of dark-grey limestones with a variable amount of interbedded siliceous limestone and impure black chert nodules yielding well preserved radiolaria (section 5, Sample 052-2B, Fig. 2).

This part of the succession contains rare aptychi of *Lamelaptychus angulicostatus* TROUTH, such megafossils as belemnite *Hibolites subfusiformis* and the microfossils including foraminifera *Hedbergella hoterivica* and *Gavelinella* spp.

The Barremian-Aptian radiolaria were obtained from dark-grey to black clay limestones with chert nodules (about 100 m thick) lying directly over the previously described interval from the Mt. Susuzlukh section (Sample 124-90, Fig. 2). In clayey, slightly cherty limestones of this stratigraphical unit (Section 5), radiolarians are found together with the planktonic foraminifer *Hedbergella hoterivica* and the belemnite *Neohibolites ewaldi* (STROMBECK).

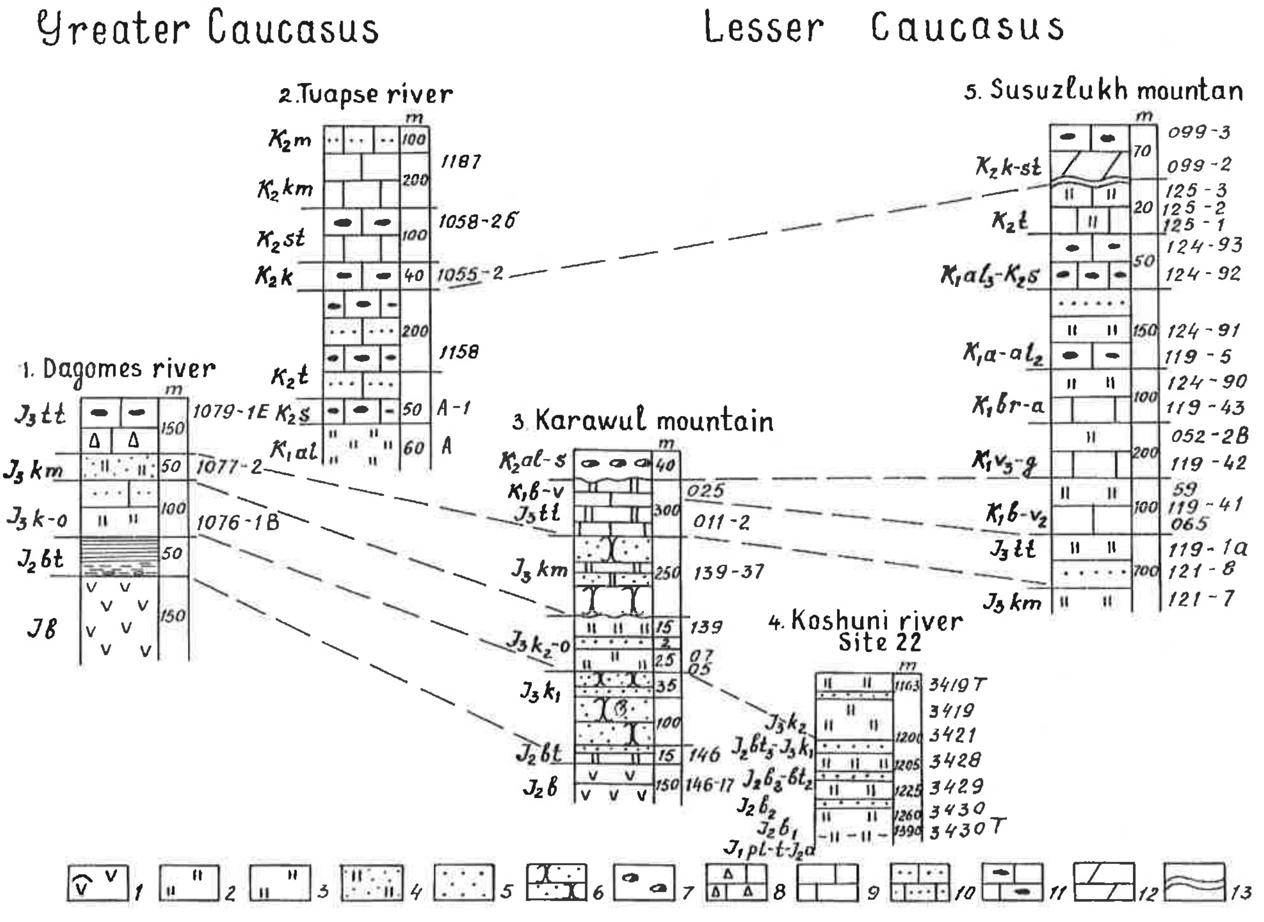


Figure 2. Biostratigraphic correlation of sections with indication of sites where the main samples were taken. **1.** Andesite and basalt; **2.** Argillite; **3.** Chert and jasper; **4.** Siliceous aleurolite; **5.** Aleurolite (siltstone); **6.** Sandstone; **7.** Conglomerate; **8.** Limestone: Breccial; **9.** Massive, **10.** Siltstone, **11.** Limestone with chert nodules; **12.** Marl; **13.** Stratigraphic gap or hiatus.

The Aptian-Middle Albian radiolarians were found in the upper part of Section 5, Sample 119-5 (Fig. 2) within black chert nodules between pelagic limestone (60-150 m) where they co-occur with planktonic foraminifera *Hedbergella trocoidea, H. quadricamerata* and *H. infracretacea.*

The Late Albian-Cenomanian radiolarians were collected in the upper part (about 50 meters) of Mt. Susuzlukh from the organic-rich limestone and mudstone and from the black chert nodules (Section 5, Sample 124-92). Up the section, these deposits seem to represent a regression cycle with increasing anoxia. This unique event resulting in the radiolarian-rich layers is of global character. The chert horizon about 50-60 m thick is wide-spread in the Lesser and Greater Caucasus (see the lower part of Stratigraphic Section of the Tuapse River 2 of the Tuapse River, Fig. 2). Here radiolarians always occur with the planktonic and benthic foraminifera *Praeglobotruncana ultimus*, *Gumbelitria cenomana*, *Anomalina cenomana*, and others.

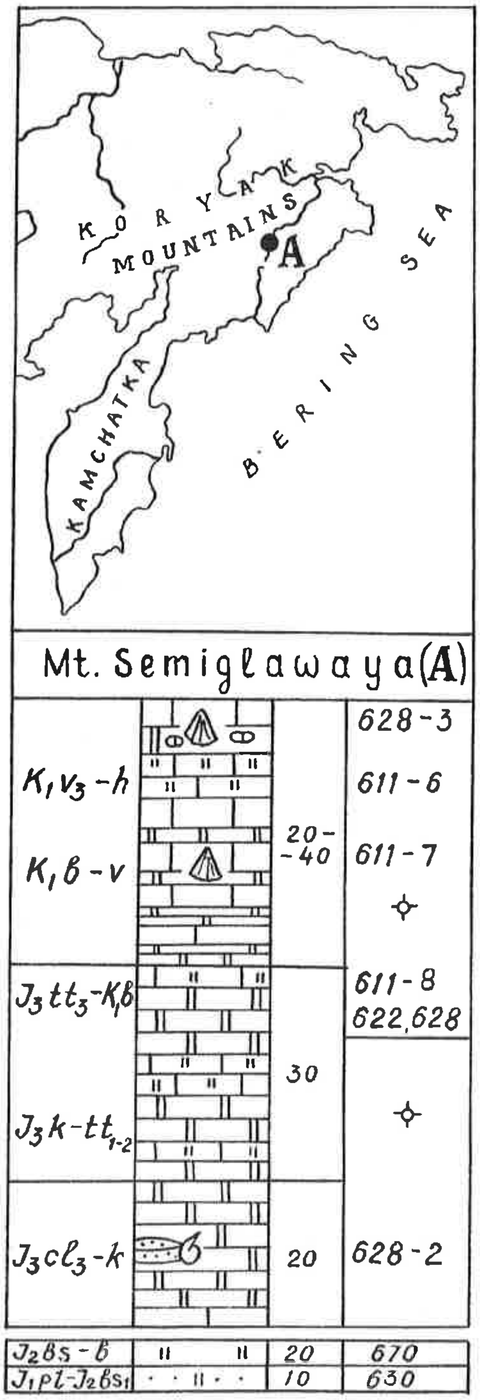


Figure 3. Map showing the section (A) of the Pacific Rim with sampling and stratigraphic position of radiolarians, ammonites and buchias.

About 3000 sample of jasper, chert and siliceous limestone were collected for radiolarian analyses in the course of the mapping project (1:50.000 - 1:200.000) and thematic investigations in the Koryak mountains, Kamchatka, Sikhote-Alin and Sakhalin (Russia). The carbonate rocks often yielded Buchias, whereas the siliceous rocks yielded only radiolarians.

All the radiolarians were extracted from the jasper and chert samples using Hydrofluoric acid (5-100%). The age of the samples was determined with the help of the concurrent range zones. Some radiolarian ages were controlled by other microfaunas.

A rich radiolarian fauna was found in Mt. Semiglavaya of the Koryak Mountains (NE Russia). The best sequence is represented in Fig. 3. The majority of the siliceous horizons were dated by radiolarians ranging in age from Bajocian to Hauterivian. The early Callovian ammonites *Choffatia* cf. *lunula*, *Putaelicras zieteni* were found in calcareous turbidites underlying the middle Callovian-Kimmeridgian radiolarian-bearing sequence (Vishnevskaya *et al.*, 1991). Silicified limestone levels overlying this sequence yielded the following Buchias: *Buchia inflata*, *B. sibirica*, *B. crassa*, *B. fisheriana*, *B. volgensis*, *B. keyserlingi*, mainly of late Tithonian-Valanginian age. The uppermost part of the sequence is represented by limestone containing the Hauterivian inoceramid species *Inoceramus* ? *colonicus*. The Early Jurassic sequence contains no fossils other than radiolaria.

4. Biostratigraphy

Hettangian-Sinemurian. The *Parahsum simplum* concurrent range zone is identified in the chert sequence from the Koryak mountains of Russia (Fig. 3). The base of the zone (Hettangian) is recognised by the first appearance of *Parahsum simplum* and the absence of *Triassocampe* and *Yeharaia*. Its top (Sinemurian) is defined by the final appearance of *Paleosaturnalis* and *Multimonilis*. This zone is believed to be approximately the equivalent of the Japanese *Parahsuum simplum* Zone (Hori, 1990; Mizutani & Yao, 1990).

At the base of the Caucasian sediments (Site 22) Pliensbachian-Toarcian *Parahsuum cruciferum-Trillus elkhornensis* concurrent range zone is undetermined. The main species of this zone include *Crubus wilsonensis* CARTER, *Parvicingula* (?) *gigantocornis* KISHIDA & HISADA, *Hsuum minoratum* SASHIDA. The top of this zone is characterised by the final appearance of *Bipedis* DE WEVER, *Katroma bicornis* DE WEVER. The presence of the ammonites *Aegoceras henley* SOWERBY from the time-equivalent area confirmed the radiolarian age.

The Pleinsbachian-early Bajocian *Laxtorum jurassicum* zone is singled out in the Koryak mountains (the Mt. Semiglavaya sequence). The base is undetermined (there is no subjacent fauna to provide a basis for definition); the top of the Zone is marked by the final appearance of *Zartus dickinsoni* PESSAGNO & BLOME, *Canoptum anulatum* PESSAGNO & POISON, *Laxtorum jurassicum* ISOZAKI & MATSUDA.

The base of the Aalenian-mid Bajocian interval sediments Caucasian (Site 22) *Lupherium officerence-Eoxitus hungaricus* Zone is recognised by the first appearance of *Eoxitus* KOZUR, and the top is marked by the final appearance of *Lupherium* PESSAGNO & WHALEN.

The late Bajocian-middle Bathonian *Transhsuum medium* range Zone is recognised in the Caucasus sequence (Site 22). The base is placed immediately above the final appearance of *Lupherium* s.s. and the first appearance of *T. medium*. The top of the zone is marked by the final appearance of *Parvicingula aculeata* CARTER. Ammonites *Parkinsonia parkinsoni* SOWERBY found in the coeval strata of Armenia are zonal markers for the late Bajocian interval.

The late Bajocian-early Bathonian *Bagotum maudense* Zone was defined in the Koryak mountains in the Far East of Russia (Mt. Semiglavaya). The base is recognised by the first appearance of abundant representatives of the genera *Bagotum, Canutus* and of the Family Amphipyndacidae RIEDEL. The top of the zone is marked by the final appearance of *Bagotum maudense*, *Canutus* s.s., *Droltus* s.s., *Canoptum* s.s.

The base of the late Bathonian-early Callovian Caucasian *Ristola turpicula-Hsuum lupheri* Zone is marked by the first appearance of *R. turpicula* and the final appearance of *H. lupheri* marks its top.

The base of the Late Bathonian-early Callovian Koryakian *Parvicingula vera-Ristola turpicula* Zone is also recognised by the first appearance of *R. turpicula*, but the top of the zone is marked by the final appearance of the genera *Milax* and the common occurrence of *P. vera*.

The middle Callovian-Oxfordian Caucasian *Hsuum maxwelli-Cinguloturris carpatica* Zone is established in the Lesser Caucasus sequences (Mt. Karawul). The base is recognised by the first appearance of *C. carpatica* DUMITRICA, *Mirifusus dianae* (KARRER), and the top is marked by the final appearance of *C. carpatica* DUMITRICA. and *H. maxwelli*. Ammonites *Helticoceras pseudopunctatum* LAH. were collected in these strata.

The base of the middle Callovian-middle Tithonian Koryak *Mirifusus fragilis-M. dianae* Zone is recognised by the first appearance of *Bernoullis cristatus* and *M. dianae,* and the top of the zone is marked by the final appearance of *M. fragilis* and of the genus *Hsuum*. The ammonites *Choffatia* were found in the underlying sandstone.

The base of the late Oxfordian-Kimmeridgian Caucasian *M. dianae -M. fragilis* Zone is recognised by the first appearances of *M. dianae , Sethocapsa cetia, Emiluvia orea, Syringocapsa rotunda*, the top (the end of Kimmeridgian) is marked by the final appearance of *M. fragilis.*

The base of the Tithonian Caucasian *Triactoma tithonianum-Ristola altissima* Zone is recognised by the first appearance of *Pseudodictyomitra carpatica*, the top is marked by the final appearance of *R. altissima* and of the genus *Hsuum*. The abundance of *Triactoma tithonianum* and *T. echiodes* is marked here. Aptychi from the ammonites *Aptychus lamellosus* QUENSTED and *Punctaptychus punctatus* VOLTZ were collected together with radiolarians.

The base of the late Tithonian-early Berriasian *Mirifusus baileyi-Parvicingula khabakovi* Zone of the Koryak mountains is recognised by the first appearances of *Parvicingula khabakovi, Pseudodictyomitra ? carpatica, P. primitiva* and *Ditrabs sansalvadorensis*. The top of the zone is marked by the final appearance of *Mirifusus baileyi.*

The base of the Berriasian-early Valanginian Caucasian *Podobursa polylophia-Pseudodictyomitra cosmoconica* Zone is determined by the first appearances of *Pseudodictyomitra cosmoconica, Ristola cretacea, Ditrabs sansalvadorensis* and *Pantanellium berriasianum,* and *Xitus clivosa*; the top is marked by the final appearance of *Podobursa polylophia*. The Ammonites *Beriasella paunnei* (POM.) were recovered from radiolarian-bearing strata in Mt. Susuzlukh.

The base of the late Berriasian-middle Valanginian Koryak *Dibolochras tytthopora* Zone is recognised by the first appearance of abundant species of *Pseudodictyomitra, Xitus,* and *Dibolachras tytthopora.* The top of the zone is marked by the final appearance of the majority of species of the genus *Parvicingula*. The mutual presence of radiolarians and the above-mentioned Buchias confirms the age and indicates that this radiolarian fauna is of North-Tethyan affinity.

The base of the middle Valanginian-Hauterivian Caucasian *Cecrops septemporatus-Sethocapsa uterculus* Zone is defined by the first appearances of *C. septemporatus, Thanarla elegantissima*, the top of the zone is marked by the final appearances of *Archaeodictyomitra, Sethocapsa uterculus* and parvicingulid species Some aptychi and the belemnite *Hibolites subfusiformis* as well as the foraminifera *Hedbergella hoterivica* were collected within these strata.

The base of the middle Valanginian-Hauterivian Koryak *Cecrops septemporatus-Mirifusus chenodes* Zone is recognised by the first appearances of *Cecrops septemporatus*, *Thanarla elegantissima*, *Mirifusus chenodes*, the top of the zone is marked by the final appearance of the last species of *Parvicingula*.

The base of the Barremian-Aptian Caucasian *Crolanium pythiae-Xitus alievi* Zone is recognised by the first appearance of *Crolanium pythiae*, and the top of the zone is defined by the final appearance of *Xitus alievi.*

The base of the Aptian-Middle Albian Caucasian *Thanarla conica-Acaeniotyle umbilicata* Zone is identified by the first appearance of *T. conica*, the top of the zone is marked by the final appearances of *C. pythiae, C. cuneatus, C. triquetrum,* and *A. umbilicata*.

The base of the Late Albian-Cenomanian Caucasian *Pseudodictyomitra pseudomacrocephala-Holocryptocanium barbui* Zone is recognised by the first appearance of *P.*

pseudomacrocephala, the top of the zone is marked by the last occurrence of *Holocryptocanium barbui*.

5. Paleobiogeography

The study of biolithofacies, the diversity of assemblages and the morphological structure of walls in radiolarian skeletons (Vishnevskaya, 1990) of the Mesozoic radiolarian-bearing formations of the Caucasus and the Pacific Rim region allowed us to reconstruct the original depositional environments for radiolarian-bearing rocks.

Many discoidal forms with long spines and high taxonomic and morphological variety among the Hettangian-Sinemurian radiolarians from the Koryak Mountains may be interpreted as indicative of warm waters, i.e. there is a good correlation with the low-latitude radiolarian assemblages of the European Alps (De Wever, 1982; Baumgartner, 1984; Baumgartner *et al.*, 1980) and of the Japanese Islands (Hori, 1990).

The Pliensbachian-early Bajocian radiolarian assemblages of the *Laxtorum jurassicum* Zone, in contrast to the coeval Caucasian association, include many species strikingly similar to those of North America (Carter *et al.*, 1988) and to those of the Sub-Boreal or non-Tethyan of New Zealand (Sporli *et al.*, 1989). The higher paleolatitude character of these faunas is proved by low pantanellid and high parvicigullid diversity. A special diversity of "high-conical" forms of *Parvicingula* of late Bajocian-early Bathonian age from the Koryak mountains seems to also indicate a North Tethyan affinity.

The broad analyses of morphological trends in Radiolaria and the dominance of the genera *Mirifusus* and *Parvicingula* show the North Tethyan or South Boreal Realms affinities of the majority of the Koryak assemblages during the Middle Jurassic-Early Cretaceous. The Callovian-Hauterivian radiolarian faunas of the Koryak mountains reveal the Central Tethyan or Equatorial and Tethyan affinities as being closely related to the Caucasian and to the American faunasdescribed by Pessagno *et al.* (1986), Pessagno & Mizutani 1992).

In contrast to the Boreal, the warm water provenance of this fauna is proved by the presence of genus *Ristola* together with several species of the genera *Pantanellium* and *Acanthocircus*, and also by the high diversity accompanied by the complicated sculpture of the shell surface.

6. Conclusion

The Pleinsbachian-Albian radiolarians of the Caucasus are closely associated with well-preserved macro- and microfaunas. They can be useful for dating the ophiolite sequences of Tethys and other regions, as well as for global correlation of radiolarian-bearing sections.

The Hettangian-Hauterivian radiolarians of the Koryak Mountains from the northern and Far East Russia are distinguished by their intimate relations with such types of Boreal and North Tethyan faunas as Buchias since the Kimmeridgian times. Ammonite paleogeographic studies show a strong Tethyan influence in Callovian times. All the Koryak faunas have strong Pacific endemic components which are represented by the *Yeharaia* in the Triassic restricted to the Western Pacific Rim (Russia, China, Japan, the Phillippines), by "high-conical" forms of the genus *Parvicingula* with a horn in the Jurassic-Early Cretaceous widely spread in the Circum-Pacific Rim and in Boreal areas of Central Russia, Norway, possibly in West Australia and the eastern part of Indian Ocean (Site 765, Argo Abyssal Plain; Site 766, Exmouth Plateau; Baumgartner, 1992). The existence of mixed radiolarian faunas, containing the Tethyan and Boreal elements, in the Koryak mountains of NE Russia can be useful for correlation of Tethyan and Pacific zonation schemes, as well as promoting much in elaboration of the global radiolarian scale being applied both to the Mesozoic sediments of the ocean bottom and orogenic belts.

References

Basov, V.A. & Vishnevskaya, V.S. (1991). Upper Mesozoic stratigraphy of the Pacific Ocean. *Circum-Pacific Council for Energy and Mineral Resources* - Nauka, Moscow, 200 p. *(in Russian)*

Baumgartner, P., De Wever, P. & Kocher, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

Baumgartner, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

Baumgartner, P.O. (1992). Lower Cretaceous radiolarian biostratigraphy and biogeography off northwestern Australian (ODP sites 765 and 766 and DSDP site 261), Argo abyssal plain and lower Exmouth Plateau. *In* Gradstein, F.M., Ludden, J.N. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results* - College Station, TX (Ocean Drilling Program), **123**, 299-342.

Carter, E.S., Cameron, B.E.B. & Smith, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

De Wever, P. (1982). Radiolaires du Trias et du Lias de la Tethys (Systématique, Stratigraphie). *Société Géologique du Nord, Publication*, **7**, 1-599.

HORI, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the palaeontological Society of Japan, new Series*, **159**, 562-586.

LIPMAN, R.K. (1952). Data on the monographic study of the radiolarians of the Upper Cretaceous deposits of the Russian Platform. *Transactions of the All Union Scientific Research Institute of Geology (VSEGEI), Paleontology and Stratigraphy*, 24-51. (*in Russian*)

MIZUTANI, S. & YAO, A. (1991). Radiolarians and terranes: Mesozoic geology of Japan. *Episodes*, **14**, (3), 213-216.

PESSAGNO, E.A. & MIZUTANI, S. (1992). Radiolarian biozones of North America and Japan. *In* Westerman, G.E.G. Ed. *The Jurassic of the Circum-Pacific* - Cambridge University Press, New York, 293-295 and 578-585.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

SPÖRLI, K.B., AITA, Y. & GIBSON, G.W. (1989). Juxtaposition of Tethyan and non-Tethyan Mesozoic radiolarian faunas in melanges, Waipapa Terrane, North Island, New Zealand. *Geology*, **17** (8), 753-756.

VISHNEVSKAYA, V.S. (1975). About age of Sevan-Akera Lesser Caucasus radiolarites. *Doklady Akademii Nauk SSSR*, **224** (6), 1381-1383. (*in Russian*)

VISHNEVSKAYA, V.S. (1984). *Radiolarites as analogues of contemporary oozes* - Nauka, Moscow, USSR, 118 p. *(in Russian)*

VISHNEVSKAYA, V.S. (1990). Albian-Cenomanian radiolarians from northwestern Pacific Regions, a tool for Paleotectonic reconstruction. *Geology of the Pacific* - Doklady Akademii Nauk SSSR, **2**, 3-16.*(in Russian)*

VISHNEVSKAYA, V.S. (1992). Significance of Mesozoic radiolarians for tectonostratigraphy in Pacific Rim terranes of the former USSR. *In* Aitchison, J.C. & Murchey, B.L. Eds. *Significance and application of Radiolaria to terrane analysis* - Special Issue: Palaeogeogaphy. Palaeoclimatology Palaeoecology, Elsevier, Amsterdam, **96** (1-2). (23-39).

VISHNEVSKAYA, V.S. & FILATOVA, N.I. (1992). Sedimentary paleoenvironments for the middle Mesozoic formations in the Anadyr-Koryak region. *Geologia i Razvedka*, **1**, 29-49. (*in Russian*)

VISHNEVSKAYA, V.S., FILATOVA, N.I. & DVORYANKIN, A.I. (1991). New data on Jurassic sediments of Semiglavaya Mountain (Koryak Highland). *Izvestija Akademii Nauk SSSR, serija geologiceskaja*, **4**, 21-30. (*in Russian*)

VISHNEVSKAYA, V.S. & KASINZOVA, L.I. (1989). Cretaceous radiolarians from USSR. The use of radiolarians in stratigraphy and paleobiology. *Sverdlovsk*, 44-58. (*in Russian*)

ZHAMOIDA, A.I. (1972). Biostratigraphy of the Mesozoic siliceous strata of the east of the USSR (as based on the study of Radiolaria). *Trudy Vsesoyuznogo Ordena Lenina Nauchno-Issled ovatelskogo Geologicheskogo Instituta (VSEGEI), n. Ser.*, **183**, 1-199. (*In Russian*)

ZHAMOIDA, A.I., LIPMAN, R.K., MIKHAILOV, A.F. & TITOV, V.A. (1963). Age of silico-volcanic deposits from the Koryak Plateau using radiolarians. *Data for theGeology of the Far East and Trans Baikal Area* - Trudy VSEGEI, new Series. **81**, 75-103. *(in Russian)*

26. Upper Jurassic to Lower Cretaceous Stratigraphy of Hokkaido, Japan

by Norio Kito

Institute of Earth Sciences, College of General Education, Hokkaido University of Education, 1-2 Hachiman-cho, 040 Hakodate, Japan

ABSTRACT

Examined sections of the Sorachi and the Lower Yezo Groups, central Hokkaido, Japan, are described. The Sorachi Group is composed of greenstones (the lower part) and siliceous sedimentary rocks accompanied by intermediate to acidic volcaniclastics (the upper part). The Lower Yezo Group composed of turbidites conformably overlies the Sorachi Group. The upper part of the Sorachi Group and the Lower Yezo Group yield Late Jurassic Early Cretaceous radiolarians.

1. Geological setting

In this study, the Upper Jurassic to Lower Cretaceous Sorachi Group and the Yezo Supergroup, exposed in the Sorachi Yezo Belt of central Hokkaido, are examined for radiolarian biostratigraphy. Three areas (Teshio, Furano and Ashibetsudake), where the stratigraphical succession is less disturbed, are selected for study.

The Sorachi Yezo Belt, occupying central Hokkaido (Fig. 1), is composed of two geological units, one the Sorachi Group and the other the Yezo Supergroup. The Sorachi Group is made up mainly of greenstone, acidic to intermediate volcaniclastic rock and siliceous rock. The group yields many radiolarians. A few megafossils of Late Jurassic to Early Cretaceous age have also been recovered from sporadically intercalated limestone. The overlying Yezo Supergroup, divided into the Lower, Middle, Upper Yezo Group and Hakobuchi Group, is composed of thick (10'000 meters maximum thickness) siliciclastic sedimentary rock. Flysch facies is dominant in the lower portion of the supergroup, while shallow marine facies is dominant in the middle to upper portion (Ando, 1990a, b). Excepting the Lower Yezo Group, the supergroup is biostratigraphically well-defined by ammonites, inoceramids (e.g. Matsumoto, 1977), Foraminifera (e.g. Maiya & Takayanagi, 1977), which allow correlation with the Upper Cretaceous to Paleogene. Based on these biostratigraphical works, Taketani (1982) established a radiolarian biostratigraphy for the Upper Cretaceous. However the Lower Yezo Group is very poor in fossils except for the Orbitolina Limestone (Aptian to Albian) of the upper portion of the group. The boundary between the Sorachi and the Lower Yezo Group is believed to be Valanginian to Barremian in age based on Radiolaria (Kito, 1987). Serpentinite including "mélange" facies is exposed in the central zone of the belt.

To the west of the Sorachi Yezo Belt is the Oshima Belt which is composed of Jurassic/Cretaceous "mélanges" which contain allochthonous blocks of greenstone, Carboniferous, Permian and Triassic limestone, and Jurassic chert blocks in a muddy matrix, together with Lower Cretaceous granitic intrusions and andesitic volcanic rock. These igneous rocks indicate that the belt was a magmatic arc at least in Early Cretaceous time.

To the east of this belt lies the Hidaka Belt which is composed of Early-Late Cretaceous to Paleogene "mélanges" containing allochthonous greenstone, limestone and chert blocks of various age (Permian to Cretaceous) and Upper Cretaceous greenstones from *in-situ* volcanism (Kiminami *et al.* 1986b).

2. Tectonic setting

Mesozoic terrains of Hokkaido consist of the Oshima Belt, the Sorachi-Yezo Belt, the Hidaka Belt, the Tokoro Belt and the Nemuro Belt (Kiminami *et al.*, 1986a; Fig. 1). Recent reconstruction of the tectonic history of Mesozoic Hokkaido is based on the plate tectonics theory. The Oshima, Sorachi-Yezo and Hidaka Belts are considered to have formed as an arc-trench system with westward subduction (Okada, 1974; Kiminami & Kontani, 1983; Komatsu *et al.*, 1983; Niida & Kito, 1986, etc.). The following interpretations are generally accepted;

i) "Mélanges" of the Oshima Belt were formed by westward subduction during Jurassic time.

ii) Greenstone of the Sorachi Group represents the upper part of Jurassic oceanic crust which was trapped or accreted at a continental margin.

iii) The westward subduction caused the Early Cretaceous igneous activity of the Oshima Belt.

iv) The Yezo Supergroup is a Cretaceous forearc sediment.

v) The "mélanges" of the Hidaka Belt were formed by westward subduction during Cretaceous to Paleogene time.

The Sorachi-Yezo Belt is considered to be composed of trapped oceanic crust (lower part of the Sorachi Group) and thick forearc sedimentary rocks (the Yezo Supergroup).

Greenstones of the Sorachi Group are petrochemically classified into 3 categories, mid-oceanic ridge basalt, alkaline basalt and low K2O-type alkaline basalt (Niida & Kito, 1986). The first two types of basalt consist of oceanic crust. The third type, intercalated in the S3 Formation (see below), is inferred to be from primitive arc volcanism (Niida, 1992). Abundant radiolarian remains in the group suggest deep water depositional environments. Acidic to intermediate volcanic materials are inferred to be derived from the magmatic arc of the Oshima Belt (Kiminami *et al.*, 1985; Kiminami *et al.*, 1987; Girard *et al.*, 1991).

The beginning of the sedimentation of the Yezo Supergroup suggests that a large amount of siliciclastic debris was supplied by turbidity currents. Kiminami (1986) suggests that the sedimentation corresponds to the upheaval of the Oshima Belt which is composed of older sedimentary rocks and acidic igneous rocks. The petrographic composition of the sandstone suggests that the provenance was dominantly from granitic rocks (Fujii, 1958). Palaeocurrent analysis of the Yezo Supergroup indicates that currents with a northward direction (axial currents)

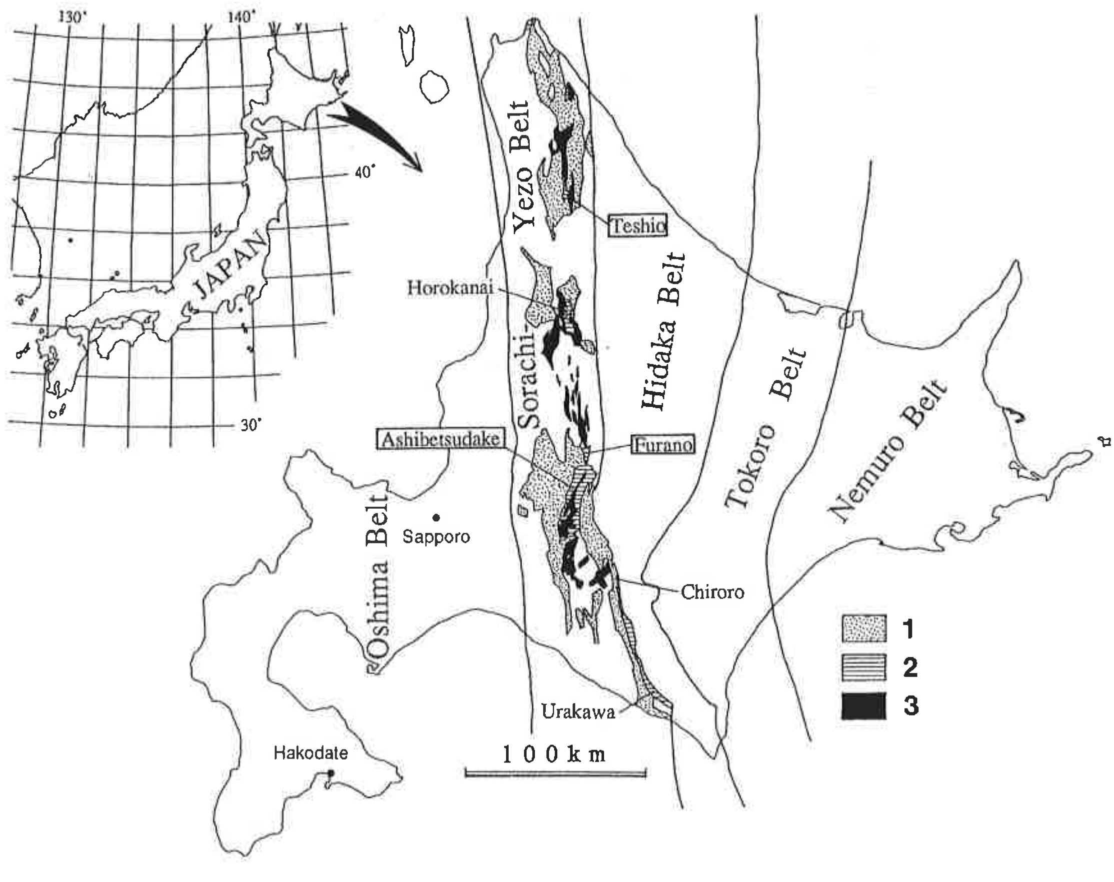


Figure 1. Mesozoic terrains of Hokkaido (after Kiminami *et al.*, 1986a) and distribution of the Sorachi Group and Yezo Supergroup in the Sorachi-Yezo Belt. Locations of the sections examined in this study are indicated. **1.** Yezo Supergroup, **2.** Sorachi Group, **3.** Serpentinite.

were predominant (Tanaka & Sumi, 1981) with lateral eastward and westward currents. The "Orbitolina Limestone" of the Lower Yezo Group was formed on a tectonic-high in the forearc basin. The Middle Yezo Group unconformably overlies the Lower Yezo Group in central Hokkaido. The unconformity is inferred to be a result of the extrusion of serpentinite in the forearc basin (corresponding to the Ashibetsugawa area; see below). The supergroup has a general tendency to shallow upwards, and is unconformably overlain by Palaeogene coal-bearing formations.

3. Lithostratigraphy of studied sections

The stratigraphy of the Sorachi Group was recently re-examined, and it has been divided into two units (Kito *et al.*, 1986). The lower part is composed mainly of greenstone, and the upper composed mainly of siliceous and volcanogenic sedimentary rocks. The stratigraphy of the group was originally established by Hashimoto (1936, 1953, 1955) based on study of the Ashibetsudake and Furano areas. The group was divided into the Yamabe Formation, composed of 3 members, and the Shuyubari Formation, composed of 7 members. This subdivision has been used for a long time for the group all over the Sorachi-Yezo Belt. Recently Kito *et al.* (1986) and Kito (1987) pointed out that the stratigraphical subdivision was based on an erroneous correlation of members. The usage of the names "Yamabe" and "Shuyubari" Formations has therefore since tended to decrease. The description of the examined sections principally follows the subdivision of Kito *et al.* (1986) and Kito (1987).

The present work includes new data from the Ashibetsudake and Teshio areas, the revised data of Minoura *et al.* (1982) and Kito (1987).

3.1. Furano area

The Sorachi Group and the Yezo Supergroup in this area have been studied stratigraphically by a number of workers including Otatsume (1940) and Hashimoto (1936, 1955). Kito (1987) divided the Sorachi Group into 3 formations, which were provisionally named the S1, S2 and S3 Formations in ascending order (Figs. 2 and 3).

The S1 Formation of the Sorachi Group is composed of greenstone. The formation contains pillow basalt in the lower portion and hyaloclastic breccia in the upper portion (Fig. 3). Some layers of red chert containing poorly-preserved radiolarians are intercalated. The thickness exceeds 800 meters.

The S2 formation is made up of well-bedded green siliceous shale interlayered with thin white tuffaceous mudstone. The shale contains many poorly-preserved radiolarian remains except in the uppermost portion in the Naegawa Section (Section 6 in Fig. 3). The thickness is about 100 meters.

The S3 Formation consists of shale, siliceous shale, pillow basalt and acidic tuffaceous/siliceous shale. Pillow basalts are intercalated in the lower portion (Fig. 3). Radiolarian remains are abundant throughout the formation. A supply of terrigenous material was initiated at the onset of deposition of this formation and intercalations of this siliciclastic material occur throughout. The S3 formation may overlie the S2 formation, although a dolerite sill is intruded into the boundary of these two formations. The formation is exposed also at the Nunobe Quarry (Nunobe Section, not figured) where pillow basalts are overlain by dark green volcanic shale interbedded with acidic tuff (Minoura *et al.*, 1982). The thickness is about 560 meters maximum.

The Tomitoi Sandstone conformably overlies the Sorachi Group. This formation is composed of thick alternating beds of sandstone and shale showing proximal turbidite facies. The thickness is about 450 meters. In the Nunobe Section volcanic shale with acidic tuff of the S3 Formation grades upward into alternating beds of sandstone and shale of the Tomitoi Sandstone (Minoura *et al.*, 1982). Occasionally plant remains have been recovered from the shale beds.

The Tomitoi Sandstone is overlain by the Shimanoshita Shale which is a thin-bedded turbidite. The shale has an intercalated "Orbitolina Limestone". The limestone yields many fossils as mentioned below.

Thirty four samples were examined from the area, of which 7 samples are from the S2 formation, 23 from the S3 Formation (including an additional sample from the Nunobe Quarry) and 5 from the Shimanoshita Shale.

3.2. Ashibetsudake area

Studied sections in the area are situated at the eastern and western sides of the Ashibetsudake mountain range (Fig. 4). The mountain range is composed of serpentinite, trondhjemite, the Sorachi Group and the Yezo Supergroup. These groups form a north-south trending, broken, asymmetric anticline with a steeply dipping western flank. Examined sections are shown in Figs. 5 and 6.

The stratigraphy of the area was studied by Matsumoto (1942), Hashimoto (1936, 1953, 1955), Yoshida & Kambe (1955), etc. The stratigraphic division established in the Furano area is partially applicable to this area. The S1 Formation of the Sorachi Group is overlain by volcaniclastic beds which do not occur in the Furano area. The S2 and S3 Formations are not distinguished because of similar lithologies. The Sorachi Group is therefore subdivided into 3 formations within this area (Fig. 4).

The S1 Formation consists of pillow basalt, basalt intrusive rock and a small amount of hyaloclastic breccia. Pillow structures are generally well-preserved. No sedimentary rock has been observed. The lower limit contact is faulted against serpentinite. The formation is quite barren of fossils.

The second formation, the "unnamed" formation in Figs. 4, 5 and 6, is composed of greenstone conglomerate or volcaniclastic rocks. On the western flank of the anticline, the formation is composed of green volcaniclastic sandstone and conglomerate consisting of acidic to intermediate volcanic clasts with alternating beds of red chert and volcanic sandstone at the base. Volcanic conglomerate contains rhyolite, dacite and andesite clasts (Girard *et al.*, 1991). Red chert yields poorly-preserved radiolarian fossils except in the Shuparogawa Section (Section 1 in Fig. 5). On the eastern flank, the formation is composed of dolerite or basalt conglomerate. The unit is about 300 meters in maximum thickness. The stratigraphical relationship between the S1 Formation and the "unnamed" formation is not known.

The third formation, "S2 + S3" formation, conformably

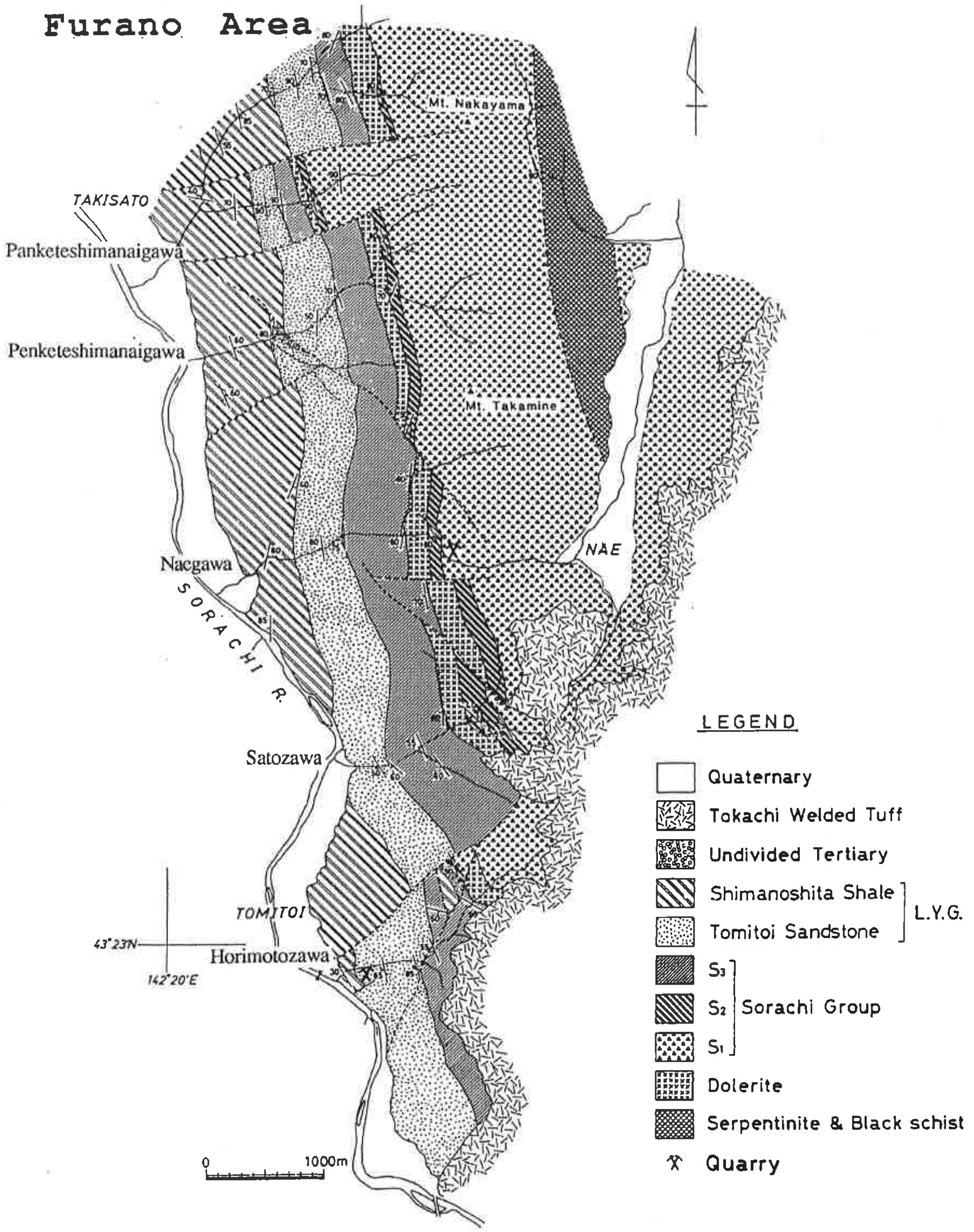


Figure 2. Geological map of the Furano area (after Kito, 1987).

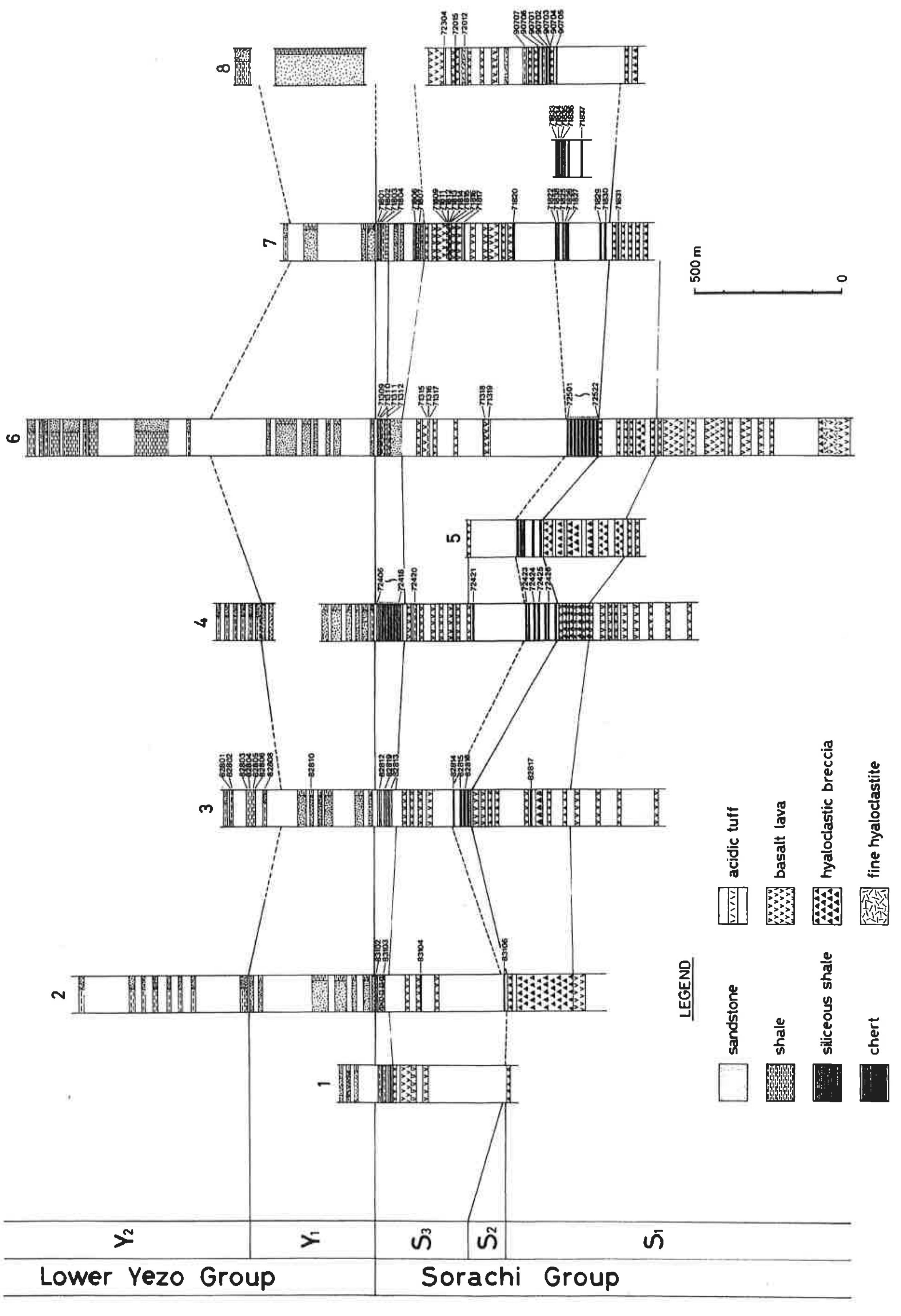


Figure 3. Lithostratigraphical correlation of geological columns in the Furano area (after Kito, 1987). **1-3.** Panketeshimanaigawa Section, **4-5.** Penketeshimanaigawa Section, **6.** Naegawa Section, **7.** Satozawa Section, **8.** Horimotozawa Section. Sampled horizons are shown.

overlying the lower unit, is composed of dark green acidic tuffaceous /siliceous shale. The shale is well-stratified and yields abundant well-preserved radiolarians throughout the unit. The lowermost portion of the unit (Section 2 and 4 in Fig. 5) contains an intercalated bed of oolitic limestone (1 metre thick) in the western flank. In the Ashibetsugawa Section (Section 2 in Fig. 5), a layer of green volcanic sandstone (several meters thick) is intercalated. The thickness of the formation is about 800 meters on the western flank, and 300 meters on the east.

The Lower Yezo Group, composed of flysch-type sediments, conformably overlies the Sorachi Group. Sole marks are frequently exposed. On the western flank of the anticline the upper portion of the group contains an intercalated "Orbitolina Limestone", about 50 meters thick in the Ashibetsugawa Section. The limestone, which is traceable for a distance of 15 kilometres (Fig. 4), is believed to form a reef composed of pachyodonts, corals and calcareous algae with *Orbitolina*. The facies corresponds to the Urgonian. The following fossils are reported (Yoshida & Kambe, 1955): *Dermosmilia ? jezoensis*, *Favia ? jezoensis*, *Isastraea matsumotoi*, *Thamnasteria jezoensis* (corals), *Praecaprotina yaegashii*, *Toucasia carinata* var. *orientalis* (pachyodonts), *Nipponophyx ramosus* (calcareous algae), *Orbitolina discoidea-conoidea* var. *ezoensis* (foraminifer), etc. The fauna indicates a Neocomian (Aptian to Albian) age. The underlying flysch contains many plant remains in the muddy part. Coaly shale layers were also observed.

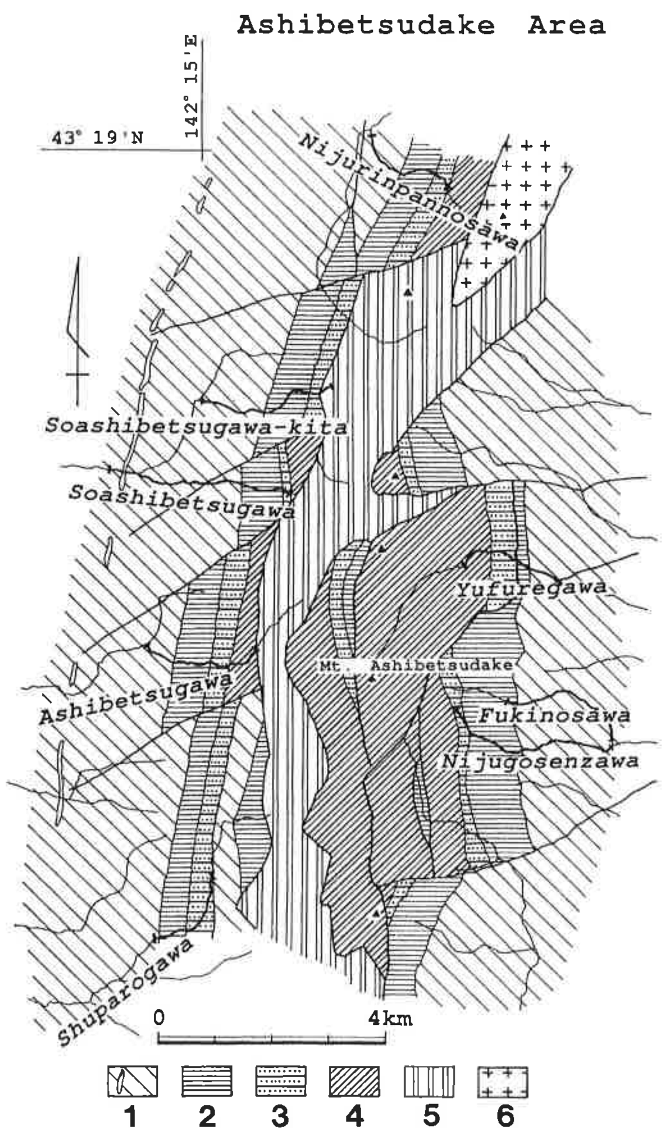


Figure 4. Geological map of Ashibetsudake area. Examined sections are indicated. **1.** Lower Yezo Group (intercalated limestones are shown), **2.** S2 and S3 Formation (Sorachi Group), **3.** Volcaniclastic rocks (unnamed formation of the Sorachi Group), **4.** S1 Formation (Sorachi Group), **5.** Serpentinite, **6.** Trondhjemite.

Seventy two samples (of which 2 samples are from the volcaniclastic formation, 68 from the S2+S3 Formations and 2 from the Lower Yezo Group) were examined from the area.

3.3. Teshio area

The stratigraphy of the Sorachi Group (originally called the Onisashi Group) and the Yezo Supergroup in this area was studied by Ijima & Shinada (1952). The Onisashi Group was not subdivided, while the Yezo Supergroup was divided into the Kamiji Group, the Saku Group, the Abeshinai Group and the Hakobuchi Group. Later Nagao (1962) re-examined the stratigraphy of the Sorachi and Lower Yezo Groups, and divided the former into the Shibunnaigawa Formation and Panakushigawa Formation, and the latter, into the Onodera Formation and the Kamiji Formation. The lithological description of the Section follows the subdivision by Nagao (1962).

The examined Section (Section 4 in Fig. 6), which is situated at the upper stream of the Sakkotangawa (or Sakugawa) River, exposes the Sorachi Group and the Lower Yezo Group which strike north-south, overturn steeply and face westwards (Fig. 7).

The Shibunnaigawa Formation, the lower unit of the Sorachi Group, is chiefly composed of pillow basalt with red chert at the top. The thickness is about 300 meters according to Nagao (1962). The lower limit is a fault contact on serpentinite in the Section examined. The formation corresponds to the S1 Formation in the Furano area.

The overlying Panakushigawa Formation is composed of well-bedded grey and dark green siliceous shale with conglomerate at the base. The conglomerate, several meters thick, is composed of greenstone cobbles. Green shale, containing well-preserved radiolarian remains, grades upward into grey shale in the uppermost portion of the formation. The total thickness is

Figure 5. Lithostratigraphical correlation of examined sections in the Ashibetsugawa area with sampled horizons. **1.** Shuparogawa Section, **2.** Ashibetsgawa Section, **3.** Soashibetsugawa Section, **4.** Soashibetsugawa-kita Section, **5.** Nijurinpannosawa Section.

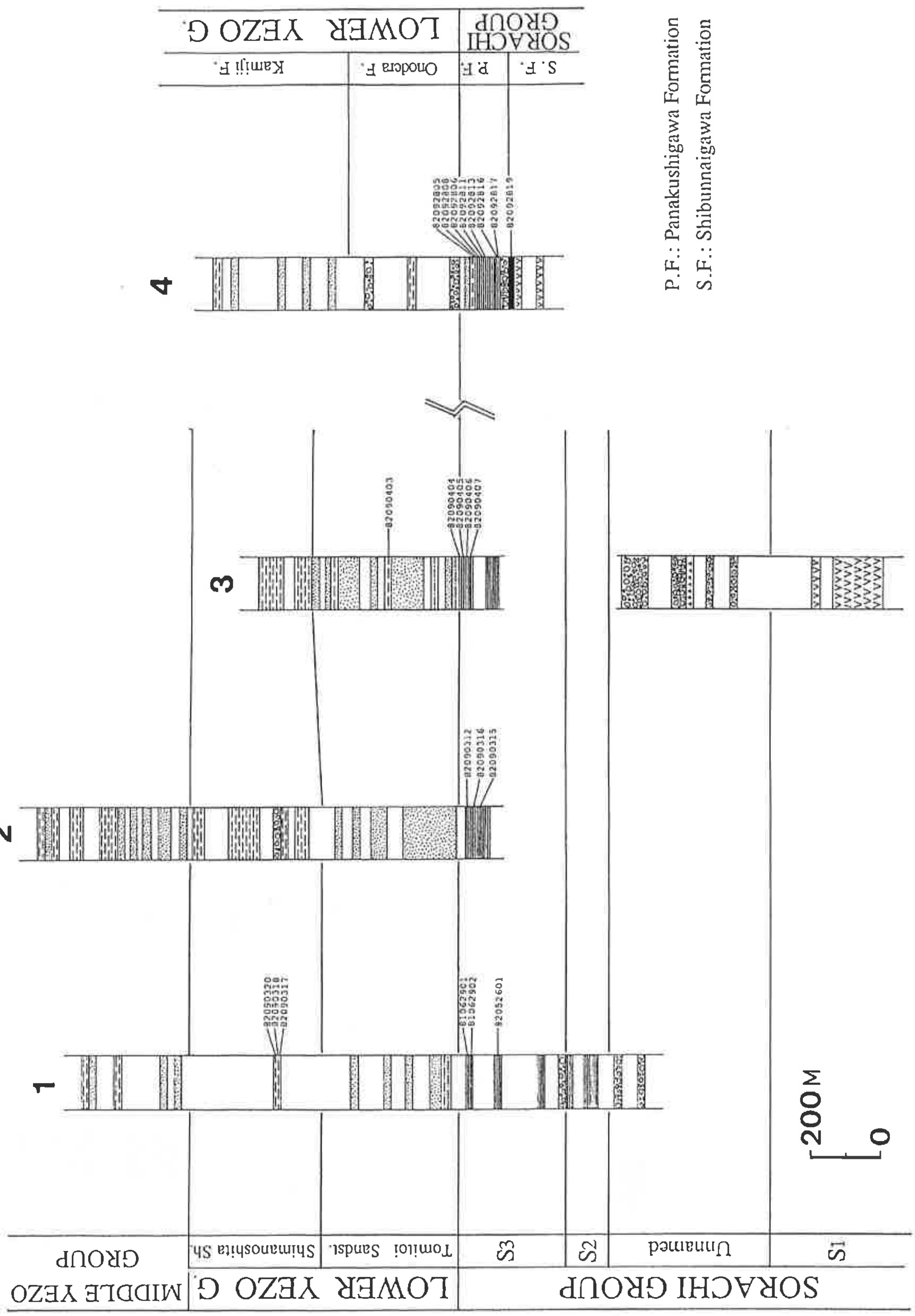


Fig.ure 6. Lithostratigraphical correlation of examined sections in the Ashibetsudake area (Section 1-3) and Teshio area (Section 4). **1.** Nijugosenzawa Section, **2.** Fukinosawa Section, **3.** Yufuregawa Section, **4.** Sakkotangawa Section. Legend as for Fig. 5.

about 100 meters. The formation is correlative with the S3 Formation in the Furano area.

The Onodera Formation, made up of conglomerate, sandstone and shale, overlies the Panakushigawa Formation with a basal conglomerate. The thickness is about 300 meters. Ijima & Shinada (1952) and Nagao (1962) considered that the Onodera Formation unconformably overlies the Panakushigawa Formation in the Section. Kawaguchi (1984) considered, however, that the basal conglomerate of the Onodera Formation did not imply unconformity. Considering the relationship between the Sorachi and Lower Yezo Groups in the other areas, the time gap between the two formations may not be considerable even if it exists.

The Onodera Formation is overlain by the Kamiji Formation which is composed of thin-bedded turbidite.

No fossils have been recorded from the Sorachi Group in this area other than radiolarians. An ammonite, *Parahoplites colossus*, was obtained from the upper portion of the Kamiji Formation in the northern extension of the area (Matsumoto, 1984). The ammonite, allied to *P. maximus* and *P. nutfieldiensis* of Europe, suggests a mid late Aptian age (Matsumoto, 1984).

Eight samples from Panakushigawa Formation were examined from this area.

4. Radiolarians from Sorachi-Yezo Belt

Late Jurassic to Early Cretaceous radiolarians are reported from many localities in Hokkaido.

In the Sorachi-Yezo Belt: from the Horokanai area by Ishizuka *et al.* (1993), Kiminami *et al.* (1986b), Kawabata (1988); from the Furano area by Okada *et al.* (1982), Minoura *et al.* (1982) and Kito (1987); from the Chiroro area by Kiminami *et al.* (1985); and from the Urakawa area by Kanie *et al.* (1981). These biostratigraphical studies revealed that the chert overlying the greenstone (correlative with the S1 Formation) is assignable to the Upper Jurassic (Kimmeridgian to Tithonian), and the upper portion of the Sorachi Group (correlative with S2 and S3 Formations) is assignable to the Lower Cretaceous (Valanginian to Barremian).

The Late Jurassic age radiolarian fauna includes *Archaeodictyomitra apiarium*, *A. minoensis*, *Cinguloturris carpatica*, *Eucyrtidiellum ptyctum*, *Hsuum* cf. *maxwelli*, *Mirifusus mediodilatatus*, *Ristola altissima*, *Emiluvia hopsoni*, (Kawabata, 1988). The Late Jurassic to Early Cretaceous fauna includes *Emiluvia chica*, "*Cecrops*" *septemporatus*, *Sethocapsa uterculus*, *Sethocapsa trachyostraca*, *Alievium helenae*, *Archaeodictyomitra lacrimula*, (Kito, 1987). Kito (1987) established 3 zones, the *Emiluvia chica* Zone, the "*Cecrops*" *septemporatus* Zone and the *Archaeodictyomitra lacrimula* Zone in ascending order. Radiolarians of the "*Cecrops*" *septemporatus* Zone are found throughout the Sorachi-Yezo Belt, and are characteristic of the upper portion of the Sorachi Group (S3 Formation).

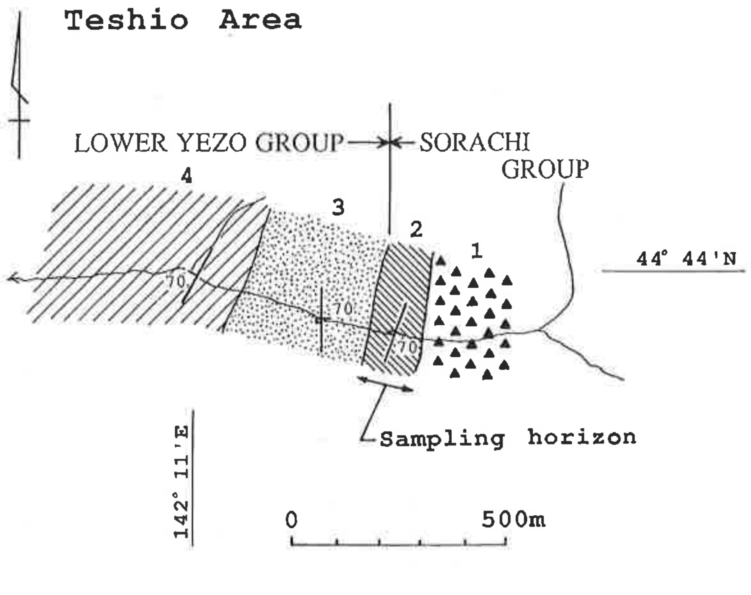


Figure 7. Geological sketch map along the Sakkotangawa (Sakugawa) River (Teshio area) showing the sampled horizon. **1.** Shubunnaigawa Formation, **2.** Panakushigawa Formation, **3.** Onodera Formation, **4.** Kamiji Formation.

References

ANDO, H. (1990a). Stratigraphy and shallow marine sedimentary facies of the Mikasa Formation, Middle Yezo Group (Upper Cretaceous). *Journal of the Geological Society of Japan*, **96**, 279-295.

ANDO, H. (1990b). Shallow-marine sedimentary facies distribution and progradational sequences of the Mikasa Formation, Middle Yezo Group (Upper Cretaceous). *Journal of the Geological Society of Japan*, **96**, 453-469.

FUJII, K. (1958). Petrology of the Cretaceous sandstone of Hokkaido. Japan. *Memoirs of the Faculty of Science, Kyushu University, Series D, Earth and Planetary Science*, **6**, 129-152.

GIRARD, M., JOLIVET, L., NAKAGAWA, M., AGUIRRE, L. & NIIDA, K. (1991). Acidic volcanic products in lower Cretaceous deposits of the Sorachi-Yezo Belt, Hokkaido, Northeast Japan. *Journal of the Geological Society of Japan*, **97**, 1-14.

HASHIMOTO, W. (1936). Geology of the western Mountain Land of Hurano Basin, Province Ishikari. *Journal of the Geological Society of Japan*, **43**, 493-530. (*in Japanese*)

HASHIMOTO, W. (1953). Geological sheet map "Yamabe", scale 1:50.000 and its explanatory text. *Hokkaido Development Agency*, 1-82. (*in Japanese*)

HASHIMOTO, W. (1955). Geological sheet map "Shimofurano", scale 1:50.000 and its explanatory text. *Hokkaido Development Agency*, 1-71. (*in Japanese*)

IJIMA, S. & SHINADA, Y. (1952). Geology of Northern Part of Abeshinai Oil Field, Hokkaido. *Bulletin of the Geological Survey of Japan*, **3**, 609-619. (*in Japanese*)

ISHIZUKA, H., OKAMURA, M. & SAITO, Y. (1983). Latest Jurassic radiolarians from the Horokanai Ophiolite in the Kamuikotan Zone, Hokkaido, Japan. *Journal of the Geological Society of Japan*, **89**, (12), 731-732.

KANIE, Y., TAKETANI, Y., SAKAI, A. & MIYATA, Y. (1981). Lower Cretaceous deposits beneath the Yezo group in the Urakawa area, Hokkaido. *Journal of the Geological Society of Japan*, **87**, 527-533. (*in Japanese*)

KAWABATA, K. (1988). New species of Latest Jurassic and Earliest Cretaceous radiolarians from the Sorachi Group in Hokkaido, Japan. *Bulletin of the Osaka Museum of Natural History*, **43**, 1-13.

KAWAGUCHI, M. (1984). The Sorachi Group along the Onisashigawa, Hokkaido. *Abstract of the 91st Annual Meeting of the Geological Society of Japan*, 207. (*in Japanese*)

KIMINAMI, K. (1986). On the change of the source area from the Sorachi Group to the Lower Yezo Group, Hokkaido, Japan. Clastic Sediments. *Journal of Research of the Clastic Sedimentology Group of Japan*, **4**, 1-7. (*in Japanese*)

KIMINAMI, K., KOMATSU, M. & KAWABATA, K. (1987). The Sorachi Group in the Horokanai area, Hokkaido, Japan: a trapped oceanic crust and the forearc sediments. *In* Komatsu, M. Ed. *Tectonic Belt in Hokkaido-petrology and tectonics*, **2**, 25-27. (*in Japanese*)

KIMINAMI, K., KOMATSU, M., NIIDA, K. & KITO, N. (1986a). Tectonic divisions and stratigraphy of the Mesozoic rocks of Hokkaido, Japan. *Monographs of the Association for the Geological Collaboration of Japan*, **31**, 1-15. (*in Japanese*)

KIMINAMI, K. & KONTANI, Y. (1983). Mesozoic arc-trench systems in Hokkaido, Japan. *In* Hashimoto, M. & Uyeda, S. Eds. *Accretion tectonics in the circum-Pacific regions* - Terrapub, Tokyo, 107-122.

KIMINAMI, K., KONTANI, Y. & MIYASHITA, S. (1985). Lower Cretaceous strata covering the abyssal tholeiite (the Hidaka Western Greenstone Belt) in the Chiroro area, central Hokkaido, Japan. *Journal of the Geological Society of Japan*, **91**, 27-42.

KIMINAMI, K., MIYASHITA, S., KIMURA, G., TAJIKA, J., IWATA, K., SAKAI, A., YOSHIDA, A., KATO, Y., WATANABE, Y., EZAKI, Y., KONTANI, Y. & KATSUSHIMA, N. (1986b). Mesozoic rocks in the Hidaka belt (Hidaka Supergroup). *Monographs of the Association for the geological Collaboration of Japan*, **31**, 137-155.

KITO, N. (1987). Stratigraphic relation between greenstones and clastic sedimentary rocks in the Kamuikotan Belt, Hokkaido, Japan. *Journal of the Geological Society of Japan*, **93**, (1), 21-35. (*in Japanese*)

KITO, N., KIMINAMI, K., NIIDA, K., KANIE, Y., WATANABE, T. & KAWAGUCHI, M. (1986). The Sorachi Group and the Supergroup: Late Mesozoic ophiolites and forearc sediments in the axial zone of Hokkaido. *Monographs of the Association for the Geological Collaboration of Japan*, **31**, 81-96. (*in Japanese*)

KOMATSU, M., MIYASHITA, S., MAEDA, J., OSANAI, Y. & TOYOSHIMA, T. (1983). Disclosing of a deepest Section of continental-type crust up-thrust as the final event of collision of arcs in Hokkaido, North Japan. *In* Hashimoto, M. & Uyeda, S. Eds. *Accretion tectonics in the circum-Pacific regions* - Terrapub, Tokyo. (149-165).

MAIYA, S. & TAKAYANAGI, Y. (1977). Cretaceous foraminiferal biostratigraphy of Hokkaido. *In* Kanmera, K. Ed. - Paleontological Society of Japan, special Papers, **21**, 41-51.

MATSUMOTO, T. (1942). Fundamentals in the Cretaceous stratigraphy of Japan. *Memoirs of the Faculty of Science, Kyushu University, Series D, Earth and planetary Science*, **1**, 129-280.

MATSUMOTO, T. (1977). Zonal correlation of the Upper Cretaceous in Japan. *In* Kanmera, K. Ed. - Paleontological Society of Japan, special Papers, **21**, 63-74.

MATSUMOTO, T. (1984). A gigantic Parahoplitid Ammonite from northern Hokkaido. *Report of the Geological Survey of Hokkaido*, **55**, 21-28.

MINOURA, N., KUMANO, S., KITO, N., KAMADA, K. & KATO, M. (1982). Lower Cretaceous deposits at Nunobe, central Hokkaido. *Earth Science, Journal of the Association for the geological Collaboration in Japan*, **36**, 348-350. (*in Japanese*)

Nagao, S. (1962). Geological sheet map "Tesionakagawa", scale 1:50.000 and its explanatory text. *Hokkaido Development Agency*, 1-39. (*in Japanese*)

Niida, K. (1992). Basalt and dolerite in the Sorachi-Yezo Belt, central Hokkaido, Japan. *Journal of the Faculty of Science Hokkaido University, Series 4: Geology and Mineralogy*, **23**, 301-319.

Niida, K. & Kito, N. (1986). Cretaceous arc-trench systems in Hokkaido. *Monographs of the Association for the geological Collaboration of Japan*, **31**, 379-402. (*in Japanese*)

Okada, H. (1974). Migration of ancient arc-trench systems. *In* Dott, R.H.J. & Shaver, R.H. Eds. *Modern and ancient geosynclinal sedimentation* - Special Publication of the Society of Economic Paleontologists and Mineralogists, **19**, 311-320.

Okada, H., Hatakenaka, A. & Nakaseko, K. (1982). Age of the Sorachi Group in its type area in Hokkaido. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 353-357.

Otatsume, K. (1940). On the stratigraphic relationship between Lower Ammonite Bed and Schalstein formation in central Hokkaido. *Bulletin of the Geological Commission of Hokkaido*, **11**, 1-48. (*in Japanese*)

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Taketani, Y. (1982). Cretaceous radiolarian biostratigraphy of the Urakawa and Obira areas, Hokkaido. *Science Reports of the Tohoku University*, **52**, (1-2), 1-75.

Tanaka, K. & Sumi, Y. (1981). Cretaceous paleocurrents in the central zone of Hokkaido, Japan. *Bulletin of the Geological Survey of Japan*, **32**, 65-127. (*in Japanese*)

Yoshida, T. & Kambe, N. (1955). Geological sheet map "Ikushumbetsu- dake" and its explanatory text. *Hokkaido Development Agency*, 1-31. (*in Japanese*)

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

Furano area

SECTION 1_PANKETESHIMANAIGAWA: bottom 1 - top 5
< 5 {81082801}: 5607, 3228, 3131, 5595
< 4 {81082802}: 3092, 3090, 5042, 3131, 5595, 5125
< 3 {81082805}: 5607, 3227, 5125, 3269
< 2 {81082806}: 3090, 5607, 5595
< 1 {81082812}: 3269, 3263, 4026, 3293

SECTION 2_PANKETESHIMANAIGAWA-2: bottom 1 - top 2
< 2 {81083103}: 3228, 3185, 4026
< 1 {81083104}: 3092, 3213, 5607, 3228, 3185, 3286, 4026

SECTION 3_PENKETESHIMANAIGAWA: bottom 1 - top 8
< 8 {81072408}: 5042
< 7 {81072410}: 3112, 3293, 3286, 5462, 4026
< 6 {81072412}: 3092, 3090, 3228, 3131, 3293, 3185, 3286, 5426, 5462, 4026
< 5 {81072413}: 3228, 5426, 3063
< 4 {81072417}: 5607, 3228, 3185, 5462, 4026
< 3 {81072420}: 5607, 5229
< 2 {81072423}: 5607, 4026, 3287
< 1 {81072425}: 3092, 3213, 5607, 3083, 3228, 3112, 3185, 3255, 3286, 3063, 5462

SECTION 4_NAEGAWA: bottoma 1 - top 4
< 4 {81071309}: 3090, 5607, 5229, 3185, 5462, 4026, 5125
< 3 {81071310}: 5229, 5042, 3228, 3185, 5462
< 2 {81071317}: 3228, 3185, 5462, 4026, 3293
< 1 {81072501}: 3092, 3090, 3213, 5607, 3087, 3228, 3115, 3185, 3241, 3255, 3286, 5462, 4026, 5125, 3264, 6101

SECTION 5_SATOZAWA: bottom 1 - top 9
< 9 {81071802}: 3092, 3090, 3228, 3063, 5462

< 8 {81071803}: 3092, 3090, 5607, 5229, 5042, 3228, 3131, 3185, 3286, 3063, 5462, 5125
< 7 {81071806}: 3090, 5607, 5229, 3087, 3228, 3185, 3286, 3063, 5462
< 6 {81071807}: 3092, 5229, 3087, 5042, 3228, 3131, 3115, 3293, 3185, 5532, 3063, 5462, 4026
< 5 {81071811}: 3228, 3293, 3185, 4026
< 4 {81071812}: 3092, 5607, 5229, 5042, 3228, 3293, 3185, 5426
< 3 {81071813}: 3092, 3090, 3228, 3131, 3113, 3116, 3185, 3063, 5462
< 2 {81071824}: 3092, 3213, 5607, 3228, 3286
< 1 {81071836}: 3185, 3284, 3263

SECTION 6_HORIMOTOZAWA: bottom 1 - top 5
< 5 {81090701: 5607, 3087,
< 4 {81090702: 3286, 5462,
< 3 {81090704: 5125
< 2 {81082904: 3293, 3185, 4026,
< 1 {81082906: 5607, 3228, 3293, 3185, 3241, 3269

SECTION 7_NUNOBE Quarry: bottom 1 - top 1
< 1 {81062827}: 3115, 3131, 3185, 3228, 3287, 3293, 4093, 4026, 5042, 5125, 5229, 5407, 5426, 5462, 5481, 5607, 5625, 5712

Ashibetsudake area

SECTION 8_NIJURINPANNOSAWA: bottom 1 - top 7
< 7 {82090101}: 5042
< 6 {82090112}: 5607, 3092, 3113,
< 5 {82090111}: 5607
< 4 {82090110}: 3287, 3228, 5607, 3092, 3185, 3083
< 3 {82090109}: 5607, 3092, 3115
< 2 {82090108}: 3228, 5607, 3092
< 1 {82090104}: 3284, 3263, 3287, 3213, 3090, 3228, 5607

SECTION 9_SOASHIBETSUGAWA-KITA: bottom 1 - top 7
< 7 {90090405}: 3185, 5073, 3295, 3263, 5636, 5607, 3092, 3285, 3090
< 6 {90090407}: 3284, 5125
< 5 {90090409}: 5607, 3293
< 4 {90090410}: 5042
< 3 {90090411}: 5073, 3295, 5607, 3092, 5042, 5595, 5407, 3228, 5049
< 2 {90090412}: 5607, 5042, 3162, 3131, 5462
< 1 {90090413}: 3185, 3295, 5607, 5407, 3228, 3131, 5462, 5744

SECTION 10_SOASHIBETSUGAWA: bottom 1 - top 9
< 9 {89081002}: 5407
< 8 {90090505}: 5073
< 7 {89081006}: 5407, 3092, 5012,
< 6 {89081007}: 5407, 3092, 5744, 3293, 5042, 5607
< 5 {89081010}: 5407, 3092, 5744, 3293, 5607, 5712, 3263, 3295, 5073, 5462, 3228, 3090, 5674
< 4 {89081009}: 3293, 5607, 3263, 3295, 4026, 5532, 5073
< 3 {89081008}: 5712
< 2 {90090510}: 3295, 3284
< 1 {90090509}: 3087, 3293, 5607, 3263, 3295, 5125, 5636, 3284

SECTION 11_ASHIBETSUGAWA: bottom 1 - top 13
< 13 {90090701}: 5595, 3269, 5073, 5407, 3287, 3092, 3293
< 12 {90090703}: 5595, 5073, 5407, 3092, 3293, 5636, 5125, 3295, 5607, 3090, 5042
< 11 {90090704}: 3269, 5073, 5407, 3293
< 10 {90090705}: 5595, 3287, 5636, 3295
< 9 {90090706}: 5073, 3295, 3185
< 8 {90090707}: 5595, 5073, 5261
< 7 {90090708}: 5595, 5073, 3287, 3293, 5125, 3295, 5607, 3090, 5042, 5481, 3285, 3131, 5186
< 6 {90090709}: 5595, 5073, 3287, 3092, 5125, 3295, 5607, 3131, 5462, 5744, 5712, 5049
< 5 {90090710}: 5407, 3287, 3092, 3293, 5125, 3295, 3090, 3131, 5186, 3113, 5183, 3228, 5903
< 4 {90090711}: 3092, 3185
< 3 {90090712}: 5073, 5407, 3092, 3293, 3295, 3090, 5042, 3185, 3131, 5462, 5712, 3228, 4026, 3112
< 2 {90090716}: 5073, 3295, 3284
< 1 {90090717}: 5073, 3287, 3293, 5636, 3295, 5607, 3185, 5481, 5462, 5744, 3228, 4026, 3284, 5469, 3263, 3213, 3255

SECTION 12_SHUPAROGAWA: bottom 1 - top 28
< 28 {82073022}: 5607, 3090, 3228, 3063, 3092, 3131, 5229, 3287, 5712
< 27 {82073019}: 3090, 3228, 3185, 3092, 5674, 5744, 3287
< 26 {82073016}: 5607, 3090, 3092
< 25 {82073015}: 5607, 3293, 5462, 5229, 5712
< 24 {82073013}: 3228, 3293, 3185, 3063, 5620, 3287, 5712
< 23 {82073011}: 5607, 3090, 3228, 3092, 3131, 3284
< 22 {82073010}: 3185, 3287
< 21 {82072803}: 3286, 3228
< 20 {82072804}: 3286
< 19 {82072805}: 4026, 3263
< 18 {82072807}: 5607, 3090, 3019, 3286, 3228, 5462, 4026, 3263, 3287
< 17 {82072808}: 3019, 4026, 3287
< 16 {82072809}: 5607, 4026
< 15 {82072810}: 3287
< 14 {82072814}: 3019, 3286, 3228, 3063, 4026, 3263, 3287, 3284
< 13 {82072816}: 5607, 3286, 3228, 3213, 3185, 3263, 3284
< 12 {82072817}: 5607, 3019, 3286, 3228, 3213, 3185, 5426, 4026, 3113, 3263, 3287, 3284
< 11 {82072818}: 5607, 3228, 3213, 3063
< 10 {82072819}: 5607, 3090, 3019, 3286, 3228, 3087, 3213, 3185, 5462, 4026, 3092, 3284
< 9 {82072820}: 3019, 3286, 3228, 3087, 3213, 3185, 5462, 3255, 4026, 3092, 3263, 3287
< 8 {82072821}: 5607, 3019, 3228, 3087, 3213, 5426, 5462, 3063, 3264, 3263, 3287, 3284
< 7 {82072822}: 5607, 3228, 3087, 3213, 3185, 3284

< 6 {82072823}: 3263, 3284
< 5 {82072824}: 3263, 3287, 3284
< 4 {82072825}: 3293, 3263, 3287, 3284
< 3 {82072826}: 3263
< 2 {LJ37}: 5607, 3019, 3286, 3228, 3287
< 1 {82072838}: 3305, 5607, 3090, 3263

SECTION 13_SHUPAROGAWA ISOLATED SAMPLE: bottom 1 - top 1
< 1 {82073012}: 3017, 3087, 3092, 3185, 3213, 3218, 3228, 3263, 3264, 3284, 3293, 4026, 5462, 5607, 5712, 5744

SECTION 14_YUFUREGAWA: bottom 1 - top 5
< 5 {82090403}: 3293, 5712, 3287, 3185, 5744, 3228, 5229, 3090, 3131, 3092
< 4 {82090404}: 3284, 5462, 3293, 3286, 3241, 4026, 3263, 5712, 3287, 3185, 5744, 3228, 5229, 3063
< 3 {82090405}: 5462, 3293, 3286, 4026, 5712, 3287, 5607, 3185, 5744, 3228, 5229, 3090, 3113, 3115, 5042, 3092
< 2 {82090406}: 5462, 3293, 4026, 3263, 5712, 3287, 5125, 5607, 3185, 5744, 3228, 5229, 3090, 3092
< 1 {82090407}: 5532, 3284, 5462, 3293, 3286, 3241, 4026, 3263, 5712, 3287, 5426, 3090, 3092

SECTION 15_FUKINOSAWA: bottom 1 - top 3
< 3 {82090312}: 5744, 3092, 3090, 5462, 3287, 3228, 5607, 3248, 4026, 3263
< 2 {82090316}: 3131, 3092, 3090, 3228, 5607, 5744, 3113, 3121, 5407
< 1 {82090315}: 3087, 3118, 3131, 5744, 3092, 3090, 5462, 3185, 3287, 3228, 5229, 5607, 5712

SECTION 16_NIJUGOSENZAWA: bottom 1 - top 6
< 6 {82090920}: 5712, 3092, 5462, 3293, 5073
< 5 {82090318}: 3293
< 4 {82090317}: 3293, 5073
< 3 {81062901}: 5712, 3287, 3185, 3090, 3092, 3228, 5229, 5607, 3063, 4026
< 2 {81062902}: 3287, 3185, 3090, 3092, 3228, 5229, 5607, 5462, 5744, 3286, 3087, 3112, 3121, 3063, 4026
< 1 {82052601}: 5712, 3287, 3185, 3090, 3092, 3228, 5229, 5607

Teshio area

SECTION 17_SAKKOTANGAWA (SAKUGAWA): bottom 1 - top 8
< 8 {82092805}: 3228, 3092, 3090, 5595, 5042
< 7 {82092808}: 3115, 3293, 3228, 3092, 5462, 3185, 5595
< 6 {82092806}: 5607, 3293, 3284, 3228, 3092, 5462, 3063, 3185, 5595, 5042
< 5 {82092811}: 3293, 3228, 5462, 5073
< 4 {82092813}: 3286, 5607, 3287, 5712, 5229, 3228, 3092, 3090, 3263, 5426, 5744, 4026
< 3 {82092816}: 5607, 3115, 3287, 5712, 5229, 3293, 3284, 3228, 3092, 3090
< 2 {82092817}: 3213, 3286, 5607, 3115
< 1 {82092819}: 3213

27. Middle Jurassic to Early Cretaceous Radiolarian Occurrences in Japan and the Western Pacific (ODP Sites 800-801)

by Atsushi Matsuoka

Department of Geology, Faculty of Science, Niigata University, Niigata 950-21, Japan

ABSTRACT

This chapter provides basic data for establishing a zonal scheme both for the entire Tethyan region (Chapter 32) and for Japan and the western Pacific (Chapter 33). A total of 212 samples from 12 sections are used for radiolarian biostratigraphic research by the Unitary Associations method. An outline of regional and local geology of the study areas in Japan and the western Pacific is presented. Two sections are located in the western Pacific (ODP Site 800 and 801 sections); six in the Southern Chichibu Terrane, Japan (Oyashiki 1, Shiraishigawa 1, Yanasegawa 1, Yanasegawa 2, Yanasegawa 3, and Kawanouchi 1 sections); four in the Mino Terrane, Japan (Kashibara, Hisuikyo, Inuyama CH-1-A, and Komami sections). Radiolarian occurrences, ranges of the Unitary Associations and radiolarian zonal assignments for all samples are presented in Tables in the Appendix.

1. Introduction

This chapter gives basic data for the Unitary Association methods, including an outline of regional and local geology of study areas in Japan and the western Pacific (Fig. 1), the geological setting of study sections and the descriptions of rock samples. A total of 212 samples from 12 sections (Fig. 2) are treated in this chapter. Two sections are located in the western Pacific and 10 sections in southwest Japan. All samples, except for two samples of a manganese band collected from the Mino Terrane in southwest Japan, have already been reported elsewhere in establishing radiolarian zones (Matsuoka, 1983a, 1986, 1988, 1992a). All sections are assigned to a framework of the upper Lower Jurassic to Lower Cretaceous radiolarian zonation in Japan and the western Pacific to show their stratigraphic intervals (Fig. 2).

Matsuoka & Yao (1986) established eight radiolarian zones for the Jurassic of Japan through biostratigraphic research on stratigraphically continuous sections in southwest Japan. Matsuoka (1992a) defined three radiolarian zones for the Lower Cretaceous of the western Pacific, revising the lowest Cretaceous zone by Matsuoka & Yao (1986) and applying the zonation of Sanfilippo & Riedel (1985). These zones are defined by the first or last appearance biohorizons of zone-diagnostic species and are categorised as interval zones (Fig. 2). In defining zones, we have made an effort to by discover reliable biohorizons tracing evolutionary lineages in continuous stratigraphic sections. The evolutionary first appearance biohorizon of *Tricolocapsa conexa* is a good example of a reliable biohorizon. The evolutionary lineage from the ancestral *Tricolocapsa plicarum* to the descendant *Tricolocapsa conexa* has been traced in continuous sections of the Southern Chichibu Terrane (Matsuoka, 1983a) and Mino

Terrane (Matsuoka, 1988) in southwest Japan. Other examples of a reliable biohorizon reflecting an evolutionary lineage include the evolutionary first appearance biohorizon of *Tricolocapsa plicarum*, *Stylocapsa* (?) *spiralis*, and *Pseudodictyomitra carpatica* (Matsuoka, 1983a, 1992a; Matsuoka & Yao, 1986).

During the course of this project, it become apparent that in some sections outside eastern Asia stratigraphic ranges of zone-diagnostic species for our zonation are different from those in Japan and the western Pacific. Some samples contain both *T. conexa* and *P. primitiva* which indicates that the last appearance biohorizon of *T. conexa* is shifted higher than the first appearance biohorizon of *P. primitiva*. This result makes our zonal definition for the Upper Jurassic invalid when we use these zones for a global correlation. However, the zonation is still valid for a regional correlation because no critical contradictory data have been obtained from Japan and the western Pacific as far as is known. .

2. Western Pacific - ODP Leg 129 Sites 800, 801

2.1. Geologic and paleoceanographic setting

Jurassic and Lower Cretaceous radiolarite sequences were recovered for the first time from the Pigafetta Basin (Fig. 3) in the deep western Pacific Ocean by ODP Leg 129. The radiolarite sequences are overlain by thick volcaniclastic turbidites of middle Cretaceous age. The radiolarites are generally carbonate-free, indicating that they accumulated below the calcium carbonate compensation depth. Paleomagnetic data suggest that the drilling sites were in low-latitudes during the Jurassic and Cretaceous (Lancelot *et al.*, 1990).

The radiolarian assemblages from the ODP Leg 129 Sites are regarded as representative of low-latitude, open ocean faunas. The radiolarites generally yield abundant and moderately preserved radiolarians, but contain very few calcareous nannofossils and are barren of foraminifera and palynomorphs. Nannofossil assemblages in the Tithonian sediments of Site 801 may be suggestive of high-fertility conditions (Lancelot *et al.*, 1990). Radiolarian assemblages from the ODP Sites 800 and 801 (Fig. 3) are reported with illustrations in Matsuoka (1991a, 1992a). Middle Jurassic to Early Cretaceous radiolarian faunas from the western Pacific are rich in nassellarian species, whereas spumellarian species are generally less abundant than nassellarians. Abundant nassellarians include closed species belonging to the genera *Gongylothorax, Hemicryptocapsa, Sethocapsa, Stichocapsa, Stylocapsa, Tricolocapsa, Williriedellum, Zhamoidellum,* and multi-segmented species belonging to the genera *Archaeodictyomitra, Hsuum, Pseudodictyomitra, and Thanarla.* Matsuoka (1991a) has pointed out that the Middle Jurassic radiolarian faunas in the western Pacific compare well with Tethyan faunas, and are especially similar to Japanese faunas.

Occurrence data of radiolarians presented here are basically the same as those in Matsuoka (1992a), but are slightly modified according to taxonomic definition for this collaboration.

2.2. Section MA1: Ocean Drilling Program Leg 129 Site 800 Hole A.

ODP Site 800 is located in the northern Pigafetta Basin (21°55.38'N, 152°19.32'E) at a water depth of 5686 m and is situated on the magnetic lineation anomaly M33 (Fig. 3). Figure 4 shows the lithostratigraphy of this site.

Radiolarians were investigated in alternating radiolarite and clay strata of lithostratigraphic unit V (Core 129-800A-51R through 129-800A-55R). This unit is overlain by Aptian

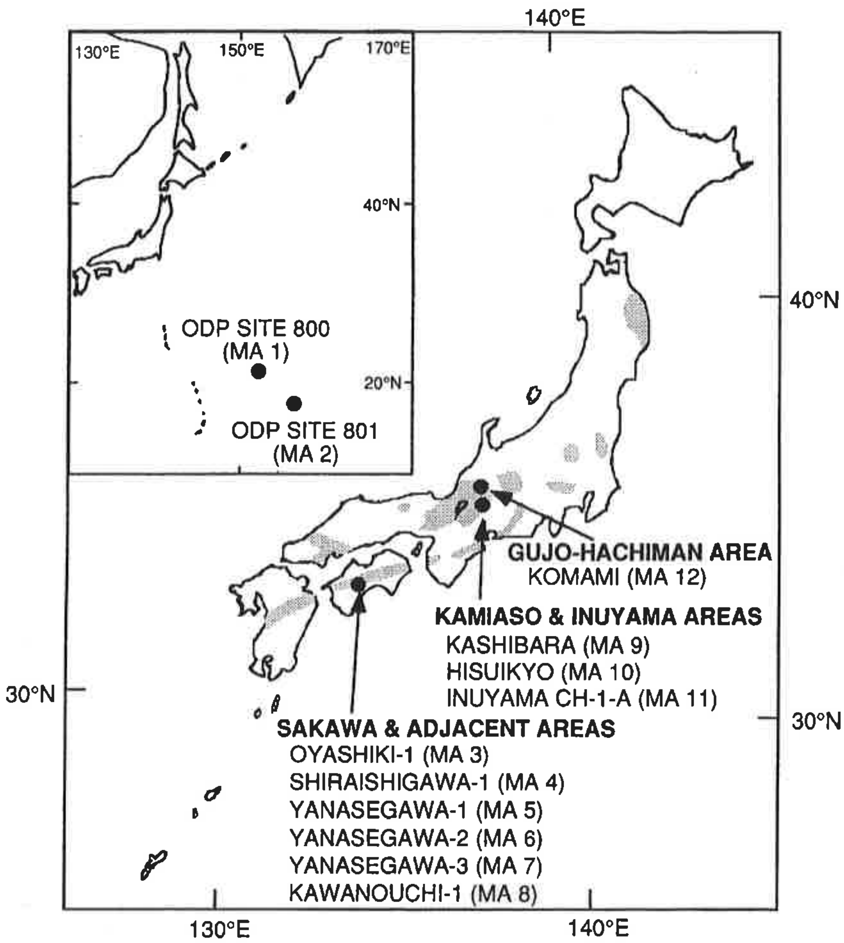


Figure 1. Map showing the location of the study sections. The stippled areas in the Japanese Islands indicate the distribution of Jurassic accretionary complexes.

volcaniclastic turbidites. The base of the unit is the contact with dolerite sills. Core recovery within the studied interval ranged from 18.2% to 55.7%. The radiolarites contain abundant and poorly- to moderately-preserved radiolarian tests. No other age-diagnostic fossils were obtained from this interval.

Eighteen samples were investigated for the section (Appendix, Table 1). *Cecrops septemporatus* and *Dibolachras tytthopora* make their first appearance in Sample 129-800A-54R-2, 50-52 cm (MA1-8) and 129-800B-52R-2, 49-51 cm (MA1-15), respectively. The radiolarite unit of this section is divided into three radiolarian zones by these first appearance biohorizons; *Pseudodictyomitra carpatica, Cecrops septemporatus,* and *Dibolachras tytthopora* zones in ascending order (Matsuoka, 1992a).

2.3. Section MA2: Ocean Drilling Program Leg 129 Site 801 Hole B.

ODP Site 801 is located in the central Pigafetta Basin (18°38.54'N, 156°21.58'E) at a water depth of 5682 m and is situated on a magnetic quiet zone southwest of the M25-M37 magnetic lineation sequence (Fig. 3). Figure 5 shows the lithostratigraphy of this site. The radiolarians investigated were taken from brown radiolarites of lithostratigraphic unit IV (Core 129-801B-14R through 129-801B-32R; MA2-59 to MA2-15) and alternating red radiolarite and claystone beds of lithostratigraphic unit V (Core 129-801B-33R through 129-801B- 37R; MA2-14 to MA2-1). The brown radiolarites (Unit IV) are overlain by Albian volcaniclastic turbidites. A hiatus is inferred between lithologic unit IV and V on the basis of the drastic change in lithology and the record of Formation Microscannar images. Radiolarian occurrences around the hiatus suggest the absence of partial radiolarian zones as mentioned later. The lower part of the interbedded radiolarite and claystone (Unit V), 22 metres thick, consists of a series of slump deposits encompassing the majority of Cores 801B-37R through 33R. The very bottom strata of Unit V conformably rest on and are intercalated with the basaltic basement including intrusive and pillow units. Core recovery of the studied interval ranged from 0.8% to 74.5% and averaged less than 15 %. Radiolarian preservation within the studied interval is poor to moderately-good.

Sample 129-801B-25R-CC contains a diverse nannoflora consisting of *Polycostella beckmannii, Hexalithus noelae, Umbria granulosa minor, Cyclagelosphaera margerelli, Watznaueria barnesae, Watznaueria communis, Watznaueria manivitae, Zygodiscus erectus, Biscutum constans, Discorhabdus* rotatorius, *Vagalapilla stradneri, Rucinolithus* sp., *Cretarhabdus* sp., *Paleopontosphaera* sp. and *Parhabdolithus* sp., probably indicating the *Hexalithus noelae* Subzone of the middle Tithonian (Lancelot *et al.*, 1990). Sample 129-801B-26R-CC contains rare nannofossils such as *W. barnesae, W. manivitae, B. constans, C. margerelii, Cretarhabdus* sp. and *P. beckmannii.* The last taxon is a marker species restricted to the late early to late Tithonian (Lancelot *et al.*, 1990).

$^{39}Ar/^{40}Ar$ laser fusion analyses give an age of 158.4 +1.5 Ma for the basement basaltic lava (Floyd *et al.*, 1991).

Fifty-nine samples were investigated for the section (Appendix, Table 2). *Stylocapsa* (?) *spiralis, Pseudodictyomitra primitiva, Pseudodictyomitra carpatica,* and *Cecrops septemporatus* make their first appearance in

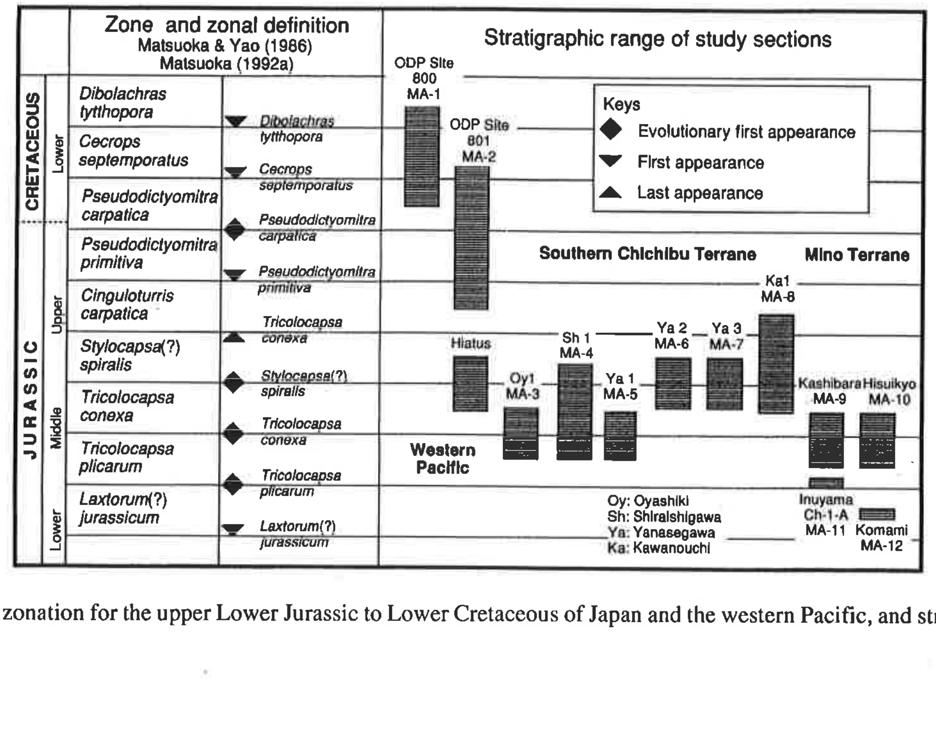


Figure 2. Radiolarian zonation for the upper Lower Jurassic to Lower Cretaceous of Japan and the western Pacific, and stratigraphic range of study sections.

Sample 129-801B-34R-1, 15-17 cm (MA2-10), 129-801B-28R-CC (MA2-24), 129-801B- 20-CC (MA2-45), and 129-801B-14R-CC (MA2-59), respectively. *Tricolocapsa conexa* makes its last appearance in Sample 129- 801B-33R-1, 8-11 cm (MA2-14). The section studied is divided according to the zonal definition in Figure 2 into six radiolarian zones by these first or last appearance biohorizons; *Tricolocapsa conexa, Stylocapsa* (?) *spiralis, Cinguloturris carpatica, Pseudodictyomitra primitiva, Pseudodictyomitra carpatica* and *Cecrops septemporatus* zones in ascending order (Matsuoka, 1992a).

The upper part of the *S.* (?) *spiralis* Zone and the lower part of the *C. carpatica* Zone are missing due to the hiatus between lithologic units IV and V. Samples 129-801B-33R-1, 8-10 cm, through 129-801B-34R-1, 15-17 cm, contain radiolarians diagnostic of the *Stylocapsa* (?) *spiralis* Zone. The samples of this interval generally contain abundant specimens of *S.* (?) *spiralis, Stichocapsa robusta,* and *Tricolocapsa conexa.* The dominance of these species, combined with the absence of *Stichocapsa naradaniensis,* typical of the upper part of the *S.* (?) *spiralis* Zone, suggests that only the lower half of the zone is present.

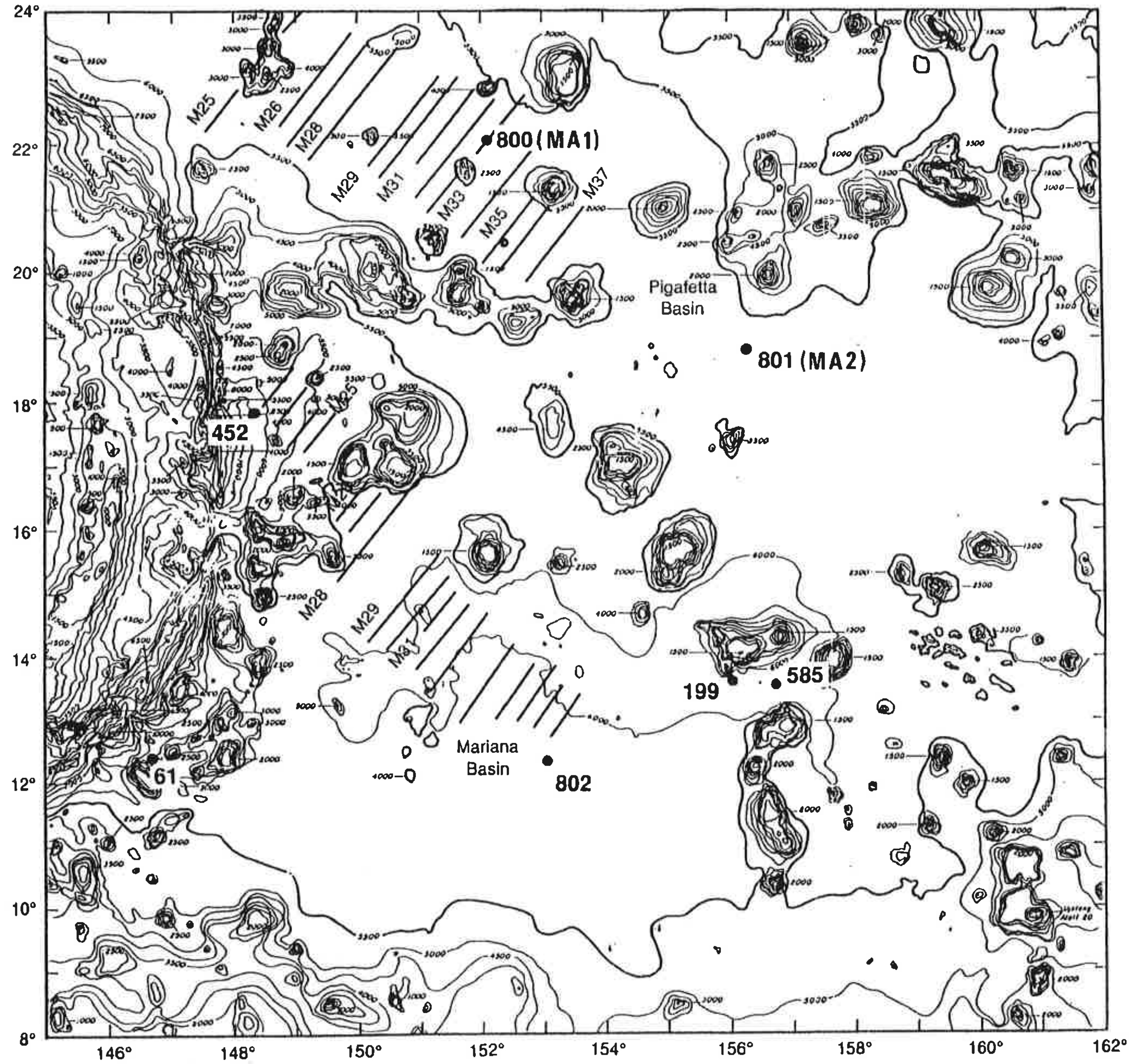


Figure 3. Location map of ODP Sites 800 (**MA1**), 801 (**MA2**), 802, drilled Leg 129, and Deep Sea Drilling Project (DSDP) Sites 61, 199, 452, and 585 (after Lancelot, Larson, *et al.*, 1990). Bathymetry in metres. Diagonal lines show magnetic anomalies M25-M37.

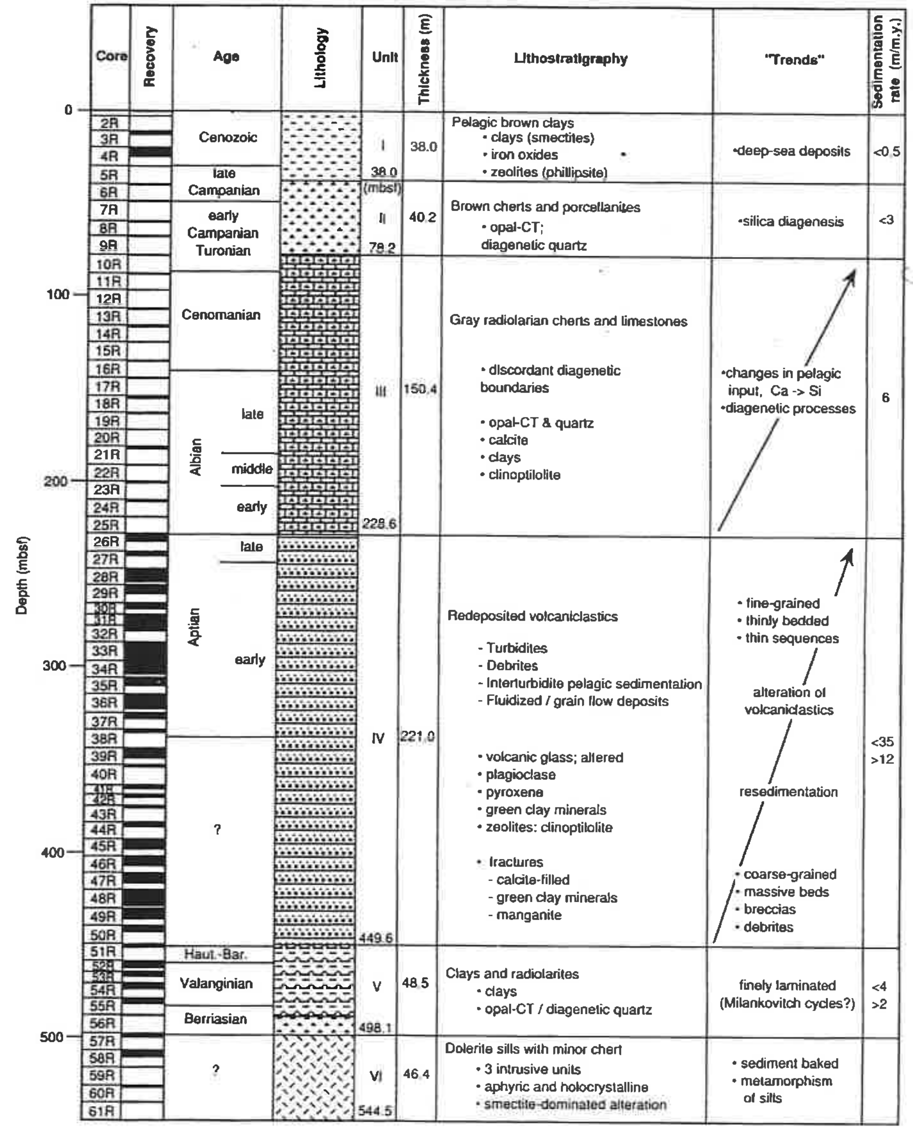


Figure 4. Lithostratigraphy of ODP Site 800, after Lancelot, Larson *et al.*, (1990).

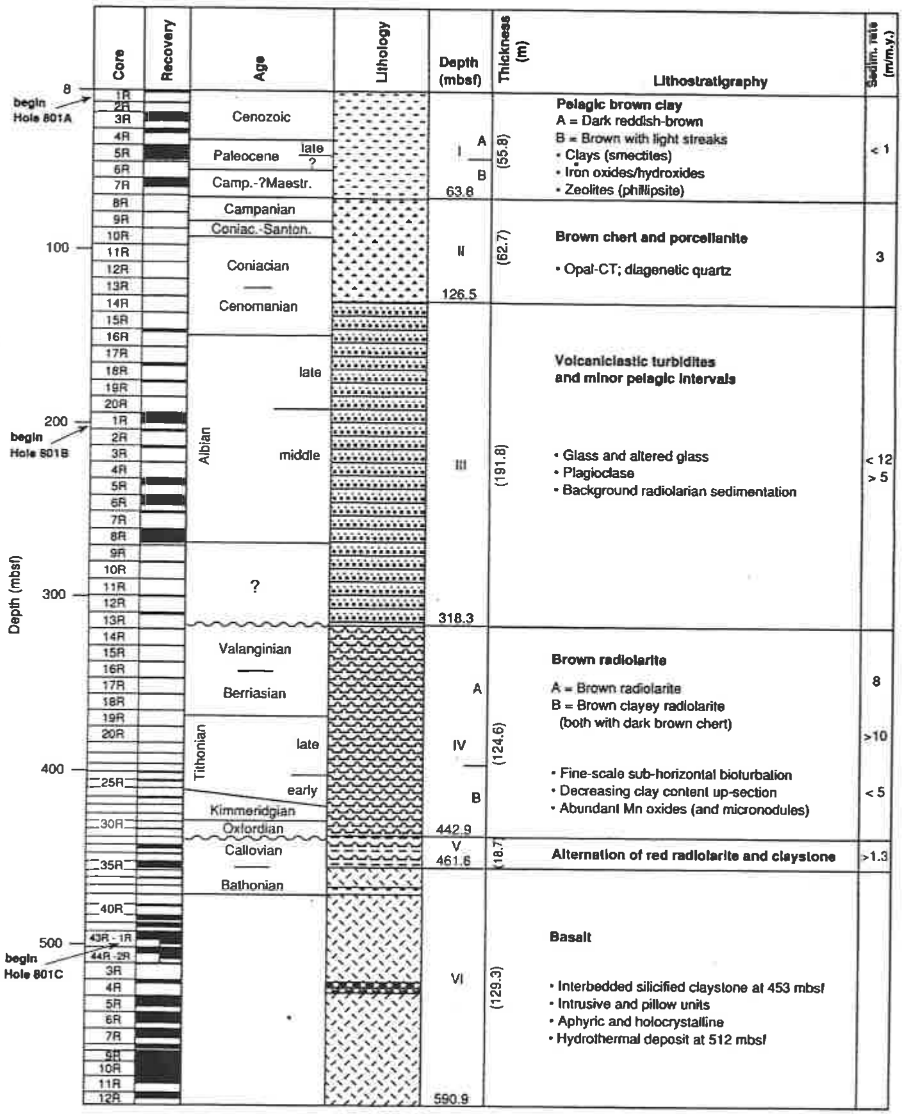


Figure 5. Lithostratigraphy of ODP Site 801, after Lancelot, Larson *et al.*, (1990).

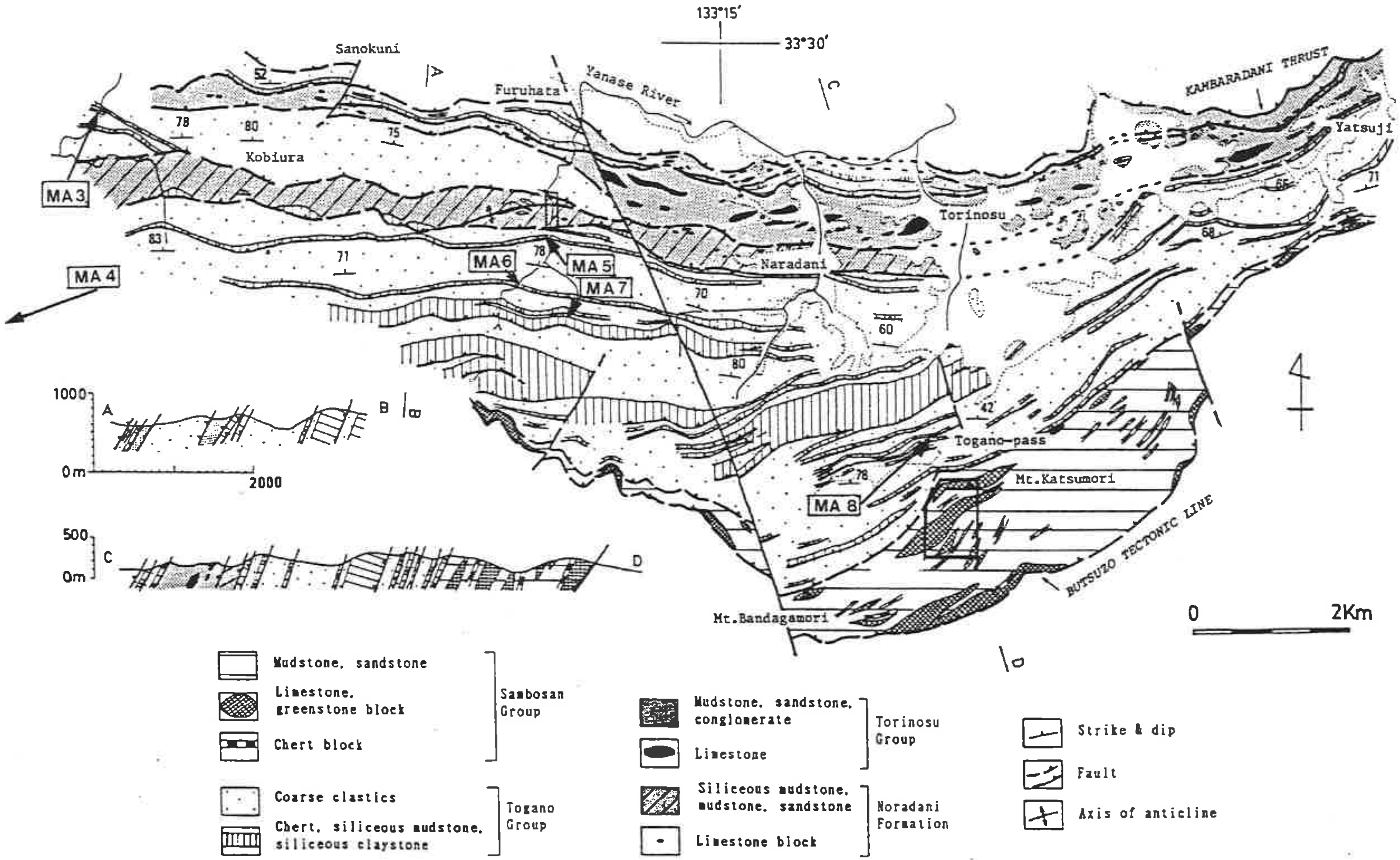


Figure 6. Geological map of the Southern Chichibu Terrane in the Sakawa and adjacent areas, central Shikoku, indicating the location of the Oyashiki 1. Section (**MA3**), Shiraishigawa 1 Section (**MA4**), Yanasegawa 1 Section (**MA5**), Yanasegawa 2 Section (**MA6**), Yanasegawa 3 Section (**MA7**), and Kawanouchi 1 Section (**MA8**), after Matsuoka (1992b).

3. Japan

3.1. Geologic framework

The Japanese Islands are divided into Northeast Japan and Southwest Japan by the Tanakura Tectonic Line on the basis of general features and structural trends of pre-Tertiary rocks. Southwest Japan is further divided into the Inner Zone and the Outer Zone by the Median Tectonic Line. Upper Paleozoic to Lower Tertiary accretionary complexes and their metamorphic equivalents are widely distributed in Southwest Japan. They are categorised into three groups based on their formational age; a Late Paleozoic complex, a Jurassic-Early Cretaceous complex, and a Late Cretaceous-Early Tertiary complex. They show a remarkable oceanward younging polarity as a whole. This regular pattern of distribution is interpreted as an episodic growth of accretionary complexes, which were related to subduction of oceanic plates of different ages. The stratigraphic sections investigated in the present work are located in the Southern Chichibu Terrane of the Outer Zone and the Mino Terrane of the Inner Zone. These terranes are representative of Jurassic-Early Cretaceous accretionary complexes in Southwest Japan.

3.2. Southern Chichibu Terrane

The **Southern Chichibu Terrane** fringes the southern margin of the Jurassic-Early Cretaceous accretionary complex of Southwest Japan. This terrane is in fault contact with the Kurosegawa Terrane to the north and borders the Shimanto Superterrane along the Butsuzo Tectonic Line to the south. The Southern Chichibu Terrane is divided into two subterranes on the basis of differences in the dominant type of lithologic sequences and geological ages (Matsuoka & Yao, 1990; Matsuoka, 1992b). These subterranes are the Togano Subterrane (north) and the Sambosan Subterrane (south). They are juxtaposed throughout the terrane from western Kyushu to the Kanto Mountains over a distance of 1000 km.

The **Togano Subterrane** is characterized by a tectonic pile of chert-clastic sequences of Triassic-Jurassic age. The chert-clastic sequence is composed of siliceous claystone, chert, siliceous mudstone and coarse clastic units from the bottom to the top and represents a coarsening-upward sequence as a whole. The siliceous clay and chert units are thought to have accumulated in a pelagic environment far from continents or island arcs. The siliceous mudstone unit has intermediate features between pelagic and terrigenous sequences and is considered to have been deposited in a hemipelagic environment. The coarse clastic unit is terrigenous and is considered to have accumulated in a trench. The vertical change in sedimentary facies from pelagic through hemipelagic to terrigenous is interpreted as a result of a lateral shift of the sedimentary site from an open ocean environment to a continental margin due to trench-ward movement of an oceanic plate.

Dating of the uppermost part of the siliceous mudstone unit or the coarse clastic unit based on radiolarian biostratigraphy has revealed an ocean-ward younging polarity which is a conspicuous feature observable throughout the Togano Subterrane. The tectonic pile of the chert-clastic sequence is regarded as an accretionary wedge constructed by the successive process of off-scrape accretion of pelagic-hemipelagic units and the overlying trench-fill deposit. This process continued during Middle to Late Jurassic time along the trench.

The chert and siliceous mudstone units in the chert-clastic sequence contain abundant radiolarian fossils and are useful for radiolarian biostratigraphical research. Many studies have been carried out using stratigraphically continuous sections composed of the chert and siliceous mudstone units, in many places within the subterrane. These works include Nishizono *et al.* (1982), Nishizono & Murata (1983), Sato *et al.* (1982), Sato & Nishizono (1983), Sato *et al.* (1986) in Kyushu; Aita (1982, 1985, 1987), Kishida & Sugano (1982), Matsuoka (1982b, 1983a, 1986) in Shikoku, and Furukubo *et al.* (1985), Sashida (1988) in the Kanto Mountains.

The **Sambosan Subterrane** is composed mainly of olistostromal sequences of Late Jurassic to Early Cretaceous age. The olistostromal sequences contain abundant Triassic limestone and greenstone blocks of seamount origin, Triassic-Jurassic chert blocks, and minor amounts of upper Paleozoic limestone and chert blocks. The Triassic limestone blocks sometimes contain bivalve (megalodont) faunas which characterise the Tethyan Realm (Tamura, 1983, 1987, 1990). Olistostromal sequences of different ages are distinguished in western Kii Peninsula (Yao, 1984), eastern Shikoku (Ishida, 1985), and other regions. They generally exhibit a younging polarity from north to south. This subterrane is considered to be formed by a series of collisions of a seamount chain during Late Jurassic to Early Cretaceous times.

Besides the chert-clastic and olistostromal sequences, limestone-bearing clastic sequences are another characteristic constituent of the Southern Chichibu Terrane. These sequences occur in both the Togano and Sambosan subterranes, but are distributed intermittently in the subterranes. Originally, the limestone-bearing clastic sequences are considered to have rested on the chert-clastic and olistostromal sequences. They consist of terrigenous strata associated typically with reef limestones which are generally called Torinosu Limestone. This type of sequence is, exceptionally for the Southern Chichibu Terrane, rich in mega- and microfossils of shallow marine organisms such as ammonites, bivalves, gastropods, brachiopods, echinoids, corals, stromatoporoids, calcareous algae, and benthic foraminifers (e. g., Tamura, 1961). Middle and Late Jurassic ammonite faunas are characterised by Tethyan elements (e.g., Sato, 1962, Bando *et al.*, 1987). Late Jurassic bivalve faunas are assigned to the East Asian Province (Hayami, 1987, 1990).

Late Jurassic-Early Cretaceous radiolarian faunas from the limestone-bearing clastic sequences were reported from Kyushu (Nishizono & Murata, 1983; Tanaka *et al.*, 1985), Shikoku (Aita, 1987; Aita & Okada, 1986; Matsuoka & Yao, 1985; Suyari, 1986; Suyari & Ishida, 1985; Suyari & Kuwano, 1986), Kii Peninsula (Matsuoka & Yao, 1985; Saka & Tezuka, 1988; Yao, 1984), and Kanto Mountains (Yasuda, 1989). Rare co-occurrences of ammonites and calcareous nannofossils with radiolarians contribute to the correlation of radiolarian zones to the standard stages. The relationship between ammonite and radiolarian biostratigraphy was discussed in western Kyushu (Matsumoto & Nishizono, 1985; Yokota & Sano, 1986), eastern Shikoku (Ishida, 1991), and western Kii Peninsula (Yao, 1984). Co-occurrence of latest Jurassic-earliest Cretaceous calcareous nannofossils with radiolarians was reported in western Shikoku (Aita & Okada, 1986).

All stratigraphic sections investigated in the Southern Chichibu Terrane are located in the Sakawa and adjacent areas, western Shikoku (Fig. 1). The geology of the areas is outlined below.

3.3. Geology of the Sakawa and adjacent areas, western Shikoku

Geology of the Sakawa and adjacent areas was reported in detail in Matsuoka (1984b, 1992b), and Matsuoka & Yao (1990). Figures 6 and 7 show a geological map and the stratigraphic succession of the Southern Chichibu Terrane in the Sakawa and adjacent areas. Geologic units of these areas are the Togano Group, Sambosan Group Naradani

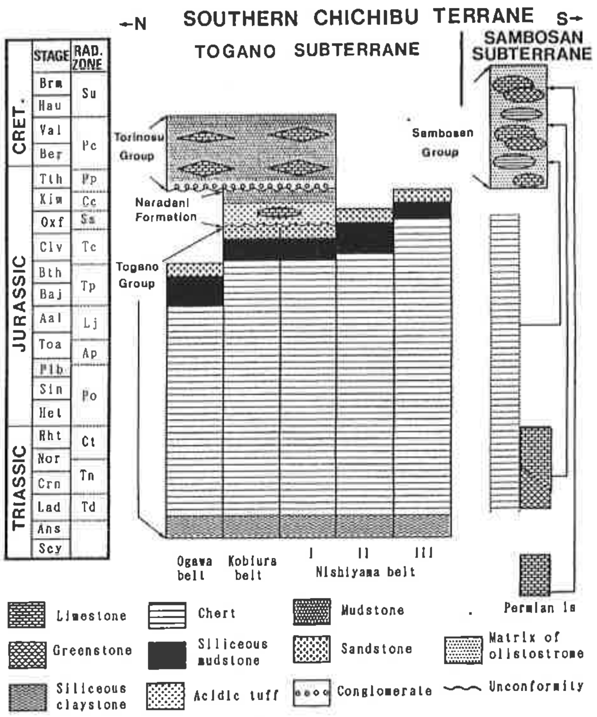


Figure 7. Stratigraphic succession of the Southern Chichibu Terrane in the Sakawa and adjacent areas in southwest Japan. After Matsuoka (1992b).

Formation, and Torinosu Group. These geologic units are generally in fault contact with each other. The strata of the terrane generally strike E-W and dip steeply northward. The E-W trending structures are cut by later NE-SW faults. The Togano Group and Sambosan Group are an accretionary complex of Middle Jurassic to Early Cretaceous age. Originally, the Naradani Formation is inferred to have rested unconformably on the Togano Group. The basal conglomerate of the Torinosu Group unconformably overlies the Togano Group or Naradani Formation in some places.

The **Togano Group** consists of chert-clastic sequences and is characterised by an imbricate structure of the sequences. The lower part of the sequences is dated as Middle Triassic by radiolarians and conodonts. Radiolarian biostratigraphic study revealed that the upper part of the sequences has a younging polarity from north (early Middle Jurassic) to south (middle Late Jurassic).

The **Sambosan Group** is an olistostromal sequence which is composed of a muddy matrix and various-sized blocks of limestone, greenstone, chert, and sandstone. The formation is dated as latest Jurassic to Early Cretaceous based on radiolarian fossils from the muddy matrix.

The **Naradani Formation** and the Torinosu Group are categorised as limestone-bearing clastic sequences. The Naradani Formation consists mainly of mudstone, siliceous mudstone, and acidic tuff associated with muddy limestone which yields brachiopods (Tokuyama, 1957, 1958) and corals (Yamagiwa *et al.*, 1976). Three four-segmented nassellarians were described from the formation (Matsuoka, 1984a); *Stichocapsa naradaniensis*, *Stichocapsa robusta* and *Cyrtocapsa* sp. A. This formation is dated as Late Jurassic by radiolarians.

The **Torinosu Group** is composed of mudstone, sandstone, conglomerate, acidic tuff and reef limestones. This group is characterised by occurrences of shallow marine fossils such as bivalves (e. g., Tamura, 1960) and ammonites (e.g., Kobayashi, 1935; Sato, 1962) from clastic rocks, and corals (Eguchi, 1951), brachiopods (Tokuyama, 1957), gastropods (Shikama & Yui, 1973), stromatoporoids, echinoids, and calcareous algae from limestones. Radiolarian faunas were reported from mudstone and acidic tuff in the group (Matsuoka & Yao, 1985; Suyari & Ishida, 1985). Aita & Okada (1986) reported radiolarians and calcareous nannofossils from calcareous mudstone in the areas and their western extension. The Torinosu Group is dated as Latest Jurassic-Early Cretaceous by radiolarians and rarely occurring ammonites and calcareous nannofossils.

All six sections (MA3 to MA8; Fig. 6) reported in this chapter from the Sakawa and adjacent areas are composed of the upper part (Jurassic) of a chert unit and overlying siliceous mudstone unit within the chert-clastic sequence of the Togano Group. Chert samples contain abundant but generally poorly-preserved radiolarians. Siliceous mudstone samples yield abundant and well-preserved radiolarians. Radiolarian assemblages in these sections are characterised by the abundant occurrence of closed nassellarians belonging to the genera *Cyrtocapsa, Dicolocapsa, Gongylothorax, Guexella, Stichocapsa, Stylocapsa, Tricolocapsa,* and *Williriedellum.* Among multi-segmented nassellarians, species belonging to the genera *Archaeodictyomitra* and *Hsuum* occur rather abundantly. Spumellarians and other multi-segmented nassellarians are less abundant than the closed nassellarians and their occurrences are somewhat sporadic. Matsuoka (1983a) has focused on evolutionary lineages of abundantly occurring taxa and has defined three radiolarian zones using the evolutionary first appearance biohorizons of reliable lineages. Occurrence data of radiolarians presented here are the same as those in Matsuoka (1983a, 1986), except for the Shiraishigawa 1 Section (MA4) where the evolutionary first appearance biohorizon of *Tricolocapsa conexa* is re-examined as mentioned later.

Triassic radiolarian or conodont assemblages were found in a few horizons below the studied interval in the Oyashiki 1 Section (MA3), Yanasegawa 1 Section (MA5), and Kawanouchi 1 Section (Matsuoka, 1983b, 1984b). No age-diagnostic fossils other than radiolarians have been obtained from the studied intervals.

4. Description of sections

4.1. Section MA3: Oyashiki 1 Section

The Oyashiki 1 Section (MA 3, Fig. 6), located 0.8 km Northeast of Oyashiki, Ochi Town, is an outcrop along the road running from Ochi to Oyashiki. Figure 8 shows a sketch of this section together with the sampling points. The lithologic column of this section and sample horizons are shown in Figure 9. Lithostratigraphy and radiolarian biostratigraphy of this section were reported in Matsuoka (1982b, 1983a, 1983b). This section is composed of chert, siliceous mudstone, sandstone, mudstone and acidic tuff. Three major faults divide this section into four blocks (A, B, C, and D). Blocks A, B, and C consist of bedded chert. In Block D, bedded chert changes gradually upward into siliceous mudstone. The siliceous mudstone is interbedded with three layers of acidic tuff and is conformably overlain by sandstone-rich alternating beds of sandstone and mudstone. A sandstone dyke intrudes near the basal part of Block D. Samples M-35 and M-37 of Block A yield Late Triassic conodonts faunas including *Epigondolella bidentata* (M-35) and *Misikella hernsteini* (M-33). Blocks B and C contain early Early Jurassic and late Early Jurassic radiolarians, respectively.

Thirteen samples from Block D (M-50 to M-64) are used for this study (Appendix, Table 3). *Tricolocapsa conexa* makes the first appearance at Sample M-54.5 (MA3-7). The chert and siliceous mudstone of Block D are divided into two radiolarian zones; *Tricolocapsa plicarum* Zone and *Tricolocapsa conexa* Zone in ascending order (Matsuoka, 1983a).

4.2. Section MA4: Shiraishigawa 1 Section

The Shiraishigawa 1 Section (MA 4, Fig. 6), located 1.5 km east of Shiraishigawa, Niyodo Town, is an outcrop along the logging road connecting Shiraishigawa and Oyashiki. Figure 10 shows a sketch of the outcrop along with sampling points. The lithologic column of this section and sample horizons are shown in Figure 9. Radiolarian biostratigraphy of this section was reported in Matsuoka (1982b, 1983a) and Matsuoka & Yao (1986). This section is composed of chert, siliceous mudstone, sandstone, mudstone, and acidic tuff. This section consists of the lower chert, middle siliceous mudstone, and upper coarse clastic units. The chert unit is made of bedded chert and changes gradually upward into the siliceous mudstone unit. Many acidic tuff layers occur in the upper part of the siliceous mudstone unit. The siliceous mudstone unit is conformably overlain by the coarse clastic unit. Several closed nassellarians belonging to the genera, *Protunuma*, *Stylocapsa*, *Tricolocapsa*, and so on, were described in samples from this section (Matsuoka, 1983a).

Twenty-five samples were taken for radiolarian biostratigraphic study from the chert and siliceous mudstone units (Appendix, Table 4). Matsuoka (1983a) reported that *Tricolocapsa conexa* and *Stylocapsa* (?) *spiralis* make their

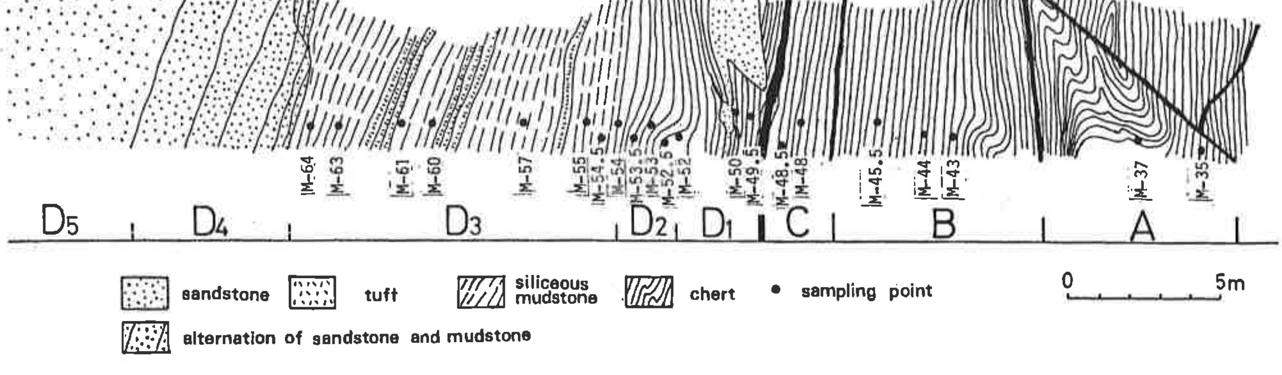


Figure 8. Sketch map of the Oyashiki 1 Section (MA3), showing sample points.

first appearance in Sample T-08 (MA4-4) and S-14.6 (MA4-18), respectively. In Matsuoka (1983a), specific identification was largely based on light microscopic observation. A tilted specimen of *T. plicarum* tends to have a transverse ridge-like image on shell surface, resulting in the misidentification of *T. plicarum* with *T. conexa*. As a result of re-examination by a scanning electron microscope, it became apparent that the first appearance of *T. conexa* is in Sample S-01 (MA4-8), about 15 m higher than the horizon in the previous examination. This section is divided into three radiolarian zones by these first appearance biohorizons; *Tricolocapsa plicarum* Zone, *Tricolocapsa conexa* Zone, and *Stylocapsa* (?) *spiralis* Zone in ascending order (Matsuoka, 1983a, re-examined herein).

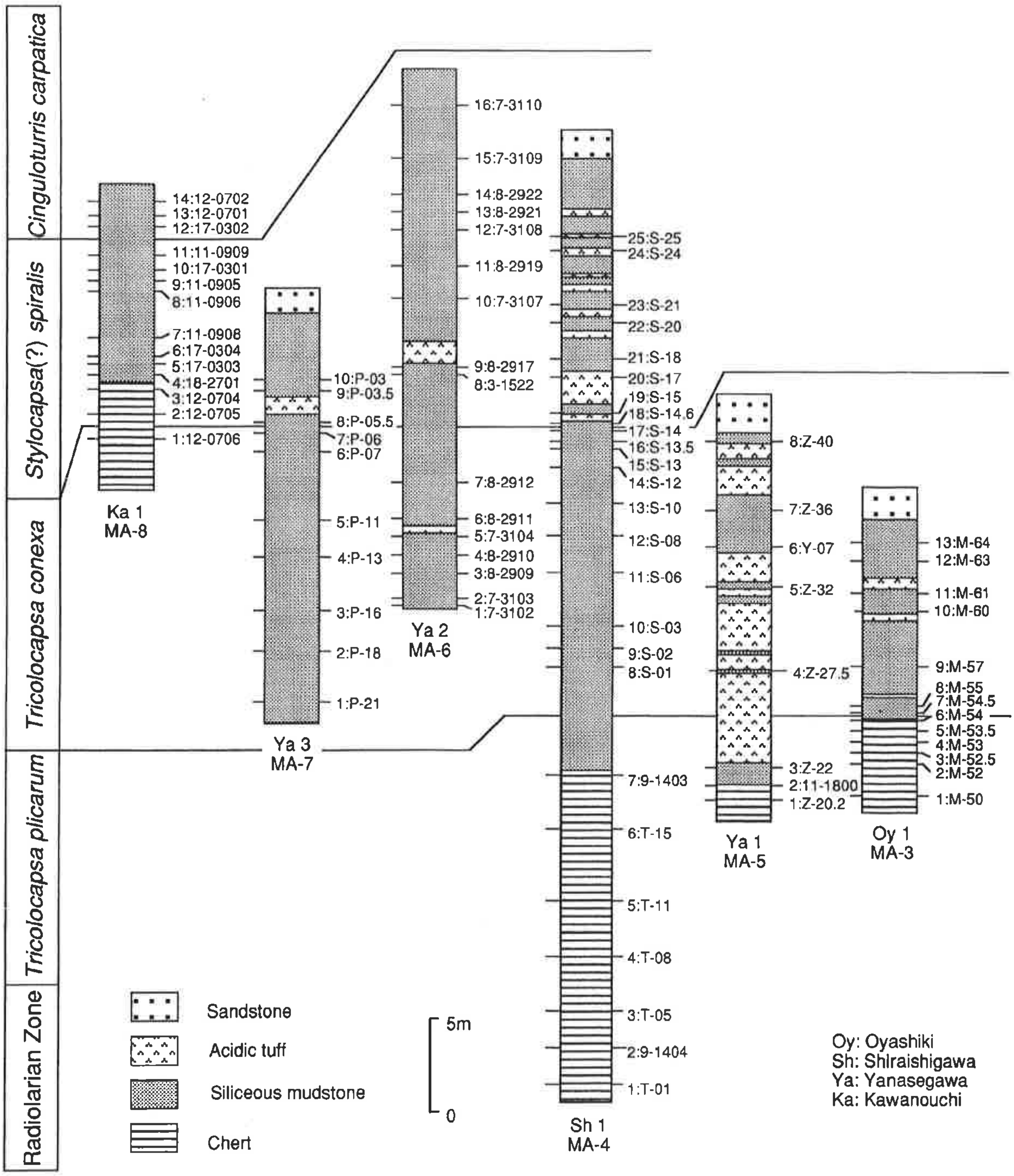


Figure 9. Lithologic columns of the studied sections in the Sakawa and adjacent areas, central Shikoku, showing sample horizons and radiolarian zonal division.

4.3. Section MA5: Yanasegawa 1 Section

The Yanasegawa 1 Section (MA 5, Fig. 6), located 1 km south of Kooku, Sakawa Town, is an outcrop along the logging road running from Kooku to the upper reaches of the Yanase River. The lithologic column of the section and sample horizons are shown in Figure 9. This section is composed of chert, siliceous mudstone, mudstone, sandstone, and acidic tuff. Bedded chert changes gradually upward into siliceous mudstone which is intercalated with acidic tuff layers of 0.6 to 5.6 m thick. Siliceous mudstone is overlain by massive, medium sandstone of coarse clastic unit. Middle Triassic radiolarians were reported from chert beds in the lower part of this section (Matsuoka, 1984b). Eight samples were investigated from this section (Appendix, Table 5). *Tricolocapsa conexa* makes its first appearance at Sample Z-27.5 (MA5-4). The section is divided into two radiolarian zones by the first appearance horizon; *Tricolocapsa plicarum* Zone and *Tricolocapsa conexa* Zone in ascending order (Matsuoka, 1983a).

4.4. Section MA6: Yanasegawa 2 Section

The Yanasegawa 2 Section (MA 6, Fig. 6), located 0.6 km Southwest of the Yanasegawa 1 Section, is an outcrop along the southern extension of the logging road which runs through the Yanasegawa 1 Section. The lithologic column of the section and sample horizons are shown in Figure 9. Strata of the section are composed of chert, siliceous mudstone, mudstone, and acidic tuff. Siliceous mudstone is intercalated with acidic tuff layers about 1m thick and grades upward into mudstone.

Jurassic two-segmented nassellarians were described from a siliceous mudstone sample in another locality (Matsuoka, 1982a); *Gongylothorax sakawaensis, Stylocapsa (?) spiralis* and *Stylocapsa catenarum.* The locality is about 1 km Southeast of the Yanasegawa 2 Section and the same stratigraphic horizon as the siliceous mudstone in the Yanasegawa 2 Section crops out (Matsuoka, 1982a). Middle Triassic radiolarians were reported from chert beds which are the western extension of the lower part of the Yanasegawa 2 Section (Matsuoka, 1984b).

Sixteen samples were investigated from this section (Appendix, Table 6). *Stylocapsa* (?) *spiralis* first appears in Sample 3- 1522 (MA6-8). This section is divided into two radiolarian zones by the first appearance horizon; *Tricolocapsa conexa* Zone and *Stylocapsa* (?) *spiralis* Zone in ascending order (Matsuoka, 1983a).

4.5. Section MA7: Yanasegawa 3 Section

The Yanasegawa 3 Section (MA 7, Fig. 6), located 1.0 km south of the Yanasegawa 1 Section (MA5), exposed along a tributary of the upper reaches of the Yanase River. The lithologic column of the section and sample horizons are shown in Figure 9. Strata of this section are composed of siliceous mudstone, mudstone, sandstone, and acidic tuff.

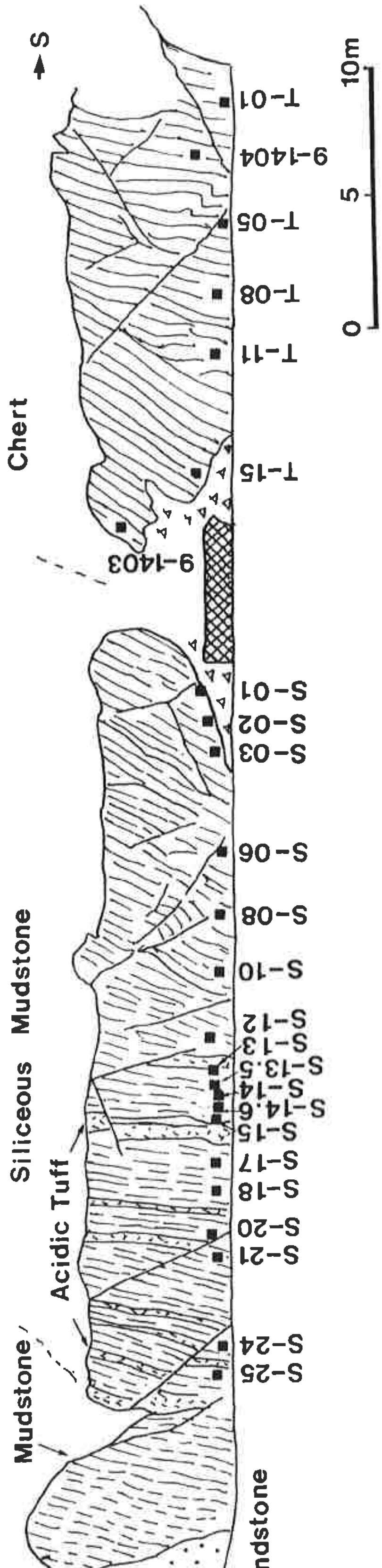


Figure 10. Sketch map of the Shiraishigawa 1 Section (MA4), showing sample points.

Siliceous mudstone is intercalated with acidic tuff layers of about 1m and gradually changes upwards into mudstone. The mudstone is conformably overlain by sandstone-rich alternating beds of sandstone and mudstone.

Ten samples were examined from this section (Appendix, Table 7). *Stylocapsa* (?) *spiralis* first appears in Sample P-05.5 (MA7-8). This section is divided into two radiolarian zones; *Tricolocapsa conexa* Zone and *Stylocapsa* (?) *spiralis* Zone in ascending order (Matsuoka, 1983a).

4.6. Section MA8: Kawanouchi 1 Section

The Kawanouchi 1 Section (MA 8, Fig. 6), located just east of Kawanouchi, Sakawa Town, is exposed along a cliff of an abandoned quarry. The radiolarian biostratigraphy of this section was reported in Matsuoka (1986) and Matsuoka & Yao (1986). The lithologic columnar section of the studied part and sample horizons are shown in Figure 9. This section consists of bedded chert, siliceous mudstone, and mudstone. Bedded chert gradually changes upward through siliceous mudstone into mudstone. In the uppermost part of the section, mudstone is intercalated with siliceous mudstone layers of 0.1 m. Middle Triassic radiolarians were reported from chert beds in the lower part of this section (Matsuoka, 1984b).

Fourteen samples were investigated from this section (Appendix, Table 8). This section is divided into three radiolarian zones; *Guexella nudata* Assemblage-zone, *Gongylothorax sakawaensis-Stichocapsa naradaniensis* Assemblage-zone, and *Tricolocapsa yaoi* Assemblage-zone in ascending order (Matsuoka, 1986). Chronologically equivalent interval-zones for the *G. nudata, G. sakawaensis-S. naradaniensis,* and *T. yaoi* Assemblage-zones are the *Tricolocapsa conexa* Zone, *Stylocapsa* (?) *spiralis* Zone, and *Cinguloturris carpatica* Zone, respectively.

5. Mino Terrane

5.1. Geological outline of the Mino Terrane

The Mino Terrane is a Jurassic-Early Cretaceous accretionary complex and occupies the central part of the inner Zone in Southwest Japan. It is in fault contact with the Hida-Gaien Belt to the north and gradually changes to the Ryoke Metamorphic Belt to the south.

The Mino Terrane consists of Jurassic-Early Cretaceous terrigenous strata, Permian-Jurassic chert, Carboniferous-Permian limestone, and greenstone. It is divided into 6 units on the basis of differences in lithologic association, geologic age, and structural style (Wakita, 1988). These are the Sakamoto-toge, Samondakej Funafuseyama, Nabi, Kanayama, and Kamiaso units from north to south (Fig. 11).

In this chapter, samples from the Samondake and the Kamiaso units are treated. The Samondake unit is composed of late Early Jurassic to late Middle Jurassic coherent stratigraphic sequences of massive sandstone and turbidite, including a small amount of chert blocks in its lower part. The Kamiaso unit contains stacked slices, each of which consists of a coarsening-upward succession including Early Triassic siliceous claystone, Middle Triassic-Early Jurassic bedded chert, Middle Jurassic siliceous mudstone and Middle Jurassic to early Late Jurassic turbidite. The lithologic succession is identical to the chert-clastic sequence in the Togano Subterrane, Outer Zone.

The six units in the Mino Terrane exhibit a younging polarity from north to south with an exception of the Kanayama unit which is assigned to the youngest age in the terrane. The Mino Terrane is considered to be formed through successive accretionary processes during Jurassic and earliest Cretaceous time (Wakita, 1988; Otsuka, 1988). The Kanayama unit is interpreted as a diapiric melange (Wakita, 1988) or olistostromal sequence which covers the pre-existing accretionary complex of Middle Jurassic age (Otsuka, 1988).

Paleomagnetic data suggest that Permian-Jurassic chert or siliceous mudstone, and Permian greenstone are of low-paleolatitude origin (e. g., Hirooka *et al.*, 1983). Rare Middle or Late Jurassic ammonites were reported from clastic strata in the Mino Terrane (Sato, 1974; Sato *et al.*, 1985).

Radiolarian biostratigraphic research has been carried out especially in the Kamiaso and Inuyama areas in both of which chert-clastic sequences of the Kamiaso unit are well exposed along river banks (e. g., Hori, 1990; Kido, 1982; Matsuda & Isozaki, 1991; Matsuoka, 1988; Yao, 1982). Manganese nodules or bands, which are sometimes found within chert and siliceous mudstone in the Kamiaso, Nabi, and Samondake units, contain excellently preserved Early or Middle Jurassic radiolarian faunas which are used for systematic descriptions (e. g., Matsuoka, l991b; Takemura, 1986; Yao, 1972).

5.2. Geology of the Kamiaso area.

The Kamiaso area (Fig. 11) has geologically been surveyed by many workers (Adachi & Mizutani, 1971; Igo, 1980; Kano, 1979; Kido, 1982; Mizutani, 1964). Tectonic repetition of the chert-clastic sequences of the Kamiaso unit is recognized along the Hida River in this area. Many biostratigraphic and paleontologic studies of radiolarians and conodonts were carried out along the well-exposed sections (Igo, 1980; Isozaki & Matsuda, 1985; Kido 1982; Kido *et al.* 1982; Matsuda & Isozaki, 1982; Matsuoka, 1988; Mizutani & Kido, 1983, Nakaseko & Nishimura, 1979). Chert beds were studied for petrology and geochemistry by Kakuwa (1987, 1988) and Yamamoto (1983).

Both the Kashibara (MA9) and Hisuikyo (MA10) sections (Fig. 12) are exposed along the left bank of the Hida River and are composed of a Triassic-Jurassic chert unit, a Jurassic siliceous mudstone unit, and a Jurassic clastic unit including black mudstone and alternating beds of sandstone and mudstone. The present work treats only the siliceous mudstone unit and the lowest part of the clastic unit.

Siliceous mudstone samples from these sections generally contain abundant and well-preserved radiolarian tests, whereas black mudstone samples yield a few and poorly- to moderately-preserved radiolarian tests. Abundant taxa include closed nassellarians belonging to the genera, *Sethocapsa, Stichocapsa, Tricolocapsa, Unuma, Williriedellum,* and multisegmented nassellarians belonging to genera, *Archaeodictyomitra* and *Hsuum.* Other multisegmented nassellarians and spumellarians are less abundant than above-mentioned taxa and their occurrences seem somewhat sporadic. Stratigraphic distribution of radiolarian species belonging to genera, *Eucyrtidiellum, Guexella, Stichocapsa, Stylocapsa, Tricolocapsa, Unuma,* and *Williriedellum* are examined and listed in the Appendix (Table 9 and 10). Occurrences of some other species from the studied sections were reported by Kido *et al.* (1982) and Mizutani & Kido (1983).

No other age-diagnostic fossils than radiolarians have been obtained from the studied intervals.

5.3. Section MA9: Kashibara Section

The Kashibara Section, located just south of Kashibara, Hichiso Town, is exposed along the left bank of the Hida River (Fig. 12). This section consists of chert, siliceous mudstone and black mudstone units. Figure 13 shows a sketch map and lithologic column of the upper part of the

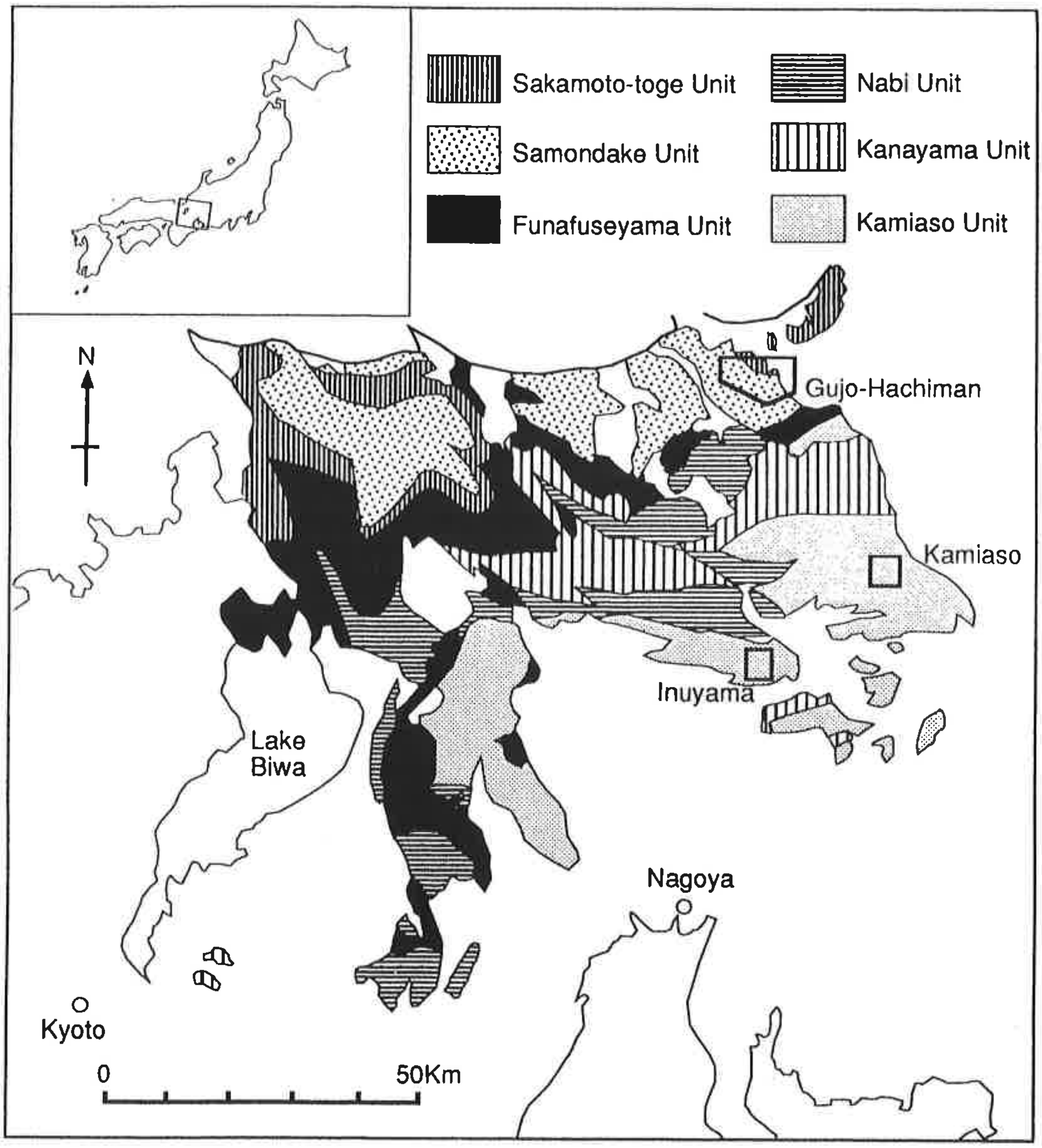


Figure 11. Geological outline of the Mino Terrane. After Wakita (1988).

section together with sampling points. The chert unit (Fig. 13, A) is composed of varicoloured bedded chert and yields Triassic and Early Jurassic radiolarians (Kido, 1982; Matsuoka, unpublished data). It is in fault contact with the Jurassic siliceous mudstone unit. The fault zone (Fig. 13, B), ranging 0.5-1.0 m in thickness, is characterised by lens-like chert blocks and a consolidated siliceous mudstone matrix. The siliceous mudstone unit (Fig. 13, C) is composed mainly of siliceous mudstone associated subordinately with mudstone and sandstone. The siliceous mudstone is red, grey, greenish grey and is intercalated with thin mudstone layers. Red siliceous mudstone occurs dominantly in the lower part, while it is not present in the upper part of the unit. The black mudstone unit (Fig. 13, D) consists of weakly stratified black mudstone and thin (2-5 cm) sandstone layers. This unit seems to overlie conformably the siliceous mudstone unit. An oblique fault (Fig. 13, E) cuts the siliceous mudstone and black sandstone units in this section. Judging from the separation by the fault, observable in the boundary between the siliceous mudstone and black mudstone units, the MKS-6b (MA9-15) horizon is set above the MKS-9. Sa (MA9-14) horizon in the columnar section (Fig. 13).

Thirty-five samples are selected in the present study (Appendix, Table 9), although more than 40 samples, some of which contain few or poorly-preserved radiolarians, were

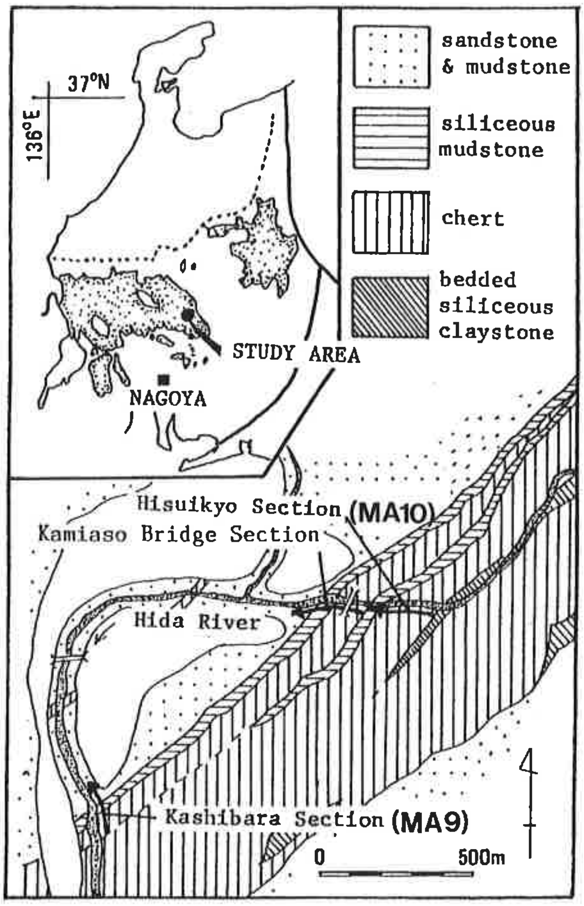


Figure 12. Geological map of the Kamiaso area, showing the Kashibara Section (MA9) and Hisuikyo Section (MA10). After Matsuoka (1988).

collected from this section. Matsuoka (1988) has examined the stratigraphic distribution of *Tricolocapsa plicarum* and *Tricolocapsa conexa* and divided this section into the lower or *Tricolocapsa plicarum* Zone and the upper or *Tricolocapsa conexa* Zone, using the evolutionary first appearance biohorizon (MKS-10; MA9-20) of *T. conexa*. The evolutionary lineage from *Eucyrtidiellum unumaense* through *E. semifactum* to *E. ptyctum* can be traced within this section (Matsuoka, 1989).

5.4. Section MA 10: Hisuikyo Section.

The Hisuikyo Section (Fig. 12), located in the Hisuikyo gorge near Kamiaso, Hichiso Town, is exposed along the left bank of the Hida River. Figure 14 shows a sketch map and lithologic column of the upper part of this section together with sampling points. This section is composed of siliceous claystone, chert, hard siliceous mudstone, and siliceous mudstone units. Because the hard siliceous mudstone unit yielded a radiolarian assemblage older than the *Unuma echinatus* Assemblage of early Middle Jurassic age (Kido, 1982), only strata above the base of the siliceous mudstone unit are treated in this study. This unit is in fault contact with the hard siliceous mudstone unit at the base and with the chert unit, which is the base of the neighbouring chert-clastic sequence, at the top. The lithology of the siliceous mudstone unit is similar to that of the same unit in the Kashibara Section (MA9).

Twelve samples are examined from this section (Appendix, Table 10). *Tricolocapsa conexa* makes its first appearance at Sample MHS-C (MA10-11). The section is divided into two zones by the first appearance biohorizon; *Tricolocapsa plicarum* and *Tricolocapsa conexa* zones in ascending order (Matsuoka, 1988).

5.5. Geology of the Inuyama area.

The Inuyama area is located in the southern part of the Mino Terrane (Fig. 11). Chert-clastic sequences of the Kamiaso unit are exposed in this area and especially along both the banks of the Kiso River (Fig. 15). Geological studies from different point of view have been carried out on the excellent exposure. These include stratigraphic and structural studies (Hayashi & Inoue, 1962; Kondo & Adachi, 1975; Matsuda & Isozaki, 1991; Mizutani, 1964; Otsuka, 1989, 1990), radiolarian and conodonts biostratigraphic and paleontologic studies (Baumgartner, 1984; Hori, 1988, 1990; Hori & Yao, 1988; Ichikawa & Yao, 1976; Matsuda & Isozaki, 1991; Matsuoka & Yao, 1986; Mizutani & Koike, 1982; Nagai & Mizutani, 1990; Yao, 1972, 1979, 1982; Yao *et al.*, 1980, 1982), paleomagnetic studies (Shibuya & Sasajima, 1986), and geochemical studies (Kakuwa, 1987, 1988).

A Middle or Late Jurassic (late Bathonian-earliest Oxfordian) ammonite, *Choffatia* (*Subgrossouvria*) sp. was reported from a float block of black laminated siltstone in the area (Sato, 1974), and is believed to come from the coarse clastic unit which conformably overlies radiolarian-rich siliceous mudstone unit probably assignable to the *Tricolocapsa conexa* Zone.

5.6. Section MA 11: Inuyama CH-1-A Section.

The Inuyama CH-1-A Section is exposed on the left bank of the Kiso River. Figure 16 shows a sketch map of this section. Strata of this section are composed of chert, siliceous mudstone associated with a lens (0.3 X 0.8 m) of manganese band which is characterised by containing rhodochrosite spherules of 1-2 mm in diameter. Chert and siliceous mudstone are well- or weakly-bedded, and mostly red or reddish brown and partly grey. Thirty-two samples were collected from this section. The manganese band yields an excellently-preserved and highly diverse radiolarian fauna, whereas the chert and siliceous mudstone contain generally moderately-preserved and less diversified radiolarian faunas. A preliminary research on radiolarian biostratigraphy has revealed that this section is assignable to the *Laxtorum* (?) *jurassicum* Zone to *Tricolocapsa plicarum* Zone. Only one sample from the manganese band (MIN-1) is used in this work. Besides species listed in the Appendix (Table 11), the sample contains the following species; *Anisicyrtis jurassica* TAKEMURA, *Archanicapsa sphaerica* TAKEMURA, *Artostrobium* (?) *primum* YAO, *Eucyrtidiellum gujoense* (TAKEMURA & NAKASEKO), *Parahsuum dentatum* TAKEMURA, *Parahsuum levicostatum* TAKEMURA, *Parahsuum parvum* TAKEMURA, *Triversus japonicus* TAKEMURA, and *Yamatoum connicinum* TAKEMURA. The

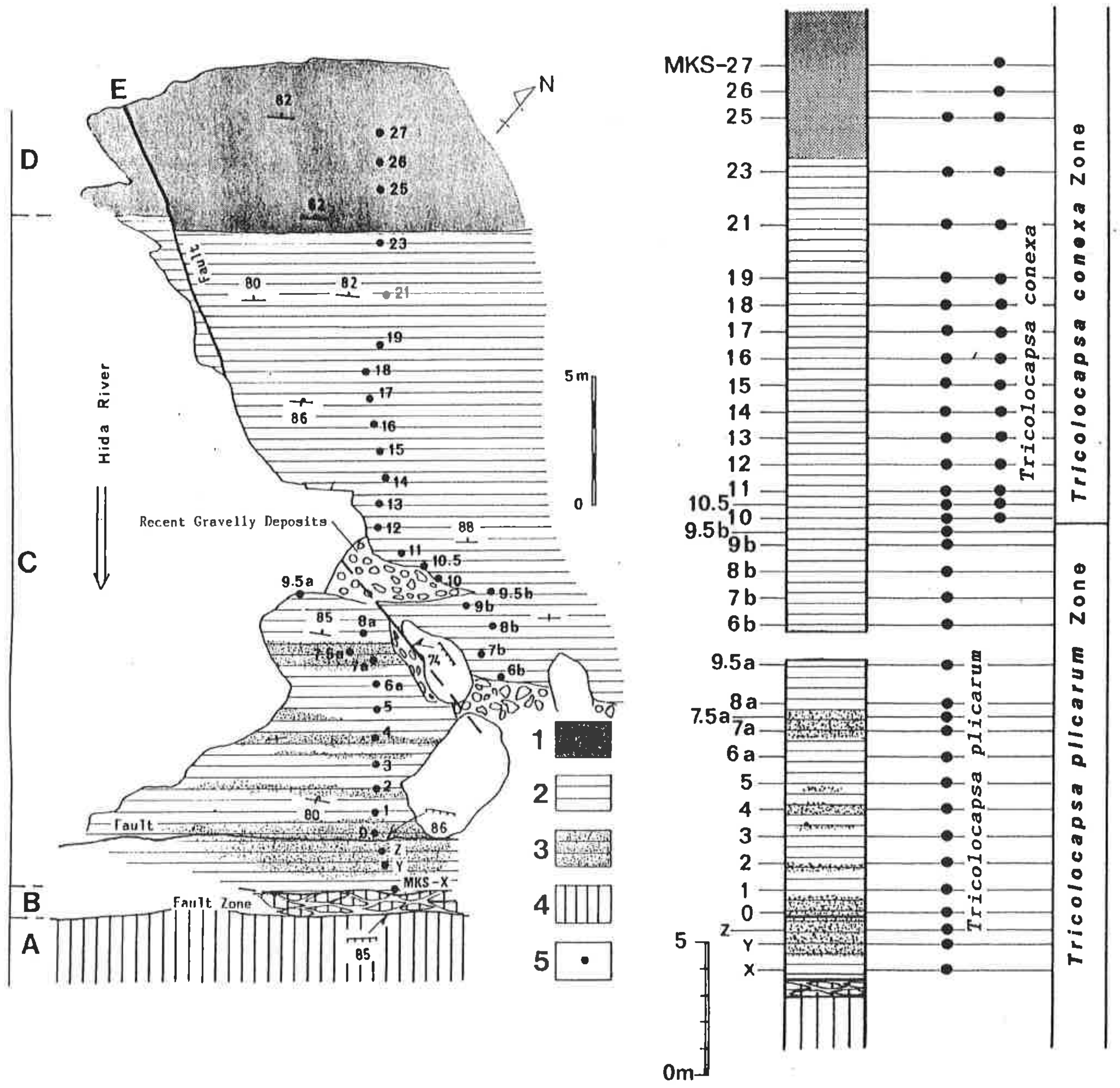


Figure 13. Sketch map and lithologic column of the Kashibara Section (MA9), showing sample points and horizons. The columnar section exhibits the vertical distribution of *Tricolocapsa plicarum* and *Tricolocapsa conexa,* and radiolarian zonal division. **1.** Black mudstone, **2, 3.** Siliceous mudstone (**3.** Red siliceous mudstone), **4.** Chert, **5** Sample points. After Matsuoka (1988).

faunal association of the sample indicates the lower part of the *Tricolocapsa plicarum* Zone. No age-diagnostic fossils other than radiolarians have been obtained from the section.

5.7. Geology of the Gujo-Hachiman area.

The Gujo-Hachiman area is located in the northern part of the Mino Terrane (Fig. 11). Strata of the Samondake unit are widely distributed in this area (Wakita, 1988). The Samondake unit is in fault contact with the Sakamoto-toge unit to the northeast, whereas it appears to conformably overlie the Funafuseyama unit to the south (Wakita, 1988). Wakita (1984) named the strata distributed northeast of the Hachiman Fault the Kodaragawa Formation and divided it into three members; the Tokunaga Sandstone Member, Komami Siliceous Shale Member, and Fukazara Sandstone and Mudstone Member in ascending order. This stratigraphic succession is apparent because of fossil evidence that is discordant with the stratigraphy as mentioned below. Wakita (1982, 1984, 1988) and Wakita & Okamura (1982) reported Permian-Triassic radiolarians and Triassic conodonts from chert blocks, Early and Middle Jurassic radiolarians from mudstone, siliceous mudstone and manganese bands. An excellently preserved radiolarian fauna of early Middle Jurassic age (*Laxtorum* (?) *jurassicum* Zone) was reported from a manganese band in the Komami Shale Member, obtained near Komami, Yamato Village (Takemura & Nakaseko, 1982, 1983, 1986; Takemura, 1986). A Middle Jurassic (late Bathonian-early Callovian) ammonite *Kepplerites* (*Seymourites*) sp., which is a typical Boreal element, was reported from fine-grained sandstone in the Tokunaga Sandstone Member, exposed on the left bank of the Nagara River near Tokunaga (Sato *et al.*, 1985). The ammonite is the youngest fossil record hitherto obtained from the Kodaragawa Formation and is younger than the radiolarian fauna from the manganese band in the Komami Shale Member.

5.8. Section MA12: Komami Section.

The Komami Section (Fig. 17), located 0.5 km Northeast of Komami, Yamato Village, is an outcrop along the road running from Komami to the northeast. The strata in this section belong to the Komami Shale Member. This section is at the same locality where Takemura collected the manganese band for his monographic description of an early Middle Jurassic radiolarian fauna (Takemura, 1986). The stratigraphic relationship between this section and the Middle Jurassic ammonite locality (Fig. 17), about 3 km southwest of the section, is unclear. Strata of this section are composed of siliceous mudstones and mudstones associated with lenses or blocks of manganese band, which are scattered in the outcrop. The lenses or blocks of manganese band yield well-preserved and diversified radiolarian faunas, whereas the surrounding mudstones and siliceous mudstones contain generally moderately preserved and less diversified radiolarian faunas. Of five samples from the manganese band, Sample MKM-1 contains the best preserved and most diverse radiolarian fauna. Besides species listed in Appendix (Table 11), the sample contains the following species: *Anisicyrtis jurassica* Takemura, *Eucyrtidiellum gujoense* (Takemura & Nakaseko), *Parahsuum dentatum* Takemura, *Parahsuum* (?) *magnum* Takemura, *Parahsuum parvum* Takemura, *Parvicingula* (?) *obesa* and *Yamatoum connicinum* Takemura. Judging from the faunal association of MKM-1, this sample is assigned to the *Laxtorum* (?) *jurassicum* Zone. No age diagnostic fossils other than radiolarians have been obtained from the section.

References

Adachi, M. & Mizutani, S. (1971). Sole markings and paleocurrent system in the Paleozoic group of the Mino Terrain, central Japan. *Memoirs of the Geological Society of Japan*, **6**, 39-48. *(in Japanese)*

Aita, Y. (1982). Jurassic radiolarian biostratigraphy in Irazuyama district, Kochi Prefecture, Japan - a preliminary report. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 255-270. *(in Japanese)*

Aita, Y. (1985). Jurassic radiolarian biostratigraphy of the Irazuyama Formation (Takano Section), Shikoku, Japan. *Scientific and Technical Reports of the Mining College, Akita University*, **6**, 33-41. *(in Japanese)*

Aita, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

Aita, Y. & Okada, H. (1986). Radiolarians and calcareous nannofossils from the uppermost Jurassic and lower Cretaceous strata of Japan and Tethyan regions. *Micropaleontology*, **32** (2), 97-128.

Bando, Y., Sato, T. & Matsumoto, T. (1987). Paleogeography of the Mesozoic Ammonoidea, with special reference to Asia and the Pacific. *In* Taira, A. & Tashiro, M. Eds. *Historical Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia* - Terra Sci. Publ. Co., Tokyo, 65-95.

Baumgartner, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

Eguchi, M. (1951). Mesozoic Hexacorals from Japan. *Science Reports of the Tohoku University, Series 2: Geology*, **24**, 1-96.

FLOYD, P.A., CASTILLO, P.R. & PRINGLE, M. (1991). Tholeiitic and alkali basalts of the oldest Pacific Ocean crust. *Terra Nova*, **3**, 257-265.

FURUKUBO, M., TONISHI, K., SASHIDA, K. & IGO, H. (1985). Biostratigraphy of the Middle Jurassic Radiolaria in the south zone of the Chichibu Terrain in the Kanto Mountains, Central Japan. *Annual Report of the Institute of Geosciences, the University of Tsukuba*, **11**, 27-31.

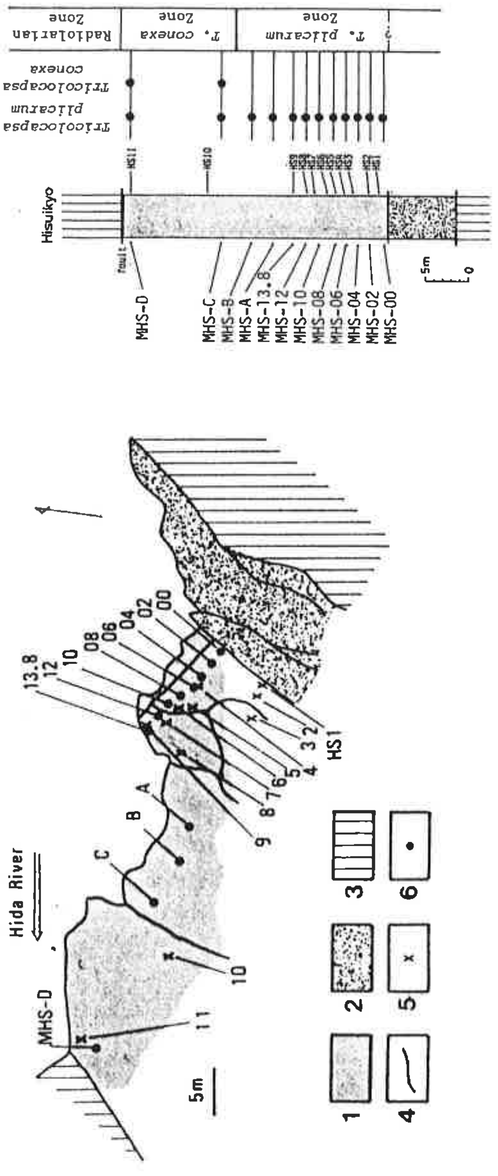


Figure 14. Sketch map and lithologic column of the Hisuikyo Section (MA10), showing sample points and horizons. The columnar section exhibits the vertical distribution of *Tricolocapsa plicarum* and *Tricolocapsa conexa*, and radiolarian zonal division. **1.** Siliceous mudstone, **2.** Hard siliceous mudstone, **3.** Chert, **4.** Fault, **5.** Sample points by Kido (1982), **6.** Sample points in the present study. The original sketch map and columnar section come from Kido (1982). After Matsuoka (1988).

HAYAMI, I. (1987). Geohistorical background of Wallace's Line and Jurassic marine biogeography. *In* Taira, A. & Tashiro, M. Eds. *Historical Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia* - Terra Sci. Publ. Co., Tokyo, 111-133.

HAYAMI, I. (1990). Geographic Distribution of Jurassic Bivalve Faunas in Eastern Asia. *In* Ichikawa, K. *et al.* Eds. *Pre-Cretaceous Terranes of Japan. Publication of IGCP Project No. 224: Pre-Jurassic Evolution of Eastern Asia* - IGCP Project 224, Osaka, 361-369.

HAYASHI, T. & INOUE, S. (1962). Sedimentary structures in the southern part of the Mino massif, central Japan. *Bulletin of the Aichi Gakugei University*, **11**, 79-90. *(in Japanese)*

HIROOKA, K., NAKAJIMA, T., SAKAI, H., DATTAMACHI, K. & HATTORI, I. (1983). Accretion tectonics inferred from paleomagnetic measurements of Paleozoic and Mesozoic rocks in central Japan. *In* Hashimoto, M. & Uyeda, S. Eds. *Accretion Tectonics in the Circum-Pacific Regions* - Terra Sci. Pub. Co., Tokyo, 179-194.

HORI, R. (1988). Some characteristic radiolarians from Lower Jurassic bedded cherts of the Inuyama area, Southwest Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **151**, 543-563.

HORI, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 562-586.

HORI, R. & YAO, A. (1988). *Parahsuum* (Radiolaria) from the Lower Jurassic of the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **31**, 47-61.

ICHIKAWA, K. & YAO, A. (1976). Two new genera of Mesozoic cyrtoid radiolarians from Japan. *In* Takayanagi, Y. & Saito, T. Eds. *Progress in Micropaleontology, Special Publication* - Micropaleontology Press, The American Museum of Natural History, New York, 110-117.

IGO, H. (1980). Re-examination of stratigraphy and geologic structure of the eastern Mino Belt by means of conodonts. Biostratigraphy of Permian and Triassic conodonts and holothurian sclerites in Japan. *Professor Kanuma M., Memorial Volume*, 103-113. *(in Japanese)*

ISHIDA, K. (1985). Radiolarian and conodont ages of the sedimentary bodies and their spatial arrangement in the South Zone of the Chichibu Belt in Tokushima Prefecture- Studies of the South Zone of the Chichibu Belt in Shikoku, Part 5. *Journal of Science, University of Tokushima*, **18**, 27-81. *(in Japanese)*

Ishida, K. & Hashimoto, H. (1991). Radiolarian assemblages from the Lower Cretaceous formation of the Chichibu Terrane in eastern Shikoku and their ammonite ages. *Journal of Science, University of Tokushima*, **25**, 23-67. *(in Japanese)*

Isozaki, Y. & Matsuda, T. (1985). Early Jurassic radiolarians from bedded chert in Kamiaso, Mino Belt, central Japan. *Earth Science, Journal of the Association for the Geological Collaboration in Japan*, **39** (6), 429-442.

Kakuwa, Y. (1987). Petrography and geochemistry of argillaceous rocks associated with Triassic to Jurassic bedded chert of the Mino-Tamba Terranes. *Scientific Papers of the College of Arts and Sciences, The University of Tokyo*, **36** (2), 137-162.

Kakuwa, Y. (1988). Geochemical study of Triassic to Jurassic bedded cherts in the Ashio, Mino, and Tamba Terranes in Japan. *Scientific Papers of the College of Arts and Sciences, The University of Tokyo*, **38** (1), 17-41.

Kano, K. (1979). Giant deckenpacket and olistostrome in eastern Mino district, central Japan. *Journal of the Faculty of Science, University of Tokyo, Section 2*, **20**, 31-59.

Kido, S. (1982). Occurrence of Triassic chert and Jurassic siliceous shale at Kamiaso, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 135-151. *(in Japanese)*

Kido, S., Kawaguchi, I., Adachi, M. & Mizutani, S. (1982). On the *Dictyomitrella* (?) *kamoensis*-*Pantanellium foveatum* assemblage in the Mino area, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 195-210. *(in Japanese)*

Kishida, Y. & Sugano, K. (1982). Radiolarian zonation of Triassic and Jurassic in outer side of southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 271-300. *(in Japanese)*

Kobayashi, T. (1935). Contributions to the Jurassic Torinosu Series of Japan. *Japanese Journal of Geology and Geography*, **12**, 69-91.

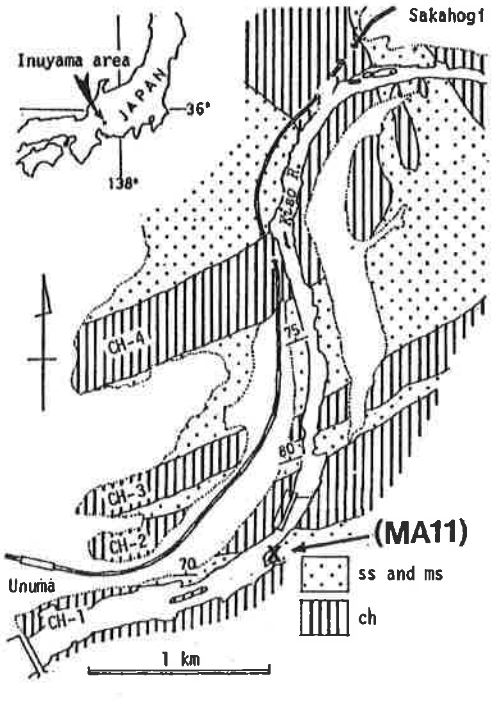


Figure 15. Geological map of the Inuyama area, showing the location of the Inuyama CH-1-A Section (MA11). Modified from Yao *et al.* (1980).

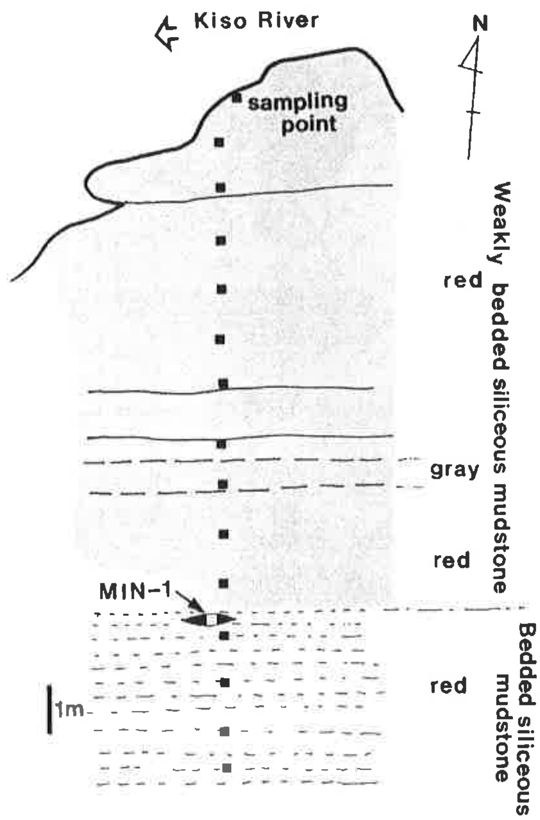


Figure 16. Sketch map of the Inuyama CH-1-A Section (MA11), showing the points for the studied sample (MIN-1; MA11-1) and some other samples.

KONDO, N. & ADACHI, M. (1975). Mesozoic strata of the area north of Inuyama, with special reference to the Sakahogi conglomerate. *Journal of the Geological Society of Japan*, **81**, 373-386. *(in Japanese)*

LANCELOT, Y., LARSON, R.L. *ET AL.* (1990). *Proceedings of the Ocean Drilling Program, old Pacific crust; covering Leg 129 of the cruises of the drilling vessel JOIDES Resolution, Apra Harbor, Guam, to Apra Harbor, Guam, sites 800-802, 20 November 1989-18 January 1990.* Proceedings of the Ocean Drilling Program, Initial Reports, **129** - College Station, TX (Ocean Drilling Program), 1-488 p.

MATSUDA, T. & ISOZAKI, Y. (1982). Radiolarians around the Triassic-Jurassic boundary from the bedded chert in the Kamiaso Area, Southwest Japan. Appendix: "Anisian radiolarians". *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 93-101. *(in Japanese)*

MATSUDA, T. & ISOZAKI, Y. (1991). Well-documented travel history of Mesozoic pelagic chert in Japan; from remote ocean to subduction zone. *Tectonics*, **10** (2), 475-499.

MATSUMOTO, T. & NISHIZONO, Y. (1985). On ammonites of the genus *Decipia* from the Ebirase Formation of Kyushu. *Journal of the Geological Society of Japan*, **91**, 421-423. *(in Japanese)*

MATSUOKA, A. (1982a). Jurassic two-segmented Nassellarians (Radiolaria) from Shikoku, Japan. *Journal of Geosciences, Osaka City University*, **25**, 71-86.

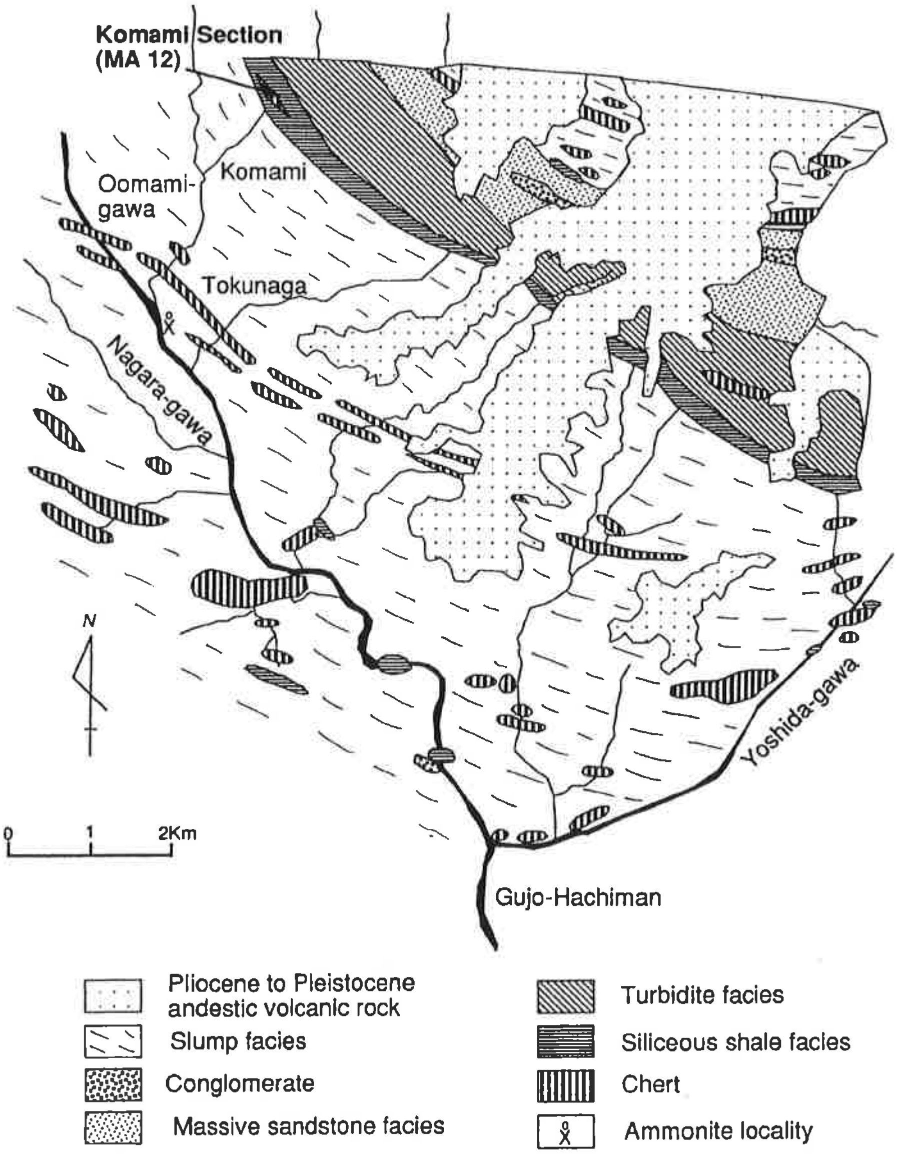


Figure 17. Geological map of the Gujo-hachiman area, showing the Komami Section (MA12). Modified from Wakita (1984, 1988).

MATSUOKA, A. (1982b). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and the Niyodo areas, Kochi Prefecture, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 237-253. *(in Japanese)*

MATSUOKA, A. (1983a). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and adjacent areas, Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **26** (1), 1-48.

MATSUOKA, A. (1983b). The conformable relationship between chert beds and clastic beds in the Triassic-Jurassic sequence of the southern subbelt of the Chichibu belt, Kochi prefecture. *Journal of the Geological Society of Japan*, **89**, 407-410. (*in Japanese*)

MATSUOKA, A. (1984a). Late Jurassic four-segmented nassellarians (Radiolaria) from Shikoku, Japan. *Journal of Geosciences, Osaka City University*, **27**, 143-153.

MATSUOKA, A. (1984b). Togano Group of the southern Chichibu Terrane in the western part of Kochi Prefecture, southwest Japan. *Journal of the Geological Society of Japan*, **90** (7), 455-477. (*in Japanese*)

MATSUOKA, A. (1986). *Tricolocapsa yaoi* Assemblage (Late Jurassic radiolarians) from the Togano Group in Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **29**, 101-115.

MATSUOKA, A. (1988). First appearance biohorizon of *Tricolocapsa conexa* within Jurassic siliceous mudstone sequences of the Kamiaso area in the Mino Terrane, central Japan; a correlation of radiolarian zones of the Middle Jurassic. *Journal of the Geological Society of Japan*, **94** (8), 583-590.

MATSUOKA, A. (1989). First appearance biohorizon of *Eucyrtidiellum ptyctum* (Middle Jurassic radiolaria). *Abstract of the Annual Meeting of the Paleontological Society of Japan*, 71. *(in Japanese)*

MATSUOKA, A. (1991). Middle Jurassic radiolarians from the western Pacific. *Proceedings of the International Symposium on Shallow Tethys* - Saito Ho-on Kai Special Publication, Sendai, Japan. **3**, 163-173.

MATSUOKA, A. (1991b). Early Jurassic radiolarians from the Nanjo Massif in the Mino Terrane, central Japan. Part 1. *Tricolocapsa*, *Stichocapsa* and *Minocapsa*, n. gen. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **161**, 720-738.

MATSUOKA, A. (1992a). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MATSUOKA, A. (1992b). Jurassic-Early Cretaceous tectonic evolution of the Southern Chichibu terrane, southwest Japan. *In* Aitchison, J.C. & Murchey, B.L. Eds. *Significance and application of Radiolaria to terrane analysis* - Special Issue: Palaeogeography Palaeoclimatology Palaeoecology, Elsevier, Amsterdam, **96** (1-2), 71-88.

MATSUOKA, A. & YAO, A. (1985). Latest Jurassic radiolarians from the Torinosu Group in Southeast Japan. *Journal of Geosciences, Osaka City University*, **28**, 125-145.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11**, (1-3), 91-106.

MATSUOKA, A. & YAO, A. (1990). Southern Chichibu Terrane. *In* Ichikawa, K. *et al.* Eds. *Pre-Cretaceous Terranes of Japan. Publication of IGCP Project No. 224: Pre-Jurassic Evolution of Eastern Asia* - IGCP Project 224, Osaka, Japan, 203-216.

MIZUTANI, S. (1964). Superficial folding of the Paleozoic system of central Japan. *Journal of Earth Sciences, Nagoya University*, **12**, 17-83.

MIZUTANI, S. & KIDO, S. (1983). Radiolarians in Middle Jurassic siliceous shale from Kamiaso, Gifu Prefecture, Central Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **132**, 253-262.

MIZUTANI, S. & KOIKE, T. (1982). Radiolarians in the Jurassic siliceous shale and the Triassic bedded chert of Unuma, Kagamigahara City, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, special Volume, **5**, 117-134. *(in Japanese)*

NAGAI, H. & MIZUTANI, S. (1990). Jurassic *Eucyrtidiellum* (Radiolaria) in the Mino Terrane. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 587-602.

NAKASEKO, K. & NISHIMURA, A. (1979). Upper Triassic Radiolaria from southwest Japan. *Science Reports, College of General Education, Osaka University*, **28** (2), 61-109.

NISHIZONO, Y. & MURATA, M. (1983). Preliminary studies on the sedimentary facies and radiolarian biostratigraphy of Paleozoic and Mesozoic sediments, exposed along the mid-stream of the Kuma River, Kyushu, Japan. *Kumanto Journal of Science, Geology*, **12**, 1-40. *(in Japanese)*

NISHIZONO, Y., OHISHI, A., SATO, T. & MURATA, M. (1982). Radiolarian fauna from the Paleozoic and Mesozoic formations, distributed along the mid-stream of Kuma River, Kyushu, Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 311-326. *(in Japanese)*

OTSUKA, T. (1988). Paleozoic-Mesozoic Sedimentary Complex in the Eastern Mino Terrane, Gentral Japan and its Jurassic Tectonics. *Journal of Geosciences, Osaka City University*, **31**, 63-122.

OTSUKA, T. (1989). Mesozoic folds of chert in Triassic-Jurassic chert-clastics sequence in the Mino Terrane, central Japan. *Journal of the Geological Society of Japan*, **95**, 97-111.

OTSUKA, T. (1990). The faults forming an imbricate structure composed of chert-clastics sequences in the Mino Terrane, central Japan. *Structural Geology, the Journal of the Tectonic Research Group of Japan*, **35**, 23-30. *(in Japanese)*

SAKA, Y. & TEZUKA, S. (1988). Southern Belt of the Chichibu Terrain in the Shima Peninsula, Southwest Japan. *Journal of Geography*, **97**, 10-24. *(in Japanese)*

SANFILIPPO, A. & RIEDEL, W.R. (1985). Cretaceous Radiolaria. *In* Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. Eds. *Plankton Stratigraphy* - Cambridge University Press, Cambridge/New York/New Rochelle/Melbourne/Sidney, 573-630.

SASHIDA, K. (1988). Lower Jurassic multisegmented Nassellaria from the Itsukaichi area, western part of Tokyo Prefecture, central Japan. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences*, **9**, 1-27.

SATO, T. (1962). Etudes biostratigraphiques des ammonites du Japon. *Mémoires de la Société Géologique de France*, **41**, 1-122.

SATO, T. (1974). A Jurassic ammonite from near Inuyama, north of Nagoya. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **96**, 427-432.

SATO, T., KASAHARA, Y. & WAKITA, K. (1985). Discovery of a Middle Jurassic ammonites *Kepplerites* from the Mino Belt, Central Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **139**, 218-221.

SATO, T., MURATA, M. & YOSHIDA, H. (1986). Triassic to Jurassic radiolarian biostratigraphy in the southern part of Chichibu terrain of Kyushu, Japan. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 9-23. *(in Japanese)*

SATO, T. & NISHIZONO, Y. (1983). Triassic and Jurassic radiolarian assemblages from two continuous sections in the Kuma massif, Kyushu, Japan. *News of Osaka Micropaleontologists*, 33-47. *(in Japanese)*

SATO, T., NISHIZONO, Y. & MURATA, M. (1982). Paleozoic and Mesozoic radiolarian faunas from the Shakumasan Formation. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 301-310. *(in Japanese)*

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SHIBUYA, H. & SASAJIMA, S. (1986). Paleomagnetism of Red Cherts: A Case Study in the Inuyama Area, Central Japan. *Journal of Geophysical Research, Series B, Solid Earth and Planets*, **91**, 14105-14116.

SHIKAMA, T. & YUI, S. (1973). On some Nerineid Gastropoda in Japan (preliminary report). *Science Reports of the Yokohama National University*, **20**, 9-57.

SUYARI, K. (1986). Radiolarian assemblages from the Torinosu Group and the cherts of the North Subbelt of the Shimanto Belt. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 245-254. *(in Japanese)*

SUYARI, K. & ISHIDA, K. (1985). Radiolarian age of the Torinosu Group, Shikoku, Japan. *Journal of Science, University of Tokushima*, **18**, 83-101. *(in Japanese)*

SUYARI, K. & KUWANO, Y. (1986). Radiolarian age of the Torinosu group, Shikoku, Japan, Part 2. *Journal of Science, University of Tokushima*, **19**, 37-43. *(in Japanese)*

TAKEMURA, A. (1986). Classification of Jurassic Nassellarians (Radiolaria). *Palaeontographica. Abteilung A: Palaozoologie-Stratigraphie*, **195** (1-3), 29-74.

TAKEMURA, A. & NAKASEKO, K. (1982b). Two new Jurassic genera of family Palaeoscenidiidae (Radiolaria). *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **128**, 452-464.

TAKEMURA, A. & NAKASEKO, K. (1983). *Perseus*, a new genus of Jurassic Palaeoscenidiidae and the phylogeny of subfamily Hilarisirecinae. *Memoirs of the Faculty of Science, Kyoto University, Series of Geology and*

Mineralogy, **49**, 111-123.

TAKEMURA, A. & NAKASEKO, K. (1986). The cephalic skeletal structure of Jurassic "*Eucyrtidium*" (Radiolaria). *Journal of Paleontology*, **60** (5), 1016-1024.

TAMURA, M. (1960). Upper Jurassic Pelecypods from the Torinosu Group in Shikoku, Japan. *Memoirs of the Faculty of Education, Kumamoto University*, **8**, 227-245.

TAMURA, M. (1961). The Torinosu Series and Fossils Therein. *Japanese Journal of Geology and Geography*, **32**, 219-251.

TAMURA, M. (1983). Megalodonts and Megalodont Limestones in Japan. *Memoirs of the Faculty of Education, Kumamoto University*, **32**, 7-28.

TAMURA, M. (1987). Distribution of Japanese Triassic Bivalve Faunas and Sedimentary Environment of Megalodont Limestone in Japan. *In* Taira, A. & Tashiro, M. Eds. *Historical Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia* - Terra Sci. Publ. Co., Tokyo, 97-110.

TAMURA, M. (1990). The distribution of Japanese Triassic bivalve faunas with special reference to parellel distribution of inner Arcto-Pacific fauna and outer Tethyan Fauna in Upper Triassic. *In* Ichikawa, K. *et al.* Eds. *Pre-Cretaceous Terranes of Japan. Publication of IGCP Project No. 224: Pre-Jurassic Evolution of Eastern Asia*, Osaka. IGCP Project 224, 347-359.

TANAKA, H., FUJITA, H., MIYAMOTO, T. & HASE, A. (1985). Discovery of late Jurassic radiolarian fossils from the Shinkai Formation developed to the south of Mt. Haidate, Oita Prefecture, Kyushu. *Journal of the Geological Society of Japan*, **91** (8), 569-571. (*in Japanese*)

TOKUYAMA, A. (1957). On some Jurassic Rhynchonellids from Shikoku, Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **28**, 128-136.

TOKUYAMA, A. (1958). On some Terebratuloids from the Middle Jurassic Naradani Formation in Shikoku, Japan. *Japanese Journal of Geology and Geography*, **29**, 1-10.

WAKITA, K. (1982). Jurassic radiolarians from Kuzuryo-ko-Gujo-hachiman area. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 153-171. *(in Japanese)*

WAKITA, K. (1984). Geology of the Hachiman district, Quadrangle Series, scale 1:50.000. *Geological Survey of Japan*, 1-89. *(in Japanese)*

WAKITA, K. (1988). Origin of chaotical mixed rock bodies in the Early Jurassic to Early Cretaceous sedimentary complex of the Mino terrane, central Japan. *Bulletin of the Geological Survey of Japan*, **39** (11), 675-757.

WAKITA, K. & OKAMURA, Y. (1982). Mesozoic sedimentary rocks containing allochthonous blocks, Gujo-hachiman, Gifu Prefecture, central Japan. *Bulletin of the Geological Survey of Japan*, **33** (4), 161-185. *(in Japanese)*

YAMAGIWA, N., HABUCHI, Y. & MIYATA, K. (1976). Some interesting fossils from the Naradani Formation at the Naradani district, Sakawa Basin, Kochi Prefecture, Southwest Japan. *Memoirs of the Osaka Kyoiku University, Series III*, **25**, 135- 142.

YAMAMOTO, K. (1983). Geochemical study of Triassic bedded cherts from Kamiaso, Gifu Prefecture. *Journal of the geological Society of Japan*, **89**, 143-162. *(in Japanese)*

YAO, A. (1972). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part I: Spongosaturnalids. *Journal of Geosciences, Osaka City University*, **15**, 21-65.

YAO, A. (1979). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part II: Nassellaria I. *Journal of Geosciences, Osaka City University*, **22**, 21-72.

YAO, A. (1982). Middle Triassic to Early Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53-70.

YAO, A. (1984). Subdivision of the Mesozoic complex in Kii-Yura area, southwest Japan and its bearing on the Mesozoic basin development in the southern Chichibu terrane. *Journal of Geosciences, Osaka City University*, **27**, 41-103.

YAO, A., MATSUDA, T. & ISOZAKI, Y. (1980). Triassic and Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **23**, 135-154.

YAO, A., MATSUOKA, A. & NAKATANI, T. (1982). Triassic and Jurassic radiolarian assemblages in southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 27-43. *(in Japanese)*

YASUDA, M. (1989). Equivalents to the Torinosu Group of the Chichibu Belt in the southeastern part of the Kanto Mountans, central Japan; lithology and radiolarian biostratigraphy. *Journal of the Geological Society of Japan*, **95** (6), 463-478. (*in Japanese*)

YOKOTA, S. & SANO, H. (1986). Radiolarian fossils from the Middle Jurassic Ammonites-bearing formation of Bisho, Yatsushiro district, Kumamoto Prefecture. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 53-58. *(in*

POSTSCRIPT

The manuscript of this paper was sent to the editors in November of 1992. As the result of the progress of the author's research, the content of the manuscript is partly out of date and is inconsistent with another chapter of the author (*Chapter 33*). Because partial modifications of the text may create further inconsistency within the volume, this postscript is added to provide information about research progress. (August, 1995)

Figure 18 shows the latest version of radiolarian zonation for the Jurassic and Lower Cretaceous in Japan and the western Pacific (Matsuoka, 1995). Comparison of zonations between the latest (Matsuoka, 1995) and previous (Matsuoka & Yao, 1986, Matsuoka, 1992) versions is presented in Figure 19. Major changes include recognition of more suitable biohorizons for zonal boundaries. In the Lower Cretaceous, the evolutionary first appearance biohorizons of *Acanthocircus carinatus* and *Cecrops septemporatus* are newly clarified. In the Upper Jurassic, it is clear that the last occurrence biohorizon of *Hsuum maxwelli* is more suitable than the first occurrence biohorizon of *Pseudodictyomitra primitiva* in defining the zonal boundary. As the result of these changes of zonal boundary biohorizon, two zonal names in the previous zonation are replaced by new ones; the *Acanthocircus carinatus* Zone replaces the previous *Dibolachras tytthopora* Zone and the *Hsuum maxwelli* Zone replaces the previous *Cinguloturris carpatica* Zone.

Because of the change in zone concept, some parts of the statement in this chapter need to be modified. The related sections are shown below. All tables in the Appendix are updated concerning zone assignment and this is shown at the bottom of each table.

2.2. Section MA1: Ocean Drilling Program Leg 129 Site 800 Hole A.

Eighteen samples were investigated from the section (Appendix, Table 1). *Cecrops septemporatus* and *Acanthocircus carinatus* make their first appearance in Sample 129-800A-54R- 2, 50-52 cm (MA1-8) and 129-800B-52R-2, 49-51 cm (MA1-15), respectively. The radiolarite unit of this section is divided into three radiolarian zones by these first appearance biohorizons; *Pseudodictyomitra carpatica*, *Cecrops septemporatus*, and *Acanthocircus carinatus* Zones in ascending order.

2.3. Section MA2: Ocean Drilling Program Leg 129 Site 801 Hole B.

Fifty-nine samples were investigated from the section (Appendix, Table 2). *Stylocapsa*(?) *spiralis*, *Pseudodictyomitra carpatica*, and *Cecrops septemporatus* make their first appearance in Sample 129-801B-34R-1, 15-17 cm (MA2-10), 129- 801B-20-CC (MA2-45), and 129-801B-14R-CC (MA2-59), respectively. *Tricolocapsa conexa* and *Hsuum maxwelli* gr. make their last occurrence in Sample 129-801B-33R-1, 8-11 cm (MA2- 14) and 129-801B-30R-CC, (MA2-19), respectively. The section studied is divided according to the zonal definition in Figure 18 into six radiolarian zones; *Tricolocapsa conexa, Stylocapsa*(?) *spiralis, Hsuum maxwelli, Pseudodictyomitra primitiva*, *Pseudodictyomitra carpatica*, and *Cecrops septemporatus* Zones in ascending order.

Section MA8: Kawanouchi 1 Section

Fourteen samples were investigated from this section (Appendix, Table 8). This section is divided into three radiolarian zones; *Guexella nudata* Assemblage-Zone, *Gongylothorax sakawaensis-Stichocapsa naradaniensis* Assemblage-Zone, and *Tricolocapsa yaoi* Assemblage-Zone in ascending order (Matsuoka, 1986). Chronologically equivalent interval-Zones for the *G. nudata, G. sakawaensis-S. naradaniensis*, and *T. yaoi* Assemblage-Zones are the *Tricolocapsa conexa* Zone, *Stylocapsa*(?) *spiralis* Zone, and *Hsuum maxwelli* Zone, respectively.

MATSUOKA, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MATSUOKA, A., 1995. Jurassic and Lower Cretaceous radiolarian zonation in Japan and Western Pacific. Island Arc, 4, (in press).

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11**, (1-3), 91-106.

ODIN, G. S., 1994. Geological Time scale (1994). *Comptes-Rendus de l'Académie des Sciences de Paris, Série II*, **318**, 59-71.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION MA1_LEG129_SITE_800A: bottom 1 - top 18
< 18 {51R-1-30-31}: 3065, 3293, 5012, 5073, 5595
< 17 {51R-CC}: 3065, 3092, 3228, 5012, 5073, 5229, 5462, 5595, 5625, 5636, 5927
< 16 {52R-1- 57-59}: 3065, 3092, 3228, 3287, 3293, 5012, 5073, 5422, 5595
< 15 {52R-2- 49-51}: 3065, 3092, 3185, 3228, 3287, 4073, 5012, 5073, 5229, 5422, 5462, 5625, 5647, 5927
< 14 {52R-CC}: 3065, 3090, 3185, 3228, 3287, 4026, 5229, 5462, 5625, 5647
< 13 {53R-1- 53-55}: 3065, 3228, 3287, 3291, 5073, 5229, 5407, 5426, 5462, 5625, 5636, 5647
< 12 {53R-2- 17-19}: 3065, 3092, 3162, 3185, 3228, 3287, 3291, 4026, 5073, 5229, 5407, 5426, 5625, 5636, 5927
< 11 {53R-CC}: 3065, 3090, 3092, 3161, 3162, 3185, 3228, 3287, 3291, 3293, 4026, 4073, 5073, 5229, 5296, 5407, 5426, 5462, 5532, 5580, 5625, 5636, 5647, 5744, 5927
< 10 {54R-1- 54-56}: 3065, 3090, 3161, 3185, 3228, 3287, 3293, 4026, 5073, 5229, 5426, 5462, 5636, 5744, 5927
< 9 {54R-1- 140-142}: 3065, 3090, 3092, 3161, 3162, 3203, 3228, 3287, 3293, 4026, 4073, 5073, 5229, 5426, 5462, 5580, 5636, 5647, 5927
< 8 {54R-2- 50-52}: 3065, 3090, 3092, 3161, 3228, 3263, 3287, 3293, 4026, 4073, 5073, 5229, 5407, 5426, 5462, 5580, 5636, 5647, 5927
< 7 {54R-2- 98-100}: 3065, 3090, 3185, 3228, 3293, 4026, 5073, 5426, 5636, 5647, 5927
< 6 {54R-CC}: 3065, 3090, 3161, 3185, 3228, 3255, 3287, 3293, 4026, 4073, 5073, 5426, 5462, 5636, 5647, 5927
< 5 {55R-1- 70-72}: 3065, 3185, 3228, 3263, 3287, 3293, 4026, 5073, 5462, 5927
< 4 {55R-1- 137-139}: 3065, 3090, 3092, 3185, 3228, 3287, 3293, 4026, 5073, 5636, 5927
< 3 {55R-2- 44-46}: 3065, 3185, 3203, 3228, 3263, 3287, 3293, 4026, 5073, 5426, 5462, 5927
< 2 {55R-2- 133-135}: 3065, 3185, 3263, 3287, 3291, 3293, 4026, 5073, 5927
< 1 {55R-CC}: 3065, 3090, 3092, 3185, 3228, 3255, 3263, 3287, 3291, 3293, 4073, 5073, 5426, 5462, 5636, 5647, 5927

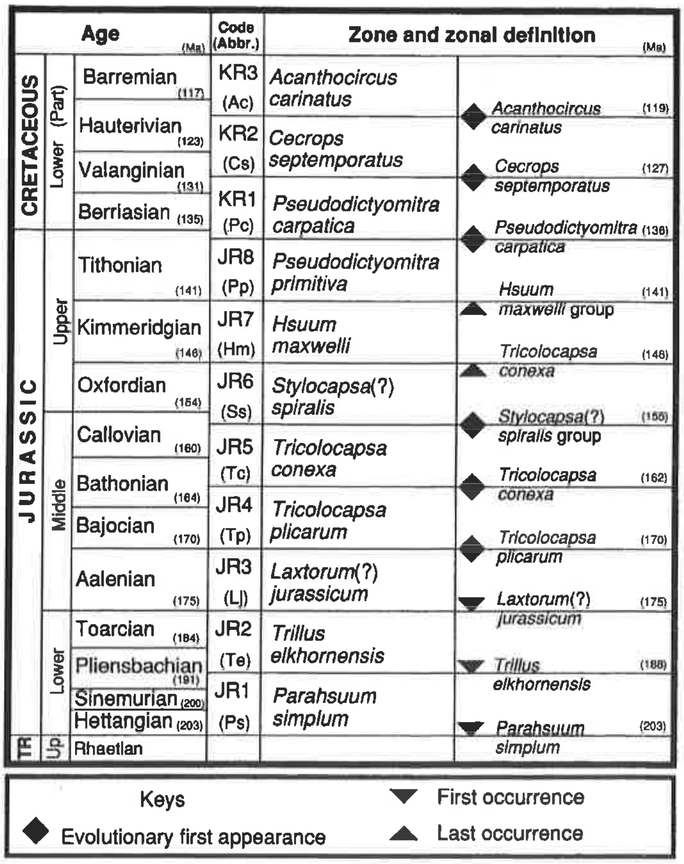


Figure 18. Jurassic and Lower Cretaceous zonal scheme for Japan and the western Pacific. After Matsuoka (1995). Numerical ages for the stage boundaries are after Odin (1994). Numerical ages for some zonal boundaries are estimated by interpolation.

SECTION MA2_LEG129_SITE_801B: bottom 1 - top 59
< 59 {14R-CC}: 3228, 3287, 5073, 5229, 5927
< 58 {15R-1- 23-25}: 3065, 3185, 3263, 3287, 3293, 5073, 5462
< 57 {16R-1- 9-11}: 3065, 3293, 5073, 5927
< 56 {16R-1- 32-34}: 3065, 3228, 3263, 3293
< 55 {16R-1- 37-39}: 3065, 5462
< 54 {16R-CC}: 3065, 3092, 3228, 3293
< 53 {17R-1- 22-25}: 3065, 3228, 3263, 3287, 3291, 3293, 5073, 5462, 5927
< 52 {17R-CC}: 3065, 5462
< 51 {18R-1- 7-9}: 3065, 3161, 3185, 3228, 3287, 3293, 5073, 5462, 5927
< 50 {18R-1- 34-36}: 3287, 3293, 5927
< 49 {18R-CC}: 3065, 3161, 3171, 3185, 3203, 3228, 3255, 3287, 3293, 4073, 5073, 5462, 5927
< 48 {19R-CC}: 3293
< 47 {20R-1- 7-9}: {corr 3033} 3189, 3263, 3293, 4037, 5771
< 46 {20R-1- 16-18}: 3033, 3189, 4037, 5462
< 45 {20R-CC}: 3033, 3090, 3161, 3185, 3263,

3293, 4037
< 44 {21R-1- 1-3}: 3189, 4037, 5771
< 43 {21R-1- 13-15}: 3189, 4037, 5771
< 42 {21R-CC}: 3189, 3193, 4037, 5771
< 41 {22R-CC- 0-2}: 3033, 3161, 3189, 4037, 5771
< 40 {22R-CC}: 3189, 4037, 4073
< 39 {23R-CC- 7-9}: 3033, 3090, 3161, 3189, 3193, 4037, 5771
< 38 {23R-CC- 14-16}: 3193, 4037, 4073, 5771
< 37 {23R-CC}: 3193, 4037, 4073, 5771
< 36 {24R-1- 22-23}: 3033, 3090, 3189, 3193, 4037, 4073, 5771
< 35 {24R-1- 66-68}: 3017, 3033, 3100, 3161, 3189
< 34 {24R-CC}: 3033, 3100, 3161, 4037
< 33 {25R-1- 10-12}: 3100, 3189, 4037
< 32 {25R-1- 32-35}: 3033, 3090, 3100, 3193, 3292, 4037
< 31 {25R-1- 65-68}: 3033, 3090, 3100, 3161, 3193, 4037, 5771
< 30 {25R-CC}: 3033, 3100, 3189, 4037, 5771
< 29 {26R-CC- 11-13}: 3033, 3100, 4037
< 28 {26R-CC}: 3033, 3189, 4037
< 27 {27R-1- 99-101}: 3033, 3090, 3193, 4037
< 26 {27R-CC}: 3100, 3193, 4073
< 25 {28R-1- 6-7}: 3254, 4037
< 24 {28R-CC}: 3090, 3100, 3189, 3193, 3213, 3254, 3279, 3292, 4037
< 23 {29R-1- 16-17}: 3254, 3279, 4037, 4055, 4060
< 22 {29R-CC}: 3014, 3017, 3100, 3131, 3193, 3199, 3292, 4037, 4060
< 21 {30R-1- 1-2}: 3090, 3100, 3131, 3193, 3254, 4037
< 20 {30R-1- 12-14}: 3199, 3254, 4037, 4060
< 19 {30R-CC}: 3017, 3090, 3100, 3160, 3180, 3193, 3199, 3213, 3254, 3279, 4037, 4055
< 18 {31R-1- 1-3}: 3014, 3090, 3100, 3193, 3199, 3213, 3254, 3279, 4037
< 17 {31R-1- 21-22}: 3100, 3193, 3254, 4014, 4037
< 16 {31R-CC}: 3014, 3017, 3180, 3193, 3254, 4055
< 15 {32R-CC}: 3014, 3017, 3064, 3100, 3159, 3180, 3181, 3193, 3213, 3225, 3279, 4014, 4055, 4060
< 14 {33R-1- 8-10}: 3014, 3017, 3169, 3181, 3213, 3297, 3298, 4060
< 13 {33R-1- 131-133}: 3014, 3044, 3046, 3180, 3297, 3298
< 12 {33R-2- 14-17}: 3017, 3044, 3046, 3169, 3180, 3181, 3213, 3297, 3298, 4060
< 11 {33R-CC}: 3004, 3046, 3064, 3121, 3159, 3164, 3169, 3180, 3181, 3213, 3297, 3298, 4023
< 10 {34R-1- 15-17}: 3044, 3046, 3052, 3213, 3297, 3298, 4047
< 9 {34R-CC}: 3044, 3052, 3059, 3061, 3181, 3297, 3298, 4047, 4060
< 8 {35R-1- 43-45}: 3061, 3180, 3181, 3213, 3277, 3297,

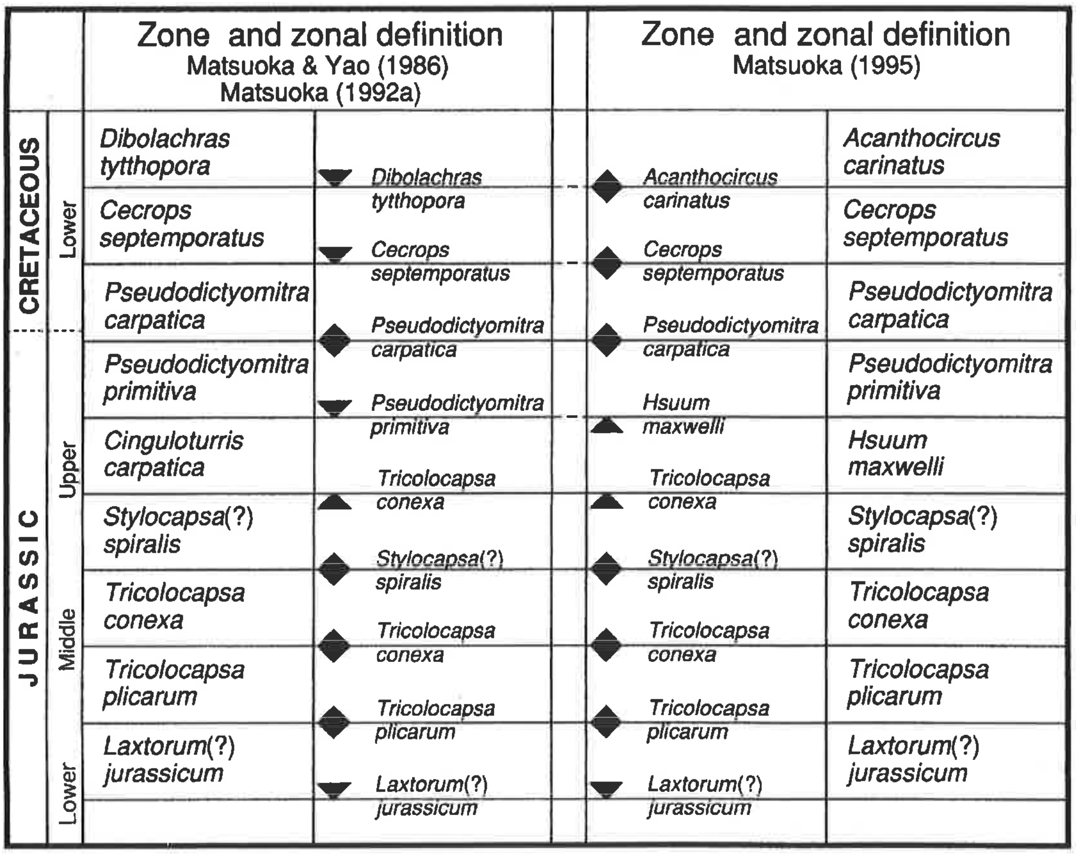


Figure 19. Comparison between zonations of Matsuoka & Yao (1986), Matsuoka (1992a) and Matsuoka (1995).

3298, 4047
< 7 {35R-1- 76-80}: 3052, 3061, 3181, 3213, 3297, 3298, 4047
< 6 {35R-2- 95-98}: 3059, 3169, 3297, 3298, 4013
< 5 {35R-2- 138-140}: 3052, 3061, 3297, 3298
< 4 {35R-3- 24-26}: 3014, 3044, 3052, 3059, 3061, 3139, 3159, 3180, 3181, 3254, 3277, 3297, 3298, 4014, 4047
< 3 {35R-CC}: 3059, 3277, 3297, 3298, 4013, 4047
< 2 {36R-CC}: 3180, 3297, 4014, 4047
< 1 {37R-1- 16-20}: 3052, 3061, 3064, 3164, 3180, 3181, 3197, 3237, 3254, 3297, 3298, 4014, 4034, 4050

SECTION MA3_OYASHIKI_1: bottom 1 - top 13
< 13 {M-64}: 3061, 3290, 3297, 4013, 4046, 4050, 4060
< 12 {M-63}: 3059, 3061, 3290, 3297, 4013, 4046, 4050, 4060
< 11 {M-61}: 3297, 4050, 4060
< 10 {M-60}: 3051, 3297, 4034, 4050, 4060
< 9 {M-57}: 3051, 3297, 4034, 4050, 4060
< 8 {M-55}: 3051, 3297, 4034, 4050, 4060
< 7 {M-54.5}: 3051, 3297, 4034, 4050, 4060
< 6 {M-54}: 3051, 4034, 4050
< 5 {M-53.5}: 3051, 4050
< 4 {M-53}: 3051, 4050
< 3 {M-52.5}: 3051, 4050
< 2 {M-52}: 3051, 3307, 4050
< 1 {M-50}: 3051, 3307, 4049

SECTION MA4_SHIRAISHIGAWA_1: bottom 1 - top 25
< 25 {S-25}: 3044, 3046, 3297, 4046
< 24 {S-24}: 3044, 3046, 3290, 3297, 4046, 4050, 4060
< 23 {S-21}: 3044, 3046, 3051, 3290, 3297, 4046, 4050, 4060
< 22 {S-20}: 3044, 3046, 3051, 3290, 3297, 4046, 4050, 4060
< 21 {S-18}: 3044, 3046, 3051, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 20 {S-17}: 3044, 3046, 3051, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 19 {S-15}: 3044, 3046, 3051, 3061, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 18 {S-14.6}: 3046, 3051, 3061, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 17 {S-14}: 3051, 3061, 3290, 3297, 4045, 4046, 4047, 4050, 4060
< 16 {S-13.5}: 3051, 3061, 3290, 3297, 4045, 4046, 4047, 4050, 4060
< 15 {S-13}: 3051, 3061, 3290, 3297, 4047, 4050, 4060
< 14 {S-12}: 3051, 3061, 3290, 3297, 4050, 4060
< 13 {S-10}: 3051, 3061, 3290, 3297, 4050, 4060
< 12 {S-8}: 3051, 3061, 3290, 3297, 4050, 4060
< 11 {S-6}: 3051, 3061, 3290, 3297, 4050, 4060
< 10 {S-3}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 9 {S-2}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 8 {S-1}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 7 {IX-1403}: 3051, 3290, 4034, 4050, 4060
< 6 {T-15}: 3051, 4034, 4050, 4060
< 5 {T-11}: 3051, 4050, 4060
< 4 {T-8}: 3051, 4049, 4050
< 3 {T-5}: 3051, 4049, 4050
< 2 {XI-1404}: 3051, 3307, 4049
< 1 {T-01}: 3050, 4049

SECTION MA5_YANASEGAWA_1: bottom 1 - top 8
< 8 {Z-40}: 3297, 4047
< 7 {Z-36}: 3051, 3059, 3061, 3290, 3297, 4046, 4047, 4050, 4060
< 6 {Y-07}: 3051, 3059, 3061, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 5 {Z-32}: 3051, 3059, 3061, 3290, 3297, 4046, 4047, 4050, 4060
< 4 {Z-27.5}: 3051, 3059, 3061, 3290, 3297, 4050, 4060
< 3 {Z-22}: 3051, 4050
< 2 {XI-1800}: 3051, 4049, 4050
< 1 {Z-20.2}: 3051, 4049, 4050

SECTION MA6_YANASEGAWA_2: bottom 1 - top 16
< 16 {VII-3110}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 15 {VII-3109}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 14 {VII-2922}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 13 {VII-2921}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 12 {VII-3108}: 3044, 3046, 3290, 3297, 4023, 4046, 4050, 4060
< 11 {VII-2919}: 3044, 3046, 3290, 3297, 4046, 4050, 4060
< 10 {VII-3107}: 3044, 3046, 3290, 3297, 4013, 4046, 4050, 4060
< 9 {VII-2917}: 3044, 3046, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 8 {VII-1522}: 3046, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 7 {VII-2912}: 3061, 3290, 3297, 4050, 4060
< 6 {VII-2911}: 3061, 3290, 3297, 4034, 4050, 4060
< 5 {VII-3104}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 4 {VII-2910}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 3 {VII-2909}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 2 {VII-3103}: 3051, 3290, 3297, 4050, 4060
< 1 {VII-3102}: 3290, 3297, 4050, 4060

SECTION MA7_YANASEGAWA_3: bottom 1 - top 10
< 10 {P-3}: 3297
< 9 {P-3.5}: 3297, 4046, 4060
< 8 {P-5.5}: 3044, 3046, 3290, 3297, 4045, 4046, 4047, 4060
< 7 {P-6}: 3059, 3061, 3290, 3297, 4046, 4050, 4060
< 6 {P-7}: 3059, 3061, 3290, 3297, 4046, 4050, 4060
< 5 {P-11}: 3051, 3061, 3290, 3297, 4050, 4060
< 4 {P-13}: 3051, 3061, 3297, 4034, 4050, 4060
< 3 {P-16}: 3051, 3297, 4034, 4050, 4054, 4060
< 2 {P-18}: 3051, 3297, 4034, 4050, 4054, 4060
< 1 {P-21}: 3051, 3297, 4034, 4050, 4054, 4060

SECTION MA8_KAWANOUCHI_1: bottom 1 - top 14
< 14 {12-0702}: 3017, 3180, 4055
< 13 {12-0701}: 3017, 3180, 4055

< 12 {17-0302}: 3017, 3180, 4055, 4060
< 11 {11-0909}: 3017, 3045, 3180, 3297, 4055, 4060
< 10 {17-0301}: 3017, 3045, 3180, 3297, 4060
< 9 {11-0905}: 3017, 3045, 3180, 3297, 4060
< 8 {11-0906}: 3017, 3045, 3046, 3180, 3297, 4060
< 7 {11-0908}: 3017, 3044, 3045, 3046, 3180, 3297, 3298, 4060
< 6 {17-0304}: 3017, 3044, 3045, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 5 {17-0303}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 4 {18-2701}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 3 {12-0704}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4013, 4046, 4047, 4050, 4060
< 2 {12-0705}: 3017, 3044, 3046, 3061, 3180, 3290, 3297, 3298, 4013, 4045, 4046, 4047, 4050, 4060
< 1 {12-0706}: 3061, 3180, 3290, 3297, 3298, 4045, 4050, 4060

SECTION MA9_KASHIBARA: bottom 1 - top 35
< 35 {MKS-27}: 3061, 3297, 3298, 4047
< 34 {MKS-26}: 3059, 3297, 3309, 4047, 4060
< 33 {MKS-25}: 3052, 3051, 3297, 3309, 4047, 4052
< 32 {MKS-23}: 3016, 3017, 3051, 3052, 3297, 4050, 4052, 4060
< 31 {MKS-21}: 3016, 3051, 3052, 3297, 3298, 3309, 4050, 4052, 4060
< 30 {MKS-19}: 3052, 3051, 3297, 4050, 4052, 4056, 4057, 4060
< 29 {MKS-18}: 3017, 3051, 3052, 3297, 4050, 4052, 4054, 4056, 4057, 4060
< 28 {MKS-17}: 3297, 3051, 4050, 4052, 4056, 4057, 4060
< 27 {MKS-16}: 3052, 3051, 3055, 3297, 3298, 3309, 4050, 4052, 4054, 4056, 4057, 4058, 4060
< 26 {MKS-15}: 3052, 3051, 3297, 4050, 4052, 4054, 4056, 4058, 4060
< 25 {MKS-14}: 3016, 3017, 3051, 3052, 3297, 3309, 4050, 4052, 4054, 4056, 4057, 4058, 4060
< 24 {MKS-13}: 3055, 3051, 3297, 3309, 4050, 4052, 4054, 4058, 4060
< 23 {MKS-12}: 3052, 3051, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 22 {MKS-11}: 3055, 3051, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 21 {MKS-10.5}: 3052, 3051, 3055, 3297, 4050, 4052, 4054, 4057, 4060
< 20 {MKS-10}: 3016, 3051, 3052, 3055, 3297, 4050, 4052, 4054, 4057, 4060
< 19 {MKS-9.5b}: 3055, 3051, 4050, 4052, 4054, 4057, 4058
< 18 {MKS-9b}: 3055, 3051, 3309, 4050, 4052, 4054, 4057
< 17 {MKS-8b}: 3016, 3051, 4052, 4054, 4057, 4060
< 16 {MKS-7b}: 4052, 3051, 4054, 4057
< 15 {MKS-6b}: 3052, 3051, 3055, 3309, 4052, 4054, 4057, 4060
< 14 {MKS-9.5a}: 3016, 3049, 3051, 3052, 3055, 3309, 4050, 4052, 4057
< 13 {MKS-8a}: 3016, 3051, 3052, 4050, 4052, 4057
< 12 {MKS-7.5a}: 3016, 3049, 3051, 3052, 3055, 4042, 4050, 4052, 4057
< 11 {MKS-7a}: 3052, 3051, 3055, 3309, 4042, 4052, 4057, 4058
< 10 {MKS-6a}: 3052, 3051, 4049, 4050, 4052, 4057
< 9 {MKS-5}: 3016, 3049, 3051, 3052, 3309, 4050, 4052, 4057
< 8 {MKS-4}: 3052, 3051, 3055, 4050, 4052, 4057
< 7 {MKS-3}: 3049, 3051, 3052, 3055, 4050, 4052, 4057
< 6 {MKS-2}: 3052, 3051, 3055, 4050, 4052, 4057
< 5 {MKS-1}: 3055, 3051, 4050, 4052, 4057
< 4 {MKS-0}: 3052, 3051, 3055, 4049, 4050, 4052, 4057
< 3 {MKS-Z}: 4050, 3051, 4053, 4057
< 2 {MKS-Y}: 3052, 3051, 3307, 3309, 4049, 4050, 4053, 4057
< 1 {MKS-X}: 3055, 3051, 3307, 4050, 4053, 4057

SECTION MA10_HISUIKYO: bottom 1 - top 12
< 12 {MHS-}: 3052, 3051, 3055, 3297, 3309, 4050, 4052, 4054, 4056, 4060
< 11 {MHS-C}: 3052, 3051, 3055, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 10 {MHS-B}: 3016, 3051, 3052, 3055, 3309, 4050, 4052, 4054, 4057, 4060
< 9 {MHS-A}: 3052, 3051, 3309, 4050, 4052, 4057, 4058, 4060
< 8 {MHS-13.8}: 3049, 3051, 3052, 3055, 3309, 4052, 4057, 4060
< 7 {MHS-12}: 3052, 3051, 3055, 3309, 4042, 4050, 4052, 4057, 4058, 4060
< 6 {MHS-10}: 3052, 3051, 3309, 4052, 4057, 4060
< 5 {MHS-08}: 3016, 3051, 3052, 3055, 3309, 4042, 4050, 4052, 4057
< 4 {MHS-06}: 3052, 3051, 3055, 4042, 4050, 4052, 4057, 4058
< 3 {MHS-04}: 3052, 3051, 3055, 3309, 4042, 4049, 4050, 4052
< 2 {MHS-02}: 3052, 3055, 4049, 4050, 4060
< 1 {MHS-00}: 3052, 3051, 3055, 4049, 4053

SECTION MA11_INUYAMA_CH1A: bottom 1 - top 1
< 1 {MIN-1}: 3001, 3012, 3020, 3026, 3031, 3033, 3039, 3040, 3041, 3049, 3050, 3051, 3052, 3064, 3076, 3088, 3195, 3197, 3204, 3231, 3244, 4007, {4022, 4024, }4027, 4049, 4053, 4059, 4061, 4063, 4066, 4071, 4072, 4077

SECTION MA12_KOMAMI: bottom 1 - top 1
< 1 {MKM-1, compl.POB7/95$}: 2002, 2008, 2009, 2021, 3001, 3033, 3039, 3040, 3041, 3050, 3072, 3076, 3081, 3089, 3125, 3151, 3194, 3195, 3204, 3231, 3271, {3280, }3302, 3410, 4007, 4027, 4061, 4063, 4066, 4077

Radiolarian occurrence data for each section studied. For Radiolarian Zone (Code) at the bottom of each Table, see Figure 18.

ODP Site 800A (MA1) — Sample		1:55,CC	2:55-2,133-135	3:55-2,44-46	4:55-1,137-139	5:55-1,70-72	6:54,CC	7:54-2,98-100	8:54-2,50-52	9:54-1,140-142	10:54-1,54-56	11:53,CC	12:53-2,17-19	13:53-1,53-55	14:52,CC	15:52-2,49-51	16:52-1,57-59	17:51,CC	18:51-1,30-31
Species	U.A.	17-20	17-18	17-17	17-17	17-17	17-17	17-17	17-17	17-17	17-18	18-18	18-18	18-18	18-18	18-21	18-21	18-21	18-21
Pseudodictyomitra carpatica	4035	■	■	■	■	■	■	■	■	■	■	■					■		■
Cecrops septemporatus	5229								■	■	■	■	■	■	■	■		■	
Dibolachras tytthopora	5422															■	■		
Acaeniotyle diagorophona	3090	■			■		■	■	■	■	■	■			■				
Formanella diamphidia	4073	■					■		■	■		■				■			
Mirifusus dianae	3161						■		■	■	■	■							
Sethocapsa uterculus	5462	■		■		■	■		■	■	■	■		■	■	■		■	
Obesacapsula cetia	3203			■						■									
Archaeodictyomitra excellens	3287	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■		
Archaeodictyomitra apiarium	3263	■	■	■		■			■										
Archaeodictyomitra pseudoscalaris	5927	■	■	■	■	■	■	■	■	■	■	■	■			■		■	
Thanarla pulchra	5073	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
Parvicingula cosmoconica	3255	■					■												
Parvicingula boesii	3185	■	■	■	■	■	■	■			■	■	■		■	■			
Acanthocircus trizonalis	3065	■	■	■	■		■	■	■	■	■	■	■	■			■	■	■
Allevium helenae	3228	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Syringocapsa agolarium	3291	■	■									■	■	■					
Acaeniotyle umbilicata	3092	■			■				■	■		■	■			■	■	■	
Hemicryptocapsa capita	4026			■	■	■	■	■	■	■	■	■	■		■				
Syringocapsa limatum	5426	■		■			■	■	■	■	■	■	■	■					
Eucyrtis hanni	5407								■			■	■	■					
Crolanium pythiae	5532											■							
Stichocapsa cribata	5744										■	■							
Mirifusus chenodes	3162									■		■	■						
Pseudodictyomitra lilyae	5625											■	■	■	■	■		■	
Pseudodictyomitra nuda	5647	■					■	■	■	■		■		■	■	■			
Parvicingula(?) columna	5580								■	■		■							
Thanarla elegantissima	5296											■							
Pseudodictyomitra puga	5636	■			■		■	■	■	■	■	■	■	■				■	
Archaeodictyomitra lacrimula	5595																■	■	■
Acanthocircus carinatus	5012															■	■	■	■
Radiolarian Zone (Code)		P. carpatica (KR1)							C. septempo. (KR2)							A. c. (KR3)			

Table 1. Occurrence of radiolarian taxa in the ODP Site 800 (MA1).

Oyashiki 1 (MA3)	Species	Tricolocapsa plicarum s.l.	Tricolocapsa conexa	Tricolocapsa(?) aff. fusiformis	Tricolocapsa(?) fusiformis	Williriedellum sp. A gr.	Crytocapsa mastoidea	Protunuma turbo	Protunuma(?) ochiensis	Guexella nudata	Stylocapsa lacrimalis	Stylocapsa oblongula	Dicolocapsa conoformis	Radiolarian Zone (Code)
Sample	U.A.	3051	3297	4050	4049	4060	3307	4034	3290	3061	4046	3059	4013	
13:M-64	6-6		■	■		■			■	■	■		■	T. conexa (JR5)
12:M-63	6-6		■	■		■			■	■	■	■	■	
11:M-61	4-6		■	■		■								
10:M-60	4-6	■	■	■		■		■						
9:M-57	4-6	■	■	■		■		■						
8:M-55	4-6	■	■	■		■		■						
7:M-54.5	4-6		■	■		■		■						
6:M-54	4-6	■		■				■						T. plicarum (JR4)
5:M-53.5	4-6	■		■										
4:M-53	4-6	■		■										
3:M-52.5	4-6			■										
2:M-52	4-4	■		■			■							
1:M-50	3-4	■			■		■							

Table 3. Occurrence of radiolarian taxa in the Oyashiki 1 Section (MA3).

Shiraishigawa 1 (MA4) — Sample		1:T-01	2:9-1404.	3:T-05	4:T-08	5:T-11	6:T-15	7:9-1403.	8:S-01	9:S-02	10:S-03	11:S-06	12:S-08	13:S-10	14:S-12	15:S-13	16:S-13.5	17:S-14	18:S-14.6	19:S-15	20:S-17	21:S-18	22:S-20	23:S-21	24:S-24	25:S-25
Species	U.A.	3-4	3-4	4-5	4-5	4-6	4-6	5-6	5-5	5-5	5-5	5-6	5-6	5-6	5-6	5-6	6-6	6-6	6-6	6-6	6-6	6-6	6-6	6-6	6-6	6-7
Tricolocapsa plicarum s.l.	3051		■	■	■	■	■		■	■	■	■	■	■							■			■		
Tricolocapsa conexa	3297								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Tricolocapsa(?) aff. fusiformis	4050			■	■	■	■	■	■	■	■	■	■	■						■	■	■			■	
Tricolocapsa(?) fusiformis	4049	■	■	■	■																					
Williriedellum sp. A gr.	4060					■		■	■	■	■	■	■	■	■		■	■	■	■	■	■	■		■	
Cyrtocapsa(?) kisoesis	3050	■																								
Crytocapsa mastoidea	3307		■																							
Protunuma turbo	4034						■	■	■	■	■															
Protunuma(?) ochiensis	3290							■	■	■	■		■	■				■	■	■	■	■	■	■	■	
Tricolocapsa tetragona	4054								■	■	■															
Guexella nudata	3061								■			■		■					■	■						
Dicolocapsa conoformis	4013																		■	■	■	■				
Cyrtocapsa(?) kisoesis	3050	■																								
Stylocapsa tecta	4047															■	■	■	■	■	■	■				
Stylocapsa(?) hemicostata	4045																■	■	■	■						
Stylocapsa(?) spiralis gr.	3046																		■	■	■	■	■	■	■	■
Stylocapsa catenarum	3044																			■	■	■	■		■	■
Radiolarian Zone (Code)		T. plicarum (JR4)							Tricolocapsa conexa (JR5)										S.(?) spiralis (JR6)							

Table 4. Occurrence of radiolarian taxa in the Shiraishigawa-1 Section (MA4).

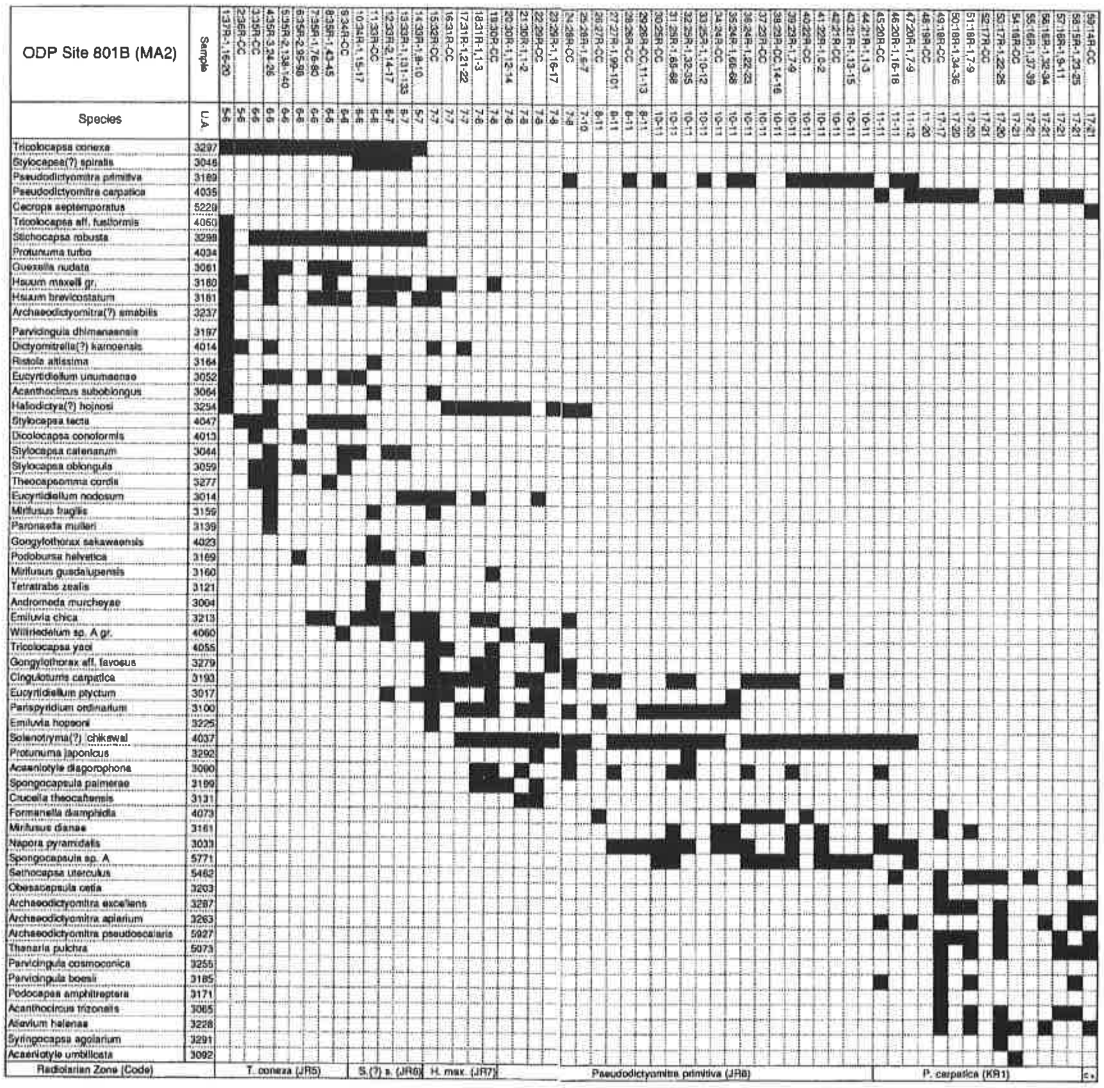


Table 2. Occurrence of radiolarian taxa in the ODP Site 801 (MA2).

Yanasegawa 1 (MA5)	Sample	1:Z-20.2	2:11-1800.	3:Z-22	4:Z-27.5	5:Z-32	6:Y-07	7:Z-36	8:Z-40
Species	U.A.	4-5	4-5	4-6	6-6	6-6	6-6	6-6	5-6
Tricolocapsa plicarum s.l.	3051	■	■					■	
Tricolocapsa conexa	3297				■	■	■	■	■
Tricolocapsa(?) aff. fusiformis	4050	■	■	■			■	■	
Tricolocapsa(?) fusiformis	4049	■	■						
Williriedellum sp. A gr.	4060				■		■	■	
Protunuma(?) ochiensis	3290				■	■		■	
Guexella nudata	3061				■		■	■	
Dicolocapsa conoformis	4013						■		
Stylocapsa tecta	4047					■	■	■	■
Stylocapsa lacrimalis	4046					■	■	■	
Stylocapsa oblongula	3059				■			■	
Radiolarian Zone (Code)		T. p. (JR4)			T. c. (JR5)				

Table 5. Occurrence of radiolarian taxa in the Yanasegawa 1 Section (MA5).

Yanasegawa 2 (MA6)	Sample	1:7-3102.	2:7-3103.	3:8-2909.	4:8-2910.	5:7-3104.	6:8-2911.	7:8-2912.	8:3-1522.	9:8-2917.	10:7-3107.	11:8-2919.	12:7-3108.	13:8-2921.	14:8-2922.	15:7-3109.	16:7-3110.
Species	U.A.	5-6	5-6	5-6	5-6	5-6	5-6	5-6	6-6	6-6	6-6	6-6	6-6	6-7	6-7	6-7	6-7
Tricolocapsa plicarum s.l.	3051		■	■	■	■											
Tricolocapsa conexa	3297	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Tricolocapsa(?) aff. fusiformis	4050	■	■	■	■	■	■	■					■				
Williriedellum sp. A gr.	4060	■		■	■	■		■		■			■				■
Protunuma turbo	4034			■			■										
Protunuma(?) ochiensis	3290	■	■	■	■	■	■	■		■	■		■				■
Guexella nudata	3061			■		■		■									
Dicolocapsa conoformis	4013								■		■						
Stylocapsa tecta	4047								■	■							
Stylocapsa(?) hemicostata	4045									■							
Stylocapsa(?) spiralis gr.	3046								■	■	■	■	■	■	■		■
Stylocapsa catenarum	3044									■	■		■	■	■		■
Stylocapsa lacrimalis	4046								■	■	■	■	■		■		■
Gongylothorax sakawaensis	4023												■	■		■	■
Radiolarian Zone (Code)		T. conexa (JR5)							S.(?) spiralis (JR6)								

Table 6. Occurrence of radiolarian taxa in the Yanasegawa 2 Section (MA6).

Yanasegawa 3 (MA7)	Sample	1:P-21	2:P-18	3:P-16	4:p-13	5:P-11	6:P-07	7:P-06	8:P-05.5	9:P-03.5	10:P-03
Species	U.A.	5-5	5-5	5-5	5-6	5-6	6-6	6-6	6-6	6-7	4-7
Tricolocapsa plicarum s.l.	3051	■	■	■	■	■					
Tricolocapsa conexa	3297	■	■	■	■	■	■	■	■	■	■
Tricolocapsa(?) aff. fusiformis	4050	■	■	■	■	■	■	■			
Williriedellum sp. A gr.	4060	■	■	■	■	■	■	■	■	■	
Protunuma turbo	4034	■	■	■	■						
Tricolocapsa tetragona	4054	■	■	■							
Protunuma(?) ochiensis	3290					■	■	■	■		
Guexella nudata	3061				■	■		■			
Stylocapsa tecta	4047								■		
Stylocapsa(?) hemicostata	4045								■		
Stylocapsa(?) spiralis gr.	3046								■		
Stylocapsa catenarum	3044								■		
Stylocapsa lacrimalis	4046						■	■	■	■	
Stylocapsa oblongula	3059						■	■			
Radiolarian Zone (Code)		T. conexa (JR5)							S.s.(JR6)		

Table 7. Occurrence of radiolarian taxa in the Yanasegawa 3 Section (MA7).

Kawanouchi 1 (MA8)	Sample	1:12-0706.	2:12-0705.	3:12-0704.	4:18-2701.	5:17-0303.	6:17-0304.	7:11-0908.	8:11-0906.	9:11-0905.	10:17-0301.	11:11-0909.	12:17-0302.	13:12-0701.	14:12-0702.
Species	U.A.	5-6	6-6	6-6	6-7	6-7	6-7	6-7	6-7	6-7	6-7	7-7	7-8	7-10	7-10
Tricolocapsa conexa	3297	■	■	■	■	■	■	■	■	■	■	■			
Tricolocapsa(?) aff. fusiformis	4050	■		■											
Protunuma(?) ochiensis	3290	■	■	■	■	■									
Guexella nudata	3061	■	■												
Dicolocapsa conoformis	4013		■	■											
Stylocapsa tecta	4047		■	■											
Stylocapsa(?) hemicostata	4045	■	■												
Stylocapsa(?) spiralis gr.	3046		■	■	■	■	■		■						
Stylocapsa catenarum	3044		■	■		■	■	■							
Stichocapsa robusta	3298	■	■	■	■	■	■	■							
Williriedellum sp. A gr.	4060	■	■		■	■			■			■	■		
Stylocapsa lacrimalis	4046		■	■	■	■	■								
Stichocapsa naradaniensis	3045						■		■	■	■	■			
Tricolocapsa yaoi	4055											■	■	■	■
Eucyrtidiellum ptyctum	3017		■			■			■		■	■		■	■
Hsuum maxwelli gr.	3180	■	■	■	■		■		■		■	■	■		■
Radiolarian Zone (Code)		T.c.(JR5)	S.(?) spiralis (JR6)										H.m.(JR7)		

Table 8. Occurrence of radiolarian taxa in the Kawanouchi 1 Section (MA8).

Inuyama CH-1-A (MA11) Komami (MA12)	Sample	MKM-1 (MA12)	MIN-1 (MA11)
Species	U.A.	3-3	4-4
Emiluvia splendida	2002	■	
Actinomma siciliensis	2008	■	
Hexastylus sp. A	2009	■	
Acanthocircus protoformis	2021	■	
Ares cylindricus cylindricus	3001	■	■
Napora pyramidalis	3033	■	■
Trillus spp.	3039	■	■
Zartus imlayi gr.	3040	■	■
Zartus dickinsoni gr.	3041	■	■
Cyrtocapsa(?) kisoensis	3050	■	■
Parahsuum (?) magnum	3072	■	
Gorgansium spp.	3076	■	■
entactinid gen. et sp. indet.	3081	■	
Hexasaturnalis tetraspinus	3089	■	
Tetraditryma praeplena	3125	■	
Laxtorum (?) jurassicum	3151	■	
Hsuum hisuikyoense	3194	■	
Hsuum matsuokai	3195	■	■
Orbiculiforma (?) heliotropica n. sp.	3204	■	■
Unuma echinatus	3231	■	■
Achaeohagiastrum munitum	3271	■	
Pantanellium berriasianum	3280	■	
Tetratrabs izeensis	3302	■	
Napora nipponica	3410	■	
Archicapsa (?) pachyderma	4007	■	■
Hexastylus (?) tetradactylus n. sp.	4027	■	■
Ares cylindricus	4061	■	■
Acaeniotylopsis variatus s. l.	4063	■	■
Acaeniotylopsis variatus triacanthus	4066	■	■
Yamatoum spinosum	4077	■	■
Eucyrtidiellum unumaense unumaense	3012		■
Saitoum pagei	3020		■
Saitoum sp. aff. S. levium	3026		■
Napora latissima	3031		■
Stichocapsa japonica	3049		■
Tricolocapsa plicarum s.l.	3051		■
Eucyrtidiellum unumaense s. l.	3052		■
Acanthocircus trizonalis s. l.	3064		■
Acanthocircus suboblongus suboblongus	3088		■
Parvicingula dhimenaensis s. l.	3197		■
Leugeo hexacubicus	3244		■
Gongylothorax oblongus	4022		■
Gongylothorax sp. aff. G. siphonofer	4024		■
Tricolocapsa(?) fusiformis	4049		■
Tricolocapsa plicarum plicarum	4053		■
Unuma latusicostatus	4059		■
Parvicingula dhimenaensis ssp. A.	4071		■
Parvicingula dhimenaensis dhimenaensis	4072		■
Radiolarian Zonal Code		JR3	JR4

Table 11. Occurrence of radiolarian taxa in the Inuyama CH-1-A Section (MA11)

Kashibara (MA9)	Sample	1:MKS-X	2:MKS-Y	3:MKS-Z	4:MKS-0	5:MKS-1	6:MKS-2	7:MKS-3	8:MKS-4	9:MKS-5	10:MKS-6a	11:MKS-7a	12:MKS-7.5a	13:MKS-8a	14:MKS-9.5a	15:MKS-6b	16:MKS-7b	17:MKS-8b	18:MKS-9b	19:MKS-9.5b	20:MKS-10	21:MKS-10.5	22:MKS-11	23:MKS-12	24:MKS-13	25:MKS-14	26:MKS-15	27:MKS-16	28:MKS-17	29:MKS-18	30:MKS-19	31:MKS-21	32:MKS-23	33:MKS-25	34:MKS-26	35:MKS-27
Species	U.A.	4-4	4-4	4-5	4-5	4-5	4-5	4-5	4-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-6	5-6
Tricolocapsa plicarum plicarum	4053	■	■	■																																
Tricolocapsa plicarum ssp. A	4052				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Tricolocapsa conexa	3297																				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Tricolocapsa(?) aff. fusiformis	4050	■	■	■	■	■	■	■	■	■	■		■	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Tricolocapsa(?) fusiformis	4049		■		■						■																									
Tricolocapsa sp. S	4057	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	■	■	■					
Tricolocapsa tetragona	4054															■	■	■	■	■	■	■	■	■	■	■	■	■		■						
Tricolocapsa sp. M	4056																									■	■	■	■	■	■					
Williriedellum sp. A gr.	4060															■		■			■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Eucyrtidiellum unumaense s.l.	3052		■		■		■	■	■	■	■	■	■	■	■	■					■	■		■		■	■			■	■	■	■	■		
Eucyrtidiellum semifactum	3016									■			■	■	■			■			■					■						■	■			
Eucyrtidiellum ptyctum	3017																									■				■			■			
Stichocapsa japonica	3049							■		■			■		■																					
Stichocapsa convexa	3055	■			■	■	■	■	■			■	■		■	■			■	■	■	■	■		■			■								
Stichocapsa robusta	3298																											■				■				■
Crytocapsa mastoidea	3307	■	■																																	
Stichocapsa sp. E	4042											■	■																							
Stichocapsa sp. F	4043					■		■																												
Unuma sp. A	3309		■							■		■			■	■			■				■	■	■	■		■				■		■	■	
Unuma latusicostatus	4058											■								■					■	■	■	■								
Stylocapsa tecta	4047																																	■	■	■
Stylocapsa oblongula	3059																																		■	
Guexella nudata	3061																																			■
Radiolarian Zone (Code)		Tricolocapsa plicarum (JR4)																			Tricolocapsa conexa (JR5)															

Table 9. Occurrence of radiolarian taxa in the Kashibara Section (MA9).

Hisuikyo (MA10)	Sample	1:MHS-00	2:MHS-02	3:MHS-04	4:MHS-06	5:MHS-08	6:MHS-10	7:MHS-12	8:MHS-13.8	9:MHS-A	10:MHS-B	11:MHS-C	12:MHS-D
Species	U.A.	4-5	4-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5	5-5
Tricolocapsa plicarum plicarum	4053	■											
Tricolocapsa plicarum ssp. A	4052			■	■	■	■	■	■	■	■	■	■
Tricolocapsa conexa	3297											■	■
Tricolocapsa(?) aff. fusiformis	4050		■	■	■	■		■		■	■	■	■
Tricolocapsa(?) fusiformis	4049	■	■	■									
Tricolocapsa sp. S	4057				■	■	■	■	■	■	■	■	
Tricolocapsa tetragona	4054										■	■	■
Tricolocapsa sp. M	4056												■
Williriedellum sp. A gr.	4060		■				■	■	■	■	■	■	■
Eucyrtidiellum unumaense s.l.	3052	■	■	■	■	■	■	■	■	■	■	■	■
Eucyrtidiellum semifactum	3016				■						■		
Stichocapsa japonica	3049								■				
Stichocapsa convexa	3055	■	■	■	■	■		■	■		■	■	■
Stichocapsa sp. E	4042			■	■	■		■					
Stichocapsa sp. F	4043		■	■		■							
Unuma sp. A	3309			■		■	■	■	■	■	■	■	■
Unuma latusicostatus	4058				■			■		■			
Radiolarian Zone (Code)		T. plicarum (JR4)										T.c.	

Table 10. Occurrence of radiolarian taxa in the Hisuikyo Section (MA10).

28. Radiolarian Occurence Data from the Middle Jurassic Manganese Carbonates of the Inuyama and Kamiaso Areas, Japan

by Akiro Yao[1] and Peter O. Baumgartner[2]

[1]Department of Geoscience, Faculty of Sciences, Osaka City University, Sugimoto 3-3-138; Sumiyoshi-ku, 558 Osaka, Japan

[2]Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

ABSTRACT

This paper reports on radiolarian data from manganese carbonate nodules that occur in the Middle Jurassic part of the "chert-clastic "sequences of the Mino Terrane, in the areas of Inuyama and Kamiaso. The assemblages described by various Japanese authors are extremely diverse and well-preserved. Only a small proportion of the entire assemblages has been incorporated within the database of this volume to obtain a correlation of the lower Middle Jurassic Japanese assemblage zones with the UAZones 95 presented in this book. Based on these calibrations, we can date these samples more precisely. Sample HK-140 from the Hisuikyo Section and Sample IN-7 from the siliceous mudstone below the Unuma CH-2 Unit are assigned to UAZone 3, dated as early -middle Bajocian. Sample IN-1 from the top of the siliceous mudstone below CH-2 is assigned to UAZone 4, dated as late Bajocian-early Callovian.

In Appendix 1, we report on the correlation of the uppermost assemblage zones proposed by Hori (1990) with the UAZones. The correlation is based on those species listed by Hori that are in common with our database. Following these correlations, the upper part of the *Mesosaturnalis hexagonus* Zone and the lower part of the *Parahsuum grande* Zone fall into UAZ. 1 (early to middle Aalenian, or older). The upper part of the *Parahsuum grande* Zone falls into UAZ.2 (late Aalenian). The *Hsuum hisuikyiense* Zone and the lower part of the *Unuma echinatus* Zone are correlated with UAZ.3 (early-middle Bajocian).

1. Introduction

Radiolarian faunal data from Middle Jurassic manganese carbonate nodules recovered from rocks of the Mino Terrane (Fig. 1) from the Inuyama and Kamiaso areas, are reported in this chapter. These data have been included within the database of the Jurassic-Cretaceous Working Group to reassess the age of these very well-preserved and extremely diverse faunas.

The Inuyama area is famous for an excellent exposures of chert-clastic sequences on the river banks along the Kiso River, that belong to the Mino Terrane. In the Kamiaso area the Hida river has cut a deep gorge in the Triassic to Jurassic siliceous sediments of the Mino Terrane. The Mino terrane is one of the major tectonostratigraphic terranes that constitute the pre-Tertiary accretionary complex of the Japanese Islands. This terrane is composed of Jurassic and earliest Cretaceous terrigenous strata and oceanic materials such as Carboniferous to Permian limestones and associated greenstones (ocean floor relics) and Permian to Jurassic cherts. As many as one hundred earth scientists have surveyed the exposures along the Kiso River from many points of view, including stratigraphy, paleontology, sedimentology, structural geology, paleomagnetism, geochemistry, and paleoceanography. A large amount of scientific results have been obtained through these activities.

In the following, we give only a brief outline of the geology of the Inuyama area in order to locate the occurrences of manganese carbonate nodules. Most of this text is adapted from Matsuoka *et al.* (1994).

2. Geological outline of the Inuyama Area

The Inuyama area (Fig. 1) is about 25 km to the north of Nagoya City and is geologically located in the southern part of the Mino Terrane. This area is characterised by large scale alternations of chert and sandstone. Kondo & Adachi (1975) illustrated a detailed outcrop map of both banks of the Kiso River. Yao *et al.* (1980) studied radiolarians and conodonts and discovered that the thick sedimentary sequence is not a single stratigraphic succession but a thinner stratigraphic succession that is repeated several times. They named four slices of laterally traceable chert units as CH-1 to CH-4 (Figs. 2). The alternations of chert and clastic rocks are now regarded as the result of tectonic stacking of Triassic-Jurassic sequences containing cherts at the base and clastics at the top. The tectonic stack forms a large west-plunging synform (Mizutani, 1964). Paleomagnetic studies on Triassic bedded cherts have shown that they accumulated in a low-paleolatitude area (Shibuya & Sasajima, 1986; Fujii *et al.*, 1993). The vertical lithologic change from pelagic chert to clastic sandstones reflects the travel history of an arc-ward moving oceanic plate (Matsuda & Isozaki, 1991) that received arc-derived clastics, before being subducted. Accretionary processes which created the tectonic stack were discussed by Otsuka, 1989; Kimura & Hori, 1993. Petrographical and geochemical studies on cherts were also carried out by Kakuwa (1987, 1988). Rb-Sr isochron ages of Middle Triassic (Anisian) chert and Middle Jurassic (Bajocian) siliceous mudstone were reported (Shibata & Mizutani, 1982).

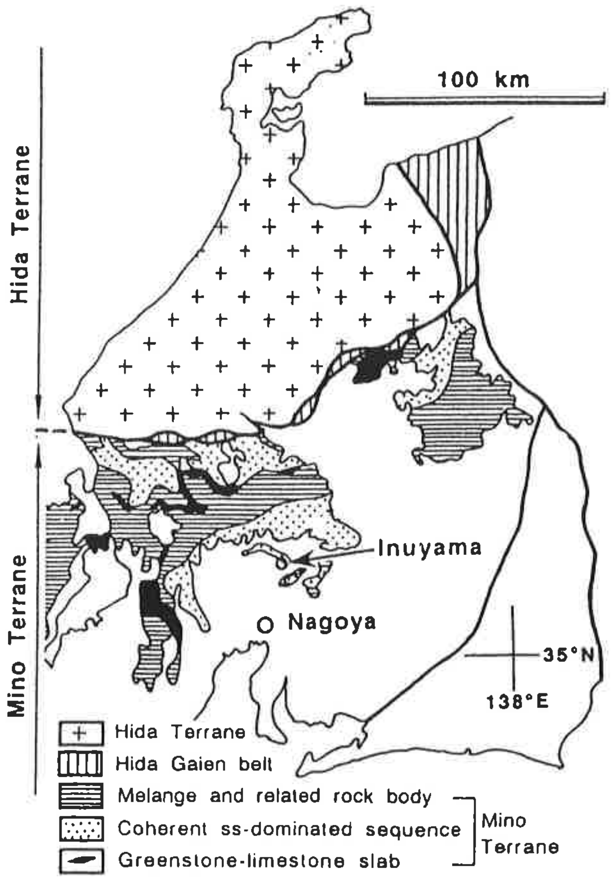


Figure 1. Index map showing the Inuyama area (modified from Wakita, 1988)

2.1 Lithostratigraphy

Figure 2 shows a generalised lithological columnar section of the chert-clastic sequence in the Inuyama area. The sequence is composed, in ascending order, of a siliceous claystone unit, a bedded chert unit, a siliceous mudstone unit, and a coarse clastic unit. The siliceous claystone unit consists of grey and black claystone and is characterised by the presence of pyrite nodules. The black claystone is rich in organic matter. Dolostone layers are found in the siliceous claystone unit below (south of) CH-3. The siliceous claystone unit gradually passes upwards into the bedded chert unit with an increase of interbebbed chert layers. The bedded chert unit consists of rhythmically alternating beds of chert and thin claystone. The bedded chert unit gradually passes upwards into the siliceous mudstone unit.

The siliceous mudstone unit is a mixture of radiolarian tests and silt- to fine sand-sized grains of terrigenous materials. The colour of this unit changes systematically: the lower part is red, the middle part is greenish grey, and the upper part is dark grey. Clastic dykes or sheets of medium to coarse sandstone sometimes intrude into this unit. Manganese carbonate nodules or lenses, which contain very well-preserved radiolarian tests, are found mainly in the lower part and rarely in the middle part of the siliceous mudstone unit between CH-1 and CH-2. The upper limit of the siliceous mudstone unit is marked by frequent occurrence of thin sandstone layers. The coarse clastic unit is composed mainly of coarse-grained thick sandstone associated with alternating beds of sandstone and mudstone.

Judging from the composition of rock forming materials, accumulation rates, and stratigraphic position, the siliceous claystone and bedded chert units are regarded as pelagic, the siliceous mudstone unit as hemipelagic, and the coarse clastic unit as a trench fill deposit.

2.2 Paleontology and biostratigraphy

Since Yao (1972) described Mesozoic radiolarians, several radiolarian workers have described new taxa from rock samples in the Inuyama area (Ichikawa & Yao, 1976; Nakaseko & Nishimura, 1979; Yao, 1979, 1982; Baumgartner, 1984; Hori, 1988; Hori & Yao, 1988). Triassic conodonts were also reported from this area (Koike *et al.*, 1971; Mizutani & Koike, 1982). The first comprehensive work on biostratigraphy of Triassic conodonts and Triassic-Jurassic radiolarians was carried out by Yao *et al.* (1980). Subsequently, Yao (1982) defined

Triassic and Jurassic radiolarian assemblages and dated them by means of co-occurring conodonts. Yao *et al.* (1982) proposed 11 radiolarian assemblages of Triassic-Jurassic age for many stratigraphic sections in SW Japan, including five sections in the Inuyama area. The CH-2 section was also used in defining the lowest Jurassic radiolarian zone (Matsuoka & Yao, 1986). Subsequently, Hori has worked on Lower Jurassic radiolarian biostratigraphy in chert sequences and established a detailed biostratigraphic zonation (Hori, 1990). Recently, Sugiyama (1993) contributed a Lower-Middle Triassic radiolarian zonation. As a result of extensive research of over ten years in this area ten radiolarian assemblage-zones have been established These are, in ascending order, the *Triassocampe coronata* (Sugiyama, 1992), *Triassocampe deweveri* (Yao *et al.*, 1980; Yao, 1982), *Triassocampe nova* (Yao, 1982), *Canoptum triassicum* (Yao, 1982), *Parahsuum simplum* (Yao *et al.*, 1980; Yao, 1982), *Mesosaturnalis hexagonus* (Hori & Otsuka, 1989; Hori, 1990), *Parahsuum (?) grande* (Yao *et al.*, 1982), *Hsuum hisuikyoense* (Yao & Matsuoka, 1981), *Unuma echinatus* (Yao, 1972, 1979), *Guexella nudata* (Matsuoka, 1982) Assemblage-Zones. The Lowest Jurassic *Parahsuum simplum* Assemblage-Zone is subdivided into four Subassemblage-Zones; namely the *Parahsuum* aff. *longiconicum* [I], *Katroma kurusuensis* [II], *Eucyrtidiellum* sp. C group [III], and *Trillus elkhornensis* [IV] Subassemblage-Zones in ascending order (Hori, 1990). Triassic assemblage-zones are compared with the biostratigraphy of co-occurring conodonts. Age assignments of Jurassic zones are based mainly on correlation with zonations in the Tethys region (e.g. Baumgartner, 1984, 1987) and North America (e.g. Pessagno *et al.*, 1987; Carter *et al.*, 1988).

Only one specimen of an ammonite was obtained from a float of mudstone which is lithologically similar to the upper siliceous mudstone unit or lower coarse clastic unit (Fig. 3: "Ammonite"). The ammonite was identified as *Choffatia (Subgrossouvia)* sp., indicating a Middle or Late Jurassic (late Bathonian earliest Oxfordian) age (Sato, 1974; Sato & Westermann, 1985). Petrified woods occasionally occur in sandstone beds in the coarse clastic unit. Nishida *et al.* (1974) described *Taxaceoxylon* sp. and *Cuprressinoxylone.*

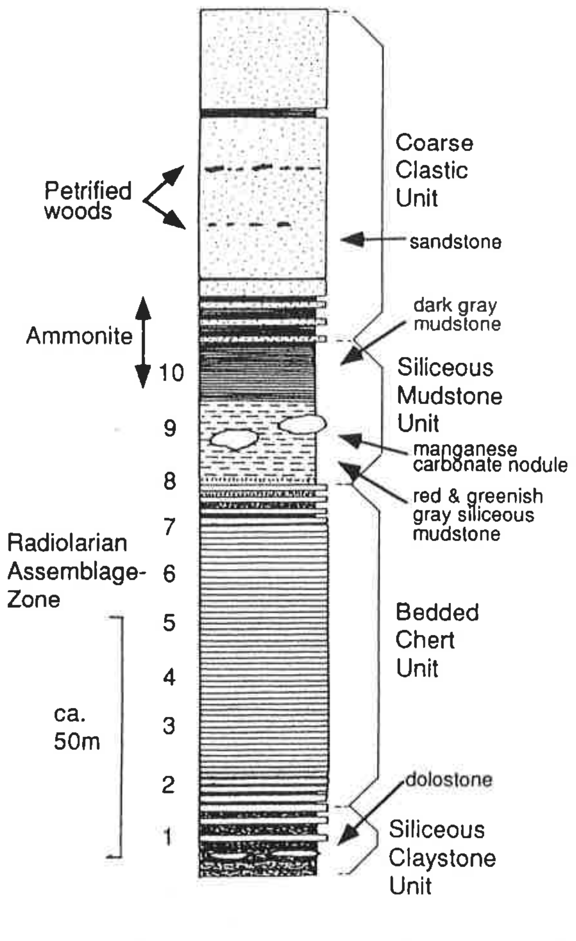


Figure 2. Generalized columnar section of Triassic-Jurassic chert-clastic sequence in the Inuyama area, showing the position of the manganese carbonate nodules (From Matsuoka *et al.*, 1994).

3. Middle Jurassic radiolarian faunas from manganese nodules: Inyuama Area

3.1 Location

South of the Unuma CH-2 section, red and grey siliceous mudstone beds were exposed containing thin beds or nodules of manganese carbonates (Fig. 4, IN7, IN1). Unfortunately, the outcrop of the siliceous mudstone has recently been covered by gravel and sand. Beds strike N 60°-80° E and dip 65°-85° N. The total thickness of the siliceous mudstone exceeds 38 m. Sedimentary structures, other than indistinct lamination, are not common in the siliceous mudstone which occasionally intercalates thin beds of fine-grained, dark grey sandstone. The sandstone beds are a few milimeters to a few centimeters thick. The manganese carbonate nodules occur sporadically in certain parts of the mudstone. These nodules are commonly lenticular, and are a few centimeters to 35 cm thick. They contain rhodochrosite spherules about 1 mm in diameter. Radiolarian remains are preserved in both the siliceous mudstone matrix and the manganese carbonates. Especially from the latter, numerous excellently-preserved specimens of radiolarians are obtained. The radiolarian fauna from both rocks was called the *Unuma echinatus* Assemblage (Yao *et al.*, 1980). The two manganese carbonate nodules (IN-7 and IN-l) were examined in detail. The IN-7 is contained in red siliceous mudstone which grades upsection into grey siliceous mudstone. The IN-l is contained in grey siliceous mudstone which is about 30 m above the horizon of IN-7. Features of the radiolarian faunas from IN-7 and IN-l are described in the following text.

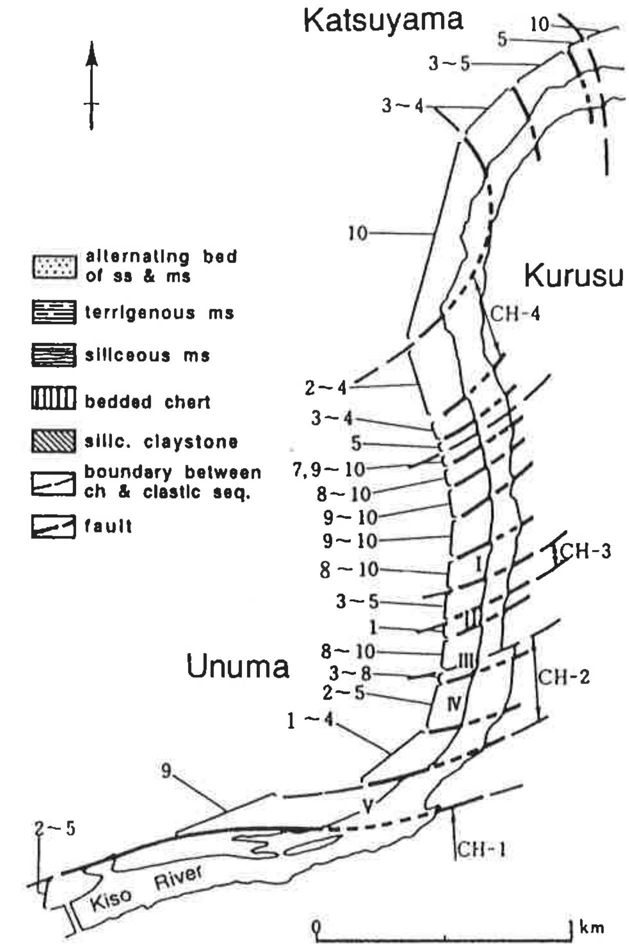


Figure 3. Sketch map of the Kiso River area showing the position of the CH2 section (Modified from Yao, 1988)

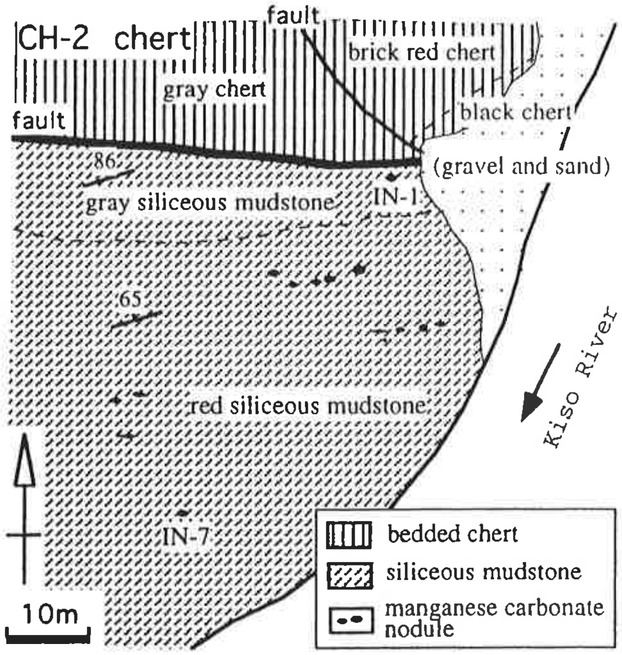


Figure 4. Sketch map showing the relationship between the basal part of the Unuma CH2 section and the siliceous mudstone (Modified from Yao, 1972)

3.2 Characteristic species

In the following list those species without IN number are common to IN-7 and IN-1.

Spumellaria.

Acanthocircus bispinus YAO
Acanthocircus inuyamaensis YAO
Acanthocircus protoformis YAO
Acanthocircus suboblongus YAO
Angulobracchia spp.
Archaeospongoprunum spp.
Archaeotriastrum spp.
Archicapsa pachyderma TAN
Archicapsa spp.
Bernoullius aff. *dicera* (BAUMGARTNER)
Bistarkum spp.
Cenosphaera spp.
Crucella sp. A
Drymosphaera spp.
Emiluvia spp.
Gorgansium spp.
Haliomma spp.
Hexalonche spp.
Hexasaturnalis hexagonus YAO
Hexasaturnalis tetraspinus YAO.
Higumastra spp.
Homoeoparonaella sp.
Orbiculiforma spp.
Pantanellium spp.
Parasaturnalis japonicus YAO
Paronaella spp.
Praeconocaryomma spp.
Pseudocrucella sp.
Pseudoheliodiscus sp. B
Spongostoma spp.
Spongotripus spp.
Spongotrochus spp.
Spongurus spp.
Staurolonche spp.
Stylosphaera spp.
Tetraditryma corralitosensis (PESSAGNO)
Tetraditryma spp.
Tetratrabs spp.
Thecosphaera (?) spp.
Trillus aff. *sidersi* PESSAGNO & BLOME (IN-1)
Trillus elkhornensis PESSAGNO & BLOME (IN-7)
Trilonche spp.
Tripocyclia brooksi PESSAGNO & YANG
Tripocyclia southforkensis PESSAGNO & YANG (IN-7)
Tripocyclia sp. B (IN-1)
Tripocyclia wickiupensis PESSAGNO & YANG
Tritrabs spp.
Xiphostylus aff. vallieri PESSAGNO & YANG
Xiphostylus lodgellensis PESSAGNO & YANG (IN-7)
Xiphostylus sinuosus PESSAGNO & YANG
Zartus dickinsoni PESSAGNO & BLOME.
Zartus spp.

Nassellaria.

Anisicyrtis jurassica TAKEMURA (IN-7)
Anisicyrtis spp.
Arcanicapsa sphaerica TAKEMURA
Arcanicapsa spp.
Archaeodictyomitra spp.
Ares cylindricus cylindricus (TAKEMURA)
Ares cylindricus flexuous (TAKEMURA) (IN-7)
Ares sp. A (IN-7)
Ares sp. G (IN-1)
Canoptum sp. A2 (IN-1)
Canoptum sp. C (IN-7)
Canoptum spp.
Cornutella reideli YAO
Cuniculiformis spp.
Cyrtocapsa kisoensis YAO (IN-7)
Cyrtocapsa mastoidea YAO
Cyrtocapsa sp. B
Diacanthocapsa normalis YAO (IN-7)
Diacanthocapsa operculi YAO
Diacanthocapsa sp. B (IN-1)
Diceratigalea sp. A
Dictyomitrella aff. *kamoensis* MIZUTANI & KIDO
Dumitricaella (?) spp. (IN-7)
Eucyrtidiellum quinatum TAKEMURA (IN-7)
Eucyrtidiellum sp. F (IN-1)
Eucyrtidiellum unumaense YAO
Gongylothorax siphonofer DUMITRICA (IN-7)
Hilarisirex quadrangularis TAKEMURA (IN7)
Hsuum matsuokai ISOZAKI & MATSUDA
Hsuum sp. C (IN-7)
Hsuum sp. H (IN-l)
Hsuum spp.
Katroma bicornus DE WEVER (IN-7)
Laxtorum (?) sp. B (IN-7)
Mirifusus fragilis BAUMGARTNER
Mirifusus spp. (IN-1)
Mita sp. B
Napora spp.
Palinandndromeda podbielensis (OZVOLDOVA)
Palinandndromeda praepodbielensis (BAUMGARTNER)
Parahsuum aff. *magnum* TAKEMURA
Parahsuum cruciferum TAKEMURA
Parahsuum officerense (PESSAGO & WHALEN) (IN-7)
Parahsuum ovale HORI & YAO (IN-7)
Parahsuum parvum TAKEMURA
Parahsuum simplum YAO
Parahsuum sp. B4 (IN-l)
Parahsuum spp.
Parvicingula dhimenaensis BAUMGARTNER
Parvicingula japonica (TAKEMURA)
Parvicingula obesa TAKEMURA
Parvicingula spinifer(TAKEMURA)
Parvicingula spp.
Parvifavus spp.
Perispyridium spp.
Poulpus sp. A
Protunuma fusiformis ICHIKAWA & YAO
Protunuma sp. E (IN- 1)
Pseudopoulpus sp.,
Quarticella conica TAKEMURA
Quarticella levis TAKEMURA
Quarticella sp. H0 (IN- 1)
Quarticella spinosa TAKEMURA (IN7)
Quarticella spp.
Saitoum levium DE WEVER
Sethocapsa(?) spp.
Solenotryma sp.
Spongocapsula spp. (IN-l)
Stichocapsa convexa YAO
Stichocapsa japonica YAO
Stichocapsa spp.
Syringocapsa spp.
Transhsuum hisuikyoense ISOZAKI & MATSUDA
Transhsuum maxwelli PESSAGNO
Transhsuum medium (TAKEMURA)
Tricolocapsa aff. *parvipora* TAN
Tricolocapsa fusiformis YAO
Tricolocapsa plicarum YAO
Tricolocapsa ruesti TAN
Tricolocapsa sp. D (IN-l)
Turanta spp.
Unuma aff. *paulsmithi* (CARTER)
Unuma echinatus ICHIKAWA & YAO
Unuma sp. I (IN-l)
Unuma spp.
Unuma typicus ICHIKAWA & YAO
Xitus spp. (IN-l)
Yamatoum caudatum TAKEMURA
Yamatoum connicinum TAKEMURA
Yamatoum elegans TAKEMURA
Yamatoum komamiensis TAKEMURA
Yamatoum spinosum TAKEMURA
Yamatoum spp.

The species in common with the Catalogue of the Interrad Jurassic-Cretaceous Working Group (this volume, *Chapter* 4) have been coded with MRD-numbers (see Appendix 2) and treated with the dataset to obtain the UAZ 95 Zonation (see *Chapter* 32).

Yao (in Matsuoka *et al.* 1994) has determined a total of 290 species from sample IN-7 (153 spumellarians, 137 nassellarians) and a total of 262 species in sample IN-1 (126 spumellarians, 136 nassellarians).

3.3 Zonal assignments and discussion of age

Although both IN-7 and IN-1 radiolarian faunas contain the characteristic species of the *Unuma echinatus* Assemblage, certain faunal differences in specific composition are recognised between them. For instance, the older IN-7 fauna contains many species of *Staurolonche* and *Trillus,* while species of these genera are rare in the younger IN1 fauna. On the other hand, many species of *Tricolocapsa, Stichocapsa* and *Mirifusus* are present in the younger IN-1 fauna, while species of these genera are rare in the older IN-7 fauna.

On the basis of the definition of the *Unuma echinatus* Assemblage and their stratigraphic horizons, the IN-7 fauna is the typical *Unuma echinatus* Assemblage and the IN-1 horizon is considered as the upper part of the *Unuma echinatus* Assemblage-zone.

Yao (1986) correlated the *Unuma echinatus* Assemblage-Zone with Zone A0 (U.A. 0-1) of Baumgartner (1984) and assigned a Bajocian to middle Bathonian age to these assemblages.

Both samples were used in the construction of the UAZones 95, presented in this volume. Based on the included species (comprising only a small portion of the total species) the older IN-7 sample is assigned to UAZ. 3, dated as early-middle Bajocian, whereas the younger IN-1 sample is assigned to UAZ. 4, dated as late Bajocian. The UAZone 3 comprises both samples assigned to the upper part of the *Hsuum hisuikyoense* Zone and samples assigned to the lower-middle part of the *Unuma echinatus* Zone, indicating a probable early-middle Bajocian age of the boundary between these two assemblage zones.

4. Middle Jurassic radiolarian faunas from manganese nodules: Kamianso Area, Hisuikyo Section

4.1 Location

The section is located 200 m upriver from the Kamiaso Bridge over the Hida river (Fig. 5) on the left river bank between the road level and the river gorge. This section was studied by Matsuda & Isozaki (1982), Kido (1982), and Isozaki & Matsuda (1985). The upper part was studied by Matsuoka *(Chapter* 27, this volume) The sample HK-140, collected by Yao at the level of sample 140 (Fig. 6) of Isozaki & Matsuda (1985) and comes from a black dusty layer containing rhodochrosite sphaerules. Stratigraphically. this layer is located above several metres of greenish-grey chert, that overlies, probably, Toarcian black cherts, dated by the presence of the *Parasaturnalis hexagonus* Zone (Hori, pers, comm., 1992). This level is underlain by bedded chert that contains the Rhaetian conodont *Misikella posthernsteini* .

4.2 Radiolarian assemblage and zonation

An extremely rich radiolarian fauna was recovered from this level (sample HK-140) partly illustrated previously by Isozaki & Matsuda (1985). Based on an SEM-image catalogue produced by A. Yao (umpublished), we have recorded the species in common with the data base presented in this book (see *Chapter* 32). This sample has been assigned to the *Hsuum hisuikyoense* Zone (Hori 1990). In this study it is assigned to UAZone 3, dated in the Tethyan area as early-middle Bajocian. This confirms the conclusion of Hori (1990) that this zone includes part of the Bajocian.

References

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

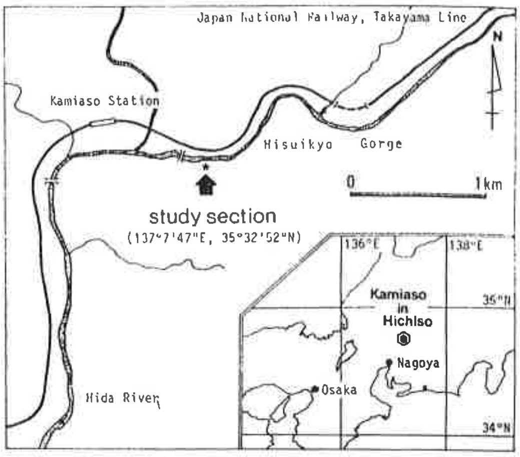


Figure 5. Index map of the study section along the Hisuikyo Gorge in Kamiaso area, Hichiso Town, Gifu Prefecture (after Isozaki & Matsuda, 1985).

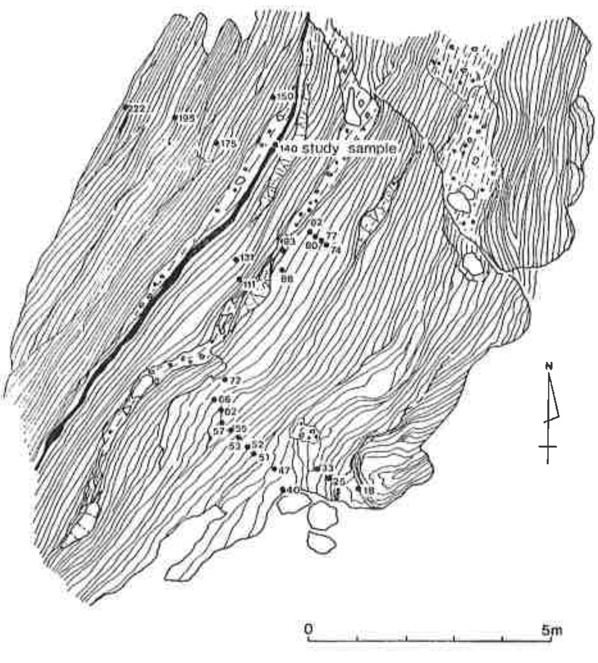


Figure 6. Closer view of the outcrop of bedded chert with manganese midronodules (after Isozaki & Matsuda, 1985).

CARTER, E.S., CAMERON, B.E.B. & SMITH, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

FUJII, J., HATTORI, I. & NAKAJIMA, T. (1993). A study of radiolarian biostratigraphy and magnetostratigraphy of early Mesozoic red bedded chert, central Japan. *News of Osaka Micropaleontologists, Special Volume*, **9**, 71-89. (*in Japanese*)

HORI, R. (1988). Some characteristic radiolarians from Lower Jurassic bedded cherts of the Inuyama area, Southwest Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **151**, 543-563.

HORI, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 562-586.

HORI, R. & OTSUKA, T. (1989). Early Jurassic radiolarians from the Mt. Norikuradake area, Mino Terrane, central Japan. *Journal of Geosciences, Osaka City University*, **32**, 175-198.

HORI, R. & YAO, A. (1988). *Parahsuum* (Radiolaria) from the Lower Jurassic of the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **31**, 47-61.

ICHIKAWA, K. & YAO, A. (1976). Two new genera of Mesozoic cyrtoid radiolarians from Japan. *In* Takayanagi, Y. & Saito, T. Eds. *Progress in Micropaleontology, Special Publication* - Micropaleontology Press, The American Museum of Natural History, New York, 110-117.

ISOZAKI, Y. & MATSUDA, T. (1985). Early Jurassic radiolarians from bedded chert in Kamiaso, Mino Belt, central Japan. *Earth Science, Journal of the Association for the Geological Collaboration in Japan*, **39** (6), 429-442.

KAKUWA, Y. (1987). Petrography and geochemistry of argillaceous rocks associated with Triassic to Jurassic bedded chert of the Mino-Tamba Terranes. *Scientific Papers of the College of Arts and Sciences, The University of Tokyo*, **36** (2), 137-162.

KAKUWA, Y. (1988). Geochemical study of Triassic to Jurassic bedded cherts in the Ashio, Mino, and Tamba Terranes in Japan. *Scientific Papers of the College of Arts and Sciences, The University of Tokyo*, **38** (1), 17-41.

KIDO, S. (1982). Occurrence of Triassic chert and Jurassic siliceous shale at Kamiaso, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 135-151.

KIMURA, K. & HORI, R. (1993). Offscraping accretion of Jurassic chert-clastic complexes in the Mino-Tamba Belt, central Japan. *Journal Structural Geology*, **15**, 145-161.

KOIKE, T., IGO, H., TAKIZAWA, S. & KINOSHITA, T. (1971). Contribution to the geological history of the Japanese Island by the conodont biostratigraphy. Part II. *Journal of the Geological Society of Japan*, **77**, 165-168.

KONDO, N. & ADACHI, M. (1975). Mesozoic strata of the area north of Inuyama, with special reference to the Skahogi conglomerate. *Journal of the Geological Society of Japan*, **81**, 373-386. (*in Japanese*)

MATSUDA, T. & ISOZAKI, Y. (1982). Radiolarians around the Triassic-Jurassic boundary from the bedded chert in the Kamiaso Area, Southwest Japan. Appendix: "Anisian radiolarians". *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 93-101.

MATSUDA, T. & ISOZAKI, Y. (1991). Well-documented travel history of Mesozoic pelagic chert in Japan; from remote ocean to subduction zone. *Tectonics*, **10** (2), 475-499.

MATSUOKA, A. (1982). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and the Niyodo areas, Kochi Prefecture, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 237-253.

MATSUOKA, A., HORI, R., KUWAHARA, K., HIRAISHI, M., YAO, A. & EZAKI, Y. (1994). Triassic-Jurassic radiolarian-bearing sequences in the Mino Terrane, central Japan. *Guidebook for Interrad VII Field Excursion*, Osaka, 19-61.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

MIZUTANI, S. (1984). Superficial folding of the Paleozoic system of cenntral Japan. *Journal of Earth Sciences Nagoya University*, **12**, 17-83.

MIZUTANI, S. & KOIKE, T. (1982). Radiolarians in the Jurassic siliceous shale and the Triassic bedded chert of Unuma, Kagamigahara City, Gifu Prefecture, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 117-134.

NAKASEKO, K. & NISHIMURA, A. (1979). Upper Triassic Radiolaria from southwest Japan. *Science Reports, College of General Education, Osaka University*, **28** (2), 61-109.

NISHIDA, M., ADACHI, M. & KONDO, N. (1974). Fossil fragments of petrified wood from pre-Tertiary formations in the northern area of the Inuyama City, Aichi Prefecture, and their bearing on geology. *Journal of Japanese Botany*, **49**, 265-272. (*in Japanese*)

OTSUKA, T. (1989). Mesozoic folds of chert in Triassic-Jurassic chert-clastic sequence in the Mino Terrane, central Japan. *Journal of the Geological Society of Japan*, **95**, 97-111.

PESSAGNO, E.A., BLOME, C., CARTER, E.S., MACLEOD, N., WHALEN, P. & YEH, K.Y. (1987b). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-18.

PESSAGNO, E.A., LONGORIA, J., MACLEOD, N. & SIX, W. (1987a). Studies of North American Jurassic Radiolaria; Part I, Upper Jurassic (Kimmeridgian-upper Tithonian) Pantanelliidae from the Taman Formation, east-central Mexico; tectonostratigraphic, chronostratigraphic, and phylogenetic implications. *Cushman Foundation for Foraminiferal Research, Special Publication*, **23**, 1-51.

SATO, T. (1974). A Jurassic ammonite from the Inuyama, north of Nagoya. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **96**, 427-443.

SATO, T. & G.E.G., W. (1985). Range chart and zonation in Japan. *Circum-Pacific Jurassic IGCP 171, third field conference, Japan*, 73-94.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SHIBATA, K. & S., M. (1982). Isotopic ages of Jurassic siliceous shale and Triassic bedded chert in Unuma, Central Japan. *Geochemical Journal*, **16** (5), 213-223.

SHIBUYA, H. & SASAJIMA, S. (1986). Paleomagnetism of red cherts; a case of study in the inuyama area, central Japan. *Journal of Geophysical Research, Series B, Solid Earth and Planets*, **91**, 14105-14116.

SUGIYAMA, K. (1992). Lower and Middle Triassic radiolarians from Mt. Kinkazan, Gifu Prefecture, Central Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **167**, 1180-1223.

SUGIYAMA, K. (1993). Skeletal structures of lower and middle Miocene Lophophaenids (Radiolaria) from central Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **169**, 44-72.

YAO, A. (1972). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part I: Spongosaturnalids. *Journal of Geosciences, Osaka City University*, **15**, 21-65.

YAO, A. (1979). Radiolarian fauna from the Mino Belt in the northern part of the Inuyama Area, Central Japan, Part II: Nassellaria I. *Journal of Geosciences, Osaka City University*, **22**, 21-72.

YAO, A. (1982). Middle Triassic to Early Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53-70.

YAO, A. (1986). Geological age of Jurassic radiolarian zones in Japan and their international correlations. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 63-74.

YAO, A., MATSUDA, T. & ISOZAKI, Y. (1980). Triassic and Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **23**, 135-154.

YAO, A. & MATSUOKA, A. (1981). *Unuma echinatus* assemblage in the Inuyama area of the Mino Belt. *Proceedings of the Kansai Branch, Geological Society of Japan*, **90**, 5-6. (*in Japanese*)

YAO, A., MATSUOKA, A. & NAKATANI, T. (1982). Triassic and Jurassic radiolarian assemblages in southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 27-43.

Appendix 1: Radiolarian data by Hori (1990)

Remarks

In order to tie the Lower Jurassic zonation proposed by Hori (1990) to the zonation proposed in this volume (UAZones 95), we have extracted from her data all species that are in common with our database. These species are only from the uppermost samples of Hori's sections (see Appendix 2) These data have been used in the construction of the UAZones 95, therefore we can establish a direct correlation between the two zonations. In the following we give a list of species included within our database, their MRD-numbers and the species number of Hori (1990) as well as the species range expressed by the UAZones 95.

Species	**MRD No.**	**Hori (1990)**	**UAZ.95**
Parashuum sp. M	2015	37	1 - 1
Hsuum sp. 1	2018	46	1 - 2
Parahsuum (?) grande	4031	45	1 - 3
Ares sp. A.	4008	25	1 - 3
Palinandromeda sognoensis	3010	48	1 - 3
Laxtorum (?) hichisoense	4028	52	1 - 4
Hexasaturnalis hexagonus	3502	42	1 - 4
Zartus imlayi gr.	3040	36	1 - 4
Hsuum matsuokai	3195	53	1 - 5
Trillus spp.	3039	30	1 - 5
Transhsuum medium	3278	43	1 - 7
Laxtorum (?) jurassicum	3151	51	2 - 3
Transhsuum hisuikyoense	3194	54	2 - 7
Zartus dickinsoni gr.	3041	55	3 - 4

Correlation of Zones

Based on the included species (which are a minor part of the total assemblages) a correlation between the uppermost assemblage zones defined by Hori (1990) and the UAZones 95, proposed in this volume is possible. The upper part of the *Mesosaturnalis hexagonus* Zone falls into UAZ. 1, dated in Tethyan sections and British Columbia as early to middle Aalenian (or older). Although Hori (1990) admits a Toarcian age for most of this zone she does not exclude the fact that its upper range reaches into the middle Jurassic. The lower part of the *Parahsuum grande* Assemblage falls into UAZ.1 (early-middle Aalenian), while the upper part falls into UAZ.2, dated in Tethyan and British Columbia sections as late Aalenian (see *Chapter* 32), this volume. This is a more precise age assignment than the one given by Hori (1990). The *Hsuum Hisuikyiense* Zone is clearly assigned to UAZ. 3, dated in Tethyan and British Columbian sections as early to middle Bajocian, and an age that is not in contradiction with the conclusion of Hori (1990) but is slightly younger than which she stated. As outlined in earlier paragraphs, the lower part of the *Unuma echinatus* Zone also falls into UAZ.3, therefore, the limit between the *H. hisuihyoense* and the *U. echinatus* Zones must lie within the early-middle Bajocian time interval, based on the present correlation. It has to be stated that these correlations are somewhat preliminary, since only very few species of the total assemblages have been considered in the calculations presented in *Chapter* 32 (this volume).

Appendix 2: Radiolarian data base used in this chapter

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991). Sample numbers are given in parenthesis.

SECTION POB40_IN_UNUMA: bottom 1-top 2

< 2: {IN 1. after SEM. A.Yao 9/92} 3020, 3001, 3005, 3006, 3011, 3012, 3041, 3042, 3049, 3051, 3052, 3054, 3055, 3064, 3071, 3076, 3088, 3089, 3096, 3109, 3110, 3124, 3125, 3135, 3149, 3158, 3159, 3169, 3180, 3192, 3195, 3204, 3220, 3231, 3247, 3253, 3269, 3271, 3273, 3303, 3307, 3410, 3502, 4007, 4009, 4010, 4011, 4044, 4049, 4050, 4052, 4058, 4059, 4061, 4063, 4077, 4078

< 1: {IN 7 check18/12/91pob} 2013, 2021, 3001, 3002, 3005, 3006, 3007, 3011, 3012, 3026, 3027, 3028, 3032, 3041, 3042, 3049, 3050, 3051, 3052, 3054, 3055, 3064, 3071, 3076, 3085, 3088, 3089, 3096, 3109, 3116, 3118, 3124, 3125, 3135, 3148, 3149, 3150, 3158, 3159, 3169, 3184, 3187, 3192, 3197, 3204, 3210, 3213, 3222, 3231, 3247, 3254, 3270, 3273, 3303, 3307, 3502, 4005, 4008, 4010, 4044, 4049, 4059, 4061, 4063

SECTION HK_UNUMA: bottom 1 top 1

< 1: {HK-140. after SEM. A. Yao. 9/92} 3033, 3012, 3014, 3039, 3041, 3042, 3052, 3055, 3076, 3089, 3125, 3151, 3158 {check!}, 3194, 3195, 3231, 3302, 3303, 4007, 4010, 4011, 4028, 4059, 4061

SECTION RH1_KS: bottom 1-top 15

< 15 {KS 20}: 3502, 3151, 3194
< 14 {KS 19}: 3039, 3041, 3151, 3194
< 13 {KS 18}: 3502, 3151, 3195, 4031, 2018
< 12 {KS 16}: 3039, 4031
< 11 {KS 15}: 3502, 2018
< 10 {KS 14}: 4031
< 9 {KS 13}: 3039, 3151, 3502, 2018
< 8 {KS 10}: 3039, 3502, 4031, 2018
< 7 {KS 9}: 3502
< 6 {KS 7}: 3502
< 5 {KS 6}: 3039, 3502
< 4 {KS 5}: 3502
< 3 {KS 4}: 3039, 2015
< 2 {KS 3}: 3039, 3502
< 1 {KS 2}: 3039, 3502, 2015

SECTION RH2_UF: bottom 1-top 4

< 4 {UF 22}: 4031, 3151, 3194

< 3 {UF 21}: 3039, 3502, 4031
< 2 {UF 20}: 4008, 3502, 2015
< 1 {UF 19}: 3039, 3502

SECTION RH3_IY: bottom 1-top 14
< 14 {IY 24}: 3502, 3194, 4031, 2018
< 13 {IY 23}: 4031, 3010, 2018
< 12 {IY 22}: 3502, 4031, 2015
< 11 {IY 21}: 3010
< 10 {IY 20}: 3278, 4031
< 9 {IY 19}: 3502, 4031
< 8 {IY 18}: 3502, 4031
< 7 {IY 17}: 3502, 3278
< 6 {IY 16}: 3502
< 5 {IY 15}: 3502
< 4 {IY 14}: 3039, 3502
< 3 {IY 13}: 3502, 2015
< 2 {IY 12}: 3502
< 1 {IY 11}: 3502

SECTION RH4_PT: bottom 1-top 8
< 8 {PT 8}: 4008, 3010, 3151, 3502, 4028, 4031
< 7 {PT 7}: 4031, 3010, 2018
< 6 {PT 6}: 3502
< 5 {PT 5}: 3502, 4031
< 4 {PT 4}: 3502
< 3 {PT 3}: 3502
< 2 {PT 2}: 3502
< 1 {PT 1}: 4008, 3039, 3502

SECTION RH5_UC: bottom 1-top 2
< 2 {UC 17}: 3039, 3502, 4031, 2015
< 1 {UC 15}: 3039, 3502

SECTION RH6_NKS: bottom 1-top 2
< 2 {NK 4}: 3039
< 1 {NK 3}: 4008, 3040

SECTION RH7_KD: bottom 1-top 6
< 6 {KD 21}: 3194
< 5 {KD 20}: 3502, 3151, 3194
< 4 {KD 18}: 3502, 3151
< 3 {KD 17}: 4031
< 2 {KD 16}: 3502, 4031, 2015
< 1 {KD 15}: 4031, 2015

29. Middle Jurassic (Aalenian and Early Bajocian) Radiolarians from the Queen Charlotte Islands, British Columbia, Canada*

by Elizabeth S. Carter

Department of Geology, Portland State University, Portland, Oregon 97207-0751, USA
Oregon, USA
Mailing Address: 58335 Timber Road, Vernonia, Oregon 97064, USA
* Geological Survey of Canada contribution N°. 17692

ABSTRACT

Aalenian and early Bajocian radiolarians from Queen Charlotte Islands are important age indicators because they are closely associated with diverse, age-diagnostic ammonites and precise time-equivalence can be established.

Aalenian radiolarian faunas are dominated by the cosmopolitan genera *Acaeniotyle, Emiluvia, Hagiastrum, Higumastra, Hsuum, Hexasaturnalis, Napora, Paronaella, Parvicingula, Triactoma, and Turanta* plus *Tympaneides* and *Perispyridium;* the latter at least is suspected of having higher latitude affinities. Multicyrtids are very abundant and constitute up to fifty percent of specimens in each sample. A few species are identical to those from low latitudes e.g. *Hexasaturnalis hexagonus*, but most are slightly different. The radiolarians occur with ammonites of the *Tmetoceras scissum* Assemblage Zone (= upper part of the *Opalinum* Zone and lower part of the *Murchisonae* Zone) and from younger faunas equivalent to the *Murchisonae* Zone. Age is early to early late Aalenian.

Lower Bajocian faunas are less diverse and contain a still greater proportion of nassellarians, especially multicyrtids. *Emiluvia, Hsuum, Parvicingula, and Perispyridium* are the most abundant genera along with smaller nassellarians such as *Tricolocapsa* and *Stichocapsa; Eucyrtidium, Paronaella,* and *Praeconocaryomma* are less common. These faunas occur with ammonites correlative with the Northwest European *Ovalis* Zone and the lower part of the *Laeviuscula* Zone.

Paleobiogeographic studies of ammonites suggest that following a strong Tethyan influence in the Toarcian, the Queen Charlotte archipelago was host to a mixed fauna during Aalenian and early Bajocian time: a fauna with cosmopolitan influences, a strong Pacific endemic component, and limited Boreal affinities. This scenario may be mirrored in the radiolarian faunas: Toarcian radiolarians are very rich and diverse; high diversity is maintained in the Aalenian but most newly appearing species differ slightly from those in low latitudes; diversity is reduced in the lower Bajocian and the trend towards endemic?/higher latitude forms seems more pronounced.

1. Introduction

Mesozoic faunas of the Queen Charlotte Islands are exceedingly important to the development of a global biostratigraphy because at some levels radiolarians, conodonts and/or foraminiferans, calcareous nannofossils, icthyoliths, and ammonites are together in the same bed or are closely associated. This establishes the exact time-equivalence of the faunas and intercalibrated time scales can be devised for the various fossil groups.

The Lower Mesozoic succession in the Queen Charlotte Islands spans late Carnian to Callovian time and is almost complete. Since the late nineteenth century, Early and Middle Jurassic faunas in particular have spawned a host of paleontographic and biostratigraphic studies with the tempo of research intensifying in the last decade. Ammonite, radiolarian and foraminiferal biostratigraphic studies are currently in progress and there is a wealth of material available for future work. New macrofossil collections from the Upper Jurassic have recently been discovered (Haggart & Tipper, 1992) ammonite and radiolarian collections from Upper Mesozoic rocks indicate that most of the Cretaceous is present as well (Haggart, 1991; Haggart & Carter, 1993).

Middle Jurassic radiolarians from the Queen Charlotte Islands were first studied by the writer who investigated the paleontology and biostratigraphy of early Aalenian-early Bajocian faunas from central Graham Island (Carter *et al.*, 1988). A diverse late Aalenian fauna from the same area more recently has been discussed and illustrated by Carter & Jakobs (1991). The faunas documented in the present paper include some from the above studies plus others from new collections along the Yakoun River (G.K. Jakobs, collector, 1991).

2. Regional and local tectonic setting

The Queen Charlotte Islands are part of the allochthonous terrane known as Wrangellia (Jones *et al.*, 1977). This terrane includes the Wrangell Mountains in Alaska, the Queen Charlotte Island archipelago, and most of Vancouver Island. The Karmutsen Formation, a several kilometre thick pile of Middle and Upper Triassic tholeiitic basalt, forms the basement of Wrangellia. These basalts are overlain disconformably by Upper Triassic and Lower Jurassic shelf limestone and fine-grained calcareous clastic and siliciclastic strata. Upon this basal package the Middle Jurassic sedimentary sequence of the Queen Charlotte Islands accumulated.

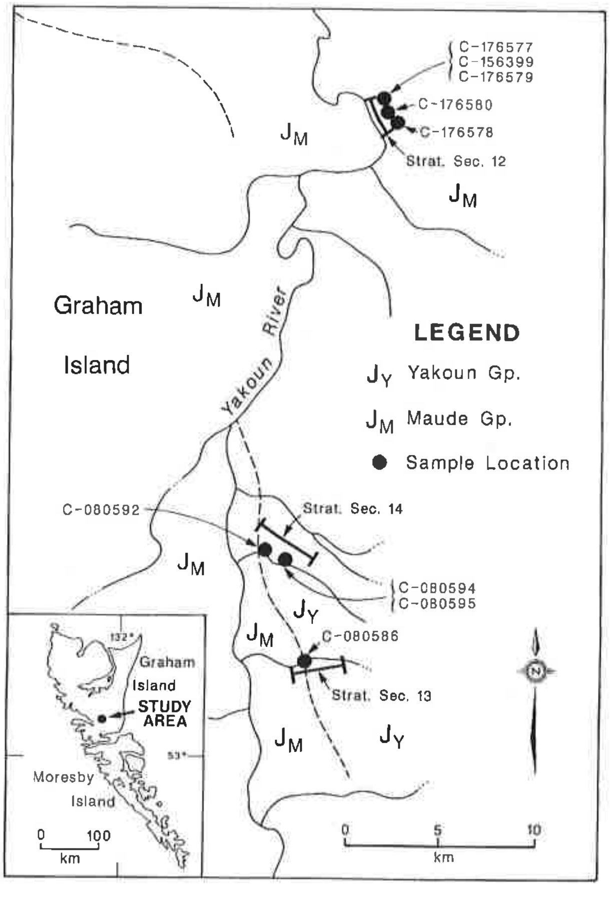


Figure 1. Index map of Queen Charlotte Islands with enlarged view showing the Yak River area of central Graham Island. The distribution of Maude and Yakoun group stratigraphic sections 12 to 14, and GSC sample localities are illustrated.

Paleomagnetic (Monger & Irving, 1980; Irving *et al.*, 1985) and paleontologic (Tozer, 1982; Smith & Tipper, 1986) evidence suggests Wrangellia originated at low latitudes, possibly near Baja California, that it drifted northward, became segmented, and eventually accreted to the western continental margin of North America. The timing of accretion is still subject to debate. Paleontologic evidence suggests Wrangellia may have been in place as early as the Middle Jurassic and certainly by the Late Cretaceous (Smith & Tipper, 1986) whereas the above mentioned paleomagnetic studies favour rapid movement northward and accretion in the Late Cretaceous.

Volcanic activity was prevalent in Early Jurassic time as evidenced initially by the many thin tuff beds in the upper part of the Sandilands Formation which is Sinememurian in age. These sediments were probably deposited in a basin remote from the volcanic source (Cameron & Tipper, 1985). This activity gradually lessened during the Pliensbachian and Toarcian as thick sequences of deep water shale and shallower water siltstone and sandstone were deposited. Volcanism resumed in the early Middle Jurassic and great thicknesses of volcaniclastic sediments were laid down. The lithologies of these strata are highly variable but differences probably directly reflect distance from volcanic source (ibid.).

3. Lithostratigraphy

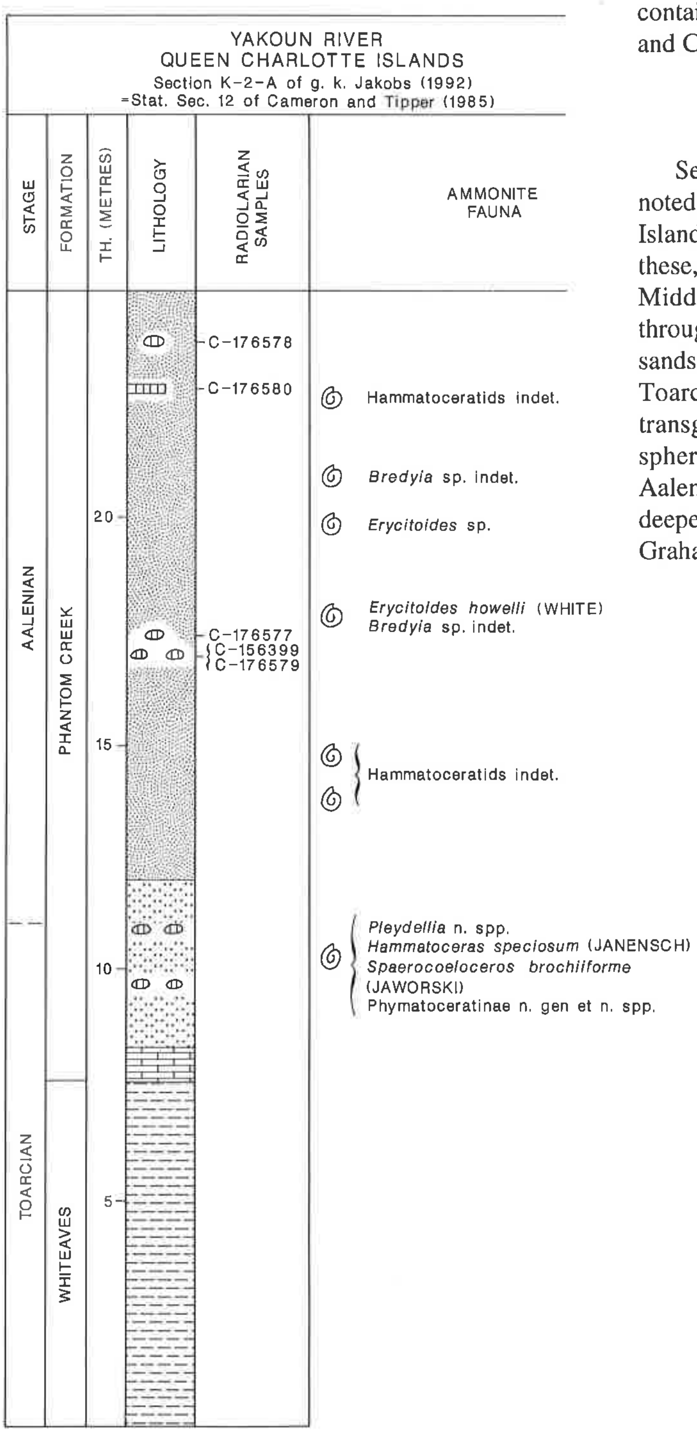
Middle Jurassic radiolarian-bearing strata of Aalenian and early Bajocian age are present in the upper part of the Phantom Creek Formation (Maude Group) and in the overlying Graham Island Formation (Yakoun Group). These formations are well represented in the Yakoun River area of central Graham Island (Fig. 1). Younger Middle Jurassic strata occur in the Richardson Bay Formation (Yakoun Group), and in the overlying Robber Point, Newcombe, and Alliford formations (Moresby Group). The Richardson Bay Formation is upper lower Bajocian, the Robber Point is largely volcanic and undated, the Newcombe and Alliford formations are upper Bathonian and Callovian respectively. Very few radiolarians have been found in Morseby Group strata.

Radiolarians of Aalenian age have been recovered from limestone concretions and sandy limestone lenses in the upper part of the Phantom Creek Formation (Maude Group in the Yakoun River area, central Graham Island (Fig. 1). The Phantom Creek Formation comprises brown-to-buff-weathering, partly calcareous, fine to coarse grained sandstone with thin shale interbeds in the lower part. Cameron & Tipper (1985) divided it into two informal members: the lower, coquinoid sandstone member, and the upper, belemnite sandstone member, possibly with a paraconformity between the two. Jakobs (1992) uses instead the terms lower concretionary sandstone, and upper spheroidal weathering sandstone; this terminology is adopted here. The concretionary sandstone is upper Toarcian and lower Aalenian; the spheroidal weathering sandstone is lower to upper Aalenian (Jakobs, pers. comm., 1992). Both units are exposed in sequence along the Yakoun River (stratigraphic section 12; Fig. 2), whereas on Branch Road 59 (stratigraphic section 13; Fig. 3) the concretionary sandstone is disconformably overlain by the lower Bajocian Graham Island Formation.

Early Bajocian radiolarians have been recovered from calcareous sandstone interbeds and lenses in the shale-tuff member of the Graham Island Formation (Yakoun Group) at Branch Road 57, central Graham Island (Fig. 1). In this area, Cameron & Tipper (1985) divided the formation into two informal members: the lower, shale-tuff member, and the upper, volcanic sandstone member. The shale-tuff member is composed of hard, slightly sandy shale and partly tuffaceous siltstone with minor sandstone and occasional fine calcareous sandstone interbeds. The entire sequence at Branch Road 57 is illustrated as stratigraphic section 14 in Carter *et al.*, 1988, but in this report only the interval containing radiolarian samples C-080592, C-080594 and C-080595 is shown (Fig. 4)

4. Environment of deposition

Several transgressive and regressive trends are noted in Lower Jurassic strata of the Queen Charlotte Islands (Cameron & Tipper, 1985, Fig. 31). One of these, a shallowing trend in the upper part of the Middle Toarcian Whiteaves Formation, persists through deposition of the shallow water concretionary sandstones of the Phantom Creek Formation during late Toarcian and early Aalenian time. The next transgressive cycle begins with deposition of the spheroidal weathering sandstone (lower to upper Aalenian) which is disconformably overlain by the deeper water, partly euxinic, shale-tuff member of the Graham Island Formation (Cameron & Tipper, 1985).



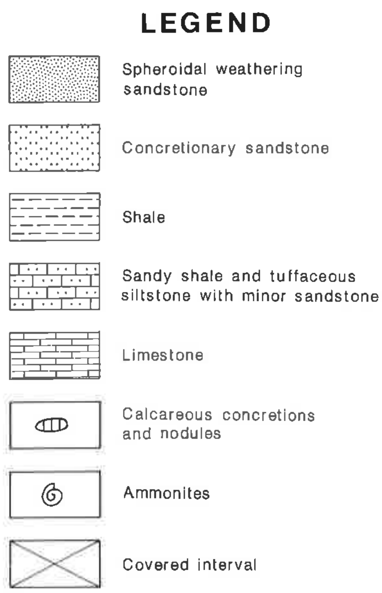


Figure 2. Stratigraphic section 12 of Cameron & Tipper (1985) = section K-2-A o Jakobs (1992); Yakoun River, central Graham Island.

5. Biostratigraphy

5.1. Aalenian

The rich Aalenian radiolarian fauna of the Queen Charlotte Islands is invaluable in tracing morphological and evolutionary faunal trends from the Lower to Middle Jurassic. Aalenian assemblages contain many undescribed taxa and appear to provide the intermediate link between faunas of Toarcian and Bajocian age both of which have distinctively different characteristics.

The most abundant and/or diverse genera within this fauna are *Acaeniotyle, Emiluvia, Hagiastrum, Hsuum, Higumastra, Hexasaturnalis, Napora, Paronaella, Parvicingula, Perispyridium, Triactoma, Turanta,* and *Tympaneides*. The fauna has moderate affinity with other low latitude Tethyan assemblages of probable Aalenian age (i.e. sample POB 1341). Generic composition is similar except for the dominance of *Perispyridium* in Queen Charlotte assemblages and the absence of *Andromeda*. Some species level taxa are identical (i.e. *Hexasaturnalis hexagonus* (YAO), *Archaeohagiastrum longipes* BAUMGARTNER, and *Tertaditryma* sp. cf. *T. praeplena* BAUMGARTNER but the majority of species are slightly different. *Hexasaturnalis tetraspinus* (YAO) is not present in these assemblages but a similar form having, in addition, two short spines in the median horizonal position (Carter & Jakobs, 1991, pl. 2, fig. 16) is common. MRD taxa of

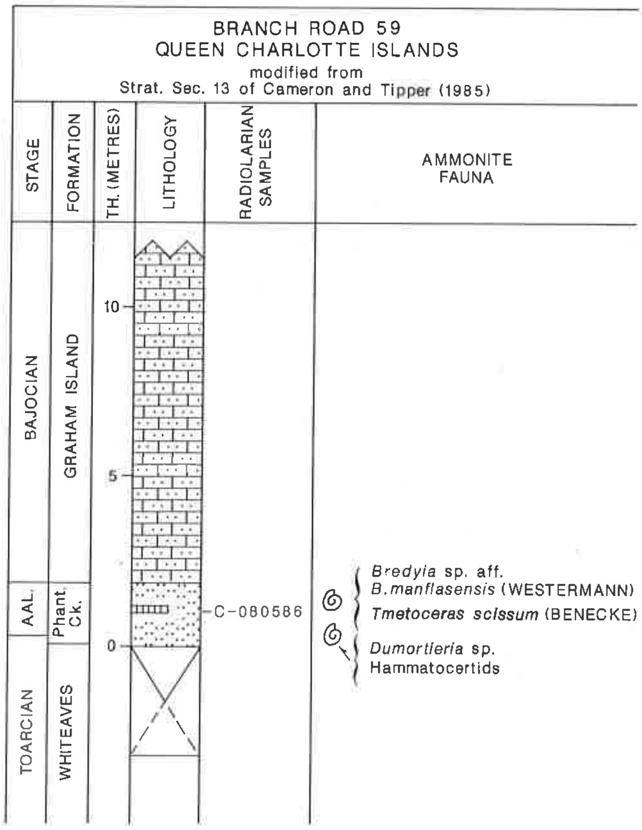


Figure 3. Stratigraphic section 13 (modified from Cameron & Tipper, 1985); Bran 59, central Graham Island. Symbols as in Figure 2.

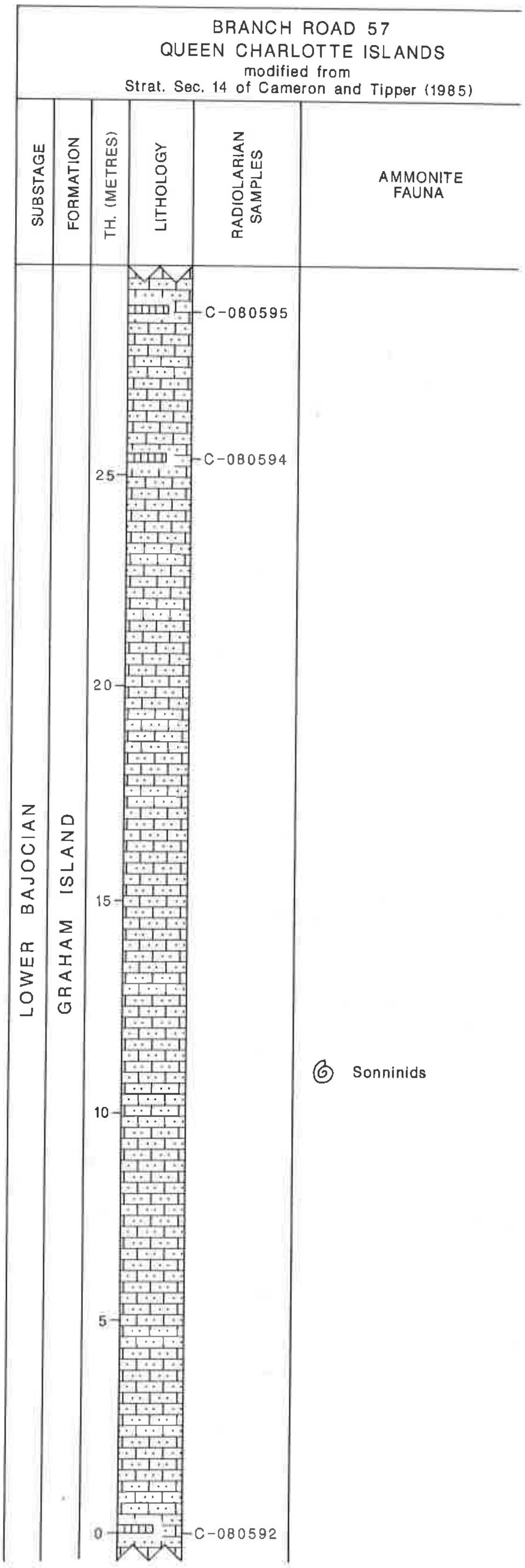


Figure 4. Stratigraphic section 14 (modified from Cameron & Tipper, 1985); Bran 57, central Graham Island. Symbols as in Figure 2.

Aalenian age from stratigraphic sections 12 and 13 are listed in the appendix.

Radiolarian sample C-080586 from the concretionary sandstone at Branch Road 59 (stratigraphic section 13, Fig. 3) was orignally discussed and illustrated in Carter et al., 1988 and formed the basis for definition of Zone 6 in the local radiolarian zonation for the Queen Charlotte Islands proposed by these authors. This sample is associated with a mixed collection of *Tmetoceras scissum* (BENECKE), *Bredyia* sp. aff. *B. manflasensis* WESTERMANN , *Dumortieria* sp. and indeterminate hammatoceratid ammonites. This association probably indicates an early Aalenian to early-mid Aalenian age (Poulton & Tipper, 1991). These authors include the ammonite-bearing beds at Branch Road 59 in the Western Canadian *Tmetoceras scissum* Assemblage Zone, which they indicate is roughly equivalent to the upper part of the *Opalinum* Zone and lower part of the *Murchisonae* Zone.

Radiolarians have been found at four levels in the spheroidal weathering sandstone of stratigraphic section 12 (Fig. 2) on the Yakoun River (samples C-176579, C-156399, C-176577, C-176580 and C-176578). Taxa from sample C-156399 discussed and illustrated in Carter & Jakobs 1991. Ammonites from the underlying concretionary sandstone include *Hammatoceras speciosum* JANENSCH, *Sphaerocoeloceras brochiiforme* JAWORSKI, *Pleydellia* spp., and *Phymatoceratinae* n.gen. et n.spp. and are latest Toarcian in age, equivalent to the upper *Levesqui* Zone of Northwest Europe (Jakobs, 1992). Ammonites from the spheroidal weathering sandstone include *Erycitoides howelli* (WHITE), *Erycitoides* sp., *Bredyia* sp., and indeterminate hammatoceratids. These ammonites are probably early late Aalenian and are approximately equivalent to the *Murchisonae* Zone (Carter & Jakobs, 1991).

5.2. Early Bajocian

Early Bajocian radiolarians from the Queen Chalrotte Islands are described and illustrated in Carter et al., 1988. *Parvicingula, Emiluvia, Hsuum, Perispyridium,* and small nassellarians with constricted distal end such as *Tricolocapsa* and *Stichocapsa* are the most abundant forms. Species of *Eucyrtidium, Paronaella, Praeconocaryomma, Trillus,* and *Zartus* form a lesser part of the fauna. *Unuma echinatus* ICHIKAWA & YAO has not been found in Queen Charlotte assemblages. This may be because its range does not extend down to the lowest Bajocian, or alternately, it may indicate the Queen Charlotte islands had moved northward out of the Tethyan realm by early Bajocian time. The high incidence of *Perispyridium* may support Pessagno *et al.* (1986, fig. 3) who suggest this genus has wider distribution in northern Tethyan and Boreal areas. The MRD taxa from stratigraphic section 14 are listed in the appendix.

Radiolarian samples from the shale tuff member at Branch Road 57 (stratigraphic section 14, Fig. 4) are associated with poorly-preserved sonninid ammonites and are possibly earliest Bajocian in age. The ammonites suggest correlation with the Northwest European *Ovalis* Zone and the lower part of the *Laeviuscula* Zone (Smith in Carter et al., 1988, p. 17). In North America this biochronological interval encompasses the upper part of the *Docidoceras widebayense* Assemblage Zone and an unnamed interval subjacent to the *Parabigotites crassicostatus* Assemblage Zone of Hall & Westermann (1980) (Taylor, pers. comm., 1986).

6. Paleobiogeography

Jurassic faunas in the Queen Charlotte Islands are allied to the Tethyan Realm. The ammonite fauna is very diverse and more closely related to the faunas of the conterminous United States, southern Europe, North Africa and South America than to those of northern Europe and cratonic North America, for example the Fernie Basin of southeastern British Columbia, and the Arctic (Smith & Tipper, 1986, Taylor *et al.,* 1984). More specifically Jakobs (pers. commun., 1992) suggests the Toarcian fauna is Tethyan having close ties with Greece and Italy, whereas the Aalenian fauna is more endemic. It is essentially a mixed fauna with a strong Pacific influence and includes forms from South America. Species tend to have Pacific affinities and may be endemic but the genera are cosmopolitan. It includes *Tmetoceras,* a cosmopolitan genus, and a few boreal forms from Alaska such as *Erycitoides howelli* (WHITE) but lacks other more boreal forms such as *Leioceras opalinum* (REINECKE). According to Taylor *et al.,* 1984, the early Bajocian fauna contains cosmopolitan and endemic forms, and others from the East Pacific Realm.

Early Middle Jurassic radiolarians of Queen Charlotte Islands share some species in common with low latitude Tethyan faunas but the overall composition, and particularly the dominating genera of the two faunas, is somewhat different. Aalenian assemblages are more diverse and contain a greater proportion of spumellarian taxa than early Bajocian assemblages do, but in both, *Emiluvia, Hsuum, Parvicingula,* and *Perispyridium* are the most abundant genera; their species, however, differ considerably with time.

7. Conclusion

Aalenian and early Bajocian radiolarians of Queen Charlotte Islands are closely associated with diverse, age-diagnostic ammonites so that time-equivalence can be precisely established. This makes them highly useful in dating radiolarian faunas in other parts of the world where independent fossil control is not available.

Ammonite paleobiogeographic studies suggest that following a strong Tethyan influence in the Toarcian, the Queen Charlotte archipelago was host to a mixed fauna during Aalenian and early Bajocian time; a fauna with cosmopolitan influences, a strong Pacific endemic component, and limited Boreal affinities as well. Although it is possible the Queen Charlotte Islands may have moved north of the low latitude Tethyan Realm by the Aalenian and early Bajocian, Tethyan influences are still reflected among the ammonite and radiolarian faunas. Some radiolarians are identical to species described from Tethys, whereas others have only slight differences. On a larger scale, some genera that dominate Queen Charlotte assemblages are less well developed in low latitude faunas, and conversely, a few Tethyan genera have not been found in Queen Charlotte Islands.

References

CAMERON, B.E.B. & TIPPER, H.W. (1985). Jurassic stratigraphy of the Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **365**, 1-49.

CARTER, E.S., CAMERON, B.E.B. & SMITH, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

CARTER, E.S. & JAKOBS, G.K. (1991). New Aalenian Radiolaria from the Queen Charlotte Islands, British Columbia: implications for biostratigraphic correlation. *Geological Survey of Canada, Current Research, Paper*, **91-1A**, 337-351.

HAGGART, J.W. (1991). A synthesis of Cretaceous stratigraphy, Queen Charlotte Islands, British Columbia. Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia. *Geological Survey of Canada, Paper*, **90-10**, 253-277.

HAGGART, J.W. & CARTER, E.S. (1993). Cretaceous (Barremian-Aptian) Radiolaria from Queen Charlotte Islands, British Columbia: newly recognized faunas and stratigraphic implications. *Geological Survey of Canada, Current Research, Paper*, **93-1E**, 55-65.

HAGGART, J.W. & TIPPER, H.W. (1992). Newly recognized Middle and Upper Jurassic sedimentary rocks in the Queen Charlotte Islands, British Columbia, and implications for regional tectonics. *Geological Society of America, Abstracts with Programs*, **24** (5), 29.

HALL, R.L. & WESTERMANN, G.E.G. (1980). Lower Bajocian (Jurassic) cephalopod faunas from Western Canada and proposed assemblage zones for the Lower Bajocian of North America. *Palaeontographica Americana*, **9** (52), 1-93.

IRVING, E., WOODSWORTH, G.J. & WYNNE, P.J. (1985). Paleomagnetic evidence for northward motion of the Western Cordillera in latest Cretaceous to early Tertiary times. *Geological Society of America, Abstracts with Programs*, **17** (6), 363.

JAKOBS, G.K. (1992). *Toarcian (Lower Jurassic) Ammonite Biostratigraphy of North America*. Ph.D. Thesis. University of British Columbia, Vancouver.

JONES, D.L., SILBERLING, N.J. & HILLHOUSE, J. (1977). Wrangellia - A displaced terrane in northwestern North America. *Canadian Journal of Earth Science*, **14**, 2565-2577.

MONGER, J.W.H. & IRVING, E. (1980). Northward displacement of north-central British Columbia. *Nature*, **285**, 289-294.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

POULTON, T.P. & TIPPER, H.W. (1991). Aalenian ammonites and strata of western Canada. *Geological Survey of Canada, Bulletin*, **411**, 1-71.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SMITH, P.L. & TIPPER, H.W. (1986). Plate tectonics and paleobiogeography: Early Jurassic (Pliensbachian) endemism and diversity. *Palaios*, **1**, 339-412.

TAYLOR, D.G., CALLOMON, J.H., HALL, R., SMITH, P.L., TIPPER, H.W. & WESTERMAN, G.E.G. (1984). Jurassic ammonite biogeography of western North America: tectonic implications. *Geological Association of Canada, Special Paper*, **27**, 121 -142.

TOZER, E.T. (1982). Marine Triassic faunas of North America: their significance in assessing plate and terrane movements. *Geologische Rundschau*, **71**, 1077-1104.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION 12_ESC_Graham_Island_-_Yakoun River: bottom 1 - top 5
< 5 {GSC C-176578}: 3148, 3247, 3310, 3409, 3411, 3502
< 4 {GSC C-176580}: 3310, 3411
< 3 {GSC C-176577}: 3033, 3055, 3148, 3149, 3247, 3310, 3407, 3408, 3409, 3410, 3411, 3502, 4063
< 2 {GSC C-156399}: 3033, 3055, 3148, 3149, 3247, 3253, 3310, 3407, 3408, 3409, 3410, 3411, 3502, 4063
< 1 {GSC C-176579}: 3033, 3148, 3149, 3247, 3253, 3408, 3409, 3410, 3411, 3502, 4063

SECTION 13_ESC_Graham_Island_-_Branch Rd._59: bottom 1 - top 1
< 1 {GSC C-080586}: 3055, 3148, 3310, 3408, 3409, 3411

SECTION 14_ESC_Graham Island_-_Branch Rd._57: bottom 1 - top 3
< 3 {GSC C-080595}: 3055, 3125, 3148, 3184, 3210
< 2 {GSC C-080594}: 3055, 3039, 3148
< 1 {GSC C-080592}: 3012, 3039, 3055

30. Radiolarian Stratigraphic Study of Stanley Mountain, California

by Donna M. Hull and Emile A. Pessagno

Programs in Geosciences, University of Texas at Dallas, P.O.Box 830688, Richardson, Texas 75083-0688, U.S.A.

ABSTRACT

The following chapter presents the results of a biostratigraphic and lithostratigraphic study of the Stanley Mountain remnant of the Coast Range ophiolite in the southern Coast Ranges of California. The sedimentary succession overlying the ophiolite at Stanley Mountain is one of the most complete in the California Coast Ranges, consisting of approximately 130 m of deep-sea cherts and siliceous mudstones. These strata are transitional with, and overlain by, more than 130 m of alternating shales and graywackes of the Great Valley Supergroup. Over 100 samples collected from this locality have yielded over 400 species of Upper Jurassic Radiolaria.

Zonal assignments herein follow the radiolarian biostratigraphic zonation of Pessagno *et al.* (1993). Ages also are presented utilizing the Unitary Associations method of Guex (1977, 1991) (see Baumgartner *et al.*, *Chapter* 32, this volume) and their chronostratigraphic calibrations. Correlations between the two zonations are difficult throughout most of the Stanley Mountain succession and differ by up to one-half stage. These differences are likely due to the predominance of Boreal faunas at Stanley Mountain, to different methodologies, and to chronostratigraphic calibrations of radiolarian data to different successions.

1. Introduction and geological setting

The Stanley Mountain remnant of the Coast Range ophiolite is approximately 25 km northeast of the city of Santa Maria, California and 96 km north-northwest of Santa Barbara, California (Fig. 1). The field area is east of Twitchell Reservoir, north of California State Highway 166, on private ranch property. On its northern side, Stanley Mountain slopes downward into a shallow canyon dominated by Alamo Creek, a cobble-filled, dry river bed active only during heavy seasonal rains. The primary sections sampled crop out on the northern side of Alamo Creek (Fig. 2). Smaller sections do crop out on the south side and in tributary canyons (e.g., Corral Creek and Fish Creek).

The California Coast Ranges extend from the northern border of California to the Santa Ynez River (Santa Barbara County) of southern California. The Coast Ranges consist of two subprovinces: (1) the Northern Coast Ranges, north of San Francisco Bay; and (2) the Southern California Coast Ranges, south of San Francisco Bay (Norris & Webb, 1976). Two complexes are present: (1) the "granitic-metamorphic" complex, which includes the Sur Series of the Salinian Block in the Santa Lucia Range; and (2) the Franciscan Complex. The latter is composed of over 15,000 m of Late Jurassic to Eocene graywackes intercalated with lesser amounts of dark shale, limestone, red radiolarian cherts and metamorphosed volcanics (predominantly greenstones, glaucophane schist and chlorite schist). At many localities these rocks are in contact with serpentinized ultrabasic igneous rocks. Geologists working in the Franciscan Complex over the last twenty years have identified numerous highly dismembered ophiolite sequences, occurring as small remnants at over two dozen localities throughout the California Coast Ranges (Bailey &

Jones, 1970; Page, 1966, 1972; Blake & Jones, 1981; Hopson *et al.*, 1981). Collectively, the remnants are known as the Coast Range ophiolite (Bailey & Jones, 1970).

Radiometric dating of the Coast Range ophiolite indicates that the ophiolite formed 169 to 161 My (Middle to Late Jurassic; Hopson *et al.*, 1981; Sharp & Evarts, 1982). Most of these dates are based on U/Pb isotopic data from minerals extracted in sill and dike complexes in the southern Coast Ranges. According to Robertson (1989, p. 195; see also Shervais & Kimbrough, 1985), extrusive rocks of the ophiolite succession are composed of "sub-alkaline tholeiites and subordinate intermediate to acidic extrusives." These extrusives are predominantly massive lava flows (some columnar-jointed), pillow lavas, and brecciated lava. Thicknesses vary, but range as high as 2.4 km (Llanada remnant, southern Diablo Range). Interpillow pelagic sediments containing Radiolaria are present at several localities (e.g., Point Sal remnant; Hopson *et al.*, 1981).

The basal strata of the Coast Range ophiolite are in thrust contact with the Franciscan Complex throughout the California Coast Ranges. Geophysical data indicates that the ophiolite extends underneath the Great Valley in the Diablo Range, east of the San Andreas Fault (Cady, 1975). Conformably or unconformably overlying the extrusive rocks of the ophiolite, is a succession of Callovian to uppermost Tithonian volcanic-rich pelagic sediments. These deposits are referred to as the "volcanopelagic succession" by Hopson *et al.* (1981), and the "Lotta Creek Unit" by Robertson (1989). The volcanopelagic succession has been included in the older literature as part of the Knoxville, Toro, or Jollo Formations (Page, 1966; Ingersoll, 1983; Seiders, 1983). Field studies of the volcanopelagic succession suggest that these sediments were deposited in the proximal to distal facies of a volcaniclastic apron derived from an oceanic volcanic arc. Where exposed (Llanada, Del Puerto, and Stanley Mountain), the Great Valley Supergroup conformably overlies the volcanopelagic succession. This contact is transitional in nature, consisting of siliceous mudstones with rare interbeds of sandstone passing into more regularly alternating sandstones and dark shales. The Great Valley Supergroup is interpreted to have been deposited primarily by deepwater turbidity currents, although shallow marginal deposits have also been recognized (Dickinson & Rich, 1972; Dickinson & Seely, 1979). The provenance of these sediments has been studied by Dickinson & Rich (1972), Dickinson *et al.* (1982), and Ingersoll (1983). In general, the primary sources of the clastic sediments are the Sierra Nevada and Klamath regions to the north and east. Paleocurrent analyses indicate sediment transportation to the south.

Several theories have been proposed in recent years concerning the evolution of the Coast Range ophiolite. Hopson *et al.* (1981, 1986; Pessagno *et al.*, in prep.) propose formation of the ophiolite at an open-ocean spreading center, far removed from sources of volcaniclastic or terriginous sediments. Subsea volcanism at this site was accompanied by ferruginous/siliceous hydrothermal deposition and calcareous pelagic deposition. According to this model, after formation, the ophiolite subsided and was carried east or northeast towards the source of arc-derived volcaniclastics which are present in the overlying volcanopelagic succession. A 5-10 My unconformity is recognized by these authors at the contact between the pillow basalts and overlying volcanopelagic unit. The ophiolite accreted to the western margin of North America during the Nevadan orogeny (Hopson *et al.*, 1981, 1986).

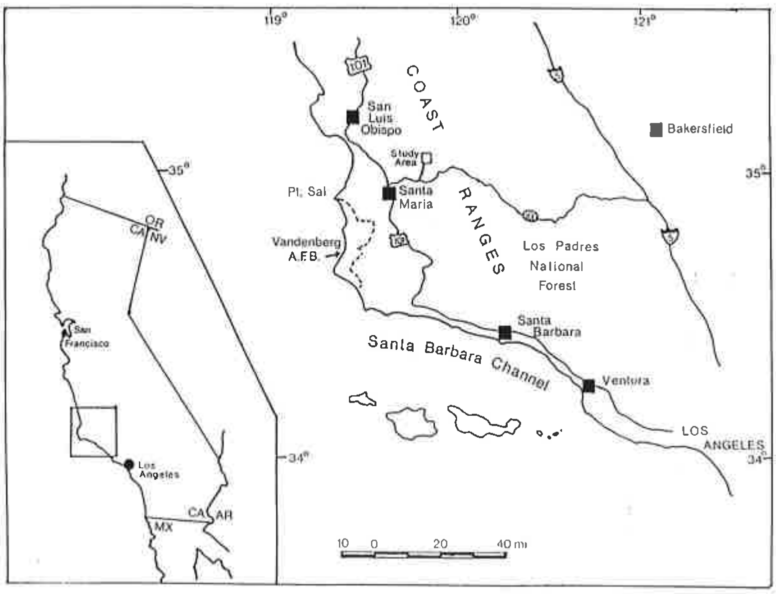


Figure 1. Location map of the study area, Stanley Mountain, in the southern California Coast Ranges of western North America. Sections are exposed approximately 25 km northeast of the city of Santa Maria.

Robertson (1989) has raised objections to Hopson *et al.*'s model, citing stable trace element geochemistry which indicates that the ophiolitic extrusives possess arc-type characteristics (Evarts, 1977; Menzies *et al.*, 1977; Shervais & Kimbrough, 1985). Thus, according to these authors, formation of the ophiolite need not be far from the site of volcanopelagic deposition. Robertson (1989, p. 213) also questions the presence of an unconformity between the extrusive pillow basalts and overlying volcanopelagic sediments. Geochemical arguments aside, it is difficult to *prove* the presence of an unconformity at this contact solely based on radiolarian biostratigraphy, particularly in view of contrasting chronostratigraphic assignments of radiolarian assemblages. The isotopic data in conjunction with the biostratigraphy does suggest, however, that a hiatus is represented at this contact.

2. Lithostratigraphy of the Stanley Mountain remnant

The Stanley Mountain remnant along Alamo Creek in southern California consists of a thick succession of volcanopelagic sediments resting unconformably on pillow basalts at the base; the volcanopelagic succession is in turn conformably overlain by the Great Valley Supergroup (sensu stricto). The latter contact is transitional, occurring over several meters of section. Six lithologic units and three radiolarian biostratigraphic zones sensu Pessagno *et al.* (1993) are recognized; each of these units is discussed in greater detail below (Text-figures 3 through 8). Radiometric dating of the Stanley Mountain remnant has yielded an age of 166.0 ±1 m.y. (U/Pb; Pessagno *et al.*, in prep.).

The Stanley Mountain remnant along Alamo Creek is separated structurally by faulting into three sections (Fig. 3). Weathered extrusive rocks are present only at the base of Section 1; the remainder of the succession along Alamo Creek is composed of the volcanopelagic succession and overlying Great Valley Supergroup (Text-figures 3, 4). Extrusives in the Stanley Mountain remnant consist largely of pillow basalts, although Robertson (1989, p. 198, 210) also mentions a predominance of "stratified lava breccia interlayered with lava flows." According to Robertson, the lava breccia probably formed by the collapse and cascading of pillow lava down submarine slopes. Small amounts of red chert, lacking Radiolaria, have been documented within the breccia at Stanley Mountain. Extrusives at the base of the Alamo Creek succession consist of at least 50 m of severely weathered pillow basalts (Robertson, 1989).

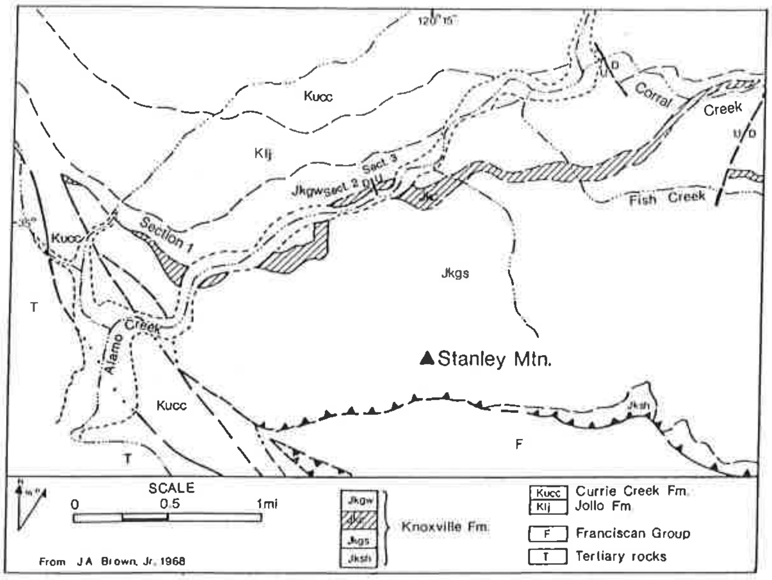


Figure 2. Geologic map of the Stanley Mountain area, showing the three sections measured and sampled in this study. These sections were originally mapped as part of the Knoxville Formation (J.A. Brown, Jr., 1968, M.S. thesis, University of California at Santa Barbara), but have since been reinterpreted as the deep-sea chert, or "volcanopelagic" succession which overlies pillow basalts at the top of the Coast Range ophiolite. Diagonal-line pattern indicates the approximate outcrop pattern of the volcanopelagic succession (designated lithologic Units 1 and 2 herein) along Alamo Creek.

The sedimentary sequence overlying the pillow basalts has been divided informally in this study into six lithologic packages designated as Units 1 through 6, from stratigraphically lowest to highest (Figures 3, 4). This includes 130m. of volcanopelagic strata, approximately 15m. of transitional strata, and an additional 115m. or more of the Great Valley Supergroup. The lithologic characteristics of each of these units is described in the following paragraphs.

Unit 1 is characterized by 62m. of interbedded black, green, and red chert, with rare beds of tuff breccia and thin beds of limestone. This unit is recognized in Sections 1 and 3, where it unconformably overlies pillow basalts at the base of the section. Beds of tuff breccia in this unit have been described as "redeposited (via turbidity currents) tuffaceous volcaniclastic sandstones" (Robertson, 1989, p. 209).

Unit 2 is composed predominantly of red cherts and red siliceous mudstones which attain thicknesses of more than 68 m. Radiolarian-bearing manganiferous limestones lenses and beds are present throughout the unit at irregular intervals. Parallel laminations attributed to bottom currents have been observed in the cherts and mudstones. Small-scale burrows are also present in the siliceous red mudstones. Whole-rock X-ray diffraction of these mudstones shows a predominance of quartz, followed by feldspar, kaolinite, calcite, phrenite and smectite (Robertson, 1989, p. 207).

Unit 2 is conformable with both Unit 1 below and Unit 3 above. These rocks attain a thickness of 41m. in the first section, where the uppermost beds are in fault contact with the Great Valley Supergroup. The lower boundary of Unit 2 is also fault-bounded in sections 2 and 3, where Unit 2 attains thicknesses of 48 and 70m. respectively. Because Unit 2 is fault-bound either at its top or bottom in all three sections studied along Alamo Creek, the true thickness of this unit is unknown.

Unit 3 consists of 6m. of interbedded black chert and graywacke. Its base is identified as the first occurrence of graywacke in the section. Unit 3 is considered herein to be a "transitional" unit, signaling the onset of flysch deposition of the Great Valley Supergroup. Unit 3 is present in sections 2 and 3, and is conformable with overlying Unit 4.

Unit 4 differs from Unit 3 by possessing alternating beds of graywacke and shale, as opposed to alternating graywacke and chert. The shale is dark brown-black to black, relatively soft, and fissile in nature. It is 9m. thick in both sections 2 and 3.

Unit 5 possesses a lithologic character typical of the Great Valley Supergroup: regularly alternating black shale and mudstone with thin beds of graywacke and limestone. Along Alamo Creek, this unit is recognized in sections 2 and 3, although its upper boundary is faulted along the creek bed in both sections. The unit can, however, be traced in the hills above Alamo Creek for approximately 100 m. Unit 5 is conformable with Unit 4 below it. Its contact with Unit 6 appears to be conformable.

Unit 6 is a massive graywacke over 15 m in thickness overlying Unit 5 which was discovered in the hills above Alamo Creek. This graywacke unit has not been observed along Alamo Creek. The lower contact of Unit 6 appears to be transitional; its upper contact is unknown.

The Stanley Mountain remnant of the Coast Range ophiolite also crops out in Fish Creek canyon and along Corral Creek (Fig. 2). The precise structural relationship of those rocks to the sections along Alamo Creek is not known. Robertson (1989, p. 209) described the section in Fish Creek as consisting of "medium to thick beds of volcaniclastic turbiditic sandstone...within 10 m of the ophiolitic basement" suggesting that this section, at least, can be correlated on the basis of lithology to Unit 1 along Alamo Creek. The first author's observations of the Corral Creek section revealed a succession of red cherts and mudstones lithologically similar to Unit 2. No biostratigraphic data is available at this point to confirm lithostratigraphic correlations.

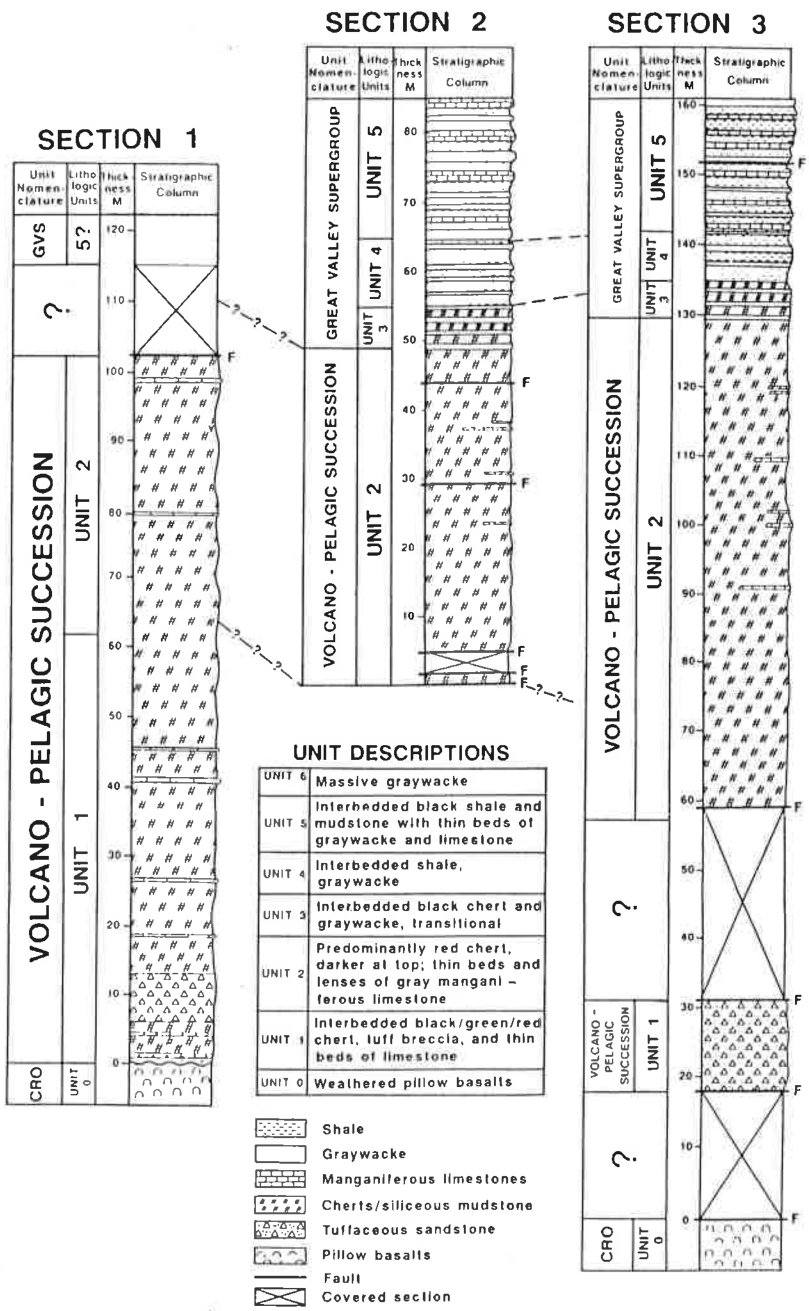


Figure 3. Lithologic correlation of units in three sections sampled and measured at Stanley Mountain, California. All three sections outcrop along the northern side of Alamo Creek except for the basal 30 meters of Section 3.

3. Previous dating

Studies of the Stanley Mountain remnant of the Coast Range ophiolite were initiated over 15 years by E. A. Pessagno, Jr., A.H.F. Robertson, C. Hopson, and numerous other geologists working in the California Coast Ranges of western North America. Initial ages of the radiolarian faunas were presented by Pessagno (1977). The interest in this area is due to several factors. First, the sedimentary succession overlying the Coast Range ophiolite at this locality is one of the most complete in the Coast Ranges, where most stratigraphic sections are highly dismembered due to faulting and folding along the tectonically active margin of western North America. Thus it serves as an excellent locality for collecting information on the ancient ocean basin in which these sediments were deposited. Second, the preservation of Radiolaria in the succession is moderate to good, providing geologists with age control on the events in this area. Third, within the deep-sea chert and siliceous mudstone succession there are limestone beds and lenses with beautifully preserved, nearly pristine Radiolaria, which lend themselves well to taxonomic studies. Fourth and finally, such well-preserved radiolarian assemblages may be useful in both paleogeographic and paleoceanographic studies (Pessagno & Blome, 1986; Hull, 1991; Hull, 1995; Hull & Pessagno, 1994).

4 Biostratigraphy

Thus far, Radiolaria preserved in cherts, siliceous mudstones and manganiferous limestones provide the only means for biostratigraphically dating the Stanley Mountain remnant of the Coast Range ophiolite. No megafossils occur within the volcanopelagic succession. A single ammonite has been found within Unit 6 of the Great Valley Supergroup which has been identified as a Tithonian species of *Micranthoceras* (Zeiss, person. commun.). Within the same unit, we have collected specimens of the Tithonian mollusk *Buchia piochii* (GABB).

The most abundant and diversified radiolarian assemblages in the volcanopelagic succession have been extracted from manganiferous limestone beds and lenses, which occur at irregular intervals throughout lithologic Units 1 and 2. Although calcified in some limestone lenses, siliceous Radiolaria discovered in other lenses exhibit nearly pristine preservation. Cherts and mudstones often possess numerous Radiolaria, but diversity is significantly lower and preservation is moderate at best. Radiolaria are more rare in the stratigraphically higher transitional and Great Valley Supergroup units.

In this study, data was compiled from over 100 radiolarian-bearing chert, mudstone, and limestone samples (Hull, 1991). Over 400 species of Radiolaria (many new) have been recognized in the Stanley Mountain remnant. Contrary to much of this volume, in this chapter these faunas have been assigned to the radiolarian biostratigraphic zones of Pessagno *et al.* (1993; Fig. 5). Inasmuch as the latter zonation was developed in western North America and includes many Boreal species, the Stanley Mountain assemblages are more easily correlated to Pessagno *et al.*'s zones. Further, the chronostratigraphic ties of radiolarian zones used herein also are based on North American data. Some discrepancies do exist between the radiolarian age assignments of Pessagno *et al.* 1993 and the chronostratigraphic calibrations of the unitary associations of this volume (see Fig. 9 and text below). Most of these differences at Stanley Mountain are on the order of one-half stage, and are likely due to the development of increasing endemism above the base of the succession which makes comparisons of the two zonations difficult. A more complete discussion of the age discrepancies from the North American perspective can be found in Pessagno *et al.* (1993), although readers should also refer to this volume (Murchey & Baumgartner; Baumgartner *et al.* (*Chapter* 32, this volume) for the latest information on the development

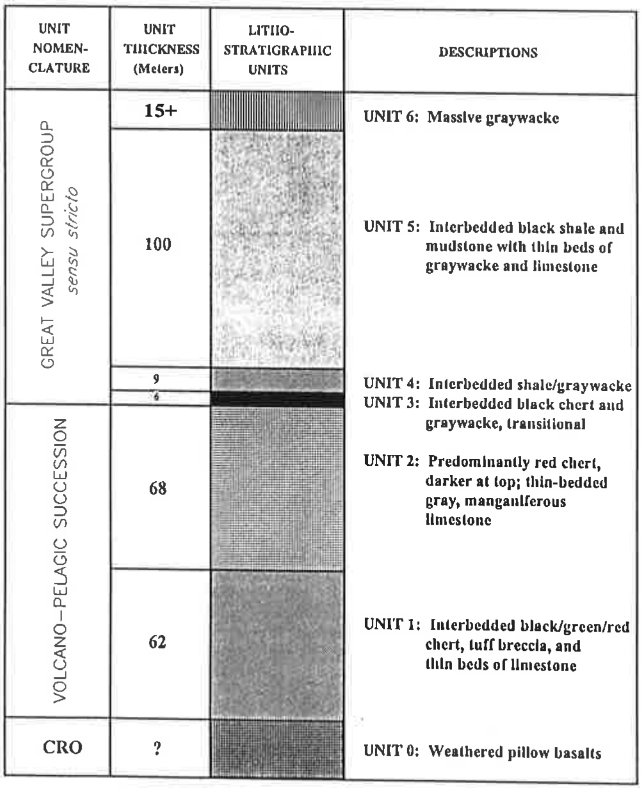


Figure 4. Composite stratigraphic column of the Stanley Mountain succession. The sedimentary cover overlying the ophiolite has been divided informally into six lithologic units, described above, and in text.
The lower two units are included in the "volcanopelagic" succession; Unit 3 is considered transitional into Units 4 through 6, which are assigned herein to the Great Valley Supergroup.

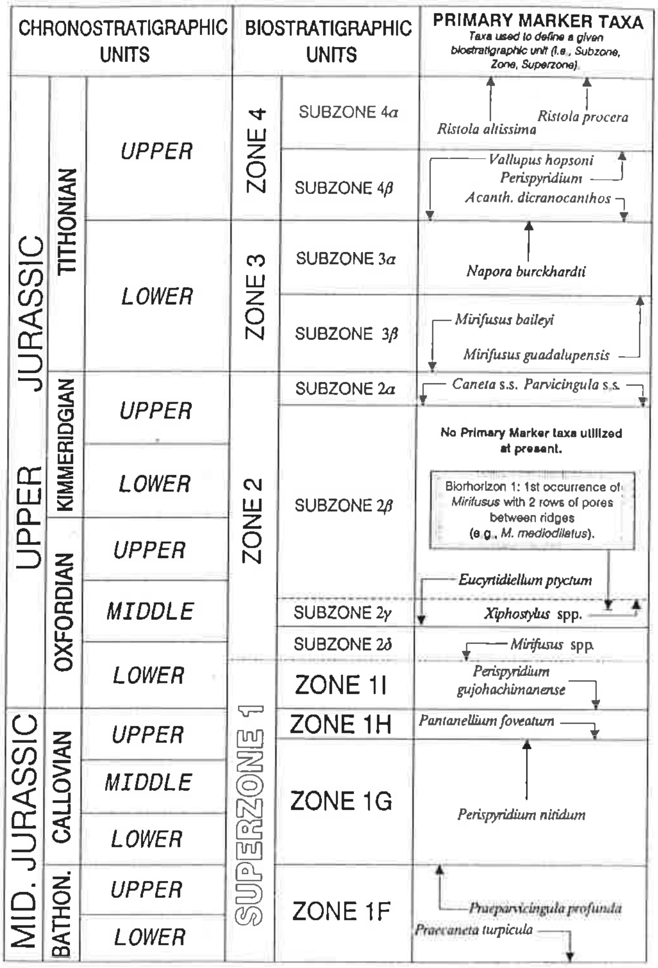


Figure 5. Radiolarian biostratigraphic zonation scheme proposed for western North America from Pessagno *et al.* (1993).

and calibrations of radiolarian unitary associations.

The radiolarian biostratigraphic zones of Pessagno *et al.* which have been discovered at Stanley Mountain include: (1) Zone 2, Subzones 2 gamma and 2 beta (middle Oxfordian to lower upper Kimmeridgian); (2) Zone 3, Subzone 3 alpha (upper lower Tithonian); and (3) Zone 4, Subzones 4 beta and 4 alpha (upper Tithonian). Significant absences, representing a 2- to 3-m.y. hiatus, include Zone 2, Subzone 2 alpha and Zone 3, Subzone 3 beta (uppermost Kimmeridgian to lower lower Tithonian). This data is presented for each section along Alamo Creek in the following paragraphs.

Section 1 (Fig. 6). The first occurrence of identifiable Radiolaria along Alamo Creek is 2.7 m (SA-34) above the contact between the volcanopelagic succession with pillow basalts of the Coast Range ophiolite. Radiolaria extracted from chert at this horizon include *Eucyrtidiellum ptyctum*, and were initially assigned to Zone 2, Subzone 2 beta (lower to lower upper Kimmeridgian). The more recent discovery of *Xiphostylus* HAECKEL in an extremely radiolarian-rich limestone 27 m above the base of the succession (SM-105) indicates an older age, and lowers the assignment of the lower 27 m of the section to Zone 2, Subzone 2 gamma, biohorizon 1 (middle Oxfordian; see Fig.5). Zone 2, Subzone 2 beta Radiolaria, including *E. ptyctum* RIEDEL & SANFILIPPO and *Mirifusus guadalupensis* PESSAGNO, do occur in strata between 27 m and 62 m; Zone 3, Subzone 3 alpha Radiolaria occur from 62 to 75.3 m. The latter assemblage includes *Mirifusus baileyi* PESSAGNO, *Parvicingula blowi* PESSAGNO, other *Parvicingula* spp. and *Praeparvicingula* spp. No samples have been collected between 75.3 and 79.6 m, but a limestone collected at 80 m contains *Acanthocircus dicranacanthos* (SQUINABOL) and *Parvicingula jonesi* PESSAGNO. Both of these Radiolaria indicate that the horizon at 79.6 m is assignable to Zone 4, Subzone 4 beta. Radiolaria typical of Zone 4, Subzone 4 beta (including *Perispyridium* DUMITRICA) continue to the top of Section 1.

The chronostratigraphic assignment of the lowermost portion of Section 1 is lower Callovian to middle Oxfordian using the current unitary association calibrations (Fig. 9) of Baumgartner *et al. (Chapter* 32, this volume). The potential age range of the sample is thus longer, partly due to the unitary association methodology and partly because of the recognition and calibration of Pessagno *et al.*'s "Biohorizon 1." This horizon - defined as the first occurrence of *Mirifusus* with two rows of pores between circumferential ridges - is recognized around the Pacific region (Coast Ranges and Klamath Mountains of California) and Japan (Mino Complex) and is age-calibrated to sections in western North America. Thus it serves as a good time marker in that region, and we continue to interpret the lowermost part of the Stanley Mountain succession as middle Oxfordian, in agreement with the uppermost part of the range suggested by unitary associations.

Above the basal portion of the Stanley Mountain

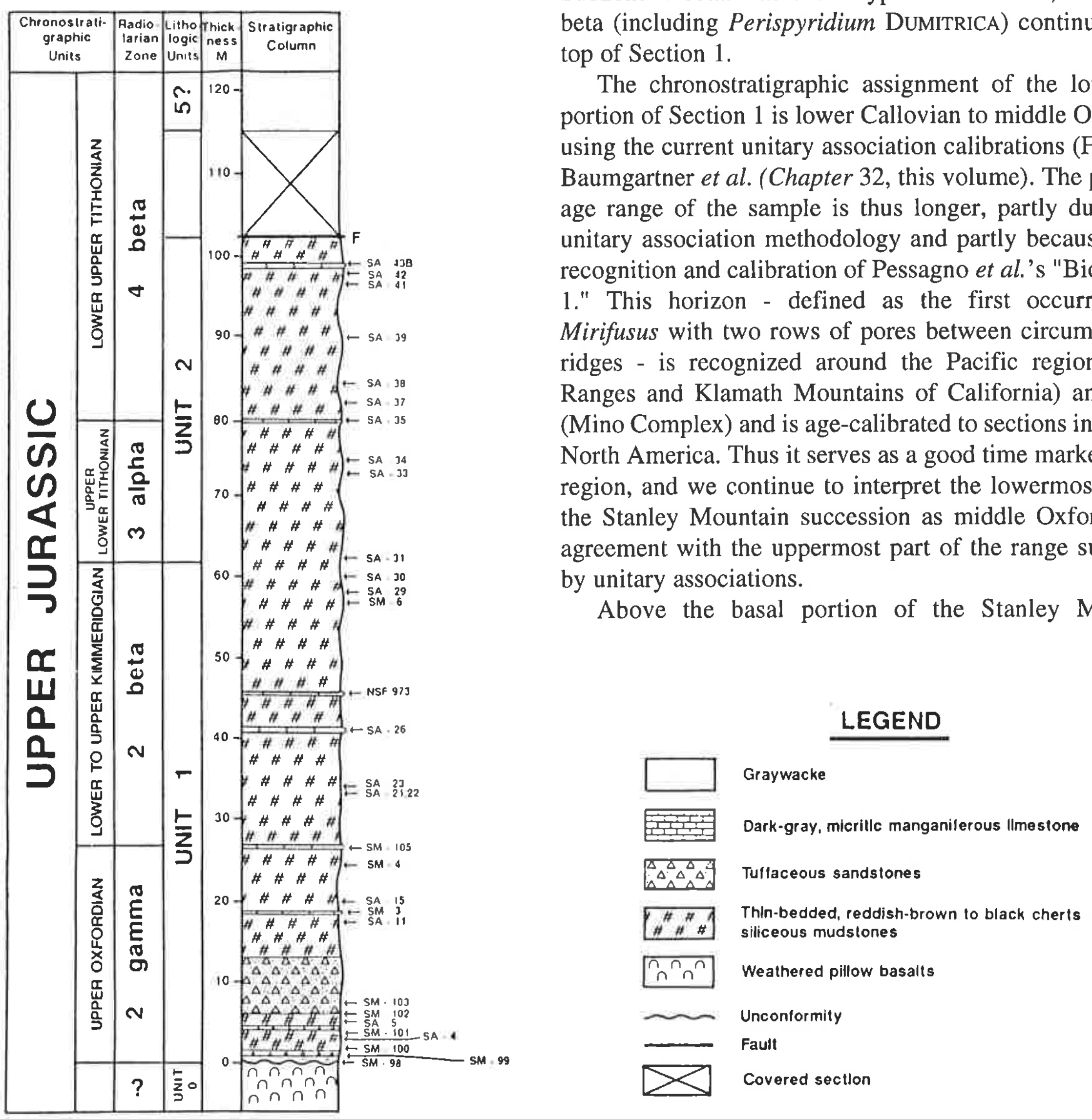


Figure 6. Stratigraphic column of Section 1 along Alamo Creek, Stanley Mountain remnant of the Coast Range ophiolite. Location of section is shown on Fig. 2; lithologic units are described in text and on Fig. 4. Thickness shown in meters. Radiolarian zonal units are those proposed by Pessagno *et al.* (1987 1993). Zonal units are illustrated on Fig. 5.

succession, accurate correlation with the radiolarian unitary associations becomes difficult due to the rare occurrences of species which are utilized by the database of Baumgartner *et al. (Chapter* 32, this volume). This is attributable to increasing Boreal influences in the upper part of the volcanopelagic succession. An exception to this trend is a 3- to 5-meter interval collected within Section 2 which contains a greater number of similar species; the characteristics of that assemblage and its zonal assignment are discussed below.

Section 2 (Fig.7). The base of Section 2 (lithologic Unit 2) is bound by a fault. The first samples containing useful Radiolaria were collected 6.7m. above the base of this section. Cherts collected from this horizon to 15m. above the base possess Radiolaria assignable to Zone 3, Subzone 3 alpha. Between 15 and approximately 38m., cherts, mudstones, and limestones contain moderate- to well-preserved Radiolaria assigned herein to Zone 4, Subzone 4 beta. Limestones collected just below 40 m (SM-50 and SM-51; Fig. 7) possess a well-preserved, very diverse and abundant assemblage which lacks *Perispyridium* Dumitrica. The final occurrence of *Perispyridium* Dumitrica marks the top of Zone 4, Subzone 4 beta, and thus radiolarian assemblages in strata above 40 m which lack *Perispyridium* are assigned to Zone 4, Subzone 4 alpha. While the absence of fauna is usually not a suitable criterion for recognition of a zone, the abrupt and distinctive disappearance of *Perispyridium* from these well-preserved assemblages is considered significant. The contact between Subzones 4 alpha and 4 beta is 11.4 m below the contact between lithologic Units 2 and 3. The Jurassic-Cretaceous boundary has not been documented in this section.

Approximately 23 m above the base of Section 2, there is a 3- to 5-m interval of siliceous mudstone and limestone which contains several species utilized in the unitary associations database of Baumgartner *et al. (Chapter* 32, this volume). This is in distinct contrast to samples above and below this interval, which are dominated by Boreal faunas. These transitions are believed to be the result of changes in the paleoceanographic regime during deposition of this part of the succession (Hull, 1995). Analysis of the fauna by the computer program BioGraph (Savary & Guex, 1990, 1991) based on the unitary association method of Guex (1977, 1991) indicates that the chronostratigraphic assignment of this interval is lower Tithonian. Pessagno *et al.*, based on data in western North America, assign this interval to Zone 4, Subzone 4 beta, or the lower upper Tithonian, a difference of approximately one-half stage (see Fig. 9).

Section 3 (Fig. 8). The base of Section 3 is characterized by pillow basalts in fault contact with a 18.3m.-thick covered section. Overlying the covered area is approximately 13 m of greenish tuff breccia. Continuing up-section, the breccia is in fault contact with an additional 25m. or more of covered section overlain by cherts and mudstones of Unit 2. The first sample with useful Radiolaria was collected 18.3 m above the base of the volcanopelagic succession (Unit 1) in Section 3. Poorly-preserved Radiolaria in this sample and others up to 20m. above the base of the section tentatively are assigned to Zone 2, Subzone 2 beta. Including the covered section, the contact between Subzone 2 beta and Zone 3, Subzone 3 alpha is at least 81m. above the base of Section 3. Samples collected at 81m. and 90m. above the base of the section contain

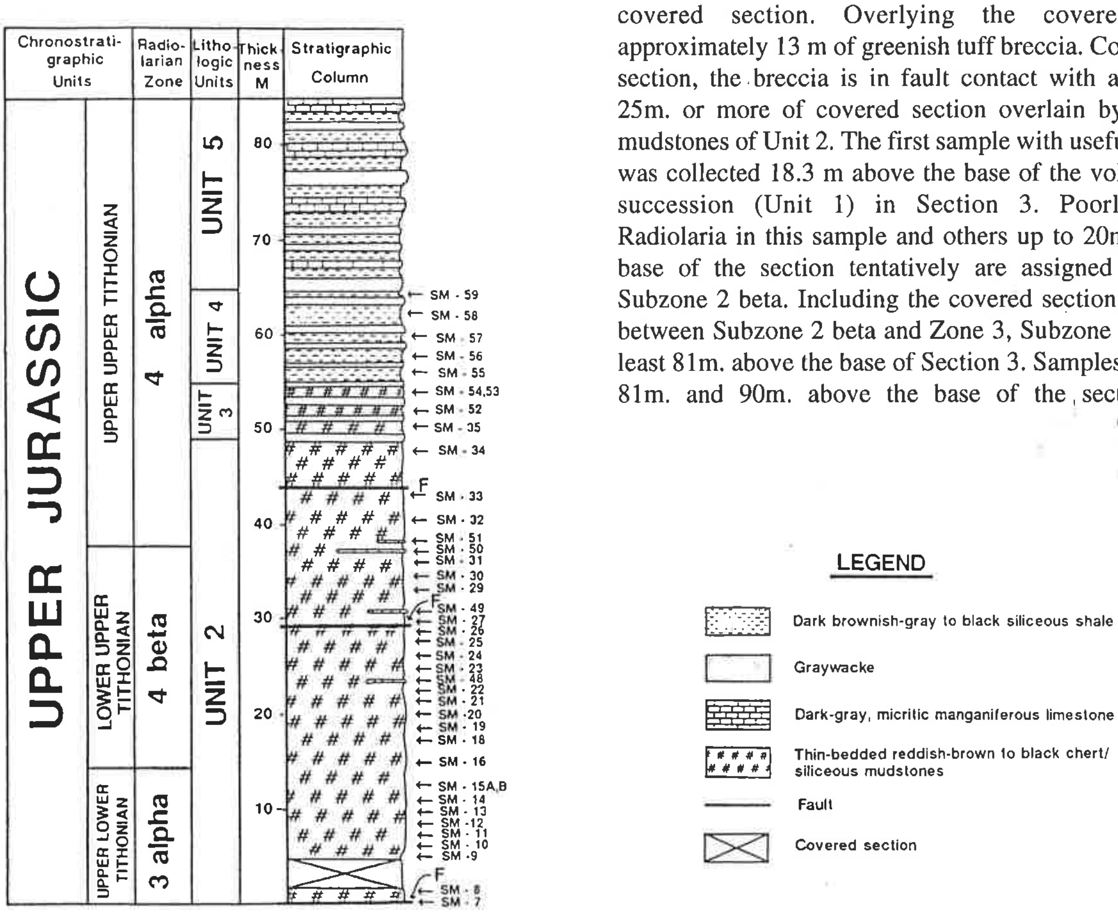


Figure 7. Stratigraphic column of Section 2 along Alamo Creek, southern California Coast Ranges. Lithologic units are described in text and on Fig. 4. Thickness shown in meters. Radiolarian zonal units are those of Pessagno *et al.* (1987, 1993). Zonal units are shown on Fig. 5.

Radiolaria assignable to Zone 3, Subzone 3 alpha. Numerous chert, mudstone, and limestone samples collected above this horizon, from 91m. to 115m. above the base, possess Zone 4, Subzone 4 beta Radiolaria. No samples were collected between 115m. and 119.5m.; a limestone sample with well-preserved Radiolaria at 119.5m. lacks *Perispyridium* Dumitrica, indicating that this sample is at or just above the boundary between Zone 4, Subzone 4 beta and Subzone 4 alpha. The latter boundary is 10.8m. below the contact between lithologic Units 2 and 3, compared to 11.4m. below the contact in Section 2.

Samples collected above lithologic Unit 3 at Stanley Mountain produced relatively poor results, with the exception of a sample collected in Section 2 approximately 56m. above the base, or 5m. above the contact between lithologic Units 2 and 3 (Fig. 7). This sample (SM-53) possesses Radiolaria assignable to Zone 4, Subzone 4 alpha. As noted previously, a single ammonite collected from Unit 6 at Stanley Mountain has been identified as a Tithonian species (Zeiss, pers. commun.). Efforts to find the Jurassic-Cretaceous boundary at the Stanley Mountain remnant of the Coast Range ophiolite have not been successful on the basis of radiolarian biostratigraphy thus far.

5. Radiolarian methodology

Radiolarians were extracted from siliceous mudstones and cherts by etching the rocks in a solution of Hydrofluoric acid and water (1:9) over a 24-hour period. Limestones with silicified radiolarians were slowly broken down in Hydrochloric acid to free the skeletons from the matrix.

The construction of a composite stratigraphic column for the Stanley Mountain remnant has been accomplished on the basis of very general lithologic correlations made in the field (Fig. 3). Fig. 4 illustrates the resulting composite column produced by these correlations. As noted above, however, lithologic Unit 2 is bounded by a fault at either its top or bottom in all three sections along Alamo Creek. Thus, the true thickness of Unit 2 is unknown, and the precise original measured intervals between samples are impossible to determine. Their stratigraphic positions and measurements relative to one another can be determined by field data. Samples containing biostratigraphically useful radiolarians for the unitary association analyses are listed below. Although listed by section, the approximate position above the base of the composite stratigraphic column (in m) is presented in parentheses adjacent to the sample number.

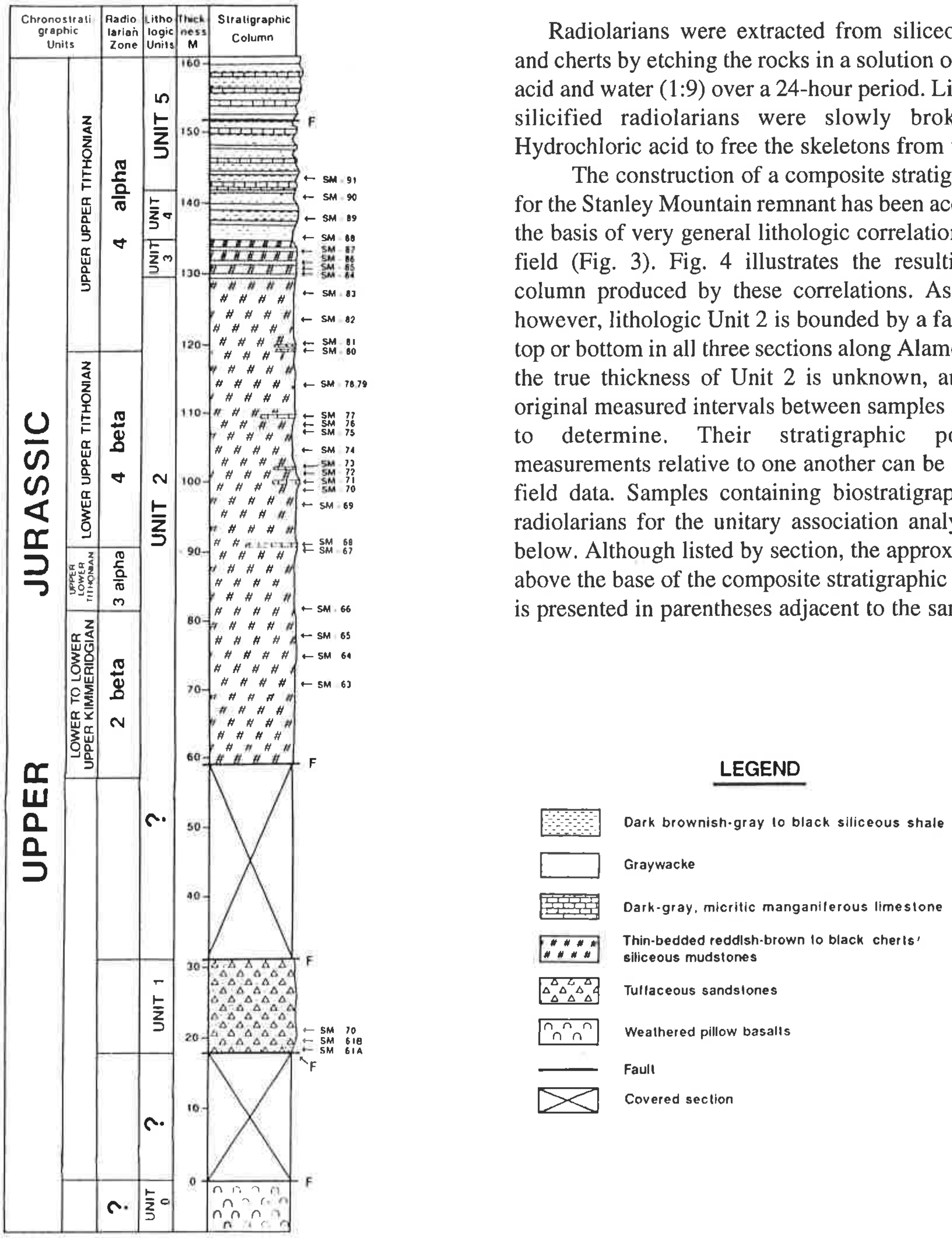


Figure 8. Stratigraphic column of Section 3 along Alamo Creek, Stanley Mountain remnant of the Coast Range ophiolite. Location of section is shown on Fig. 2; lithologic units are described in text and on Fig. 4. Thickness shown in meters. Radiolarian zonal units are those proposed by Pessagno *et al.* (1987, 1993). Zonal units are illustrated on Fig. 5.

Section 1

Sample SM-105 (27.1 m):
- *Acanthocircus suboblongus suboblongus* (YAO)
- *Bernoullius cristatus* BAUMGARTNER
- *B. dicera* (BAUMGARTNER)
- *Emiluvia chica* s.l. FOREMAN
- *E. hopsoni* PESSAGNO
- *E. premyogii* BAUMGARTNER
- *Eucyrtidiellum unumaense pustulatum* BAUMGARTNER
- *Gorgansium* spp.
- *Higumastra imbricata* (OZVOLDOVA)
- *Leugeo hexacubicus* (BAUMGARTNER)
- *Mirifisus dianae dianae* (KARRER)
- *M. fragilis* s.l. BAUMGARTNER
- *M. guadalupensis* PESSAGNO
- *Orbiculiforma* (?) *heliotropica* BAUMGARTNER
- *P. podbielensis* (OZVOLDOVA)
- *Palinandromeda depressa* (DE WEVER & MICONNET)
- *Paronaella kotura* BAUMGARTNER
- *Parvicingula dhimenaensis* ssp. A
- *Perispyridium ordinarium* gr. (PESSAGNO)
- *Podobursa helvetica* (RÜST)
- *Ristola altissima major* BAUMGARTNER & DE WEVER
- *R: procera* (PESSAGNO)
- *Sethocapsa dorysphaeroides* NEVIANI sensu SCHAAF
- *Spongocapsula palmerae* PESSAGNO
- *Stichocapsa decora* RÜST
- *Stylocapsa* (?) *spiralis* gr. MATSUOKA
- *Tetraditryma corralitosensis corralitosensis* (PESSAGNO)
- *T. pseudoplena* BAUMGARTNER
- *Tetratrabs zealis* (OZVOLDOVA)
- *Transhsuum brevicostatum* gr. (OZVOLDOVA)
- *Triactoma cornuta* BAUMGARTNER
- *Tricolocapsa plicarum* ssp. A
- *Unuma echinatus* ICHIKAWA & YAO.

Sample NSF 973 (45.6 m):
- *Crucella theokaftensis* BAUMGARTNER
- *Eucyrtidiellum ptyctum* (RIEDEL & SANFILIPPO)
- *Mirifisus dianae dianae*
- *Mirifusus fragilis* s.l.
- *Palinandromeda podbielensis* (OZVOLDOVA)
- *Pseudoeucyrtis* sp. J
- *Sethocapsa dorysphaeroides*
- *Tricolocapsa plicarum* ssp. A

Sample SA-35 (80 m):
- *Acanthocircus carinatus* FOREMAN
- *Acanthocircus trizonalis dicranacanthos* (SQUINABOL)
- *Gorgansium* spp.
- *Hsuum* sp. aff. *H. cuestaense* PESSAGNO
- *Napora pyramidalis* BAUMGARTNER
- *Podocapsa amphitreptera* FOREMAN

Sample SA-43B (99.1 m):
- *Angulobracchia purisimaensis* (PESSAGNO)
- *Emiluvia orea orea* BAUMGARTNER
- *Napora pyramidalis* BAUMGARTNER
- *Podocapsa amphitreptera* FOREMAN
- *Tritrabs casmaliaensis* (PESSAGNO)

Section 2

Sample SM-11 (75 m):
- *Mirifusus dianae baileyi* PESSAGNO

Sample SM-48 (90.5 m):
- *Acaeniotyle umbilicata* (RÜST)
- *Acanthocircus trizonalis trizonalis* (RÜST)
- *Gorgansium* spp.
- *Hexastylus* (?) *tetradactylus* CONTI & MARCUCCI
- *Homoeoparonaella* (?) *giganthea* BAUMGARTNER
- *Homoeoparonaella elegans* (PESSAGNO)
- *Mirifisus dianae dianae* (KARRER)
- *Mirifusus dianae baileyi* PESSAGNO
- *Napora pyramidalis* BAUMGARTNER
- *Pantanellium riedeli* PESSAGNO
- *Paronaella bandyi* PESSAGNO
- *Paronaella mulleri* PESSAGNO
- *Podobursa spinosa* (OZVOLDOVA)
- *Sethocapsa* (?) *zweilii* JUD
- *Spongocapsula palmerae* PESSAGNO
- *Transhsuum maxwelli* gr. (PESSAGNO)
- *Triactoma blakei* (PESSAGNO)
- *Tritrabs casmaliaensis* (PESSAGNO)
- *Tritrabs ewingi* s.l. (PESSAGNO)
- *Tritrabs exotica* (PESSAGNO)
- *Tritrabs rhododactylus* BAUMGARTNER

Sample 49 (99 m):
- *Acanthocircus carinatus* FOREMAN
- *Emiluvia hopsoni* PESSAGNO
- *Triactoma luciae* JUD
- *Tritrabs exotica* (PESSAGNO)

Sample SM-29 (100 m):
- *Mirifusus dianae baileyi* PESSAGNO
- *Triactoma luciae* JUD

Sample SM-50 (104 m):
- *Acanthocircus trizonalis trizonalis* (RÜST)
- *Angulobracchia purisimaensis* (PESSAGNO)
- *Deviatus diamphidius hipposidericus* (FOREMAN)
- *Emiluvia hopsoni* PESSAGNO
- *Sethocapsa* (?) *zweilii* JUD
- *Tritrabs exotica* (PESSAGNO)

Sample SM-51 (106 m):
- *Triactoma luciae* JUD

Section 3

Sample SM-67 (80 m):
- *Acanthocircus trizonalis dicranacanthos* (SQUINABOL)

Sample SM-68 (81 m):
- *Hexastylus* (?) *tetradactylus* CONTI & MARCUCCI
- *Mirifusus dianae baileyi* PESSAGNO

Sample SM-69 (85.5 m):
- *Mirifusus dianae baileyi* PESSAGNO
- *Tetraditryma corralitosensis corralitosensis* (PESSAGNO)

Sample SM-75 (96.5 m):
- *Acanthocircus carinatus* FOREMAN
- *Mirifusus dianae baileyi* PESSAGNO
- *Triactoma luciae* JUD

6. Synthesis of radiolarian ages

From the composite column of the Stanley Mountain succession an overview of the biostratigraphy (sensu Pessagno *et al.*, 1993) is as follows. The lower 27m. of the volcanopelagic succession overlying pillow basalts along Alamo Creek contain radiolarians assignable to Zone 2, Subzone 2 gamma (middle Oxfordian). Zone 2, Subzone 2 beta Radiolaria occur in strata between 27.0m. and 62.0m. above the contact between the pillow basalts and volcanopelagic strata. These assemblages contain marker species *Eucyrtidiellum ptyctum* and *Mirifusus guadalupensis*. *Parvicingula* sensu strictu are absent from these assemblages. Immediately overlying these faunas are Zone 3, Subzone 3 alpha (upper lower Tithonian) radiolarian assemblages (from 62.0 to 75.3m.) containing *Mirifusus baileyi*, *Parvicingula* sensu strictu, and *Parvicingula blowi*. The absence of Zone 2, Subzone 2 alpha and Zone 3, Subzone 3 beta (upper Kimmeridgian to lower lower Tithonian) faunas suggests the presence of a hiatus or bedding-plane fault within the succession. Zone 4, Subzone 4 beta (lower upper Tithonian) radiolarian assemblages occur 80m. above the base of the succession; Subzone 4 alpha (uppermost Tithonian) faunas occur approximately 24m. above the base of Subzone 4 beta. Radiolaria do occur within the overlying Great Valley Supergroup, but are poorly-preserved, and have not been extracted successfully as yet.

Relatively few of the species utilized in the radiolarian unitary association database by Baumgartner *et al.* (*Chapter* 32, this volume) are present in the Stanley Mountain succession. Nevertheless, general stage determinations are possible. The chronostratigraphic assignments proposed by this method are comparable to those proposed by Pessagno *et al.* (1993), but differ by up to one-half stage (see Fig. 9). According to the age calibrations of Baumgartner *et al.* (*Chapter* 32, this volume), sample SM-105, 27.1m. above the base of the Stanley Mountain section is dated as late Bathonian-early Callovian. Sample NSF973, 45.6 m. above this base is dated as late Bathonian to middle-late Oxfordian, a range that overlaps with the age of Subzone 2beta. Sample located 80 to 104 m. above the base are dated as late Oxfordian-early Kimmeridgina to early Tithonian. The uppermost sample at 105m. is poorly constrained as late Oxfordian to late Valanginian. The differences between these calibrations and those of Pessagno *et al.* (1993) are probably due to several factors, including a greater number of Boreal species in the Stanley Mountain succession, different methodologies, and the calibration of radiolarian assemblages to different successions.

7. Conclusions

The Stanley Mountain remnant of the Coast Range ophiolite contains one of the most complete sedimentary successions overlying the ophiolite in the Coast Ranges of California. This succession includes approximately 130 m of deep-sea cherts and siliceous mudstones (the "volcanopelagic succession") which are transitionally overlain by more than 130m. of the Great Valley Supergroup;

The age of the volcanopelagic succession, utilizing the Pessagno *et al.* (1993) zonation scheme for western North America, ranges from middle Oxfordian near the base of the succession to uppermost Tithonian at the base of the Great Valley Supergroup; and

Utilizing the radiolarian unitary associations method of Baumgartner *et al.* (*Chapter* 32, this volume), the age of the base of the volcanopelagic succession is late Bathonian-early Callovian; the upper part of the succession is mostly lower Tithonian, becoming lower Tithonian or younger at the top.

Section	Sample	UAZ.95	Chronostratigraphic Correlation of Baumgartner *et al.* (*Chapter* 32)	Chronostratigraphic Correlation of Pessagno *et al.* 1993	N.A. Rad. Zone
15	SM-51	10-17	Late Oxfordian to Late Valanginian	uppermost Tithonian	4
14	SM-50	10-11	Late Oxfordian - early Kimmeridgian to early Tithonian		alpha
13	SM-29			lower upper Tithonian	4 beta
12	SA-43B				
11	SM-49				
10	SM-75				
9	SM-48				
8	SM-69				
7	SM-68				
6	SM-67			upper lower Tithonian	3 alpha
5	SA-35				
4	SM-11	9-11	Mid late Oxfordian to late Kimmeridgian-early Tithonian		
3	SA-34				
2	NSF 973	7-9	Late Bathonian to mid-late Oxfordian	middle Oxfordian early Kimmeridgian	2 beta
1	SM-105	7-7	late Bathonian-early Callovian	middle Oxfordian	2 gamma

Figure 9. Comparison of chronostratigraphic assignments of the Stanley Mountain succession using the Pessagno *et al.* (1993) biostratigraphic zonation and the UAZones of Baumgartner *et al.* (*Chapter* 32, this volume).

References

BAILEY, E.H. & JONES, D.L. (1970). Onland Mesozoic oceanic crust in California Coast Ranges. *United States geological Survey, Professional Paper, Report*, **700-C**, 70-81.

BLAKE, M.C. & JONES, D.L. (1981). The Franciscan assemblage and related rocks in northern California: a reinterpretation. *In* Ernst, W.G. Ed. *The Geotectonic Development of California* - Prentice-Hall, Englewood Cliffs, 307-328.

CADY, J.W. (1975). Magnetic and gravity anomalies in the Great Valley and western Sierra Nevada metamorphic belt, California. *Geological Society of America, Special Papers*, **168**, 1-56.

DICKINSON, W.R., INGERSOLL, R.V., COWAN, D.S., HELMOLD, K.P. & SUCZEK, C.A. (1982). Provenance of Franciscan graywackes in coastal California. *Geological Society of America, Bulletin*, **93**, 95-107.

DICKINSON, W.R. & RICH, E.I. (1972). Petrologic intervals and petrofacies in the Great Valley Sequence, Sacramento Valley, California. *Geological Society of America, Bulletin*, **83**, 3007-3024.

DICKINSON, W.R. & SEELY, D.R. (1979). Structure and stratigraphy of forearc regions. *Bulletin of the American Association of Petroleum Geologists*, **63**, 2-31.

EVARTS, R.C. (1977). The geology and petrology of the Del Puerto ophiolite, Diablo Range, central California Coast Ranges: North American Ophiolites. *Bulletin of the Oregon State Department of Geology and Mineral Industries*, **95**, 121-139.

GUEX, J. (1977). Une nouvelle méthode d'analyse biochronologique. *Bulletin de la Société Vaudoise des Science Naturelles*, **73**, 309-322.

GUEX, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

HOPSON, C.A., MATTINSON, J.M. & PESSAGNO, E.A. (1981). Coast Range ophiolite, western California. *In* Ernst, W.G. Ed. *The Geotectonic Development of California* - Prentice-Hall, Englewood Cliffs, 419-450.

HOPSON, C.A., MATTINSON, J.M., PESSAGNO, E.A. & BLOME, C.D. (1986). California Coast Range ophiolite: Jurassic tectonics. *EOS, american geophysical Union, Transactions*, **67**, 1232.

HULL, D.M. (1991). *Upper Jurassic radiolarian biostratigraphy of the lower member of the Taman Formation, east-central Mexico and of volcanopelagic strata overlying the Coast Range ophilite, Stanley Mountain, Southern California Coast Range*. Ph.D. Thesis. Programs in Geoscience. University of Texas at Dallas (unpublished), Dallas, 696 p.

HULL, D.M. (1995). Morphologic diversity and paleogeographic significance of the family Parvicingulidae (Radiolaria). *Micropaleontology*, **41** (1), 1-48.

HULL, D.M. & PESSAGNO, E.A. (1994). Upper Jurassic radiolarian biostratigraphy of Stanley Mountain, southern California Coast Ranges. *Geobios*, **Mém. spec. 17**, 309-315.

INGERSOLL, R.V. (1983). Petrofacies and provenance of late Mesozoic forearc basin, northern and central California. *Bulletin of the American Association of Petroleum Geologists*, **67**, 1125-1142.

MENZIES, M., BLANCHARD, D. & JACOBS, J. (1977). Rare earth and trace element geochemistry of metabasalt from the Point Sal ophiolite. *Earth and Planetary Science Letters*, **37**, 203-215.

NORRIS, R.M. & WEBB, R.W. (1976). *The Geology of California* - John Wiley & Sons, New York, 365 p.

PAGE, B.M. (1966). Geology of the Coast Ranges of California. *In* Bailey, E.H. Ed. *Geology of Northern California* - Bulletin of the State geologist, California Division of Mines and Geology, **190**, 255-276.

PAGE, B.M. (1972). Oceanic crust and mantle fragment in subduction complex near San Luis Obispo, California. *Geological Society of America, Bulletin*, **83**, 957-972.

PESSAGNO, E.A. (1977). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A., BLOME, C., CARTER, E.S., MACLEOD, N., WHALEN, P. & YEH, K.Y. (1987). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, 1-18.

PESSAGNO, E.A. & BLOME, C.D. (1986). Faunal affinities and tectonogenesis of Mesozoic rocks in the Blue Mountains of eastern Oregon and western Idaho. *In* Wallier, T.L. & Brooks, H.C. Eds. *Geologic Implications of Paleozoic and Mesozoic Paleontology and Biostratigraphy, Blue Mountains Province, Oregon, Idaho and Washington* - United States geological Survey, professional Paper, Report, U.S. Government Printing Office, Washington D.C., **1435**, 65-78.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath

Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

Pessagno, E.A., Hopson, C.A., Mattinson, J.M., Blome, C.D., Hull, D.M. & Beebe, W. (in prep). Coast Range ophiolite and its sedimentary cover (California Coast Ranges): Jurassic stratigraphy and northward tectonic transport. *Contribution No. 670, Programs in Geosciences, University of Texas at Dallas.*

Robertson, A.H.F. (1989). Palaeoceanography and tectonic setting of the Jurassic Coast Range ophiolite, central California: evidence from the extrusive rocks and the volcaniclastic sediment cover. *Marine and Petroleum Geology*, **6**, 194-220.

Savary, J. & Guex, J. (1990). BioGraph, version 2.02. *Institute of Geology and Paleontology, University of Lausanne.*

Savary, J. & Guex, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

Seiders, V.M. (1983). Correlation and provenance of Upper Mesozoic chert-rich conglomerate of California. *Geological Society of America, Bulletin*, **94**, 875-888.

Sharp, W.D. & Evarts, R.C. (1982). New constraints of the environment of formation of the Coast Range ophiolite at Del Puerto Canyon, California. *Geological Society of America, Abstracts with Programs*, **14**, 233.

Shervais, J.W. & Kimbrough, D.L. (1985). Geochemical evidence for the tectonic setting of the Coast Range ophiolite: a composite island arc-oceanic crust terrane in western California. *Geology*, **13**, 35-38.

APPENDIX

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION 1: bottom 1 - top 4
< 4 {SA-43B; 99.1 m}: 3033, 3117, 3144, 3171, 3224

< 3 {SA-35; 80 m}: 3033, 3076, 3087, 3171, 3182, 5012
< 2 {NSF 973; 45.6 m}: 3008, 3017, 3131, 3159, 3176, 3274, 4052, 5544
< 1 {SM-105; 27.1 m}: 3005, 3008, 3013, 3046, 3076, 3088, 3100, 3110, 3121, 3123, 3124, 3140, 3159, 3160, 3163, 3166, 3169, 3181, 3199, 3210, 3204, 3213, 3221, 3223, 3225, 3231, 3238, 3244, 3269, 3274, 4052, 4071, 5544

SECTION 2: bottom 1 - top 5
< 5 {SM-51; 106 m}: 5055
< 4 {SM-50; 104 m}: 3083, 3111, 3119, 3144, 3225, 5464
< 3 {SM-29; 100 m}: 3406, 5055
< 2 {SM-48; 90.5 m}: 3033, 3076, 3078, 3083, 3092, 3095, 3104, 3105, 3113, 3117, 3118, 3119, 3135, 3139, 3180, 3199, 3230, 3274, 3406, 4027, 5464
49; 99 m}: 3119, 3225, 5012, 5055
< 1 {SM-11; 75 m}: 3406

SECTION 3: bottom 1 - top 4
< 4 {SM-75; 96.5 m}: 3406, 5012, 5055
< 3 {SM-69; 85.5 m}: 3124, 3406
< 2 {SM-68; 81 m}: 3406, 4027
< 1 {SM-67; 80 m}: 3087

31. Biostratigraphy of Middle Jurassic Radiolarians in the Franciscan Complex, California: Implications for Resolution of Age Discrepancies between North American and European Zonations

by Benita L. Murchey[1] and Peter O. Baumgartner[2]

[1] U.S. Geological Survey, Paleontology Branch, MS 915, Middlefield Road 345, Menlo Park, California 94025 , USA

[2] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland

ABSTRACT

We correlated faunas from assemblage zones MH-2, MH-3, and MH-4 of Murchey (1984) in the Franciscan Complex, California with Tethyan and western North American zonations. In so doing, we tested the hypothesis of Pessagno et al. (1993), that Tethyan radiolarian faunas associated with Bajocian and Bathonian ammonites are actually younger than North American radiolarian faunas also associated with early Middle Jurassic mollusks.

The long, superposed sequences of radiolarian faunas (Early Jurassic to mid-Cretaceous) in Franciscan chert bracket the disputed time interval. We correlated Zones MH-2 to -4 with Tethyan UAZones 1 to 6 (Aalenian or older to middle Bathonian) of Baumgartner *et al.* (*Chapter* 32, this volume) and with North American Zones 1A to 1F (late Toarcian to Bathonian) of Pessagno *et al.* (1987). In addition, we correlated MH-2 and lower MH- 3 with North American Zones 4 to 7 (middle or late Toarcian to early Bajocian) of Carter *et al.* (1988). Therefore, the ammonite-based latest Early and Middle Jurassic ages assigned to radiolarian faunas in the Tethys and Pacific Northwest are fundamentally concordant. No significant miscorrelation of molluscan zones is apparent and no large-scale diachroneity of entire radiolarian or molluscan assemblages is required. By inference, if faunas assigned to Zones 1H and 1I of California ophiolite sequences have been correctly correlated with Middle Jurassic zones in the Tethys (Pessagno *et al.*, 1993; Hull & Pessagno, this volume), they also correlate, in part, with arc-basins of the Pacific Northwest of North America.

1. Introduction

We describe Middle Jurassic Assemblage Zones MH-2, MH-3, and MH-4 of Murchey (1984) from three localities in the Franciscan Complex, California: The Geysers, the Marin Headlands, and the Mount Umunhum sequences. The Geysers Section was first described by Pessagno (1977); the Marin Headlands Section at Alexander Avenue was first described by Murchey (1984). Both successions represent long, unbroken records of radiolarian deposition. A third section near Mt. Umunhum contains a critical biostratigraphic transition that is briefly described herein. We correlate the paleogeographically intermediate faunas of the Franciscan Complex with low-latitude Tethyan faunas of Europe and with mid-latitude, eastern-Pacific, arc-basin faunas of eastern Oregon and British Columbia in North America. By so doing, we demonstrate the coeval nature of strata in Europe and the Pacific Northwest that were previously dated as Middle Jurassic with mollusks but considered not to be correlative in the radiolarian zonation of Pessagno *et al.* (1987, 1993).

2. Geographical and geological framework

The Franciscan Complex of California is a late Mesozoic and Tertiary accretionary complex. Based upon age, structural style, and metamorphic history, the Franciscan Complex has been subdivided into fault-bounded belts and further subdivided into lithotectonic terranes (Blake *et al.*, 1984, 1988). The Marin Headlands terrane in the central belt is characterized by a coherent stratigraphic sequence that includes pillow basalt, Jurassic and Cretaceous radiolarian chert, and mid-Cretaceous lithic arkose. The best exposures of the Marin Headlands terrane are located in the Marin Headlands on the northern side of the Golden Gate to San Francisco Bay (Wahrhaftig, 1984; Murchey, 1984). A similar sequence crops out near The Geysers geothermal field about 100 km north of San Francisco (McLaughlin & Pessagno, 1978). A large block of chert with a stratigraphic range similar to that in the Marin Headlands occurs on Bald Mountain near Mount Umunhum and south of San Jose (Hagstrum & Murchey, 1993).

The Marin Headlands terrane has been interpreted as a fragment or fragments of off-scraped ocean crust because of its sedimentary history (Murchey, 1984; Murchey & Jones, 1984) as well as its basalt and chert geochemistry (Shervais, 1989; Yamamoto, 1987; Murray *et al.*, 1990). Based on its radiolarian faunas, the oldest chert in the Marin Headlands terrane is Pliensbachian or possibly older, and the youngest is mid-Cretaceous (Murchey, 1984). Murchey (1984) and Murchey & Jones (1984) speculated that the terrane originated on an ocean plate at low latitudes in the equatorial high-productivity zone. Recent paleomagnetic studies of chert in the Marin Headlands sequence, The Geysers sequence, and the Mt. Umunhum (Bald Mountain) sequence support the low-latitude hypothesis (Hagstrum & Murchey, 1993). The off-scraped ocean crust is presumed to have been transported northward along the continental margin between the Cenomanian and Eocene (Hagstrum & Murchey, 1993).

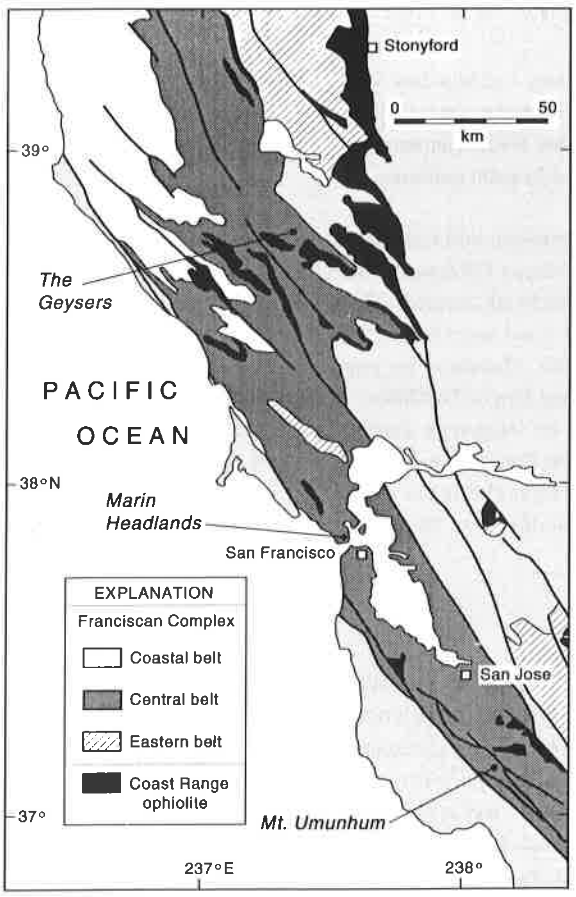


Figure 1. Localities of three stratigraphic sections in the Franciscan Complex of California: The Geysers, the Marin Headlands, and Mount Umunhum (Bald Mountain).

2.1. Access

Figure 1 shows the localities of the three stratigraphic sections discussed in this manuscript: the Marin Headlands, The Geysers, and the Mount Umunhum (Bald Mountain). Figure 2 shows the location of samples within measured sections.

The primary section in the Marin Headlands is located on the off ramp to Sausalito (Alexander Avenue exit) on the east side of U.S. Highway 101 just north of the Golden Gate Bridge (locality M-2a of Murchey, 1984: latitude 37.8^{O} N, longitude 237.5^{O} E). The stratigraphic levels of chert samples 7 to 16 (USGS MR 5100 to 5110) within the 82-m-thick chert section are shown in Figure 2. The entire chert sequence, which is underlain by basalt and overlain by black shale and graywacke sandstone, ranges in age from Pliensbachian or older to Albian or early Cenomanian. Part of the Alexander Avenue Section is covered, but another locality on the west side of Point Diablo (samples 4342a and b at locality M-19 of Murchey, 1984) contains part of the missing faunal succession (Fig. 2). Point Diablo can be reached by foot from Bonita Cove during low tides. Because both localities lie within the boundaries of the Golden Gate National Recreation Area, a permit is required for rock-collecting.

The Geysers Section is exposed in a roadcut on the road to The Geysers geothermal field (latitude 38.8^{O} N, longitude 237.2^{O} E). The section lies across the road from a scenic-view road marker that overlooks the geothermal field. The 67-m-thick chert sequence depositionally overlies pillow basalt, and is overlain by graywacke (Fig. 2). Samples 702 to 716 from the lower part of the chert sequence are the focus of this study.

We briefly describe faunas from two samples in a chert block south of San Jose. The chert, on the side of Bald Mountain, is located on a turnout along the road from New Almaden to the top of Mount Umunhum (latitude 37.2^{O} N, longitude 238.1^{O} E). The entire block (about 50-m-thick) is structurally complex but ranges in age from Pliensbachian or older to at least as young as Valanginian.

2.2. Previous dating

Radiolarians in the central belt of the Franciscan Complex range in age from Early Jurassic to Late

Cretaceous. Murchey (1984) described the biostratigraphic sequence of Early Jurassic to mid-Cretaceous radiolarians in the Marin Headlands north of San Francisco and divided the sequence into seven assemblages, MH(Marin Headlands)-1 to MH-7. These assemblages also occur elsewhere in the Franciscan Complex (Murchey & Jones, 1984). Assemblage zones MH-2, MH-3, and MH-4 of Murchey (1984) are the focus of this study. Parts of two measured sections, the Alexander Avenue Section (interval from 0 to 65 m above basal basalt, especially the 45 to 65 m interval) in the Marin Headlands (Murchey, 1984) and The Geysers Section (7 m to 50 m interval above basalt) (Pessagno, 1977; McLaughlin & Pessagno, 1978) are examined in greater detail than in previous studies. Faunas of the Mt. Umunhum (Bald Mountain) Section have not been previously described.

The oldest assemblage zone in the Franciscan Complex is MH-1. Based on correlations of the taxa in MH-1 with well-dated faunas from British Columbia and eastern Oregon, the zone ranges in age from late Pliensbachian to early or early middle Toarcian (Murchey, 1984 and herein).

Franciscan Complex assemblage MH-2 depositionally overlies MH-1 in the Mt. Umunhum area (Bald Mountain)(Fig. 2) as well as in scattered blocks in Marin County. The taxa in MH-2 in the Bald Mountain Section and in the Marin Headlands (where it is overlain by MH-3 faunas) will be discussed in the text of the manuscript. Particular emphasis will be paid, however, to the occurrence of MH-2 in The Geysers Section where the contact with overlying MH-3 is well-exposed. In both the Marin Headlands and The Geysers area, MH-3 faunas are depositionally overlain by MH-4 faunas and MH-4 faunas are separated from much younger MH-5 faunas by an undated interval of recrystallized chert (Murchey, 1984).

A Cenomanian ammonite, *Mantelliceras* sp., recovered from sandstone in the upper part of the Marin Headlands sequence constrains the age of cessation of radiolarite deposition.

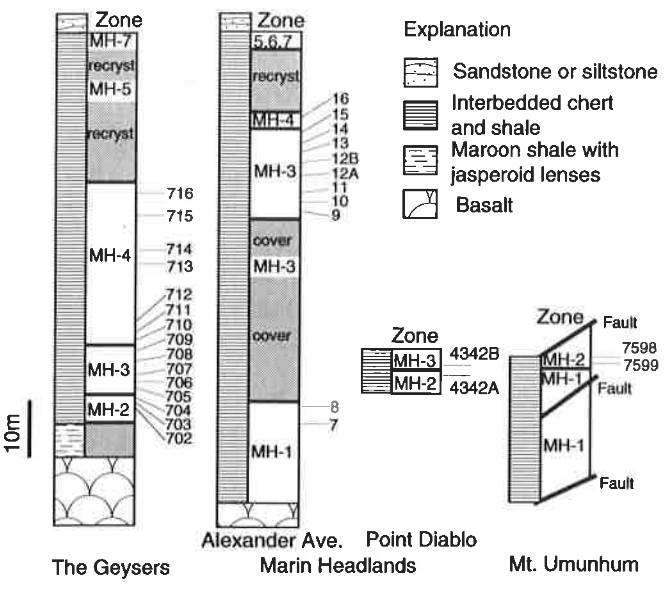


Figure 2. Stratigraphic location of samples from three measured sections in the Franciscan Complex of California: The Geysers, the Marin Headlands, and Mount Umunhum (Bald Mountain).

2.3. Biostratigraphic data

Radiolarians were extracted from the cherts by etching them with dilute Hydrofluoric acid. First and last occurrences of radiolarian taxa in the two sections are listed below by sample (f=first; l=last; p=present but not first appearance in entire section). Taxa included in this volume are listed by name with MRD-numbers. Taxa without MRD-numbers are listed only by name; these taxa generally are included because we use them for correlation with well-dated strata in western North America. Only those parts of the sections from uppermost MH-1 to MH-4 assemblage zones of Murchey (1984) are included in this reexamination of the biostratigraphy of the Franciscan Complex.

The Geysers

a. Sample 702 (Zone MH-2 of Murchey, 1984):
Hexasaturnalis hexagonus (YAO) 3502-f
Parahsuum (?) *natorensis* (EL KADIRI) 3073-f
Xiphostylus spp. 3414-f
Acaeniotylopsis variatus triacanthus KITO & DE WEVER 4066-fl
Acaeniotylopsis variatus s.l. (OZVOLDOVA) 4063-fl
Canoptum PESSAGNO 3615-f
Tetraditryma BAUMGARTNER 3638-f
Emiluvia FOREMAN, emend. FOREMAN, emend. PESSAGNO 3631-f
genus *"Lupherium"* sensu PESSAGNO & WHALEN-f
Xiphostylus vallieri PESSAGNO & YANG (in Pessagno *et al.*, 1989)-fl
Paronaella skowkonaensis CARTER (in Carter *et al.*, 1988)-fl
Paronaella grahamensis CARTER (in Carter *et al.*, 1988)-f
Canoptum (?) sp. A of PESSAGNO & WHALEN *sensu* CARTER (in Carter *et al.*, 1988)-f
Acaeniotyle(?) *ghostensis* CARTER (Carter *et al.*, 1988)-f
Napora sp. B (in Murchey (1984), form closely related to *N. turgida* PESSAGNO, WHALEN, & YEH-f).

b. Sample 703 (Zone MH-2 of Murchey, 1984):
Parahsuum (?) *natorensis* (EL KADIRI) 3073-l
Palinandromeda depressa (DE WEVER & MICONNET) 3005-f
Linaresia EL KADIRI 3811-f
Archicapsa (?) sp. aff. *A.* (?) *pachyderma*-fl
Canoptum anulatum PESSAGNO & POISSON -fl
Napora sp. B-l
Paronaella sp. aff. *P. grahamensis*-l, *Canoptum* (?) sp. A-l,
Acaeniotyle (?) *ghostensis*-l, *Hagiastrum* sp. cf *H. egregium* RÜST as in Carter *et al.* (1988)-fl
Xiphostylus logdellensis PESSAGNO & YANG (Pessagno *et al.*, 1989)-fl
Emiluvia oldmassetensis CARTER (Carter *et al.*, 1988)-fl
genus *Elodium* CARTER (Carter *et al.*, 1988)-f

c. Sample 704 (Zone MH-2 of Murchey, 1984):
Trillus spp. 3039-fl
Unuma sp. A 3309-fl

Hexasaturnalis hexagonus (YAO) 3502-l
Transhsuum hisuikyoense (ISOZAKI & MATSUDA) 3194-fl
Tritrabs simplex KITO & DE WEVER 3303-fl
Hsuum matsuokai ISOZAKI & MATSUDA 3195-f
Canoptum PESSAGNO 3615-l, *Napora* PESSAGNO 3661-f
Trillus elkhornensis PESSAGNO & BLOME -fl
genus *Elodium*-l
Praeconocaryomma sp. cf. *P. immodica* PESSAGNO & POISSON -fl
Parvicingulidae -f

Sample 705 (MH-2 of Murchey, 1984):
Emiluvia premyogii BAUMGARTNER 3210-f
Tetraditryma pseudoplena BAUMGARTNER 3123-f
Parvicingula dhimenaensis s.l. BAUMGARTNER 3197-f
Sethocapsa leiostraca FOREMAN 3062-f
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO 4014-f
Mirifusus fragilis s.l. BAUMGARTNER 3159-f
Tetraditryma corralitosensis corralitosensis (PESSAGNO) 3124-f
Acanthocircus suboblongus s.l. (YAO) 3064-f
Acanthocircus suboblongus suboblongus (YAO) 3088-f
Transhsuum brevicostatum gr. (OZVOLDOVA) 3181-f
Stichocapsa convexa YAO 3055-f
Higumastra BAUMGARTNER 3644-f
Turanta PESSAGNO & BLOME 3663-f
Perispyridium DUMITRICA 3675-f
Protunuma ICHIKAWA & YAO 3682-f
Lanubus holdsworthi PESSAGNO & YANG (Pessagno *et al.*, 1989)-f

d. Sample 706 (MH-3 of Murchey, 1984):
Pantanellium sp. L 3042-f
Emiluvia premyogii BAUMGARTNER 3210-l
Turanta morinae gr. PESSAGNO & BLOME 3247-fl
Unuma echinatus ICHIKAWA & YAO 3231-fl
Stauroloncbe robusta RÜST *sensu* PESSAGNO 3220-fl
Linaresia EL KADIRI 3811-l
Napora PESSAGNO 3661-l
Angulobracchia BAUMGARTNER 3607-f
Pantanellium vigrassi PESSAGNO & BLOME group-f (includes *P. sincerum, P. ultrasincerum, P. foveatum*)
Xiphostylus gasquetensis PESSAGNO & YANG (Pessagno *et al.*, 1989) group (includes forms with compressed tests)-f

e. Sample 707 (MH-3 of Murchey, 1984):
Tetraditryma pseudoplena BAUMGARTNER 3123-l

f. Sample 708 (MH-3 of Murchey, 1984):
Archaeodictyomitra PESSAGNO 3608-f

g. Sample 709 (MH-3 of Murchey, 1984):
Palinandromeda depressa (DE WEVER & MICONNET) 3005-l
Parvicingula dhimenaensis s.l. BAUMGARTNER 3197-l
Napora pyramidalis BAUMGARTNER 3033-fl
Podobursa helvetica (RÜST) 3169-f
Perispyridium ordinarium gr. (PESSAGNO) 3100-f
genus *"Lupherium"*-l

h. Sample 710 (MH-4 of Murchey, 1984):
Hsuum matsuokai ISOZAKI & MATSUDA 3195-l
Transhsuum maxwelli gr. (PESSAGNO) 3180-f
Ristola (?) *turpicula* PESSAGNO & WHALEN 3543-f
Pantanellium sp. L 3042-l
Praecaneta (Ristola) decora (PESSAGNO & WHALEN)-fl

i. Sample 711 (MH-4 of Murchey, 1984):
Sethocapsa leiostraca FOREMAN 3062-l,
Archaeohagiastrum munitum BAUMGARTNER 3271-fl

j. Sample 712 (MH-4 of Murchey, 1984): No first or last occurrences

Sample 713 (MH-4 of Murchey, 1984):
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO 4014-l
Hilarisirex quadrangularis TAKEMURA & NAKASEKO 3002-fl
Tetraditryma BAUMGARTNER 3638-l
Higumastra BAUMGARTNER 3644-l
Turanta PESSAGNO & BLOME 3663-l
Tetraditryma corralitosensis corralitosensis (PESSAGNO) 3124-l
Napora sp. B 3034-fl
Napora bukryi PESSAGNO-fl
Turanta sp. aff. *T. nodosa* PESSAGNO & BLOME.

k. Sample 714 (MH-4 of Murchey, 1984):
Mirifusus fragilis s.l. BAUMGARTNER 3159-l

l. Sample 715 (MH-4 of Murchey, 1984):
Guexella nudata (KOCHER) 3061-fl
Protunuma ICHIKAWA & YAO 3682-l
Perispyridium DUMITRICA 3675-l

m. Sample 716 (MH-4 of Murchey, 1984):
Xiphostylus spp. 3414-l
Acanthocircus suboblongus s.l. (YAO) 3064-l
Acanthocircus suboblongus suboblongus (YAO) 3088-l
Transhsuum brevicostatum gr. (OZVOLDOVA) 3181-l
Stichocapsa convexa YAO 3055-l
Podobursa helvetica (RÜST) 3169-l
Perispyridium ordinarium gr. (PESSAGNO) 3100-l
Transhsuum maxwelli gr. (PESSAGNO) 3180-l
Ristola (?) *turpicula* PESSAGNO & WHALEN 3543-l
Stichocapsa naradaniensis MATSUOKA 3045-fl
Ristola procera (PESSAGNO) 3163-fl
Mirifusus guadalupensis PESSAGNO 3160-fl
Emiluvia FOREMAN, emend. FOREMAN, emend. PESSAGNO 3631-l
Parvicingulidae-l
Lanubus holdsworthi-l
Pantanellium vigrassi gr.-l
Xiphostylus gasquetensis group-l,

Marin Headlands

Samples 7 to 16 from Alexander Avenue; sample 4342A from Point Diablo:

a. Sample 7 (upper MH-1 of Murchey, 1984):
Canoptum PESSAGNO 3615-p
Trillus spp. 3039-f
Canoptum anulatum-p
Trillus elkhornensis-f
Jacus sp. aff. *J.(?) sandspitense* gr. PESSAGNO, WHALEN, & YEH -f

b. Sample 8 (upper MH-1 of Murchey, 1984):
Parahsuum (?) *natorensis* (EL KADIRI) 3073-f
Xiphostylus spp. 3414-f
genus *"Lupherium"*-f
Canoptum anulatum-l

c. Sample 4342A (MH-2 of Murchey, 1984—inserted herein to represent MH-2 in covered interval): 3126-l?
Canoptum PESSAGNO 3615-l
Tympaneides charlottensis CARTER 3408
Hexasaturnalis hexagonus (YAO) 3502-fl
Emiluvia FOREMAN, emend. FOREMAN, emend. PESSAGNO 3631-f
Parahsuum (?) *natorensis* (EL KADIRI) 3073-l
Jacus DE WEVER 3651-l
Trillus elkhornensis-l
Hsuum altile HORI & OTSUKA-fl
Napora sp. B of Murchey (= aff. *N. turgida*)-fl
Parvicingulidae-f
Praeparvicingula nanoconica (HORI & OTSUKA)-fl
Canoptum rugosum PESSAGNO & POISSON -fl
Jacus sp. aff. *J.(?) sandspitense* group-l
Hagiastrum sp. cf. *H. egregium* RÜST as in Carter *et al.* (1988)-fl
Spongiostoma sp.-fl
Riedelius sp. aff *R. venustus* (PESSAGNO, WHALEN, & YEH)-fl
Acaeniotyle(?) *ghostensis*-fl
Pantanellium sp. aff. *P. buntonense* PESSAGNO & POISSON -fl

d. Sample 9 (MH-3 of Murchey, 1984):
Unuma latusicostatus (AITA) 4058-f
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO 4014-f
Turanta PESSAGNO & BLOME 3663-fl
Pseudocrucella BAUMGARTNER 3683-f
Perispyridium DUMITRICA 3675-f
Acanthocircus suboblongus s.l. (YAO) 3064-f
Acanthocircus suboblongus suboblongus (YAO) 3088-f
Transhsuum brevicostatum gr. (OZVOLDOVA) 3181-f

e. Sample 10 (MH-3 of Murchey, 1984): 4049-f
Dictyomitrella (?) *kamoensis* MIZUTANI & KIDO 4014-l
Mirifusus fragilis s.l. BAUMGARTNER 3159-fl
Podobursa helvetica (RÜST) 3169-f
Lanubus holdsworthi-fl

f. Sample 11 (MH-3 of Murchey, 1984): 4058-l
Tricolocapsa (?) *fusiformis* YAO 4049-l
Parvicingula dhimenaensis s.l. BAUMGARTNER 3197-f
Perispyridium DUMITRICA 3675-f
Stichocapsa convexa YAO 3055-f
Angulobracchia BAUMGARTNER 3607-fl
Archaeodictyomitra PESSAGNO 3608-f
Higumastra wintereri BAUMGARTNER & KITO 3148-fl
Perispyridium ordinarium gr. (PESSAGNO) 3100-f

g. Sample 12A (MH-3 of Murchey, 1984):
Sethocapsa leiostraca FOREMAN 3062-f

h. Sample 12B (MH-3 of Murchey, 1984): No first or last occurrences.

i. Sample 13 (MH-3 of Murchey, 1984): No first or last occurrences.

Tethys: Baumgartner, 1984, 1987	Tethys: Baumgartner, *et al.* *Chapter* 32, this volume		Franciscan Complex: The Geysers section Zones of Murchey, 1984		Pacific Northwest, North America: Eastern Oregon Zones of Pessagno *et al.*, 1987		British Columbia Zones of Carter *et al.*, 1988	
Zone	Age	UAZone	Zone	Sample	Zone	Age	Zone	Age
A1	middle Bathonian	6-6	MH-4	716	1F or younger			
	early-middle Bathonian	5-6		715				
				714				
				713	1F	Bathonian		
				712				
				711				
	latest Bajocian to early Bathonian	5-5		710	1E-1F			
			MH-3	709	1D-1E	late Bajocian		
	late Bajocian	4-5		708				
- - -				707				
A0				706	1B-1C	early Bajocian	6?-7	early Bajocian
				705				
	early-late Bajocian	3-4	MH-2	704	1A1	Aalenian?	5-6	Aalenian
	early-middle Bajocian	3-3		703	1A2	late Toarcian	4-5	l. middle to late Toarcian
	early-middleAalenian or older	1-2		702				

Figure 3. Correlation of Assemblage Zones MH-2, MH-3, and MH-4 (Murchey, 1984) in The Geysers Section, Franciscan Complex, California with well-dated biostratigraphic zones in the Tethys (Baumgartner *et al.*, *Chapter* 32 this volume) and Pacific Northwest, North America (Pessagno *et al.*, 1987; Carter *et al.*, 1988).

j. Sample 14 (MH-3 of Murchey, 1984):
Trillus spp. 3039-l
Tetraditryma BAUMGARTNER 3638-f
Emiluvia premyogii BAUMGARTNER 3210-f
Parvicingula dhimenaensis s.l. BAUMGARTNER 3197-l
Higumastra BAUMGARTNER 3644-l
Sethocapsa leiostraca FOREMAN 3062-l
Tetraditryma corralitosensis corralitosensis (PESSAGNO) 3124-f
Acanthocircus suboblongus s.l. (YAO) 3064-l
Acanthocircus suboblongus suboblongus (YAO) 3088-l
Pantanellium sp. L 3042-fl
Tritrabs rhododactylus BAUMGARTNER3118-fl
genus *"Lupherium"*-l
Paronaella pygmaea BAUMGARTNER-fl
Tricolocapsa sp. cf. *T. parvipora*-f
Praecaneta (Ristola) decora-f

k. Sample 15 (MH-3 of Murchey, 1984): No first or last occurrences.

l. Sample 16 (MH-4 of Murchey, 1984):
Xiphostylus spp. 3414-l
Tetraditryma BAUMGARTNER 3638-l
Emiluvia FOREMAN 3631-l
Emiluvia premyogii BAUMGARTNER 3210-l
Tetraditryma corralitosensis corralitosensis (PESSAGNO) 3124-l
Protunuma ICHIKAWA & YAO 3682-l
Transhsuum brevicostatum gr. (OZVOLDOVA) 3181-l
Stichocapsa convexa YAO 3055-l
Stauroloncher robusta RÜST sensu PESSAGNO 3220-fl
Ristola (?) *turpicula* PESSAGNO & WHALEN 3543-fl
Podobursa helvetica (RÜST) 3169-l
Transhsuum maxwelli gr. (PESSAGNO) 3180-l
Praecaneta (Ristola) decora-l
Parvicingulidae-l
Pantanellium vigrassi group-fl
Xiphostylus gasquetensis group-fl

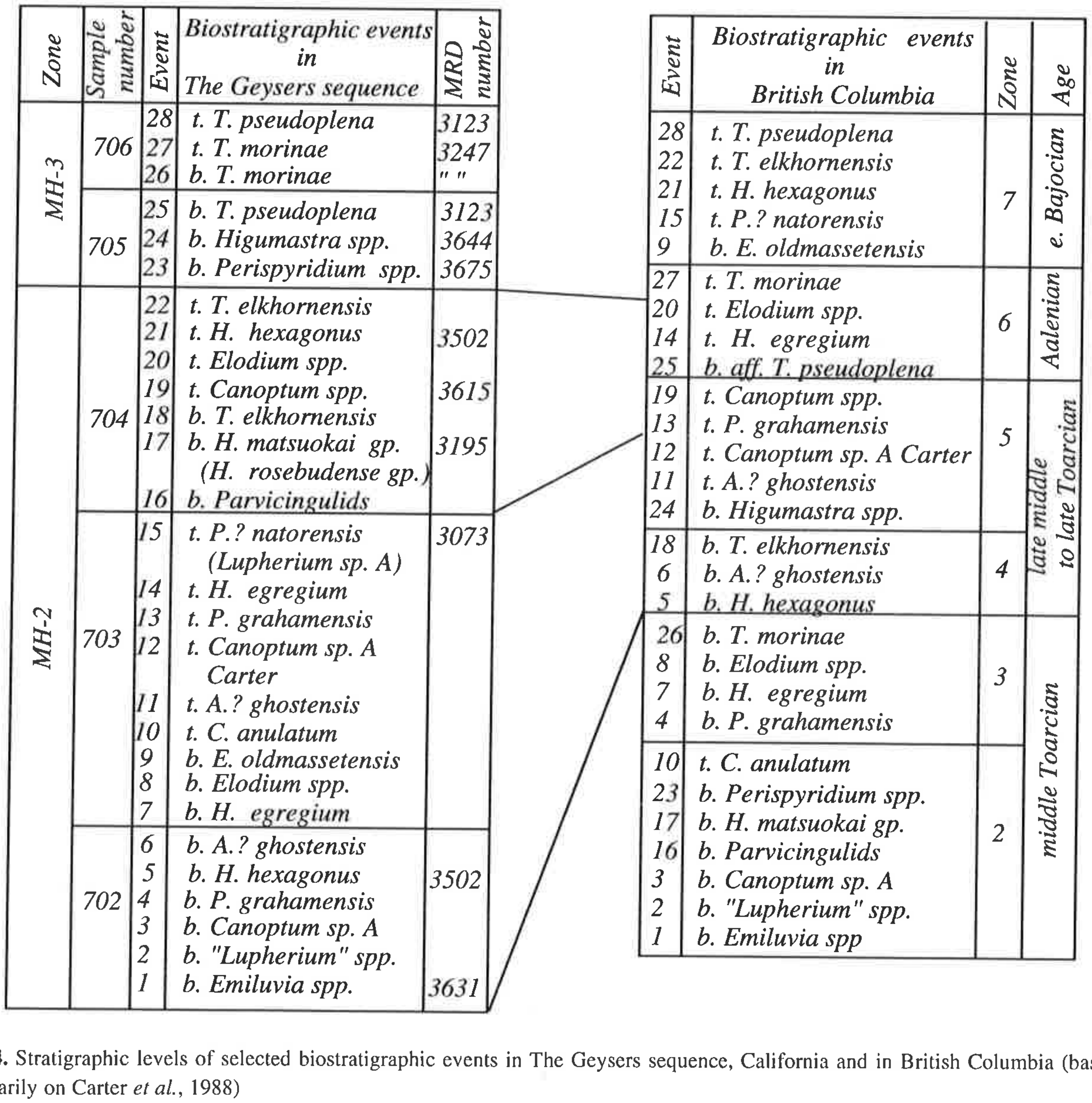


Figure 4. Stratigraphic levels of selected biostratigraphic events in The Geysers sequence, California and in British Columbia (based primarily on Carter *et al.*, 1988)

Zone	Sample number	Event	Biostratigraphic events in The Geysers sequence	MRD number
MH-4	716	46	t. *Xiphostylus* spp.	3414
		45	t. *P. vigrassi* gp.	
	714			
	713	44	t. *T.* sp. *aff. T. nodosa*	
		43	t. *H. quadrangularis* (= *Hilarisirex* sp. C)	3002
		42	t. *Napora* sp. B (*N. cosmica*)	3034
		41	t. *D.(?) kamoensis* (="*Canop.*" sp. A)	4014
		40	b. *T. aff. T. nodosa*	
		39	b. *H. quadrangularis* (= *Hilarisirex* sp. C)	3002
		38	b. *Napora* sp. B (*N. cosmica*)	3034
	712			
	711	37	p. *Archaeohagiastrum* sp.	3609
	710	36	t. *Pant.* sp. L (*Pachyoncus* spp.)	3042
		35	t. *H. matsuokai* gp. (*rosebudense* gp.)	
		34	b. *P. turpicula*	
		33	b. *P. decora*	
MH-3	709	32	t. "*Lupherium*" spp.	
		31	t. *Angulobracchia* spp.	3607
	708	30	b. *Archaeodictyomitra* spp.	3608
	707			
	706	29	t. *T. morinae*	3247
		28	b. *Pant.* sp. L(*Pachyoncus* spp.)	3042
		27	b. *Xiph. gasquetensis* gp.	
		26	b. *P. vigrassi* gp.	3607
		25	b. *Angulobracchia* spp.	
		24	b. *Napora*, med.round cephalis	
		23	b. *T. morinae*	3247
	705	22	b. *D.(?) kamoensis* (="*Canop.*" sp. A)	4014
		21	b. *T. brevicostatum* gp.	3181
		20	b. *Lanubus holdsworthi*	
		19	b. *Lanubus* spp.	
		18	b. *Perispyridium* spp.	3675
		17	b. *Higumastra* spp.	3663
		16	b. *Turanta* spp.	
MH-2	704	15	t. *T. elkhornensis*	
		14	t. *N. aff. N. fructuosa*	
		13	t. *Canoptum* s.s.	3615
		12	b. *H. matsuokai* gp. (*rosebudense* gp.)	3195
		11	b. *N.* sp. *aff N. fructuosa*	
		10	b. *Praeparvicingula* spp.	
		9	b. *T. elkhornensis*	
	703	8	t. *C. anulatum*	
		7	t. *P(?). natorensis* (*Lupherium* sp. A)	3073
		6	b. *Linaresia* spp.	
	702	5	b. *Xiphostylus vallieri*	
		4	b. *Saldorfus* spp.	
		3	b. *Emiluvia* spp.	3631
		2	b. *Xiphostylus* spp.	3414
		1	b. *P(?). natorensis* (*Lupherium* sp. A)	3073

Event	Biostratigraphic events in eastern Oregon	Zone	Age
46	t. *Xiphostylus* spp.	1F	Bathonian
45	t. *P. vigrassi* gp.		
36	t. *Pant.* sp. L		
34	b. *P. turpicula*		
33	b. *P. decora*		
44	t. *T. nodosa* s.s.	1E	late Bajocian
43	t. *H. quadrangularis*		
32	t. "*Lupherium*" spp.		
15	t. *T. elkhornensis*		
40	b. *T. nodosa*		
39	b. *H. quadrangularis*		
28	b. *Pant.* sp. L		
42	t. *Napora* sp. B (*cosmica*)	1D	
38	b. *Napora* sp. B (*cosmica*)		
30	b. *Archaeodictyomitra* sp.		
27	b.? *Xiph. gasquetensis* gp.		
41	t. *D. (?) kamoensis*	1C	early Bajocian
37	p. *Archaeohagiastrum* spp.		
35	t? *H. matsuokai*		
31	t? *Angulobracchia* spp.		
26	b. *P. vigrassi* gp.		
22	b. *D.(?) kamoensis*		
6	b. *Linaresia* spp.		
25	b? *Angulobracchia* spp.	1B	
24	b? *Napora*, med.round ceph.		
21	b? *T. brevicostatum* gp.		
20	b. *Lanubus holdsworthi*		
12	b? *H. matsuokai*		
5	b. *Xiphostylus vallieri*		
29	t. *T. morinae*	1A1	Aalenian?
14	t. *N. fructuosa*		
23	b. *T. morinae*		
19	b. *Lanubus* spp.		
11	b. *N. fructuosa*		
4	b. *Saldorfus* spp.		
13	t. *Canoptum* s.s.	1A2	Toarcian
8	t. *Canoptum anulatum*		
18	b. *Perispyridium* spp.		
10	b. *Praeparvicingula* spp.		
3	b. *Emiluvia* spp.		
17	b. *Higumastra* spp.	01B	
16	b. *Turanta* spp.		
7	t. *P.(?) natorensis*	01A	Pliensb.
9	b. *T. elkhornensis*		
2	b. *Xiphostylus* spp.		
1	b. *P.(?) natorensis*		

Figure 5. Stratigraphic levels of selected biostratigraphic events in The Geysers sequence, California and in eastern Oregon (based on Pessagno and Blome, 1980, 1982, 1990; Pessagno and Whalen, 1982; Pessagno *et al.*, 1984, 1986, 1989; Yeh, 1987)

Bald Mountain

Near Mount Umunhum (uppermost two samples from a ten meter measured section-samples depositionally overlie faunas assigned to MH-1 assemblage of Murchey, 1984):

a. Sample 7599 (MH-2 of Murchey, 1984):
Tympaneides charlottensis CARTER 3408-fl
Jacus DE WEVER 3651-l
Trillus spp. 3039-p
Jacus (?) sp. aff. *J.* (?) *sandspitensis* group-l
Trillus elkhornensis-p
Praeparvicingula nanoconica-fl
Napora sp. B of Murchey, 1984 (= aff. *N. turgida*)-fl
Praeconocaryomma sp. cf. *P. immodica*-f
Acaeniotyle(?) *ghostensis*-f

b. Sample 7598 (MH-2 of Murchey, 1984):
Trillus spp. 3039-p
Hexasaturnalis hexagonus (YAO) 3502-fl
Zartus PESSAGNO & BLOME 3686-p
Xiphostylus spp. 3414-fl
Hagiastrum sp. cf. *H. egregium*-l
Trillus elkhornensis-l
"Lupherium" sp. cf. *"L." snowshoense* PESSAGNO & WHALEN -fl
Triactoma sp. aff. *T. rosespitense* (CARTER)-fl
Praeconocaryomma sp. cf *P. immodica*-l
Acaeniotyle(?) *ghostensis*-l
Zartus thayeri PESSAGNO & BLOME -fl
Paronaella sp. aff. *P. grahamensis* CARTER (Carter *et al.*, 1988)-fl

3. Synthesis of ages as indicated by correlation of radiolarian faunas

3.1. Discussion

In the field of radiolarian biostratigraphy, an unresolved difference of opinions exists as to whether European radiolarian faunas calibrated with Middle Jurassic ammonites (Baumgartner *et al.*, 1980; Baumgartner, 1984, 1987; Baumgartner & Murchey, 1987; O'Dogherty *et al.*, 1989) are correlative with North American (eastern Oregon and British Columbia) radiolarian faunas also calibrated with Middle Jurassic ammonites (Pessagno *et al.*, 1984, 1987, 1989, 1993; Pessagno & Blome, 1990; Carter *et al.*, 1988).

Baumgartner (1984, 1987) established nine assemblage zones based on Unitary Associations derived from a computer program analysis (Guex & Davaud, 1984) of concurrent ranges in many stratigraphic sequences, primarily from the Tethys ocean. From oldest to youngest, these zones are Zones A0, A1, A2, B, C1, C2, D, E1, and E2. In 1984, Baumgartner considered the age of Zone A0 to be Bathonian and (or) Callovian. Pessagno *et al.* (1984) considered the European ammonite data suspect and suggested that all the ammonite control was in redeposited strata. Baumgartner (1987) countered that the ammonites did not appear in far-displaced or allochthonous units and that the paleomagnetic signature of the ammonite-bearing rocks did not show discordance with the radiolarian-bearing rocks. Baumgartner (1987) revised the ranges of Zone A0 downward to include the Bajocian and part of the Bathonian. O'Dogherty *et al.*, (1989), using ammonite-bearing stratigraphic sections in the Betic Cordillera of Spain revised the range of Zone A0 downward to include only the Bajocian, and revised the ranges of Zones A1 to B downward as well. Some additional fossil control for calibrating the Tethyan zones occurs in Italy. Radiolarian faunas in the upper part of the Sogno Formation near the town of Sogno are assigned to Zone A0. The top of the Sogno Formation is Aalenian to early Bajocian. Sample BO 320.8 from the Fiume Bosso Section in Umbria (Zone A0) occurs above the early Bajocian *Humphresianum* ammonite zone. Figure 1 shows the most recent recalibrations of the zones using all available data.

Recently, Pessagno and his co-workers appear more inclined to accept the most recent European calibrations, but they still argue (Hull & Pessagno, this volume), that the Middle Jurassic radiolarian faunas of eastern Oregon and British Columbia (Zones 1A to 1F of Pessagno *et al.*, 1987) are older than European Zones A0 and A1. The North American zones 1A to 1F have a stratigraphic range from the Toarcian or Aalenian to the Bathonian, based on associated ammonites (Pessagno *et al.*, 1987).

If one accepts the arguments of O'Dogherty *et al.* (1989), as we do, for the calibration of the European radiolarian zones, then only two alternatives exist for resolving the biostratigraphic dispute: either the Middle Jurassic ammonite zones in Europe and western North America are miscorrelated by several stages or radiolarian Zones A0 and A1 of Europe and Zones 1A to 1F of the Pacific Northwest *are* correlative. Before concluding that the European and North American ammonite correlations are seriously in error, we feel it advisable to review evidence favouring a correlation between the radiolarian zones in question. In this manuscript, we approach the problem by correlating the very different European and Pacific Northwestern faunas with paleogeographically intermediate faunas of the Franciscan Complex of California. The long, superposed sequences of radiolarian faunas in the Franciscan Complex contain taxa found in both Europe and northwestern North America. Thus, correlations between the Franciscan Complex, Europe, and northwestern North America should demonstrate whether the zones in question actually overlap in age.

In the following discussion, assemblage zones of the Franciscan Complex (MH-2, -3, and -4) are correlated first with the European zonation (Baumgartner, 1984, 1987, and herein) and then with well-dated North American sequences (Pessagno, 1977; Pessagno & Blome, 1980, 1982, 1990; Pessagno & Whalen, 1982; Pessagno *et al.*, 1984, 1986, 1987, 1989; Yeh, 1987; Carter *et al.*, 1988) (Figures 1, 4, 5).

3.2. Correlation with the Tethyan zonation:

Baumgartner's (1984, 1987) nine assemblage zones (A0 to E2) were each defined by one or more Unitary Associations. In the zonation presented in this volume

Baumgartner *et al. (Chapter* 32, this volume) 127 initial Unitary Associations have been regrouped into 22 biochronozones, called UAZones, that have been calibrated in many localities. In the following discussion, both the old zonal designations (A0-E2) and the recent UAZones (UAZ.) will be used (Fig. 3). First, The Geysers Section is discussed, then, the Marin Headlands Section.

The oldest samples of MH-2 in The Geysers (samples 702 and 703) are assigned to UAZ. 1-2 (early-middle to late Aalenian) and 3-3 (early-middle Bajocian) respectively. Sample 704, also assigned to MH-2, has a possible range of UAZ. 3-4 (early-middle to late Bajocian). Samples 705 to 708 (MH-3) are assigned UAZ. 4-5 (late Bajocian to latest Bajocian-early Bathonian). Sample 709 (uppermost MH-3) and Sample 710 (base of MH-4, first appearance of *Parvicingula turpicula*) are equivalent to UAZ. 5 (latest Bajocian-early Bathonian). Samples 711 to 715 (MH-4) have possible ranges of UAZ. 5-6 (latest Bajocain-early Bathonian to middle Bathonian). Sample 716 (MH-4) is assigned to UAZ. 6 (middle Bathonian).

In the Marin Headlands, the uppermost part of MH-1, where exposed at Alexander Avenue, Sample 8, is assigned to UAZ. 1-3 (early-middle Aalenian to early-middle Bajocian), as is Sample 4342A (MH-2) from Point Diablo. Sample 9, in the lower part of MH-3 at Alexander Avenue corresponds io UAZ. 3-5 (early-middle Bajocian to latest Bajocian-early Bathonian). Samples 10, 11, 12A, 12B, 13, and 14, all have a range of UAZ. 4-5 (late Bajocian to latest Bajocian-early Bathonian).

Sample 15, uppermost MH-3, has a possible range from UAZ. 3-6 based on its faunal assemblage, but because it overlies stratigraphically constrained faunas, Sample 15 must be interpreted as restricted to UAZ. 4-6 (late Bajocian to middle Bathonian). The base of MH-4 at Alexander Avenue, Sample 16, has possible range from UAZ. 5-6 (latest Bajocian-early Bathonian to middle Bathonian).

Therefore, the uppermost part of MH-1 (Marin Headlands) and lowermost part of MH-2 (Marin Headlands and The Geysers) are Aalenian (or older) or Aalenian to early Bajocian in Baumgartner *et al. (Chapter* 32, this volume) most recent zonation. The uppermost part of MH-2 at The Geysers may be as young as late Bajocian. Assemblage MH-3 has a possible range from UAZ. 4-5 (late Bajocian to latest Bajocian-early Bathonian) at The Geysers and a range from UAZ. 3-6 at Alexander Avenue where we have not constrained the faunas as well. Assemblage MH-4 at the Geysers ranges from UAZ. 5 (Sample 710, latest Bajocian - early Bathonian) to UAZ. 6 (Sample 716, middle Bathonian) while the lower part of MH-4 at Alexander Avenue (Sample 16) has a possible range within the same interval, UAZ. 5-6.

3.3. Correlation with sequences in British Columbia and eastern Oregon

British Columbia: Carter *et al.* (1988) used assemblage-based zones (Zones 1 to 7) to characterize the biostratigraphy of Early to early Middle Jurassic radiolarians in the Queen Charlotte Islands of British Columbia. The faunas are well-dated with megafossils. Many of the taxa in the zonation of Carter *et al.* (1988) also occur in MH-1, MH-2, and lower MH-3 of the Franciscan Complex.

Figure 4 is a graphic correlation of 28 biostratigraphic events in the basal part of The Geysers Section and in the Early and early Middle Jurassic faunal sequence of British Columbia (Carter *et al.*, 1988). Biostratigraphic events 1 to 8 in Figure 4, first occurrences of eight taxa in The Geysers Section samples 702 (base) and 703, also occur in Zones 2 to 4 of Carter *et al.* (1988). Thus, Sample 702 is probably not older than Zone 4 in British Columbia. Biostratigraphic event 10 (final occurrence of *Canoptum anulatum*) is represented by a single specimen in Sample 703 and occurs in Zone 2 of British Columbia. All other final occurrences in 703 (events 11 to 15 of Fig. 4) occur in Zones 5 to 7 in British Columbia with most occurring in Zone 5. Therefore, samples 702 and 703 best correlate with late middle to late Toarcian Zones 4 and 5 of Carter *et al.* (1988). Sample 704 may also be correlative with these zones or be slightly younger as biostratigraphic events 19 to 22 (final occurrences of taxa in 704) occur in Zones 5, 6, and 7 of Carter *et al.* (1988). Franciscan Complex assemblage MH-2 in the Geysers Section is herein correlated with Zones 4, 5, and 6 (?) of Carter *et al.* (1988) which are considered to be late middle and late Toarcian and Aalenian age on the basis of ammonites.

The base of MH-3 in The Geysers is represented by samples 705 and 706. Biostratigraphic events 28 (first appearance of *Saldorfus (Tetraditryma) pseudoplena*, Sample 705) and 26 and 27 (first and last appearances of *Turanta morinae*, Sample 706) somewhat constrain the possible correlation between the two sequences. *Saldorfus (Tetraditryma)* sp. aff. *S. pseudoplena* occurs in Zone 7 of Carter *et al.* (1988) while *Turanta morinae* occurs in Zones 3-6 of Carter *et al.* (1988). (Well-preserved specimens of *T. morinae* also occur in Sample BO 230.8, Zone A0 of Baumgartner's Fiume Bosso Section in the Umbria Marche, Italy, in strata overlying the late early Bajocian *Humphresianum* ammonite zone.) Solely on the basis of radiolarians found in the two sequences, basal MH-3 at The Geysers is correlative with Zones 6 or 7 of Carter *et al.* (1988) which are assigned to Aalenian and early Bajocian ages, respectively, on the basis of ammonites.

In the Marin Headlands, the upper part of MH-1 (samples 7 and 8) is correlative with late Pliensbachian Zone 1 of Carter *et al.* (1988). At Bald Mountain (Mount Umunhum), where the uppermost part of MH-1 is exposed and depositionally underlies MH-2, the upper part of MH-1 correlates best with Zone 1 but the youngest samples could be as young as Zones 2 to 3 (middle Toarcian) of Carter *et al.* (1988)(Murchey, unpublished data). In both the Marin Headlands and Bald Mountain localities, assemblage MH-2 best correlates with late middle to late Toarcian Zones 4 and 5 of Carter *et al.* (1988). The lower part of MH-3 at the Marin Headlands (samples 10 and 11) contains *Tricolocapsa*(?) *fusiformis* which is also found in early Bajocian Zone 7 of Carter *et al.* (1988). At least part of lower MH-3 in the Marin Headlands may be correlative with early Bajocian Zone 7 of Carter *et al.* (1988) but the unexposed boundary between MH-2 and MH-3 may be older.

Eastern Oregon: Superzone 1 of Pessagno *et al.* (1987) is based primarily on reference sections in eastern Oregon. There is apparent overlap in age between the upper part of the British Columbia sections and the lower part of the Oregon sections near the boundary between the Early and Middle Jurassic. In eastern Oregon, Superzone 1 includes Zones 1A (Toarcian to Aalenian?) to Zone 1F (Bathonian). The ranges of many radiolarian taxa in these rocks are well documented although Pessagno *et al.* (1987) included only a few in their formal zonation. We used the zonal ranges of as many of the Oregon taxa as possible for correlation with Franciscan Complex faunas. Within The Geysers and Marin Headlands sequences, the order of first and last occurrences roughly parallels biostratigraphic events in eastern Oregon. Figure 5 shows a comparison of 46 biostratigraphic events in The Geysers sequence with Early and Middle Jurassic events in the eastern Oregon sequence (Pessagno & Blome, 1980, 1982, 1990; Pessagno & Whalen, 1982; Pessagno *et al.*, 1984, 1986, 1987, 1989; Yeh, 1987).

Assemblage MH-2 in The Geysers Section: In the Geysers Section, three samples, samples 702 to 704, are assigned to MH-2. Based on the correlation of biostratigraphic events 1 to 15 in Fig. 5, MH-2 in The Geysers correlates best with faunas assigned to Subzones 1A2 and 1A1 of Pessagno *et al.* (1987). These subzones are considered to be Toarcian and Aalenian(?) age on the basis of associated ammonite faunas. Important biostratigraphic events occurring in both MH-2 (many localities) and Zone 1A include the first appearances of parvicingulids (*Praeparvicingula* spp.), *Emiluvia* spp., and *Saldorfus* (*Tetraditryma*-like spp. with pointed tips) spp. and the final appearance of *Canoptum* spp.

Assemblage MH-3 in The Geysers Section: Samples 705 and 706, the lower part of MH-3, contain the first appearances of many taxa (events 16 to 28). In eastern Oregon, the first appearances of the same taxa occur in Zones 01B to 1E with eight of the thirteen events occurring in Zones 1A1 to 1C (Fig. 5). The first appearances of *Turanta* and *Higumastra* spp., markers for the base of Subzone 01B, occur in Sample 705 along with the first appearance of the genus *Mirifusus*, primary marker taxon for the base of Zone 2 in the zonation of Pessagno *et al.* (1987, 1993). *Turanta morinae*, a marker for Subzone 1A1, occurs in Sample 706 (events 23 and 29). Based on events 16 to 29 in Fig. 5, samples 705 and 706, the lower part of MH-3, correlate best with faunas assigned to Zones 1A1, 1B, and 1C of Pessagno *et al.* (1987). These zones are assigned to the Aalenian(?) and early Bajocian on the basis of associated ammonite faunas. Based on biostratigraphic events 30 (first occurrence of *Archaeodictyomitra* spp.) and 32 (last occurrence of "*Lupherium*" spp.) in Fig. 5, samples 708 and 709 may correlate with faunas assigned to Zones 1D and (or) 1E of Pessagno *et al.* (1987). These zones are considered to be late Bajocian on the basis of associated ammonite faunas.

MH-4 in The Geysers Section: Samples 710 to 716 in The Geysers Section are assigned to Franciscan Complex Zone MH-4. Based on correlation of biostratigraphic events 33 to 44 in Fig. 5, samples 710 to 713 correlate best with faunas assigned to Zones 1E and 1F of Pessagno *et al.* (1987). The base of *Praecaneta (Ristola) turpicula*, arbitrarily chosen by Murchey (1984) as a marker for the base of MH-4 in the Franciscan Complex, is also a marker for the base of Zone 1F. Pessagno *et al.* (1987) considered faunas assigned to 1E to be late Bajocian and faunas assigned to 1F to be Bathonian on the basis of associated ammonites. Neither *Eucyrtidiellum ptyctum* (reported by Pessagno, 1977, from a level approximately equal to Sample 712 in The Geysers, but not observed by us), *Perispyridium ordinarium sensu strictu* (reported by Pessagno & Blome, 1982, from levels approximately equivalent to 713 and 714), nor *Ristola procera* (716) have been reported in the Oregon sections. Therefore, samples 712 to 716 may be younger than faunas assigned to Zone 1F (Bathonian) in Oregon.

In the Marin Headlands and at Bald Mountain near Mt. Umunhum, the upper part of MH-1 (postdating the first appearance of *Canoptum anulatum* and subsequent first appearance of *Trillus elkhornensis*, markers for the base of Zone 01), is correlative with late Pliensbachian and Toarcian Zone 01 of Pessagno *et al.* (1987). The biostratigraphic markers for the boundary between Subzones 01A and 01B of Pessagno *et al.* (1987) (base of *Turanta* and *Higumastra* spp.) are absent in the short Bald Mountain Section and occur high (MH-3 Assemblage Zone) in the sections at the Marin Headlands and The Geysers. In both the Marin Headlands and Bald Mountain (Mt. Umunhum) localities, MH-2 correlates fairly well with Toarcian Subzone 1A2 of Pessagno *et al.* (1987). In the Marin Headlands, MH-3 correlates best with Bajocian Zones 1B to 1D; MH-4 correlates best with Bathonian Zone 1F.

4. Conclusions and discussion

We correlate Zones MH-2, 3, and 4 in the Franciscan Complex of California with old Zones A0 to A1 (Baumgartner, 1984) or with UAZ. 1-6 (Aalenian or older to middle Bathonian) of Baumgartner *et al. (Chapter* 32, this volume) and with radiolarian assemblages assigned to Zones 1A to 1F of Pessagno *et al.* (1987) (Toarcian to Bathonian) (Fig. 3). We also correlate MH-2 and lower MH-3 with Zones 4 to 7 of Carter *et al.* (1988) (middle Toarcian to early Bajocian) (Fig. 3). By implication, Zones A0 to A1 (UAZ. 1-6) of Baumgartner are correlative with Zones 1A to 1F of Pessagno *et al.* (1987) and Zone A0 is also correlative with Zones 4 to 7 of Carter (1988). Therefore, the ammonite-based Early and Middle Jurassic stage assignments for strata of eastern Oregon and British Columbia fundamentally agree with those for strata in the Betic Cordillera of Spain and elsewhere in the Tethys. The only difference created by correlating the Franciscan Complex assemblage zones with the North American and Tethyan zonations is a minor variation in the placement of the boundary between the Aalenian and Bajocian. No significant miscorrelation of molluscan zones is apparent and no large-scale diachroneity of entire radiolarian or molluscan assemblages is required.

International correlations of radiolarian zonations of Japan with those of the European Tethys and the Pacific Northwest of North America support our conclusions (for example: Yao, 1986, 1990; Nagai & Mizutani, 1990; Matsuoka, 1992). The apparent occurrence of the *Unuma echinatus* assemblage 30m. below the Bajocian to Bathonian ammonites *Cadomites* sp. and *Planisphinctes?* sp. in southern Kyushu also supports our interpretations (Yokata & Sano, 1986).

An issue of critical importance to the overall zonation scheme of Pessagno *et al.* (1987, 1993) is the comparative age of Jurassic sedimentary rocks overlying extrusive volcanic rocks in the ophiolite sequences of California (Josephine and Coast Range ophiolites, Zones 1H and younger) relative to the age of Middle Jurassic strata in eastern Oregon (Zones 1A to 1F of Pessagno *et al.* 1987, 1989). Within the ophiolite sequences, Zones 1H, 1I, and Subzone 2 delta have no independent megafossil control. Recent U/Pb ages of plagiogranites in the ophiolite sequences range from 162±1 Ma (Saleeby, 1987) to 165-173 Ma (Mattinson & Hopson, 1992) (Bathonian to Bajocian on the time scale of Harland *et al.*, 1989; Bathonian to Aalenian on the time scale of Haq *et al.*, 1988). Pessagno *et al.* (1993) and Hull & Pessagno (this volume) correlate the lower part of the ophiolite sequences (Zones 1I to 2 gamma [part]) with latest Early to Middle Jurassic Zones A0 and A1 of Baumgartner (1987). Though our interpretations of the correlation between the ophiolite sequences and the Tethyan sequences are slightly different, we fundamentally agree that the very oldest sedimentary strata in the ophiolites (Zones 1H, 1I) are correlative with Zones A0 (upper part) and A1 of Baumgartner (1987 and *Chapter* 32). Pessagno *et al.* (1993), also correlate the oldest strata in the ophiolites to the *Unuma echinatus* and *older* assemblages in Japan (see comment above). Despite their own correlations, despite the absence of independent megafossil control in the older strata, and despite the isotopic dates on underlying plagiogranites, Pessagno *et al.* (1993) and Hull & Pessagno (this volume) assign late Callovian and early Oxfordian ages to the oldest sedimentary strata in the ophiolite sequences. Pessagno *et al.* (1993) argue that the radiolarian-bearing strata of the ophiolites entirely post-date the radiolarian-bearing strata of eastern Oregon as well as Callovian radiolarian faunas of southern Alaska (Zone 1G). In contrast, we conclude that, during the Bajocian and Bathonian, radiolarian-bearing sediments accumulated in both the ophiolite basins of California and the arc-related basins of the Pacific Northwest.

We believe we have adequately demonstrated that radiolarian Zones A0 and A1 of Europe (Baumgartner, 1987) and the new UAZ. 1-6 Baumgartner *et al. (Chapter* 32, this volume) are correlative with Zones 1A to 1F of eastern Oregon (Pessagno *et al.*, 1987) and that Zone A0 i. e. UAZ. 1-4 are correlative with Zones 4 to 7 of British Columbia (Carter *et al.*, 1988). Previous difficulties in correlating the zonation schemes are largely the result of assemblage differences between faunas deposited in pelagic sediments of the low-latitude Tethyan ocean and those deposited in hemipelagic to clastic sediments of the mid-latitude, eastern Pacific arc-basins. Pessagno & Blome (1986) were first to discuss some of these differences in detail. They developed a schematic model in which low-latitude (Tethyan) faunas are distinguished from higher-latitude (Boreal) faunas based on differences in abundance and diversity of parvicingulids and pantanellids. The distribution of parvicingulids is affected not only by paleolatitude but also by paleobathymetry. For instance, Pessagno *et al.* (1993) state that *Mirifusus* (a parvicingulid genus) is absent in certain strata of Mexico and California (Coast Range ophiolite) because it may be a "stenobathic abyssal" taxon. Hence, the choice of the first appearance of *Mirifusus* as the definitive biostratigraphic marker (primary marker taxon) for the base of their Zone 2 has created important correlation problems. Hull *et al.* (1993, p. 158 and Fig. 2) illustrate a clear trend of lowering the chronostratigraphic base of Zone 2 (*Mirifusus* first occurrence event) as each of three revisions of the North American zonation (Pessagno *et al.*, 1987, 1989, 1993) includes a recognition of "an older age of the *Mirifusus* first occurrence event than previously recognized". It seems plausible, therefore, that the absence of *Mirifusus* in the lowermost strata of the ophiolite sequences and in the Pacific Northwest arc-basin sequences is also environmentally-controlled, especially since the genus occurs with Aalenian, Bajocian, and Bathonian markers (North American zonation) such as *Turanta morinae*, *Parasaturnalis* spp. (Fiume Bosso Section), and *Praecaneta (Ristola) turpicula* in Europe and (or) the Franciscan Complex. Likewise, Murchey's (1984) arbitrary choice of *P. turpicula* as the marker for the base of MH-4 works well within the Franciscan Complex (and for correlation with Oregon) but is not particularly useful for correlations with the European Tethys where the species is much less common. In order to diminish the effects of environmentally-controlled faunal differences and to increase the accuracy of correlations, comparisons of entire assemblages are preferable to comparisons of the ranges of a few selected taxa.

Acknowledgements

We thank the staff of the Golden Gate National Recreation Area for permission to sample within the Marin Headlands; and W. Sliter for constructive reviews; C. Wahrhaftig, R. McLaughlin, M.C. Blake, Jr., J. T. Hagstrum, D.L. Jones, and L. O'Dogherty for consultation on geologic framework.

References

Baumgartner, P., De Wever, P. & Kocher, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tethyan Jurassic radiolarites. *Eclogae Geologicae Helvetiae*, **80** (3), 831-879.

BAUMGARTNER, P.O. & MURCHEY, B. (1987). Correlation of Tethyan and W-North American Jurassic radiolarian zonations and age of Franciscan terranes. *Terra Cognita*, **7** (2-3), 210.

BLAKE, M.C., HOWELL, D.G. & JAYKO, A.S. (1984). Tectonostratigraphic terranes of the San Francisco Bay region. *In* Blake, M.C. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of economic Paleontologists and Mineralogists, Los Angeles, **43**, 5-22.

BLAKE, M.C., JAYKO, A.S. & MCLAUGHLIN, R.J. (1988). Metamorphism and crustal evolution of the western United States. *In* Ernst, W.G. Ed. *Rubey Volume VII: Englewood Cliffs* - Prentice-Hall, New Jersey, 1035-1060.

CARTER, E.S., CAMERON, B.E.B. & SMITH, P.L. (1988). Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. *Geological Survey of Canada, Bulletin*, **386**, 1-109.

GUEX, J. & DAVAUD, E. (1984). The Unitary Associations method. *Computers and Geosciences*, **10**, 69-96.

HAGSTRUM, J.T. & MURCHEY, B.L. (1993). Deposition of Franciscan Complex cherts along the paleoequator and accretion to the American margin at tropical paleolatitudes. *Geological Society of America, Bulletin*, **105**, 766-778.

HAQ, B.U., HARDENBOL, J. & VAIL, P.R. (1988). Mesozoic and Cenozoic Chronostratigraphy and Eustatic Cycles. *In* Wilgus, C.K.*et al.* Eds. *Sea level changes. An integrated approach* - Special Publication of the Society of Economic Paleontologists and Mineralogists, **42**, 71-108.

HARLAND, H.B., ARMSTRONG, R.L., COX, A.V., CRAIG, L.E., SMITH, A.G. & SMITH, D.G. (1989). *A geologic time scale* - Cambridge University Press, Cambridge/New York/Port Chester/Melbourne/Sydney. 263 p.

HULL, D.M., PESSAGNO, E.A.J., HOPSON, C.A., BLOME, C.D. & MUÑOZ, I.M. (1993). Chronostratigraphic assignment of volcanopelagic strata above the coast range ophiolite. *In* Dunn, G. & McDougall, K. Eds. *Mesozoic Paleogeography of the Western United States-II* - Pacific Section, Society of Economic Paleontologists and Mineralogists, **71**, 157-170.

MACLAUGHLIN, R.J. & PESSAGNO, E.A. (1978). Significance of age relations above and below Upper Jurassic ophiolite in The Geysers - Clear Lake region, California. *United States Geological Survey, Journal of Research*, **6** (6), 715-726.

MATSUOKA, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MATTINSON, J.M. & HOPSON, C.A. (1992). U/Pb ages of the Coast Range Ophiolite: a critical reevaluation based on new high precision Pb/Pb ages. *Bulletin of the American Association of Petroleum Geologists*, **76** (5), 425.

MURCHEY, B. (1984). Biostratigraphy and lithostratigraphy of cherts in the Franciscan Complex, Marin Headlands, California. *In* Blake, M. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles, **43**, 51-70.

MURCHEY, B. & JONES , D.L. (1984). Age and significance of chert in the Franciscan complex, San Francisco bay region. *In* Blake, M. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles, **43**, 23-30.

MURRAY, R.W., BUCHHOLTZ TEN BRINK, M.R., JONES, D.L., GERLACH, D.C. & RUSS, G.P.I. (1990). Rare earth elements as indicators of different marine depositional environments in chert and shale. *Geology*, **18**, 268-271.

NAGAI, H. & MIZUTANI, S. (1990). Jurassic *Eucyrtidiellum* (Radiolaria) in the Mino Terrane. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 587-602.

O'DOGHERTY, L., SANDOVAL, J., MARTIN-ALGARRA, A. & BAUMGARTNER, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

PESSAGNO, E.A. (1977). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. & BLOME, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26**, (3), 225-273.

PESSAGNO, E.A. & BLOME, C. (1982). Bizarre Nassellariina (Radiolaria) from the Middle and Upper Jurassic of North America. *Micropaleontology*, **28** (3), 289-318.

PESSAGNO, E.A., BLOME, C., CARTER, E.S., MACLEOD, N., WHALEN, P. & YEH, K.Y. (1987). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, 1-18.

PESSAGNO, E.A., BLOME, C. & LONGORIA, J. (1984). A revised radiolarian zonation from Upper Jurassic of western North America. *Bulletins of American Paleontology*, **87** (320), 1-51.

PESSAGNO, E.A. & BLOME, C.D. (1986). Faunal affinities and tectonogenesis of Mesozoic rocks in the Blue Mountains of eastern Oregon and western Idaho. *In* Wallier, T.L. & Brooks, H.C. Eds. *Geologic Implications of Paleozoic and Mesozoic Paleontology andBiostratigraphy, Blue Mountains Province, Oregon, Idaho and Washington* - United States Geological Survey, Professional Paper, Report, **1435**, 65-78.

PESSAGNO, E.A. & BLOME, C.D. (1990). Implications of New Jurassic stratigraphic, geochronometric, and paleolatitudinal data from the western Klamath terrane (Smith River and Rogue Valley subterranes). *Geology*, **18**, 665-668.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

PESSAGNO, E.A., SIX, W.M. & YANG, Q. (1989). The Xiphostylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. *Micropaleontology*, **35** (3), 193-255.

PESSAGNO, E.A. & WHALEN, P. (1982). Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, **28** (2), 111-169.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

SALEEBY, J.B. (1987). Discordance patterns in Pb/U zircon ages of the Sierra Nevada and Klamath Mountains. *EOS, American geophysical Union, Transactions*, **68**, (44), 1514-1515.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

SHERVAIS, J.V. (1989). Geochemistry of igneous rocks from Marin Headlands. *In* Wahrhaftig, C. & Sloan, C. Eds. *Geology of San Francisco and vicinity* - American Geophysical Union, field Trip Guidebook, Washington, D.C., **105**, 40-41.

WAHRHAFTIG, C. (1984). Structure of the Marin Headlands block, California: A progress report. *In* Blake, M.C. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, **43**, 31-50.

YAMAMOTO, K. (1987). Geochemical characteristics and depositional environments of cherts and associated rocks in the Franciscan and Shimanto terranes. *Sedimentary Geology*, **52**, 65-108.

YAO, A. (1986). Geological age of Jurassic radiolarian zones in Japan and their international correlations. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 63-74.

YAO, A. (1990). Triassic and Jurassic radiolarians. *In* Ichikawa, K.*et al.* Eds. *Pre-Cretaceous Terranes of Japan. Publication of IGCP Project No. 224: Pre-Jurassic Evolution of Eastern Asia* - IGCP Project 224, Osaka, Japan, 329-345.

YEH, K. (1987). Taxonomic studies of lower Jurassic Radiolaria from east-central Oregon. *National Museum of Natural Science, Special Publication*, **2**, 1-169.

YOKOTA, S. & SANO, H. (1986). Radiolarian fossils from the Middle Jurassic Ammonites-bearing formation of Bisho, Yatsushiro district, Kumamoto Prefecture. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 53-58.

Appendix

Radiolarian inventory of the samples studied. Each radiolarian taxon is represented by a numerical code to enable computer treatment of data by the BioGraph program (Savary & Guex, 1991).

SECTION BM_POB1_GEYSERS: bottom 1 - top 15
< 15 {716}: 3045, 3055, 3064, 3088, 3100, 3160, 3163, 3169, 3180, 3181, 3414, 3543
< 14 {715}: 3055, 3061, 3064, 3088, 3100, 3169, 3180, 3181, 3414, 3543
< 13 {714}: 3055, 3064, 3088, 3100, 3159, 3169, 3180, 3181, 3414, 3543
< 12 {713}: 3002, 3055, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3414, 3543, 4014
< 11 {712}: 3055, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3414, 3543, 4014
< 10 {711}: 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3271, 3414, 3543, 4014
< 9 {710}: 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3195, 3414, 3543, 4014
< 8 {709}: 3005, 3033, 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3181, 3195, 3197, 3414, 4014
< 7 {708}: 3005, 3055, 3062, 3064, 3088, 3124, 3159, 3181, 3195, 3197, 3414, 4014
< 6 {707}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3414, 4014
< 5 {706}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3210, 3220, 3231, 3247, 3414, 4014
< 4 {705}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3210, 3414, 4014
< 3 {704}: 3005, 3039, 3194, 3195, 3303, 3414, 3502
< 2 {703}: 3005, 3073, 3414, 3502, 2001
< 1 {702}: 3073, 3414, 3502, 4063, 4066, 2001, 2005

SECTION BM_MARIN_HEADLANDS: bottom 1 - top 12
< 12 {16}: 3055, 3124, 3169, 3180, 3181, 3210, 3414, 3543
< 11 {15}: 3055, 3124, 3169, 3180, 3181, 3210, 3414
< 10 {14}: 3039, 3055, 3062, 3064, 3088, 3118, 3124, 3169, 3180, 3181, 3197, 3210, 3414
< 9 {13}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 8 {12B}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 7 {12A}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 6 {11}: 3039, 3055, 3064, 3088, 3148, 3169, 3180, 3181, 3197, 3414, 4049, 4058
< 5 {10}: 3039, 3064, 3088, 3159, 3169, 3181, 3220, 3414, 4014, 4049, 4058
< 4 {9}: 3039, 3064, 3088, 3181, 3414, 4014, 4058
< 3 {8}: 3039, 3073, 3414, 3502, 2001
< 2 {7}: 3039, 3073, 3414
< 1 {}: 3039

4

Radiolarian biochronology and zonations of Tethys

32. Middle Jurassic to Early Cretaceous Radiolarian Biochronology of Tethys Based on Unitary Associations

**by Peter O. Baumgartner[1], Annachiara Bartolini[2], Elisabeth S. Carter[3]
Maurizio Conti[4], Giuseppe Cortese[5], Taniel Danelian[6], Patrick De Wever[7]
Paulian Dumitrica[1,8], Ruth Dumitrica-Jud[1,8], Spela Gorican[9], Jean Guex[1]
Donna M. Hull[10], Norio Kito[11], Marta Marcucci[5]
Atsushi Matsuoka[12], Benita Murchey[13], Luis O'Dogherty[14], Jean Savary[15]
Valentina Vishnevskaya[16], Daniel Widz[17] and Akira Yao[18]**

[1] Institut de Géologie et Paléontologie, Université de Lausanne, BFSH 2, 1015 Lausanne, Switzerland
[2] Dipartimento di Scienze della Terra, Università di Perugia, Piazza dell' Universitá, 06100 Perugia, Italy
[3] Mailing address: 58335 Timber Road, Vernonia, Oregon 97064, USA
[4] Ecosystems s.a.s., Via G.F. Mariti, 10, 50127 Firenze, Italy
[5] Dipartimento di Scienze della Terra, Università di Firenze, Via La Pira, 4, 50121 Firenze, Italy
[6] Dpt of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Rd, Edinburgh EH9 3JW, UK
[7] CNRS-Université P.M. Curie, Laboratoire de Stratigraphie T15-16 E4, 4 Place Jussieu, 75252 Paris Cedex 05, France
[8] Mailing address: Könizstrasse 39, 3008 Bern, Switzerland
[9] Paleontoloski Institut Ivana Rakovca ZRC SAZU, Gosposka 13, 61000 Ljubljana, Slovenia

ABSTRACT

Unitary Associations (U.A.) were calculated with the computer program BIOGRAPH to construct a radiolarian zonation spanning the Middle Jurassic to Early Cretaceous time interval. During test runs, over 60 sections including 800 samples were selected to construct the zonation. Since single runs of the entire dataset revealed too many conflicting superpositional relationships between samples, we had to construct composite sections and to use iterative runs of BIOGRAPH. Regional syntheses were calculated first. Then, regional syntheses from the Mediterranean were combined to make the core of a "snowball" to which successively more data was added. In this way, all data added later were compared to the initially included sections. A synthesis of the Mediterranean Middle and Late Jurassic is calibrated and discussed as a protoreferential. The final zonation spans the Aalenian to early Aptian time interval. It is based on a synthesis including 127 U.A. that were grouped into 22 Unitary Association Zones (UAZones95: 1-22).

Each zone is defined by a number of characteristic taxa or pairs of taxa that co-occur in that zone only. Each zone is calibrated to the standard stages by means of ammonites, nannofossils, calpionellids, dinoflagellates, as well as paleomagnetic and stable isotope stratigraphy. The UAZones are correlated to the earlier zonations of Baumgartner, Gorican, Jud, Murchey, Matsuoka, and Pessagno *et al.*

1. Introduction

One of the prime objectives of the INTERRAD Jurassic-Cretaceous Working Group (Working Group) was to obtain a biostratigraphic correlation throughout the Tethyan Realm and a well-calibrated radiolarian zonation for the Middle Jurassic-Early Cretaceous time interval. In order to achieve a common, and hopefully consistent database, we have tried to come to a consensus concerning over 450 taxa to be used for biostratigraphy. We have limited our work to typical "Tethyan" assemblages from the Central Atlantic, Europe, the Middle East, Japan, Northern and Central Pacific, and Western North and Central America (Fig. 1) By "Tethyan" we understand assemblages extracted from predominantly biogenic sediments deposited at low to middle paleolatitudes under the influence of broadly defined tropical - subtropical current systems.

If all authors could count on similar preservation and sample quality and if all species were equally recorded by all authors then correlation between American, European and Japanese data sets would be no problem. It would just be limited by paleobiogeographic variations from one area to the other, which we tried to avoid by staying in one, broadly defined realm.

The limitations to such an endeavour became very clear during the last years of work:

- There is no exact way to define the "semantics", i.e. the limits of variability of each taxon. There will be always that form that will be included with a species by one author and not included by another. To escape semantic problems, we grouped several closely related morphotypes under species *sensu lato* (*s.l.*) and defined subspecies to be recorded in case of good preservation. (see *Chapter* 2. Concepts). Both species *s.l.* and subspecies are used in the zonation.
- Problems of selective preservation. Large radiolarian species are preferentially preserved in certain assemblages extracted from cherty limestones, while small forms are sometimes indeterminable in the same samples due to coarse recrystallisation of quartz. Small forms, on the other hand, are often abundant in ribbon-bedded cherts or siliceous mudstones. Even the best observer will not be able to produce the same species list of coeval samples in two different lithologies.
- Selective observation. The species list produced by two independent observers of the same sample is not the same, because of an increasing specialisation of radiolarian paleontologists.

At the first meeting of the Working Group, we decided to use the concept of Unitary Associations to construct a set of biochronozones to achieve correlation. Our prime objective, correlation, has governed our way of making the zonation. To achieve "global" correlation, we had to sacrifice vertical resolution and to produce broadly defined zones as will be shown in this chapter.

Since the first zonation constructed for the Tethyan Late Jurassic by Baumgartner *et al.* (1980) we have continued to apply the biochronologic concepts developed by Guex (1977, 1987, 1991). This implies a number of concepts exposed by Guex (1991):

1. We construct discrete biochronologic scales whose subdivisions are characterized by unique and mutually exclusive assemblages of taxa. These subdivisions are non-contiguous and isolated from each other by intervals of separation. This type of biochronologic scale is incompatible with "continuous" biochronologic scales based on intervals separating first and/or last appearances of taxa, such as the interval zones commonly used in microfossil biochronology.

Discrete biochronologic scales best cope with the highly discontinuous nature of the radiolarian fossil record and with the inconsistencies produced by the combination of data from several investigators.

2. The construction of a discrete biochronologic scale implies two steps:

- The compilation of an optimal synthesis of the raw data representing all coexistences, mutual exclusions and superpositional relationships, called the protoreferential (Guex 1991, p. 6-11).
- Evaluation of the lateral traceability of each association of the protoreferential and the union of subdivisions to create reproducible biochronozones (UAZones).

3. The biochronozones created are based on radiolarian data alone. Their superposition defines intervals of relative time that need to be tied to the standard stages by means of other fossils, in our case preferentially ammonites, coexisting with radiolarians in the same sections. This procedure is called calibration (Guex 1991, p. 203-204).

2. Procedures and notations

2.1. Unitary Associations

An Unitary Association (U.A.) is a maximal set of mutually compatible taxa (Guex 1991, p. 15). This means that the co-occurrences expressed in the set is not contained in any larger set. In general, Unitary Associations are constructed by stacking the co-occurrence information of the whole data set and searching for maximal sets of really or vitually coexisting taxa, in applying the law of transitivity.

2.2. The program BIOGRAPH

The program BIOGRAPH (Savary & Guex 1991) was designed to calculate Unitary Associations baed on the algorithms developed by Guex (1988, 1991). These algorithms are largely based on the Graph theory (Roberts 1976). U.A. represent a deterministic approach to resolving complex biostratigraphic relationships. In the following, we

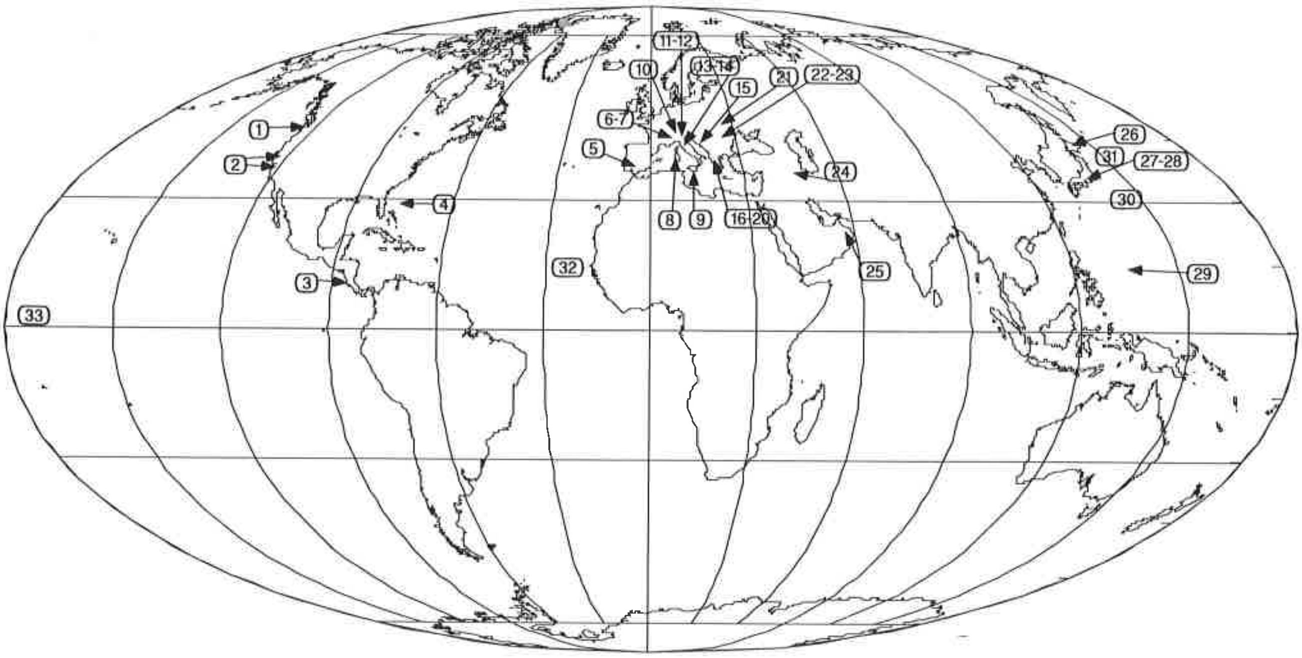


Figure 1. World map with location of the sections studied for Biostratigraphy

1. **British Columbia** Graham Island
2. **California** Geysers, Marin Headlands, Stanley Mountain
3. **Costa Rica** Nicoya
4. **DSDP** Leg 76 S 534, Leg 1, Site 5
5. **Subbetic** Cerro La Martina, Sierra De Ricote, S. Harana, Casa Blanca
6. **French Alps** Schistes Lustrés-Queyras
7. **Italian Alps** Schistes Lustrés-Traversiera
8. **Alpine Corsica** Balagne
9. **Sicily** Galati, Contrada La Ferta, Santa Anna Sicily
10. **Prealps** Pfaffengrat
11. **Southern Alps Lombardy Basin** Capriolo, Breggia-Gorge, Cava Rusconi, Torre de Busi, Sangiano, Valmaggiore, Besozzo, Saltrio
12. **Southern Alps Trento Plateau** Serrada, Ceniga, Madonna della Corona, Kaberlaba, Mazze,Vajont Dam, Val Ardo, Ponte Serra
13. **Northern Apennines, Ligurian area** Tuscan Cherts, Costa Scandella, Val Graveglia, Monte Rossola, Rocheta di Vara, Monte Vitalba, Il romito, Riparbella, Quercianella, Murlo, Il Conventino, Campanello, Sovana-Elmo
14. **Northern Apennines, Umbria-Marche area** Bosso, Valdorbia, Ranchi Superiore, Campo al Bello, Pieia, Gorgo a Cerbara, Presale, Bottacione, Terminilletto, Colle Bertone
15. **Budva Zone** Verige , Bijela I, Bijela Ii, Bijela Iii Iv, Gornja Lastva, Petrovac, Canj, Din Vrh, Bar
16. **Pindos-Olonos Zone**
17. **Argolis Peninsula** Theokafta, Koliaki,Dhimaina
18. **Ionian Zone** Ano Kouklessi, Kato Kouklessi, Vathi, Khionistra, Paliambella, Skandhalon, Varathi
19. **Maliac Zone** Maliac
20. **Almopias Zone** Almopias
21. **Carpathians Pieniny Klippen Belt** Skala, Podmaj, Szafl, Szczwyz
22. **South Carpathians** Svinita
23. **East Carpathians** Pojoritas
24. **Lesser Caucasus** Zod Pass, Mount Karawul, Koshuni River Basin
25. **Oman** Wahrah Fm Al Hammah
26. **Hokkaido** Furano area, Ashibetsudake area, Teshio area
27. **Southern Chichibu Terrane** Oyashiki, Shiraishigawa, Yanasegawa, Kawanouchi
28. **Mino Terrane** Kashibara, Hisuikyo, Inuyama, Gujo Hachiman
29. **DSDP** Leg129 Site 800a, Leg129 Site 801b
30. **DSDP** Leg32 Sites 306, 307
31. **DSDP** Leg20 Sites 195, 196
32. **DSDP** Leg41 Site 367

comment on some of the terms used in the discussion of the results obtained by BIOGRAPH. The extensions of BIOGRAPH files is given in parentheses (e.g. TGI). For a full explanation of the method and of the functionality of BIOGRAPH we refer to Savary & Guex (1991) and Guex (1991).

In the Graph theory an **arc** is a directional relationship between two **vertices**, i.e. the information "older than" or "younger than" between two taxa or samples. An **edge** is a non-directional relationship, i.e. coexistence.

Unitary Associations are ordered stratigraphically and the mutual relationships of association or exclusion are listed in a **protoreferential** (TGJ). This list looks like a range chart. However, it differs from a usual range chart by not implying any scale, i.e. the "range" of each species is defined only by the ordering of U.A. and does not imply time or thickness. A protoreferential can be expressed as numerical table listing all species and their U.A.-ranges (TGI). This table can be retreated by the program like a section, where the U.A. correspond to sample levels. The TGI describes all taxon relationships present in the included data.F

Reproducibility Tables (TGL) are established (Fig. 4) to evaluate the superpositional control and the lateral traceability of U.A. Several U.A. are united to create **UAZones** (see below).

A **Correlation Table** (TGK) is produced by the program showing the U.A. range of all samples included with the dataset (*Chapter* 38). U.A.- or UAZ.-ranges are stated for each sample individually. However, superpositional relationships of samples in a section often allow us to define more precisely the assignment of a sample: If a lower sample ranges, for instance, from UAZ. 4 to 6 and the next higher from 4- to 4, it is obvious that the lower sample does not range higher than the next one, but is less well defined. Both samples are said to range from 4 to 4.

A **Report** (REP) is produced by each run of BIOGRAPH, that contains information on the number of contradictions encountered. The information of all runs used for the construction of the UAZones95 is given in Figure 2.

3. Construction of protoreferentials based on Unitary Associations

3.1. Problems and solutions

Our complete database contains over 1400 horizons (samples) from 168 sections including 451 species (see *Chapter* 37). This is the largest database ever used to construct a biochronologic framework by means of a deterministic and computerised analytical tool, such as BIOGRAPH. During the early phases of this work, we tried to put all data into one DAT file and run it with BIOGRAPH. The program had no problem of capacity, but it would take hours to calculate a solution and the number of contradictions was enormous.

In the introduction we have mentioned a number of methodological problems that must be responsible for inconsistencies in our data, such as taxonomic inhomogeneity and selective observation amongst the different investigators. Even putting these problems aside, two fundamental difficulties remain that are characteristic of the Mesozoic radiolarian record:

1. The total ranges of radiolarian species are long relative to the time represented in our sections.

2. The local stratigraphic record is usually very incomplete due to partial preservation or non-preservation in certain intervals of a section. An excellent example is the Middle Jurassic chert section of the Inyuama area (Central Japan, *Chapters* 27-28). While chert or siliceous mudstone samples contain a few tens of morphotypes at most, the manganese carbonate levels within the same sequence have revealed up to 290 morphotypes (IN-7, *Chapter* 28). This diversity is close to diversities observed in the richest bottom samples of Recent. sediments. It is interesting to note that practically none of the species observed in coeval European or North American assemblages is absent from these extremely rich samples, whereas residues from cherts are biased towards small forms.

As a result of these two properties, the local stratigraphic ranges are in general very incomplete and the local superpositional relationships between species is very likely to be contradicted by other localities. The algorithm executed by BIOGRAPH goes through a mutual comparison of all samples and seeks to establish an "older than" or a "younger than" relationship between pairs of levels, based on the superpositional information in each section. Again, as a result of the highly truncated local ranges, this comparison may result in a contradiction, which means, some of the species of one sample of the pair indicate an "older than", whereas others indicate a "younger than " relationship. Each contradiction between two samples is analysed in terms of conflicting arcs that relate species as "younger than" or "older than". For every single contradiction there may be up to several hundred conflicting arcs. In the complete dataset over 100'000 inter-sample relationships are conflictual, which implies several million to several tens of million conflictual species relationships. These multiple conflictual relationships create cycles ("strongly connected components" = SCC in Fig. 2) in the graph that represents the superpositionsl relationships. The cycles (SCC) detected by the program imply two or more (sometimes many) samples (vertices of the graph) whose relationships create a circular structure. The detection of such cycles by the program BIOGRAPH objectively indicates that *a priori*, no univocal and reliable chronologic sequence can be established between the implied samples. The program produces a solution that minimises conflictual relationships by converting them into virtual coexistences.

However, it cannot resolve the encountered conflicts. It is up to the user, to analyse the strongly connected components and the implied samples listed by the program. The experience has shown that strongly connected components result from inconsistent data caused by taxonomic errors, poor documentation resulting from poor preservation, reworking etc. These problems can only be resolved by reexamination of the suspect samples indicated by the program. For the database used in this chapter, we have been able to revise only part of the samples. A complete revision of the data was impossible. In running even partially revised datasets, we still obtained 20 or more strongly connected components with several hundred (!) implicated samples. The resulting protoreferentials had to be qualified as totally unreliable. We had to test other ways of dealing with these problems:

1. Selection of data. Many sections in the database consist of one or two samples, containing few species only. These sections do not contribute significant superpositional information, but add numerous contradictions. In countless tests we have determined which sections are most difficult to include, because they are poorly documented (poor sample preservation) or because they consist of a few samples only, and result in adding high numbers of contradictions. We then have eliminated these sections from the dataset used for the construction of protoreferentials (these sections are marked with an * in the database, *Chapter* 37-38).

2. Composite sections. The program has no information on superposition of samples except the one provided by the data. One way to decrease the number of superpositional contradictions is to construct composite sections (for a theoretical discussion of this topic see Guex 1991, p. 17, 23). Whenever we knew stratigraphic relationships between two localities from lithologic correlation, from regional geologic data, or from associated fossils, we constructed composite sections, to tell the program all known information about superposition of the included radiolarians. We also added sometimes artificial samples containing those species known to range lower or higher than the section concerned.

These two interventions have considerably reduced the number of contradictions.

3. Snowball processing of data. This procedure was developed during the numerous runs of combinations of sections for the zonation presented here. It is explained in the next paragraph.

3.2. Snowball processing of data

The method implies multiple runs of the BIOGRAPH program. The first run creates a synthesis of a few selected sections that were thoroughly revised after test runs indicating conflictual data. These sections are well documented and cover a long stratigraphic interval. This initial synthesis contains a certain number of U.A. that are superposed and represent all relationships found in the treated sections. This information is used for the successive run as a composite section. In fact, the program produces a "numerical range chart" (TGI) that can be directly used as data for the next run. Figure 2 illustrates the procedure.

We have started the snowball with a composite of 4 sections from the Umbria-Marche Apennines, called N33UMB, that is combined with a composite of the sections from the Budva Zone (*Chapter* 18) called GO94 (Fig. 2). The two local syntheses were run together and the result was called NUMBGO. The sections of both the Umbria-Marche and the Budva zones cover the Aalenian to Berriasian time interval. The number of contradictions (noted in Fig.2 in the lower left box as C) for each run is considerable but much less than for a single run with all data combined. Even more important is the fact that we could reduce the number of strongly connected components (SCC) to one for each local synthesis and to zero for the combination. This means that such a synthesis is likely to contain reliable information on the superposition of all samples combined.

The Composite NUMBGO is combined with the composite of Sierra de Ricote and the Southern Alps, called RISA, to make NMRDA39. Each step is illustrated in Figure 2. Most of the combinations of sections have been tried out. The presented version is optimal in terms of stratigraphic length and moderate numbers of contradictions, strongly connected components and undetermined arcs.

The rationale for proceeding in this way is the following: In the early phase of the snowball, consistent, well documented and long ranging data establish a relational framework that, if compared to additional data is likely to be robust, i.e. contain a large number of superpositional relationships to compensate for the incompleteness and the possible inconsistencies of the newly added data. In fact, the more the snowball grows, the less contradictions are counted in the process of adding new data. Inevitably, this process leads to a weighing of the data. The earlier a section is entered into the snowball the more important is its weight, when the program converts conflictual superposition into association.

The following rules have governed the combination of sections: 1. Regional syntheses were produced first and then compared to other regional syntheses. 2. The major part of the snowball concerns the Jurassic only (up to NMRD44, Fig. 2). 3. We proceeded from the Mediterranean Tethys to Japan and to Western North America. 4. We added SICILY95 after, because of numerous problems with this data. 5. To splice the Jurassic and the Lower Cretaceous together, we used the Neocomian synthesis RJRUN93 by Jud (*Chapter* 12) combined it with the Jurasssic snowball NMRD44 and added 3 physical sections in which data from JUD were stratigraphically superposed on Jurassic data (Sangiano-Rusconi, Breggia, Bosso, see *Chapters* 5, 12, 37). The result was less than 500 contradictions for the synthesis JUCR95.

The cumulated total of contradictions is about 7000 up to the final snowball JUCRMASA, instead of over 25000, if all the data is run together. JUCRMASA is the immediate precursor of NMDR482, illustrated in Fig. 3, and used below to construct the UAZones.

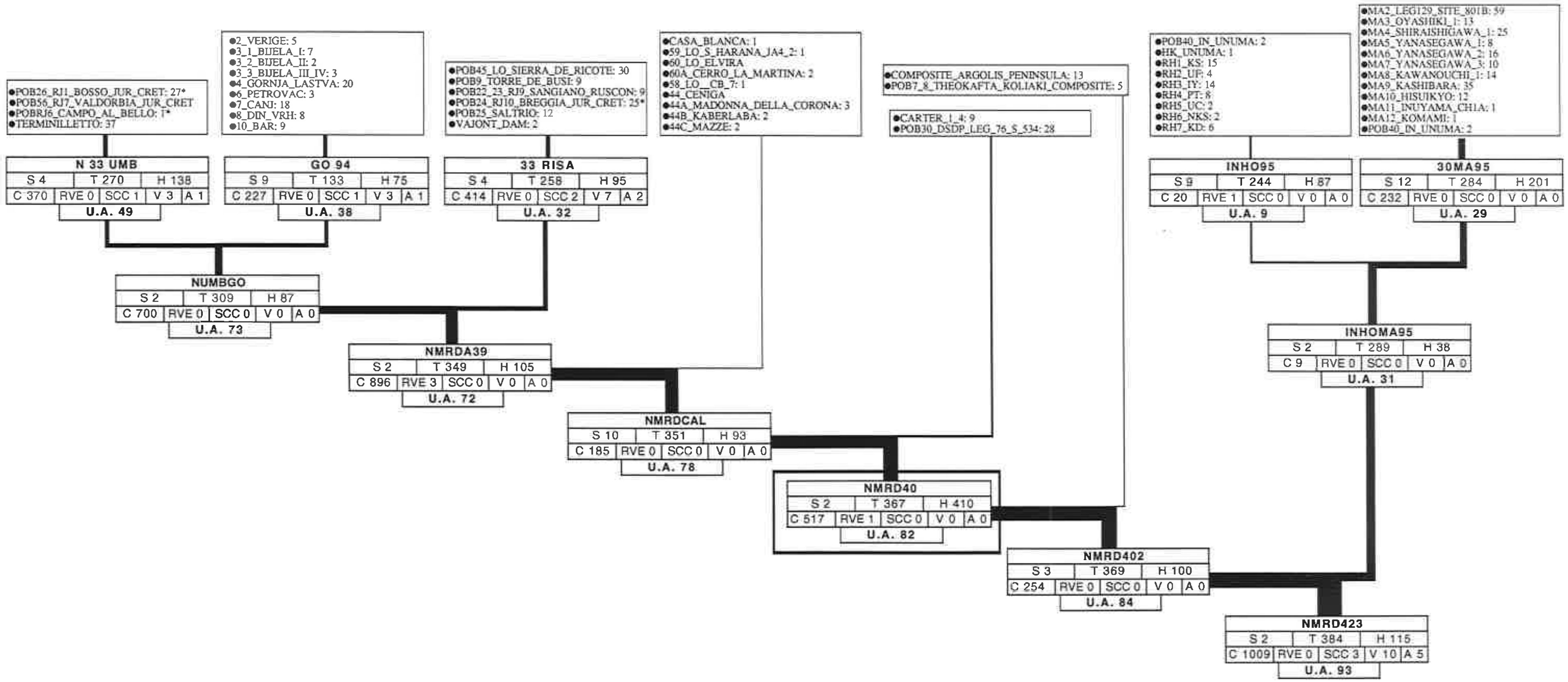


Figure 2. Flow chart indicating how the data was combined in the snowball processing to create the final zonation. Top rectangles contain the introduced sections with the number of samples. Frames with numbers indicate each individual run of BIOGRAPH. In these frames, the top rectangle gives the name of the datafile in bold (e.g. N33UMB), the bottom rectangle the number of obtained Unitary Associations in bold (e.g. U.A. 49). The internal numbers indicate: S= number of samples, T= number of taxa, H= number of horizons (samples), C= number of contradictions, RVE= number of residual virtual edges, SCC= strongly connected components, V=vertices implied in strongly connected components, A=undetermined arcs in strongly connected components. This data is extracted from the report file (REP) produced by each run of BIOGRAPH. The smaller these numbers (especially SCC, see text) the more reliable is the result. The thickness of the lines connecting the frames is proportional to the number of samples included and grows towards the bottom right as more samples are added to the snowball. Note that we have first produced local syntheses (Umbria, Budva, Southern Alps, Japan, Sicily, etc.). We have then combined these local syntheses to form the snowball. The Jurassic and the Lower Cretaceous synthesis by Dumitrica-Jud (Chapter 12) were spliced together by running the composite RJRUN93, and 3 physical sections (Sangiano-Rusconi, Breggia and Bosso) where we have a continuous Middle Jurassic-Lower Cretaceous sample record, with the Jurassic snowball NMRD44. It is obvious that some data is entered twice into the snowball. The sample numbers with stars in the top rectangles are partial sections indicating the number of new samples added. The numbers of sections (S) and horizons (H) in the run frames are not only real sections but also composites, e.g. NUMBGO contains S=2 composite sections with a total of H=87 Unitary Associations. A total of 800 samples from 66 sections has been used to construct the proporeferential JUCRMASA, that is the basis for the UAZones95.

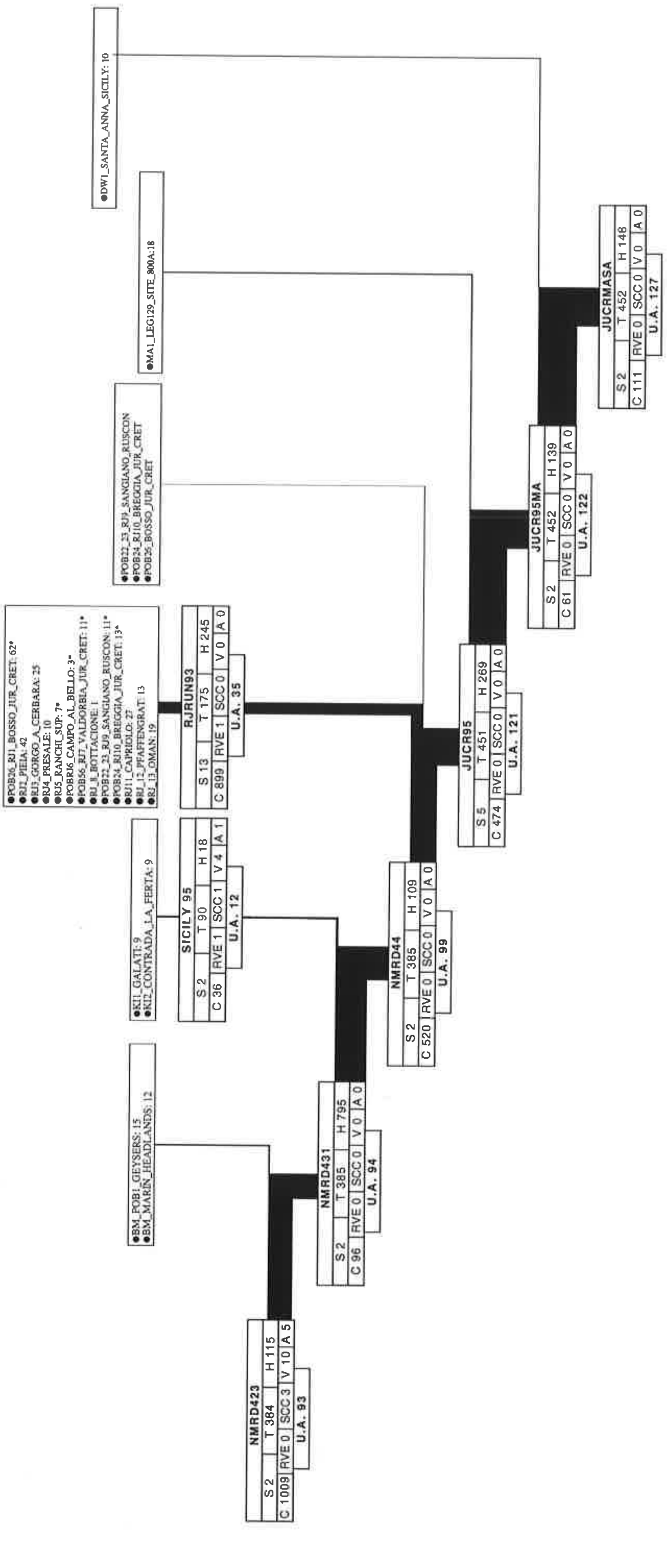


Figure 2. Continued

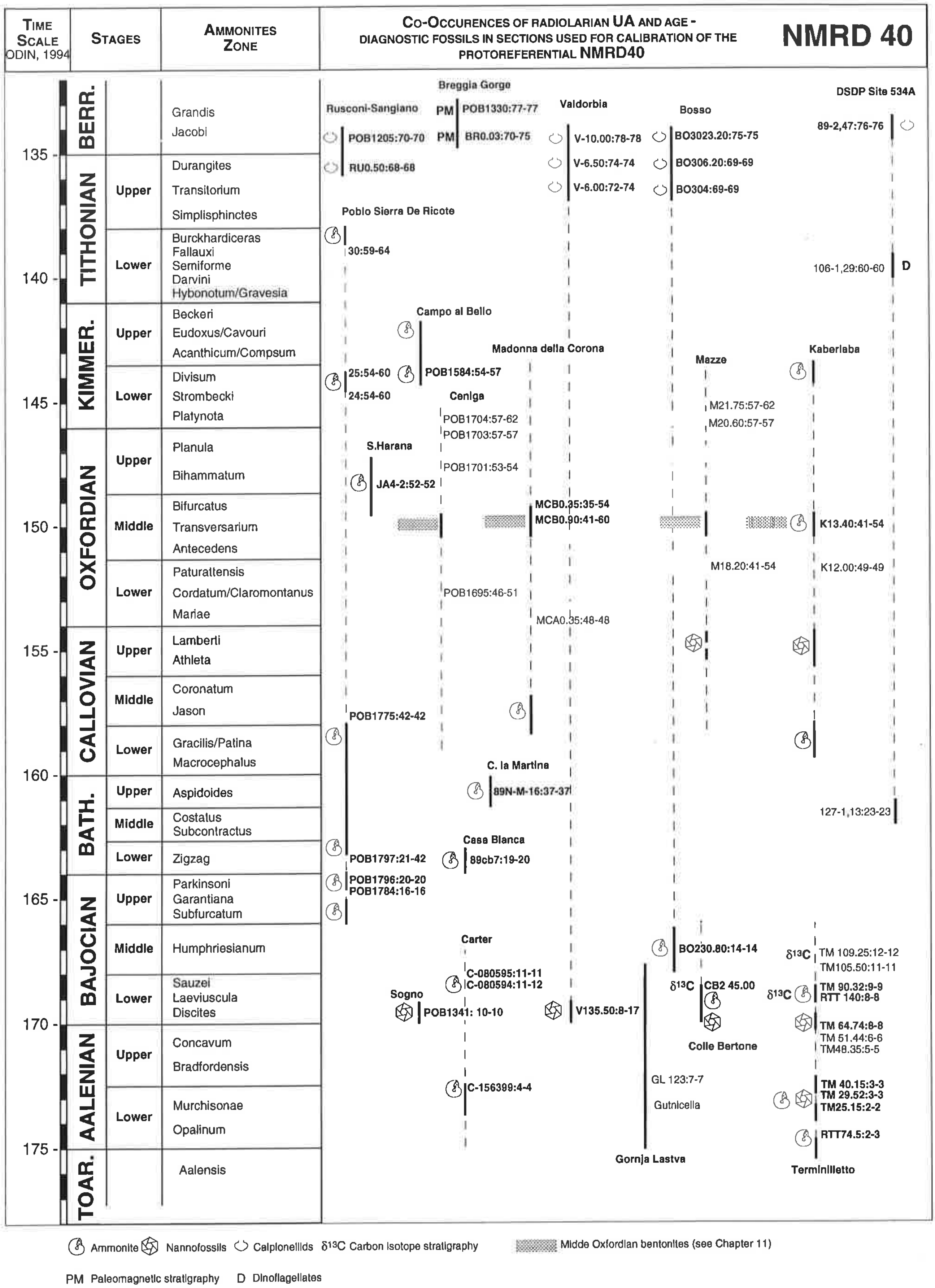


Figure 3. Co-occurrences of Unitary Associations of NMRD40 and age-diagnostic fossils in the sections used for calibration. Thick vertical lines indicate the range of the fossils shown by a symbol. The sample numbers are positioned at the same level, below or above these fossils indicating the actual stratigraphic relationship. Time scale after Odin (1994), Ammonite Zones after Poitiers Proceedings (1991).

3.3. A protoreferential for the Tethyan Jurassic: NMRD40

NMRD40 (framed in Fig. 2) is a synthesis that consists of sections from the Umbria-Marche-Sabina Apennines, the Budva Zone, the Subbetic, Southern Alps and the Central North Atlantic. The composite scction form British Columbia (*Chapter* 29) was added to achieve better calibration in the lower Middle Jurassic. The total of contradictions for all runs is about 3300, but the number of SCC is only 4 of which none occurs in the snowball. We believe that this protoreferential reflects reasonably well the stratigraphic relationships within the Atlantic-Mediterranean Tethys. In Appendix 1. we give the Correlation Table (TGK) that lists the U.A. assignment of all included samples. Appendix 2 contains the numerical ranges of all species (TGI) for this protoreferential. This synthesis was calibrated (Figure 3). It served as a test for the consistency of the core of the snowball. It is clear in Fig. 3 that no obvious contradictions exist between ascending U.A.- numbers and the position of the respective samples on the time scale. However, it is also clear from Fig. 3 that individual U.A. *a priori* have no biochronologic meaning. Note that this is the reason to call this sequence of U.A. a protoreferential and not a "zonation" (see Guex 1991, p. 6-10). As an example we may take the sections Valdorbia and Bosso, both well calibrated by calpionellids in their upper part and both in the same basin. At Valdorbia the UA-range of upper Tithonian samples is 72-74, whereas coeval samples from Bosso all fall into U.A. 69. Obviously, the U.A. 69 to 74 have to be regarded as coeval (and should be grouped into one biochronozone, see UAZ95). These U.A. may result from differences in faunal composition due to paleogeography: Valdorbia shows a more important input of resedimented material from shallower water, including different radiolarian assemblages.

3.4. The protoreferential used to construct the zonation: NMRD482

NMRD482 is directly derived from JUCRMASA (Fig. 2) by removing all the composite sections that are not physical and by adding a few more sections that do not produce contradictions. The snowball used in the calculation of this protoreferential is, however the numerical range chart (TGI) of JUCRMASA. Figure 4 illustrates the reproductibility chart of this protoreferential. There are 127 U.A. recorded in 60 sections of which two are composites: UARJRUN93 and UAJUCRMASA. Of the Lower Cretaceous only the Jurassic-Cretaceous composite sections Sangiano-Rusconi, Breggia and Bosso are represented, as well as the UARJRUN93. 7 more sections from Jud (*Chapter* 12), that were included with the snowball are not illustrated, which accounts for a lot of empty space in the upper part of the figure. Each U.A. of the protoreferential is recognised only one or a few times. These U.A. have no correlation potential and the lack of superpositional control does not allow us to assign them any biochronological value (Guex 1991). The horizontal lines indicate the limits of U.A. Groups that have been united to construct the UAZones presented below.

4. Construction and Calibrations of the Zonation UAZones95

4.1. Definition of UAZones

A UAZone (abbreviated for Unitary Association Zone) is a biochronozone that results from the union of two or more Unitary Associations that exist in the protoreferential. The procedure follows Guex (1991, p. 15-16). The union of initial Unitary Associations is necessary to increase the reproducibility of the resulting UAZones. All characteristic elements of the united Unitary Associations are considered as virtually coexisting. The UAZones are characterised by:

1. The set of species and species pairs characteristic of each of the U.A. that were united.
2. A set of new elements consisting of the species and species pairs exclusively found in this union.

4.2. Rationale for the construction of UAZones

As we have seen above (Fig. 4), the reproducibility of the Unitary Associations created by the snowball is very poor. Many U.A. exist only in one or two of the sections and their potential for correlation is therefore minimal. However, in grouping U.A. into UAZones, we reach a good reproducibility (Figure 5) that allows us to attribute a chronostratigraphic significance to each UAZone. The process of calibration (see below) has confirmed this significance in that each UAZone can be correlated with a time slice of variable duration and expressed with variable precision.

By definition, the ranges of characteristic species and species pairs start at the base or end at the top of a UAZone (Figure 6). Since we do not know the chronostratigraphic significance of the initial U.A. that constitute the UAZone, we cannot define ranges that start or end anywhere within a UAZone. This procedure has the inconvenience, that we assume certain virtual coexistences within UAZones, which result in longer ranges of species than can be observed in the data. The placement of the limits between UAZ (horizontal lines in Fig. 4) was governed by seeking reasonable superpositional control and good lateral reproducibility.

4.3. Definition and Calibration of UAZones95 1-22

In the following, each UAZone (UAZ.) is defined by its characteristic species/subspecies or species pairs, which define the zone by its co-occurrence. Only a selection of characteristic species are mentioned. For the full definition we refer to Figure 6. Radiolarian faunal change, expressed by the number of first and last occurrences (FO, LO) defining each UAZ., is briefly discussed for those UAZ that show a significant dominance of either FO or LO.

The correlation with an age range (calibration) is summarised in Figure 7. for the Jurassic UAZones. It is based on the co-occurrence with age-diagnostic fossils, and paleomagnetic or isotope stratigraphy. For the Cretaceous calibration, we refer to *Chapter* 12. For details we refer to all biostratigraphic *Chapters* 5-31, as well as to the complete listing of samples and their calibration in *Chapter* 38. The precision of this calibration is highly variable. As can be seen from Figure 7, we achieved good calibration in the Aalenian-lower Bathonian, middle Oxfordian-lower Kimmeridgian and the upper Tithonian-Berriasian

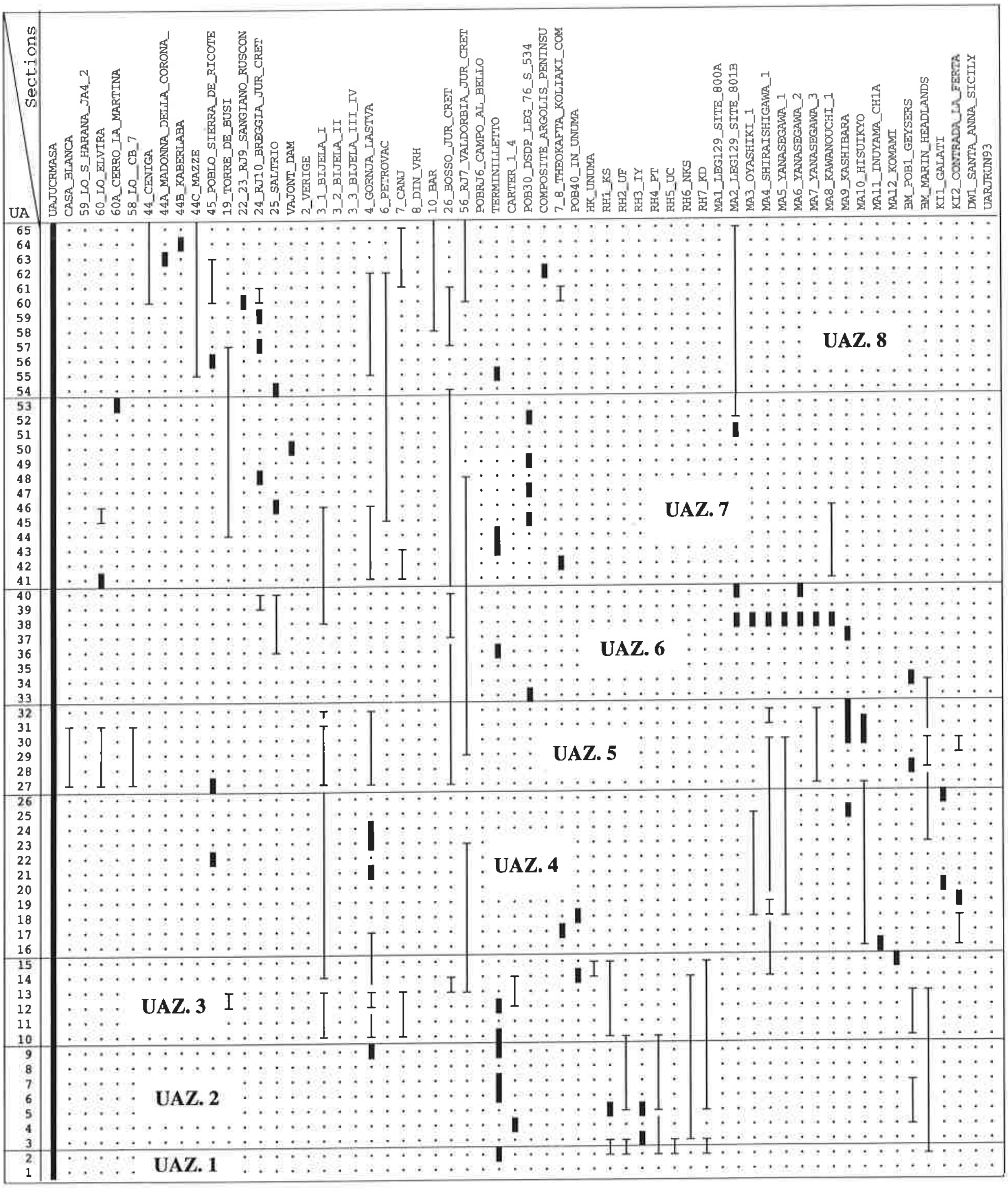
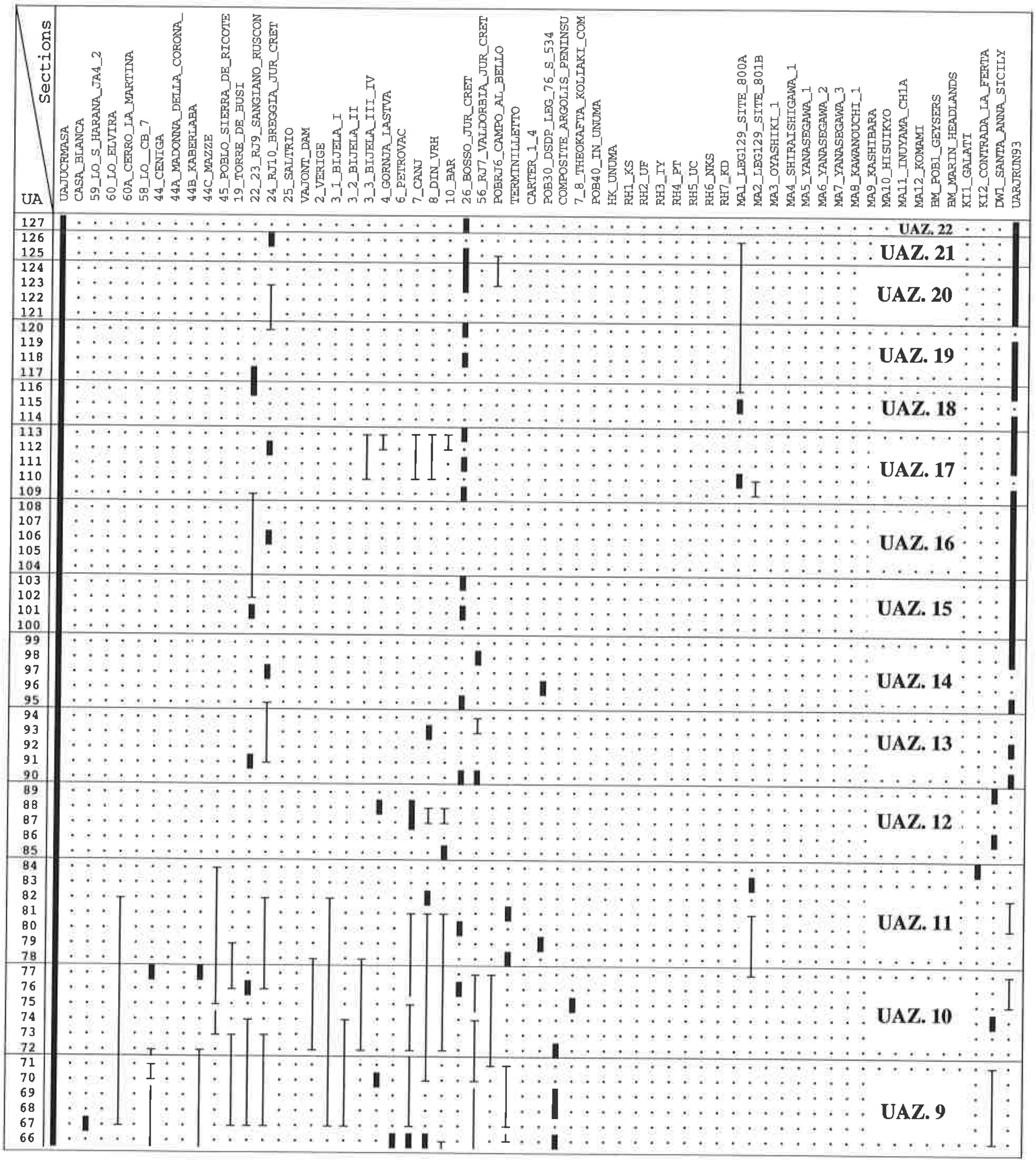


Figure 4. Reproducibility table of NMRD482 showing the distributution of 127 Unitary Associations in 60 sections, of which 2 are composites: UAJUCRMASA (left) and UARJRUN93 (right). The lower Cretaceous sections by Dumitrica-Jud (Chapter 12) were

intervals. For the Neocomian, we mostly followed the calibration of Dumitrica-Jud (Chapter 12), since there is a one to one correlation between her zonation and the UAZones95 (see below).

UAZone 1 is defined by the following characteristic species: (Fig. 6a-g, Foldouts 1-7): *Parashuum cruciferum* (MRD 2010), and *Parashuum* sp. M (MRD 2015)

Calibration: UAZone 1 is correlated with an early-middle Aalenian age, based on the co-occurrence with: Ammonites and nannofossils in the Terminiletto section in the Umbria-Marche-Sabina Apennines (Fig. 7, Chapter 15, Chapter 38). UAZ. 1 has been identified in several sections from the Inuyama Area (Central Japan, Chapter 28). Since this is the lowest UAZ. of the present zonation, its oldest age can be older than Aalenian.



included but are not shown. To increase superpositional control and lateral traceability, U.A. were grouped into UAZones (UAZ. 1-22). The horizontal lines indicate where the limits for this grouping were placed.

UAZone 2 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): *Yamatoum caudatum* (MRD 2016) and *Yamatoum komamiensis* (MRD 2020) are characteristic of UAZ.2, 8 species/subspecies range from UAZ. 1 to 2 and co-occur with 15 species/subspecies that range from UAZ 2 upwards.

Calibration: UAZone 2 is correlated with a late Aalenian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): It has been identified above middle Aalenian and below early Bajocian Ammonites and nannofossils in the Terminiletto section in the Umbria-Marche-Sabina Apennines (Chapter 15). It co-occurs with late Aalenian ammonites in the Yakoun River Section, Graham Island, British Columbia (Chapter 29).

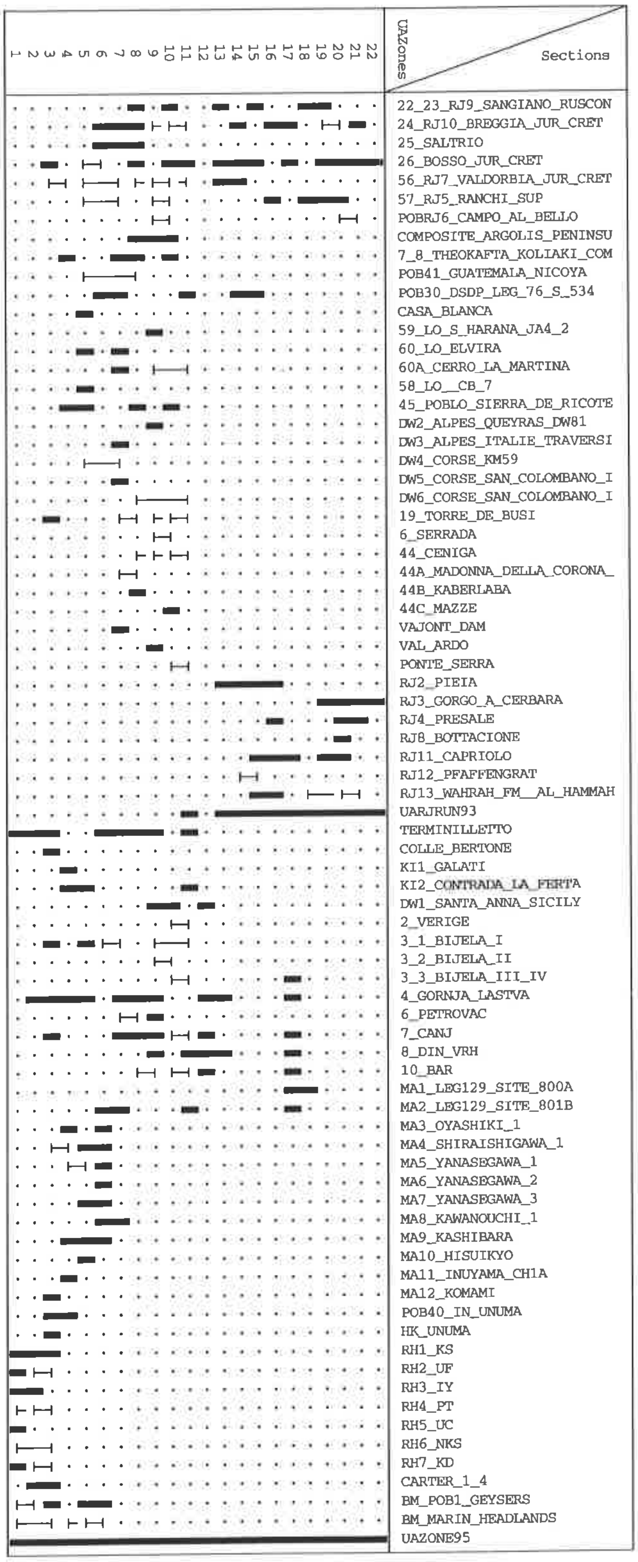


Figure 5. Reproducibility table of UAZ9504 showing the distributution of UAZones 1-22 in 60 sections, of which 2 are composites: UAZONE95 (bottom) and UARJRUN93 (middle). The lower Cretaceous sections bur Dumitrica-Jud (Chapter 12) were included but are not shown. Most UAZ. have a good superpositional control and are reproduced in the sections covering their age range.

UAZone 3 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): 4 species are characteristic of UAZ. 3. 11 species range up to UAZ. 3 and co-occur with 59 species ranging from UAZ. 3 upwards. First occurrences (FO) dominate largely over last occurrences (LO) which implies an important diversification of radiolarian faunas during the time interval represented by this UAZ.

Calibration: UAZone 3 is correlated with an early-middle Bajocian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): It has been identified co-occurring with early Bajocian Ammonites and nannofossils in the Terminiletto and Colle Bertone sections in the Umbria-Marche-Sabina Apennines (Chapter 15). It co-occurs with lower Bajocian ammonites in the Branch Road 57 Section, Graham Island, British Columbia (Chapter 29). It co-occurs with lower Bajocian nannofossils in the Torre de Busi Section (Southern Alps, Chapter 11). It is found immediately above middle Bajocian *(Humphiesianum* Zone) ammonites in the Bosso Section (Chapter 5) This UAZ. is correlated with the early Bajocian d13C maximum in the Terminilletto and Colle Bertone sections (Chapter 15). This maximum ranges from the *Laeviuscula* to the *Humphiesianum* ammonite Zones in the Digne area (Southern France, Corbin 1994).

UAZone 4 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): *Quarticella ovalis* (MRD 4078) is characteristic of UAZ. 4. 25 species range up to UAZ. 4 and co-occur with 35 species ranging from UAZ. 4 upwards.

Calibration: UAZone 4 is correlated with a late Bajocian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): It is associated with upper Bajocian *(Subfurcatum-Garantiana* Zone and Parkinsoni Zone) ammonites in the Sierra de Ricote Section (Subbetic, Chapter 8)

UAZone 5 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): 3 species are characteristic of UAZ. 5: *Stichocapsa* sp. E (MRD 4042), *Tricolocapsa tetragona* (MRD 4054), *Tricolocapsa* sp. M (MRD 4056). 10 species range up to UAZ. 5 and co-occur with 23 species ranging from UAZ. 5 upwards.

Calibration: UAZone 5 is correlated with a latest Bajocian-early Bathonian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): At Sierra de Ricote, and at Casa Blanca (Subbetic, Chapter

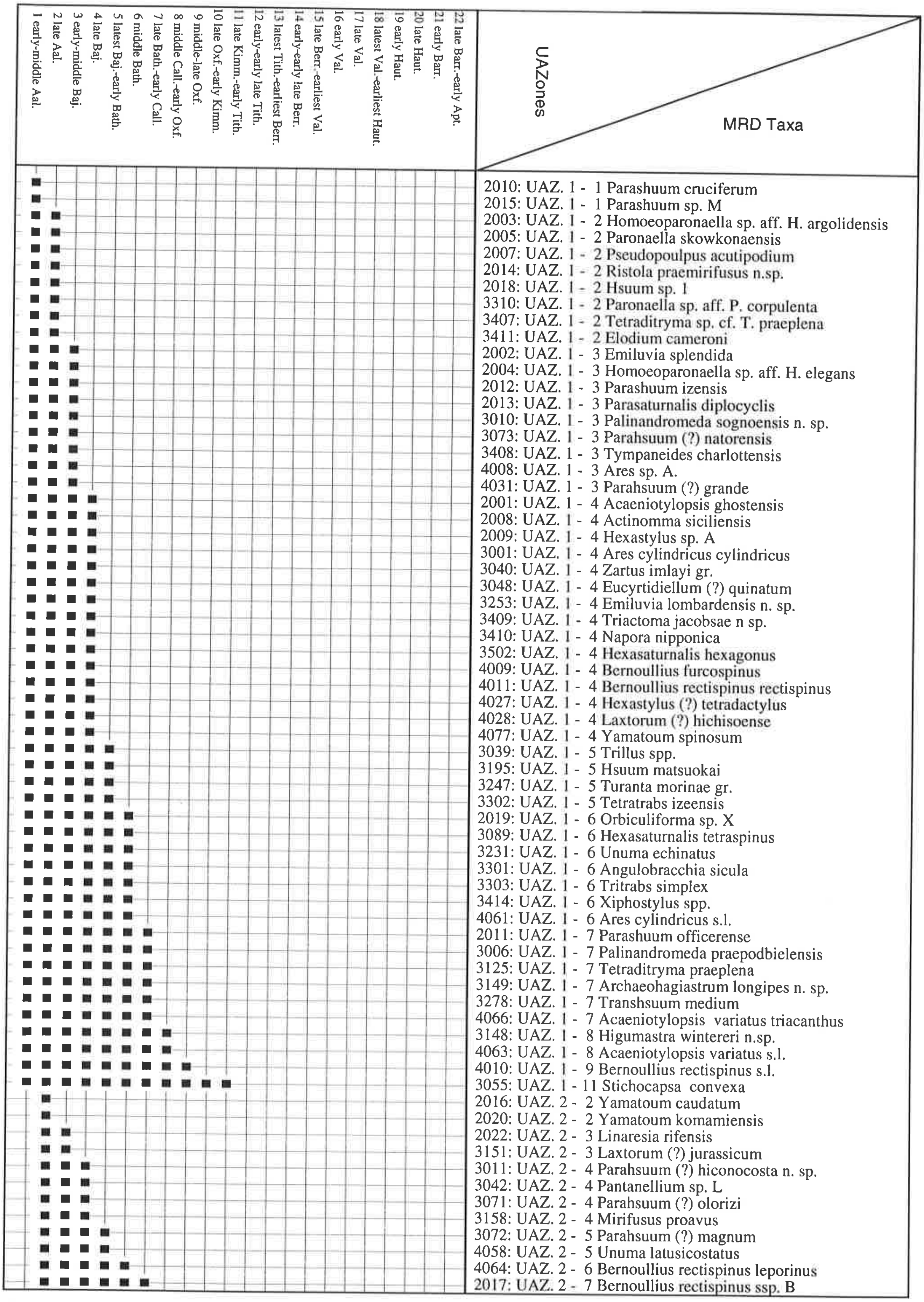


Figure 6 a -g. Ranges for 451 taxa with respect to the UAZones 1-22 (age assignment see top left). In the right column the MRD-code and the numerical range are stated together with the name of the taxa.

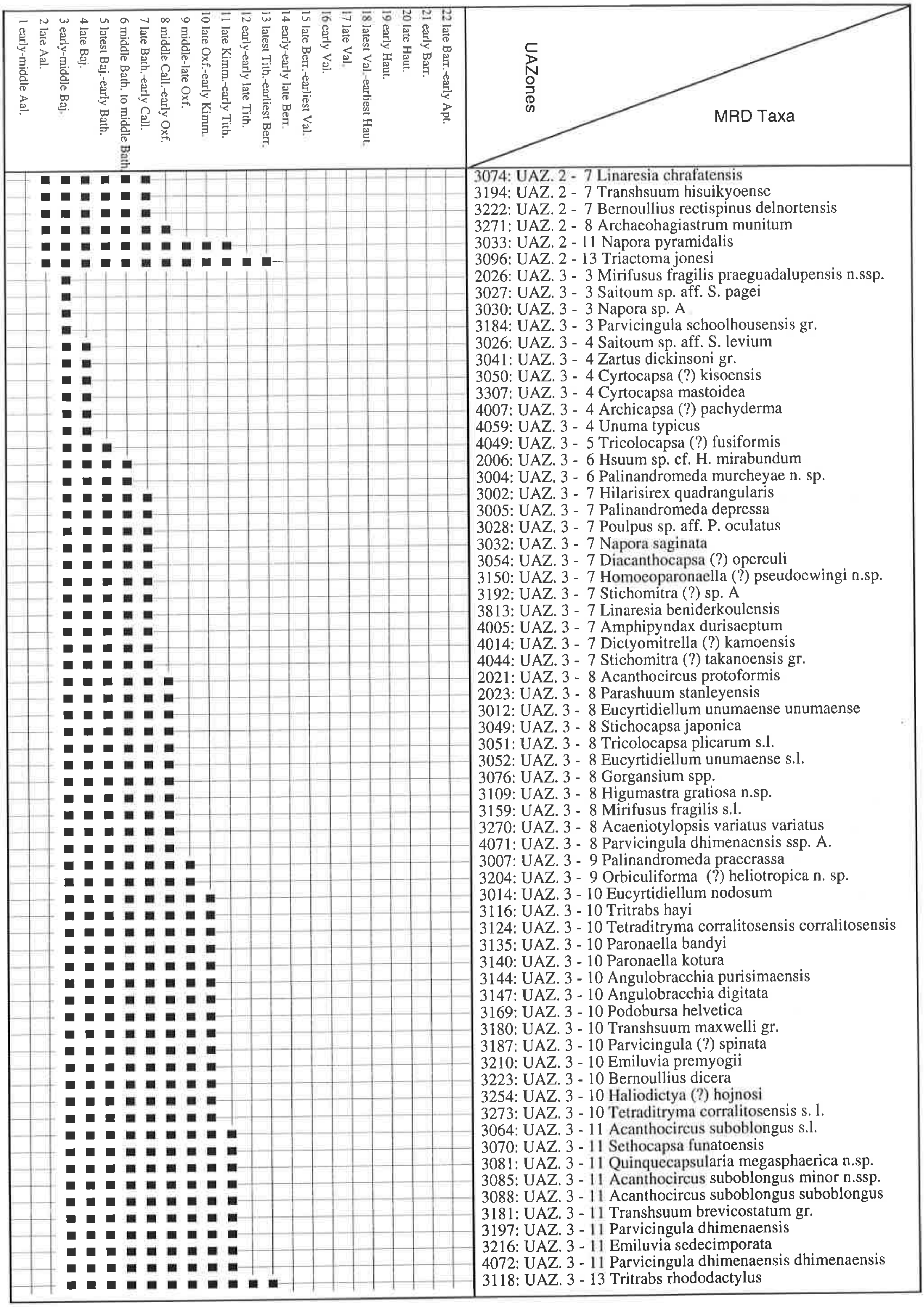

UAZones
MRD Taxa
1 early-middle Aal.
2 late Aal.
3 early-middle Baj.
4 late Baj.
5 latest Baj.-early Bath.
6 middle Bath. to middle Bath
7 late Bath.-early Call.
8 middle Call.-early Oxf.
9 middle-late Oxf.
10 late Oxf.-early Kimm.
11 late Kimm.-early Tith.
12 early-early late Tith.
13 latest Tith.-earliest Berr.
14 early-early late Berr.
15 late Berr.-earliest Val.
16 early Val.
17 late Val.
18 latest Val.-earliest Haut.
19 early Haut.
20 late Haut.
21 early Barr.
22 late Barr.-early Apt.
3074: UAZ. 2 - 7 Linaresia chrafatensis
3194: UAZ. 2 - 7 Transhsuum hisuikyoense
3222: UAZ. 2 - 7 Bernoullius rectispinus delnortensis
3271: UAZ. 2 - 8 Archaeohagiastrum munitum
3033: UAZ. 2 - 11 Napora pyramidalis
3096: UAZ. 2 - 13 Triactoma jonesi
2026: UAZ. 3 - 3 Mirifusus fragilis praeguadalupensis n.ssp.
3027: UAZ. 3 - 3 Saitoum sp. aff. S. pagei
3030: UAZ. 3 - 3 Napora sp. A
3184: UAZ. 3 - 3 Parvicingula schoolhousensis gr.
3026: UAZ. 3 - 4 Saitoum sp. aff. S. levium
3041: UAZ. 3 - 4 Zartus dickinsoni gr.
3050: UAZ. 3 - 4 Cyrtocapsa (?) kisoensis
3307: UAZ. 3 - 4 Cyrtocapsa mastoidea
4007: UAZ. 3 - 4 Archicapsa (?) pachyderma
4059: UAZ. 3 - 4 Unuma typicus
4049: UAZ. 3 - 5 Tricolocapsa (?) fusiformis
2006: UAZ. 3 - 6 Hsuum sp. cf. H. mirabundum
3004: UAZ. 3 - 6 Palinandromeda murcheyae n. sp.
3002: UAZ. 3 - 7 Hilarisirex quadrangularis
3005: UAZ. 3 - 7 Palinandromeda depressa
3028: UAZ. 3 - 7 Poulpus sp. aff. P. oculatus
3032: UAZ. 3 - 7 Napora saginata
3054: UAZ. 3 - 7 Diacanthocapsa (?) operculi
3150: UAZ. 3 - 7 Homoeoparonaella (?) pseudoewingi n.sp.
3192: UAZ. 3 - 7 Stichomitra (?) sp. A
3813: UAZ. 3 - 7 Linaresia beniderkoulensis
4005: UAZ. 3 - 7 Amphipyndax durisaeptum
4014: UAZ. 3 - 7 Dictyomitrella (?) kamoensis
4044: UAZ. 3 - 7 Stichomitra (?) takanoensis gr.
2021: UAZ. 3 - 8 Acanthocircus protoformis
2023: UAZ. 3 - 8 Parashuum stanleyensis
3012: UAZ. 3 - 8 Eucyrtidiellum unumaense unumaense
3049: UAZ. 3 - 8 Stichocapsa japonica
3051: UAZ. 3 - 8 Tricolocapsa plicarum s.l.
3052: UAZ. 3 - 8 Eucyrtidiellum unumaense s.l.
3076: UAZ. 3 - 8 Gorgansium spp.
3109: UAZ. 3 - 8 Higumastra gratiosa n.sp.
3159: UAZ. 3 - 8 Mirifusus fragilis s.l.
3270: UAZ. 3 - 8 Acaeniotylopsis variatus variatus
4071: UAZ. 3 - 8 Parvicingula dhimenaensis ssp. A.
3007: UAZ. 3 - 9 Palinandromeda praecrassa
3204: UAZ. 3 - 9 Orbiculiforma (?) heliotropica n. sp.
3014: UAZ. 3 - 10 Eucyrtidiellum nodosum
3116: UAZ. 3 - 10 Tritrabs hayi
3124: UAZ. 3 - 10 Tetraditryma corralitosensis corralitosensis
3135: UAZ. 3 - 10 Paronaella bandyi
3140: UAZ. 3 - 10 Paronaella kotura
3144: UAZ. 3 - 10 Angulobracchia purisimaensis
3147: UAZ. 3 - 10 Angulobracchia digitata
3169: UAZ. 3 - 10 Podobursa helvetica
3180: UAZ. 3 - 10 Transhsuum maxwelli gr.
3187: UAZ. 3 - 10 Parvicingula (?) spinata
3210: UAZ. 3 - 10 Emiluvia premyogii
3223: UAZ. 3 - 10 Bernoullius dicera
3254: UAZ. 3 - 10 Haliodictya (?) hojnosi
3273: UAZ. 3 - 10 Tetraditryma corralitosensis s. l.
3064: UAZ. 3 - 11 Acanthocircus suboblongus s.l.
3070: UAZ. 3 - 11 Sethocapsa funatoensis
3081: UAZ. 3 - 11 Quinquecapsularia megasphaerica n.sp.
3085: UAZ. 3 - 11 Acanthocircus suboblongus minor n.ssp.
3088: UAZ. 3 - 11 Acanthocircus suboblongus suboblongus
3181: UAZ. 3 - 11 Transhsuum brevicostatum gr.
3197: UAZ. 3 - 11 Parvicingula dhimenaensis
3216: UAZ. 3 - 11 Emiluvia sedecimporata
4072: UAZ. 3 - 11 Parvicingula dhimenaensis dhimenaensis
3118: UAZ. 3 - 13 Tritrabs rhododactylus

Figure 6b.

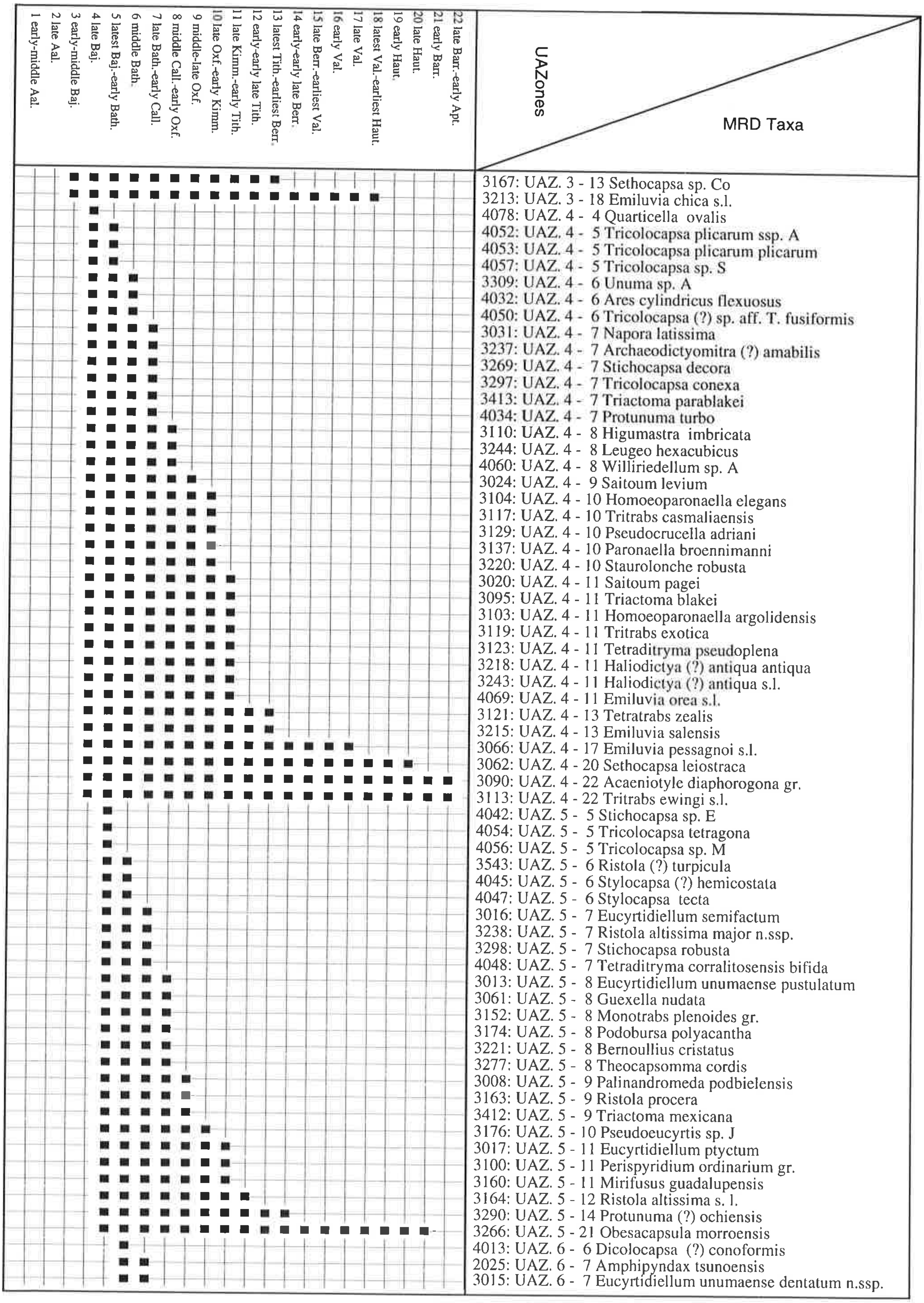

UAZones
MRD Taxa
1 early-middle Aal.
2 late Aal.
3 early-middle Baj.
4 late Baj.
5 latest Baj.-early Bath.
6 middle Bath.
7 late Bath.-early Call.
8 middle Call.-early Oxf.
9 middle-late Oxf.
10 late Oxf.-early Kimm.
11 late Kimm.-early Tith.
12 early-early late Tith.
13 latest Tith.-earliest Berr.
14 early-early late Berr.
15 late Berr.-earliest Val.
16 early Val.
17 late Val.
18 latest Val.-earliest Haut.
19 early Haut.
20 late Haut.
21 early Barr.
22 late Barr.-early Apt.
3167: UAZ. 3 - 13 Sethocapsa sp. Co
3213: UAZ. 3 - 18 Emiluvia chica s.l.
4078: UAZ. 4 - 4 Quarticella ovalis
4052: UAZ. 4 - 5 Tricolocapsa plicarum ssp. A
4053: UAZ. 4 - 5 Tricolocapsa plicarum plicarum
4057: UAZ. 4 - 5 Tricolocapsa sp. S
3309: UAZ. 4 - 6 Unuma sp. A
4032: UAZ. 4 - 6 Ares cylindricus flexuosus
4050: UAZ. 4 - 6 Tricolocapsa (?) sp. aff. T. fusiformis
3031: UAZ. 4 - 7 Napora latissima
3237: UAZ. 4 - 7 Archaeodictyomitra (?) amabilis
3269: UAZ. 4 - 7 Stichocapsa decora
3297: UAZ. 4 - 7 Tricolocapsa conexa
3413: UAZ. 4 - 7 Triactoma parablakei
4034: UAZ. 4 - 7 Protunuma turbo
3110: UAZ. 4 - 8 Higumastra imbricata
3244: UAZ. 4 - 8 Leugeo hexacubicus
4060: UAZ. 4 - 8 Williriedellum sp. A
3024: UAZ. 4 - 9 Saitoum levium
3104: UAZ. 4 - 10 Homoeoparonaella elegans
3117: UAZ. 4 - 10 Tritrabs casmaliaensis
3129: UAZ. 4 - 10 Pseudocrucella adriani
3137: UAZ. 4 - 10 Paronaella broennimanni
3220: UAZ. 4 - 10 Staurolonche robusta
3020: UAZ. 4 - 11 Saitoum pagei
3095: UAZ. 4 - 11 Triactoma blakei
3103: UAZ. 4 - 11 Homoeoparonaella argolidensis
3119: UAZ. 4 - 11 Tritrabs exotica
3123: UAZ. 4 - 11 Tetraditryma pseudoplena
3218: UAZ. 4 - 11 Haliodictya (?) antiqua antiqua
3243: UAZ. 4 - 11 Haliodictya (?) antiqua s.l.
4069: UAZ. 4 - 11 Emiluvia orea s.l.
3121: UAZ. 4 - 13 Tetratrabs zealis
3215: UAZ. 4 - 13 Emiluvia salensis
3066: UAZ. 4 - 17 Emiluvia pessagnoi s.l.
3062: UAZ. 4 - 20 Sethocapsa leiostraca
3090: UAZ. 4 - 22 Acaeniotyle diaphorogona gr.
3113: UAZ. 4 - 22 Tritrabs ewingi s.l.
4042: UAZ. 5 - 5 Stichocapsa sp. E
4054: UAZ. 5 - 5 Tricolocapsa tetragona
4056: UAZ. 5 - 5 Tricolocapsa sp. M
3543: UAZ. 5 - 6 Ristola (?) turpicula
4045: UAZ. 5 - 6 Stylocapsa (?) hemicostata
4047: UAZ. 5 - 6 Stylocapsa tecta
3016: UAZ. 5 - 7 Eucyrtidiellum semifactum
3238: UAZ. 5 - 7 Ristola altissima major n.ssp.
3298: UAZ. 5 - 7 Stichocapsa robusta
4048: UAZ. 5 - 7 Tetraditryma corralitosensis bifida
3013: UAZ. 5 - 8 Eucyrtidiellum unumaense pustulatum
3061: UAZ. 5 - 8 Guexella nudata
3152: UAZ. 5 - 8 Monotrabs plenoides gr.
3174: UAZ. 5 - 8 Podobursa polyacantha
3221: UAZ. 5 - 8 Bernoullius cristatus
3277: UAZ. 5 - 8 Theocapsomma cordis
3008: UAZ. 5 - 9 Palinandromeda podbielensis
3163: UAZ. 5 - 9 Ristola procera
3412: UAZ. 5 - 9 Triactoma mexicana
3176: UAZ. 5 - 10 Pseudoeucyrtis sp. J
3017: UAZ. 5 - 11 Eucyrtidiellum ptyctum
3100: UAZ. 5 - 11 Perispyridium ordinarium gr.
3160: UAZ. 5 - 11 Mirifusus guadalupensis
3164: UAZ. 5 - 12 Ristola altissima s. l.
3290: UAZ. 5 - 14 Protunuma (?) ochiensis
3266: UAZ. 5 - 21 Obesacapsula morroensis
4013: UAZ. 6 - 6 Dicolocapsa (?) conoformis
2025: UAZ. 6 - 7 Amphipyndax tsunoensis
3015: UAZ. 6 - 7 Eucyrtidiellum unumaense dentatum n.ssp.

Figure 6c.

1 early-middle Aal.	2 late Aal.	3 early-middle Baj.	4 late Baj.	5 latest Baj.-early Bath.	6 middle Bath.	7 late Bath.-early Call.	8 middle Call.-early Oxf.	9 middle-late Oxf.	10 late Oxf.-early Kimm.	11 late Kimm.-early Tith.	12 early-early late Tith.	13 latest Tith.-earliest Berr.	14 early-early late Berr.	15 late Berr.-earliest Val.	16 early Val.	17 late Val.	18 latest Val.-earliest Haut.	19 early Haut.	20 late Haut.	21 early Barr.	22 late Barr.-early Apt.	UAZones / MRD Taxa
					■	■																3044: UAZ. 6 - 7 Stylocapsa catenarum
					■	■																3045: UAZ. 6 - 7 Stichocapsa naradaniensis
					■	■																3046: UAZ. 6 - 7 Stylocapsa (?) spiralis gr.
					■	■																3047: UAZ. 6 - 7 Theocapsomma cucurbiformis n. sp.
					■	■																3235: UAZ. 6 - 7 Archaeodictyomitra (?) sp. A
					■	■																3276: UAZ. 6 - 7 Theocapsomma bicornis n. sp.
					■	■																4023: UAZ. 6 - 7 Gongylothorax sakawaensis
					■	■																4046: UAZ. 6 - 7 Stylocapsa lacrimalis
					■	■	■															2024: UAZ. 6 - 8 Turanta flexa
					■	■	■															3059: UAZ. 6 - 8 Stylocapsa oblongula
					■	■	■	■														3212: UAZ. 6 - 9 Emiluvia nana n. sp.
					■	■	■	■	■													3082: UAZ. 6 - 10 Acanthocircus trizonalis angustus n.ssp.
					■	■	■	■	■													3139: UAZ. 6 - 10 Paronaella mulleri
					■	■	■	■	■	■												3217: UAZ. 6 - 11 Haliodictya (?) antiqua ssp. B.
					■	■	■	■	■	■												3267: UAZ. 6 - 11 Spongocapsula perampla
					■	■	■	■	■	■	■	■										3199: UAZ. 6 - 13 Spongocapsula palmerae
					■	■	■	■	■	■	■	■	■	■								3225: UAZ. 6 - 15 Emiluvia hopsoni
					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	3065: UAZ. 6 - 22 Acanthocircus trizonalis s.l.
					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	3097: UAZ. 6 - 22 Triactoma tithonianum
					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	3162: UAZ. 6 - 22 Mirifusus chenodes
						■																3003: UAZ. 7 - 7 Thetis (?) bernoullii n. sp.
						■																3023: UAZ. 7 - 7 Saitoum corniculum
						■																3043: UAZ. 7 - 7 Theocapsomma sp A.
						■																3236: UAZ. 7 - 7 Archaeodictyomitra (?) mirabilis
						■																3239: UAZ. 7 - 7 Parvicingula (?) sp. A
						■																3268: UAZ. 7 - 7 Syringocapsa (?) sp. A
						■	■															3279: UAZ. 7 - 8 Gongylothorax sp. aff. G. favosus
						■	■	■														3021: UAZ. 7 - 9 Saitoum trichylum
						■	■	■														3133: UAZ. 7 - 9 Paronaella pygmaea
						■	■	■														3205: UAZ. 7 - 9 Orbiculiforma (?) catenaria
						■	■	■														3261: UAZ. 7 - 9 Xitus (?) sp. D
						■	■	■														4006: UAZ. 7 - 9 Angulobracchia sp. B
						■	■	■	■													3009: UAZ. 7 - 10 Palinandromeda crassa
						■	■	■	■													3106: UAZ. 7 - 10 Higumastra inflata
						■	■	■	■													3126: UAZ. 7 - 10 Pseudocrucella sanfilippoae
						■	■	■	■	■												3035: UAZ. 7 - 11 Napora deweveri
						■	■	■	■	■												3069: UAZ. 7 - 11 Williriedellum crystallinum
						■	■	■	■	■												3122: UAZ. 7 - 11 Tetratrabs bulbosa
						■	■	■	■	■												3131: UAZ. 7 - 11 Crucella theokaftensis
						■	■	■	■	■												3179: UAZ. 7 - 11 Wrangellium okamurai
						■	■	■	■	■												3193: UAZ. 7 - 11 Cinguloturris carpatica
						■	■	■	■	■												3240: UAZ. 7 - 11 Parahsuum sp. S
						■	■	■	■	■												3265: UAZ. 7 - 11 Dibolachras chandrika
						■	■	■	■	■												4055: UAZ. 7 - 11 Williriedellum carpathicum
						■	■	■	■	■												4068: UAZ. 7 - 11 Triactoma foremanae
						■	■	■	■	■	■											3078: UAZ. 7 - 12 Pantanellium riedeli
						■	■	■	■	■	■											3115: UAZ. 7 - 12 Tritrabs ewingi worzeli
						■	■	■	■	■	■											3189: UAZ. 7 - 12 Pseudodictyomitra primitiva
						■	■	■	■	■	■											3241: UAZ. 7 - 12 Ristola altissima altissima
						■	■	■	■	■	■											3274: UAZ. 7 - 12 Mirifisus dianae dianae
						■	■	■	■	■	■											3292: UAZ. 7 - 12 Protunuma japonicus
						■	■	■	■	■	■	■										3034: UAZ. 7 - 13 Napora sp. B
						■	■	■	■	■	■	■	■	■	■	■	■	■	■			3161: UAZ. 7 - 20 Mirifusus dianae s.l.
						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		4037: UAZ. 7 - 21 Solenotryma ichikawai
						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	3063: UAZ. 7 - 22 Sethocapsa trachyostraca
						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	5544: UAZ. 7 - 22 Sethocapsa dorysphaeroides
							■	■														3108: UAZ. 8 - 9 Higumastra coronaria
							■	■														3127: UAZ. 8 - 9 Pseudocrucella sp. B
							■	■														3206: UAZ. 8 - 9 Orbiculiforma(?) sp. aff. O. mclaughlini
							■	■														4004: UAZ. 8 - 9 Alievium sp. A
							■	■	■													3105: UAZ. 8 - 10 Homoeoparonaella (?) gigantheа
							■	■	■													3166: UAZ. 8 - 10 Triactoma cornuta
							■	■	■	■												3083: UAZ. 8 - 11 Acanthocircus trizonalis trizonalis
							■	■	■	■												3091: UAZ. 8 - 11 Acaeniotyle (?) sp. A
							■	■	■	■												3177: UAZ. 8 - 11 Pseudoeucyrtis reticularis
							■	■	■	■												3224: UAZ. 8 - 11 Emiluvia orea orea
							■	■	■	■												3259: UAZ. 8 - 11 Xitus magnus n. sp.

Figure 6d.

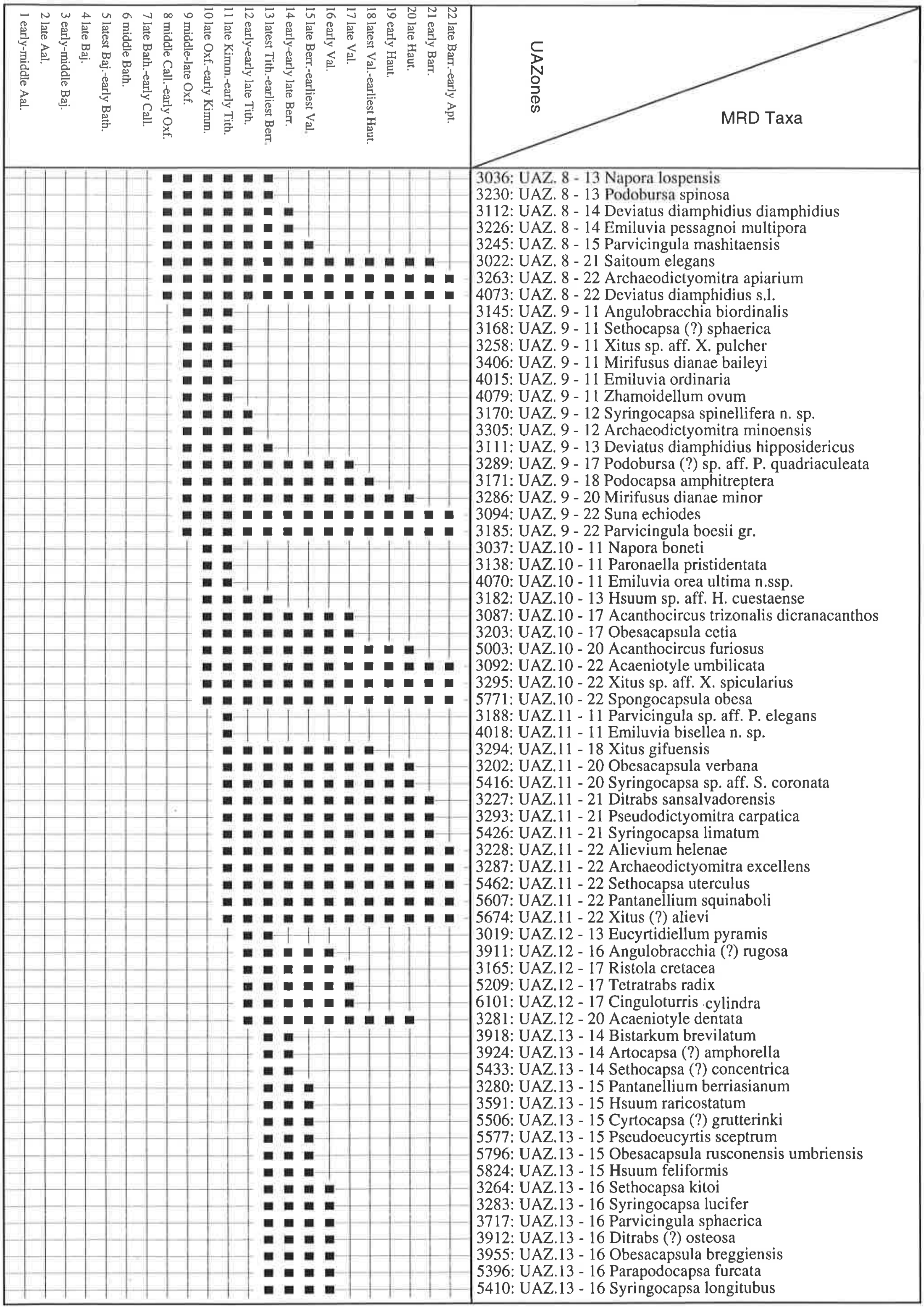

UAZones
MRD Taxa
1 early-middle Aal.
2 late Aal.
3 early-middle Baj.
4 late Baj.
5 latest Baj.-early Bath.
6 middle Bath.
7 late Bath.-early Call.
8 middle Call.-early Oxf.
9 middle-late Oxf.
10 late Oxf.-early Kimm.
11 late Kimm.-early Tith.
12 early-early late Tith.
13 latest Tith.-earliest Berr.
14 early-early late Berr.
15 late Berr.-earliest Val.
16 early Val.
17 late Val.
18 latest Val.-earliest Haut.
19 early Haut.
20 late Haut.
21 early Barr.
22 late Barr.-early Apt.
3036: UAZ. 8 - 13 Napora lospensis
3230: UAZ. 8 - 13 Podobursa spinosa
3112: UAZ. 8 - 14 Deviatus diamphidius diamphidius
3226: UAZ. 8 - 14 Emiluvia pessagnoi multipora
3245: UAZ. 8 - 15 Parvicingula mashitaensis
3022: UAZ. 8 - 21 Saitoum elegans
3263: UAZ. 8 - 22 Archaeodictyomitra apiarium
4073: UAZ. 8 - 22 Deviatus diamphidius s.l.
3145: UAZ. 9 - 11 Angulobracchia biordinalis
3168: UAZ. 9 - 11 Sethocapsa (?) sphaerica
3258: UAZ. 9 - 11 Xitus sp. aff. X. pulcher
3406: UAZ. 9 - 11 Mirifusus dianae baileyi
4015: UAZ. 9 - 11 Emiluvia ordinaria
4079: UAZ. 9 - 11 Zhamoidellum ovum
3170: UAZ. 9 - 12 Syringocapsa spinellifera n. sp.
3305: UAZ. 9 - 12 Archaeodictyomitra minoensis
3111: UAZ. 9 - 13 Deviatus diamphidius hipposidericus
3289: UAZ. 9 - 17 Podobursa (?) sp. aff. P. quadriaculeata
3171: UAZ. 9 - 18 Podocapsa amphitreptera
3286: UAZ. 9 - 20 Mirifusus dianae minor
3094: UAZ. 9 - 22 Suna echiodes
3185: UAZ. 9 - 22 Parvicingula boesii gr.
3037: UAZ.10 - 11 Napora boneti
3138: UAZ.10 - 11 Paronaella pristidentata
4070: UAZ.10 - 11 Emiluvia orea ultima n.ssp.
3182: UAZ.10 - 13 Hsuum sp. aff. H. cuestaense
3087: UAZ.10 - 17 Acanthocircus trizonalis dicranacanthos
3203: UAZ.10 - 17 Obesacapsula cetia
5003: UAZ.10 - 20 Acanthocircus furiosus
3092: UAZ.10 - 22 Acaeniotyle umbilicata
3295: UAZ.10 - 22 Xitus sp. aff. X. spicularius
5771: UAZ.10 - 22 Spongocapsula obesa
3188: UAZ.11 - 11 Parvicingula sp. aff. P. elegans
4018: UAZ.11 - 11 Emiluvia bisellea n. sp.
3294: UAZ.11 - 18 Xitus gifuensis
3202: UAZ.11 - 20 Obesacapsula verbana
5416: UAZ.11 - 20 Syringocapsa sp. aff. S. coronata
3227: UAZ.11 - 21 Ditrabs sansalvadorensis
3293: UAZ.11 - 21 Pseudodictyomitra carpatica
5426: UAZ.11 - 21 Syringocapsa limatum
3228: UAZ.11 - 22 Alievium helenae
3287: UAZ.11 - 22 Archaeodictyomitra excellens
5462: UAZ.11 - 22 Sethocapsa uterculus
5607: UAZ.11 - 22 Pantanellium squinaboli
5674: UAZ.11 - 22 Xitus (?) alievi
3019: UAZ.12 - 13 Eucyrtidiellum pyramis
3911: UAZ.12 - 16 Angulobracchia (?) rugosa
3165: UAZ.12 - 17 Ristola cretacea
5209: UAZ.12 - 17 Tetratrabs radix
6101: UAZ.12 - 17 Cinguloturris cylindra
3281: UAZ.12 - 20 Acaeniotyle dentata
3918: UAZ.13 - 14 Bistarkum brevilatum
3924: UAZ.13 - 14 Artocapsa (?) amphorella
5433: UAZ.13 - 14 Sethocapsa (?) concentrica
3280: UAZ.13 - 15 Pantanellium berriasianum
3591: UAZ.13 - 15 Hsuum raricostatum
5506: UAZ.13 - 15 Cyrtocapsa (?) grutterinki
5577: UAZ.13 - 15 Pseudoeucyrtis sceptrum
5796: UAZ.13 - 15 Obesacapsula rusconensis umbriensis
5824: UAZ.13 - 15 Hsuum feliformis
3264: UAZ.13 - 16 Sethocapsa kitoi
3283: UAZ.13 - 16 Syringocapsa lucifer
3717: UAZ.13 - 16 Parvicingula sphaerica
3912: UAZ.13 - 16 Ditrabs (?) osteosa
3955: UAZ.13 - 16 Obesacapsula breggiensis
5396: UAZ.13 - 16 Parapodocapsa furcata
5410: UAZ.13 - 16 Syringocapsa longitubus

Figure 6e.

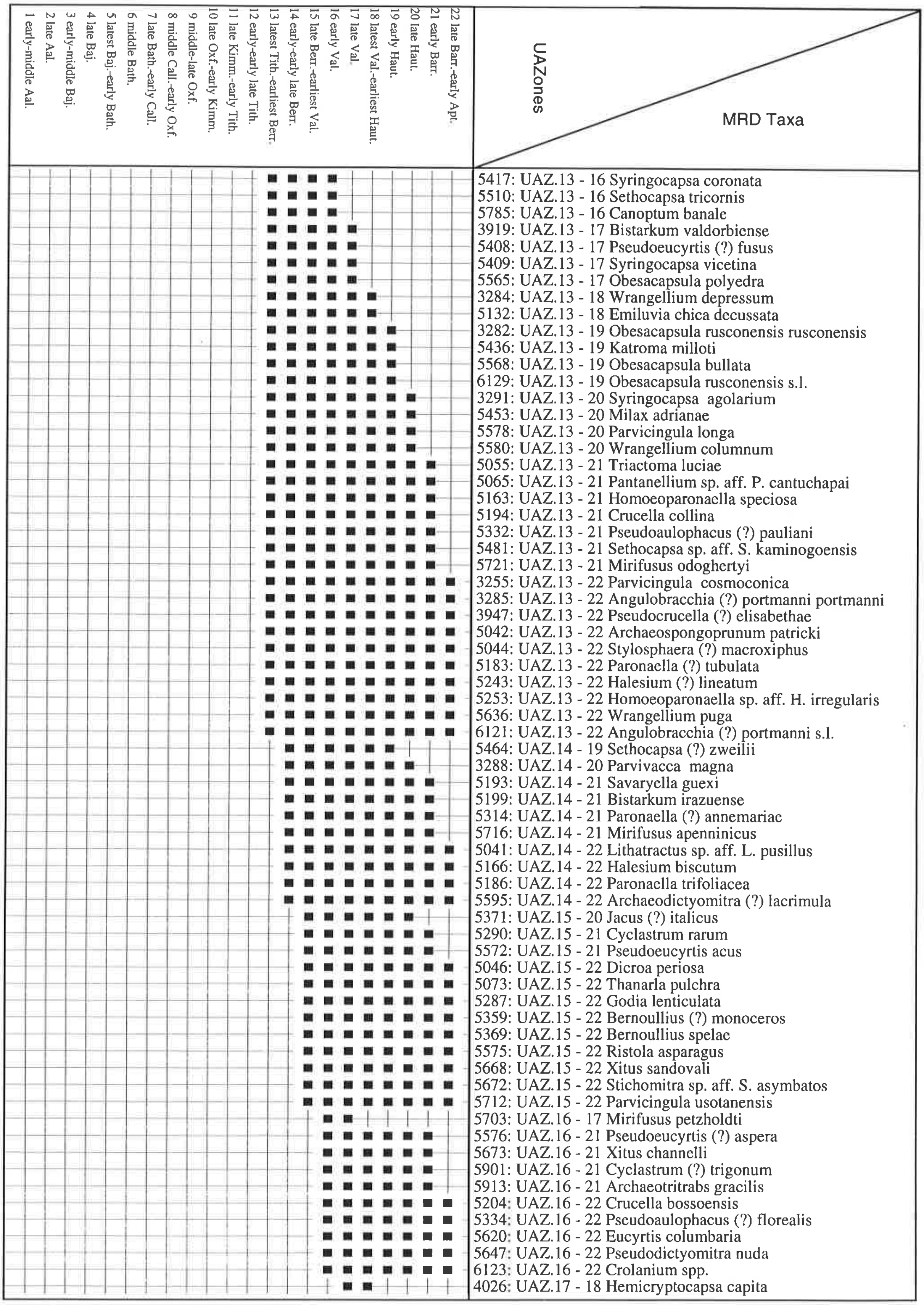

UAZones
MRD Taxa
1 early-middle Aal.
2 late Aal.
3 early-middle Baj.
4 late Baj.
5 latest Baj.-early Bath.
6 middle Bath.
7 late Bath.-early Call.
8 middle Call.-early Oxf.
9 middle-late Oxf.
10 late Oxf.-early Kimm.
11 late Kimm.-early Tith.
12 early-early late Tith.
13 latest Tith.-earliest Berr.
14 early-early late Berr.
15 late Berr.-earliest Val.
16 early Val.
17 late Val.
18 latest Val.-earliest Haut.
19 early Haut.
20 late Haut.
21 early Barr.
22 late Barr.-early Apt.
5417: UAZ.13 - 16 Syringocapsa coronata
5510: UAZ.13 - 16 Sethocapsa tricornis
5785: UAZ.13 - 16 Canoptum banale
3919: UAZ.13 - 17 Bistarkum valdorbiense
5408: UAZ.13 - 17 Pseudoeucyrtis (?) fusus
5409: UAZ.13 - 17 Syringocapsa vicetina
5565: UAZ.13 - 17 Obesacapsula polyedra
3284: UAZ.13 - 18 Wrangellium depressum
5132: UAZ.13 - 18 Emiluvia chica decussata
3282: UAZ.13 - 19 Obesacapsula rusconensis rusconensis
5436: UAZ.13 - 19 Katroma milloti
5568: UAZ.13 - 19 Obesacapsula bullata
6129: UAZ.13 - 19 Obesacapsula rusconensis s.l.
3291: UAZ.13 - 20 Syringocapsa agolarium
5453: UAZ.13 - 20 Milax adrianae
5578: UAZ.13 - 20 Parvicingula longa
5580: UAZ.13 - 20 Wrangellium columnum
5055: UAZ.13 - 21 Triactoma luciae
5065: UAZ.13 - 21 Pantanellium sp. aff. P. cantuchapai
5163: UAZ.13 - 21 Homoeoparonaella speciosa
5194: UAZ.13 - 21 Crucella collina
5332: UAZ.13 - 21 Pseudoaulophacus (?) pauliani
5481: UAZ.13 - 21 Sethocapsa sp. aff. S. kaminogoensis
5721: UAZ.13 - 21 Mirifusus odoghertyi
3255: UAZ.13 - 22 Parvicingula cosmoconica
3285: UAZ.13 - 22 Angulobracchia (?) portmanni portmanni
3947: UAZ.13 - 22 Pseudocrucella (?) elisabethae
5042: UAZ.13 - 22 Archaeospongoprunum patricki
5044: UAZ.13 - 22 Stylosphaera (?) macroxiphus
5183: UAZ.13 - 22 Paronaella (?) tubulata
5243: UAZ.13 - 22 Halesium (?) lineatum
5253: UAZ.13 - 22 Homoeoparonaella sp. aff. H. irregularis
5636: UAZ.13 - 22 Wrangellium puga
6121: UAZ.13 - 22 Angulobracchia (?) portmanni s.l.
5464: UAZ.14 - 19 Sethocapsa (?) zweilii
3288: UAZ.14 - 20 Parvivacca magna
5193: UAZ.14 - 21 Savaryella guexi
5199: UAZ.14 - 21 Bistarkum irazuense
5314: UAZ.14 - 21 Paronaella (?) annemariae
5716: UAZ.14 - 21 Mirifusus apenninicus
5041: UAZ.14 - 22 Lithatractus sp. aff. L. pusillus
5166: UAZ.14 - 22 Halesium biscutum
5186: UAZ.14 - 22 Paronaella trifoliacea
5595: UAZ.14 - 22 Archaeodictyomitra (?) lacrimula
5371: UAZ.15 - 20 Jacus (?) italicus
5290: UAZ.15 - 21 Cyclastrum rarum
5572: UAZ.15 - 21 Pseudoeucyrtis acus
5046: UAZ.15 - 22 Dicroa periosa
5073: UAZ.15 - 22 Thanarla pulchra
5287: UAZ.15 - 22 Godia lenticulata
5359: UAZ.15 - 22 Bernoullius (?) monoceros
5369: UAZ.15 - 22 Bernoullius spelae
5575: UAZ.15 - 22 Ristola asparagus
5668: UAZ.15 - 22 Xitus sandovali
5672: UAZ.15 - 22 Stichomitra sp. aff. S. asymbatos
5712: UAZ.15 - 22 Parvicingula usotanensis
5703: UAZ.16 - 17 Mirifusus petzholdti
5576: UAZ.16 - 21 Pseudoeucyrtis (?) aspera
5673: UAZ.16 - 21 Xitus channelli
5901: UAZ.16 - 21 Cyclastrum (?) trigonum
5913: UAZ.16 - 21 Archaeotritrabs gracilis
5204: UAZ.16 - 22 Crucella bossoensis
5334: UAZ.16 - 22 Pseudoaulophacus (?) florealis
5620: UAZ.16 - 22 Eucyrtis columbaria
5647: UAZ.16 - 22 Pseudodictyomitra nuda
6123: UAZ.16 - 22 Crolanium spp.
4026: UAZ.17 - 18 Hemicryptocapsa capita

Figure 6f.

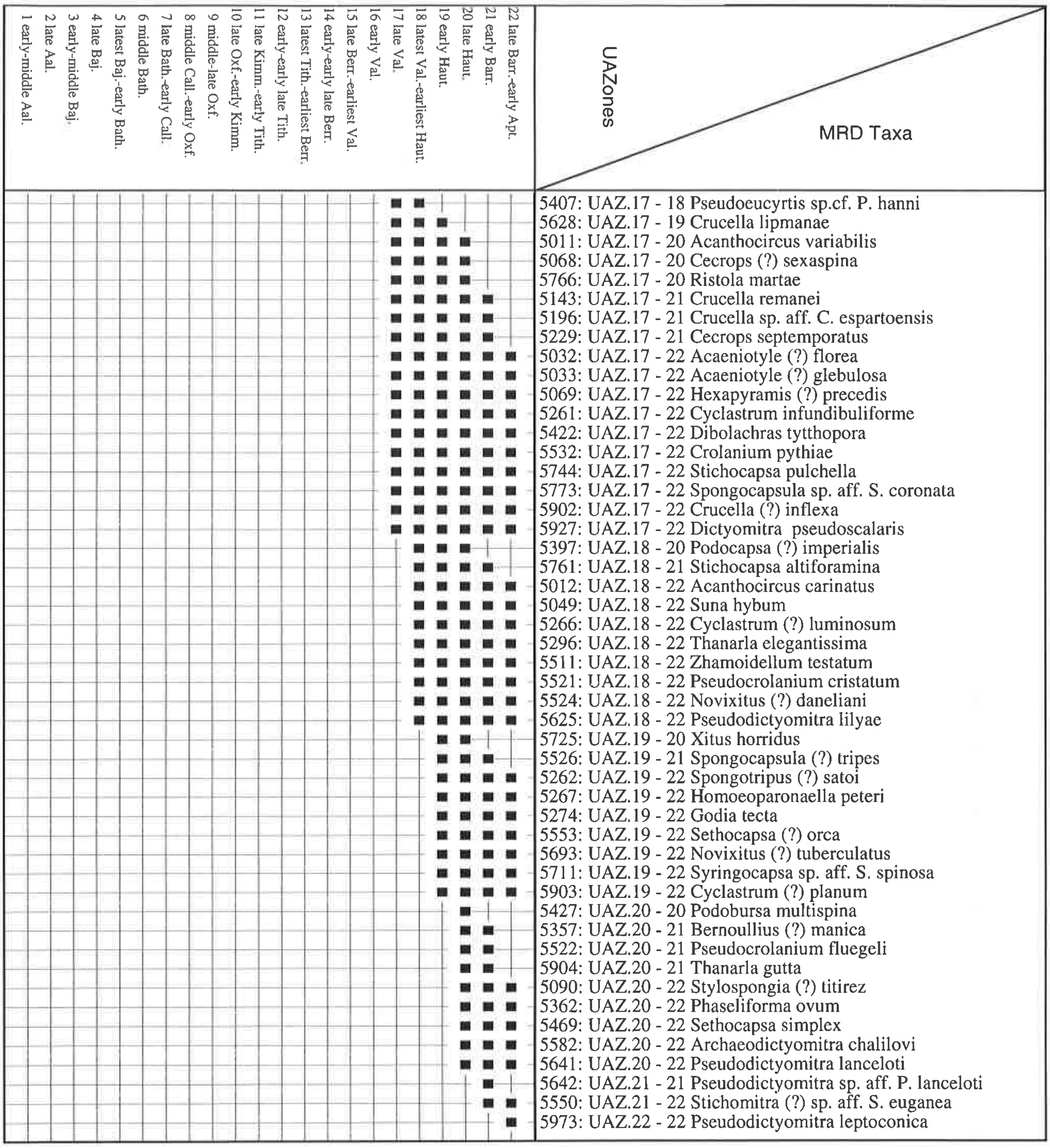


Figure 6g.

8) it is associated with latest Bajocian *(Parkinsoni* Zone) and lower Bathonian *(Zigzag* Zone) ammonites respectively.

UAZone 6 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): One species are characteristic of UAZ.6: *Dicolocapsa* (?) *conoformis* (MRD 4013). 16 species range up to UAZ. 6 and co-occur with 22 species ranging from UAZ. 6 upwards.

Calibration: UAZone 6 is tentatively correlated with a Middle Bathonian age, based on the following data (Fig. 7, Chapter 38): It is found above lower Bathonian nannofossils in the Terminilletto section (Umbira-Marche-Sabina, Chapter 15).

UAZone 7 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): 6 species are characteristic of UAZ. 7: *Thetis* (?) *bernoullii* n. sp. (MRD 3003), *Saitoum corniculum* (MRD 3023), *Theocapsomma* sp A. (MRD 3043), *Archaeodictyomitra* (?) *mirabilis* (MRD 3236), *Parvicingula* (?) sp. A (MRD 3239), *Syringocapsa* (?) sp. A (MRD 3268). 41 species range up to UAZ. 7 and

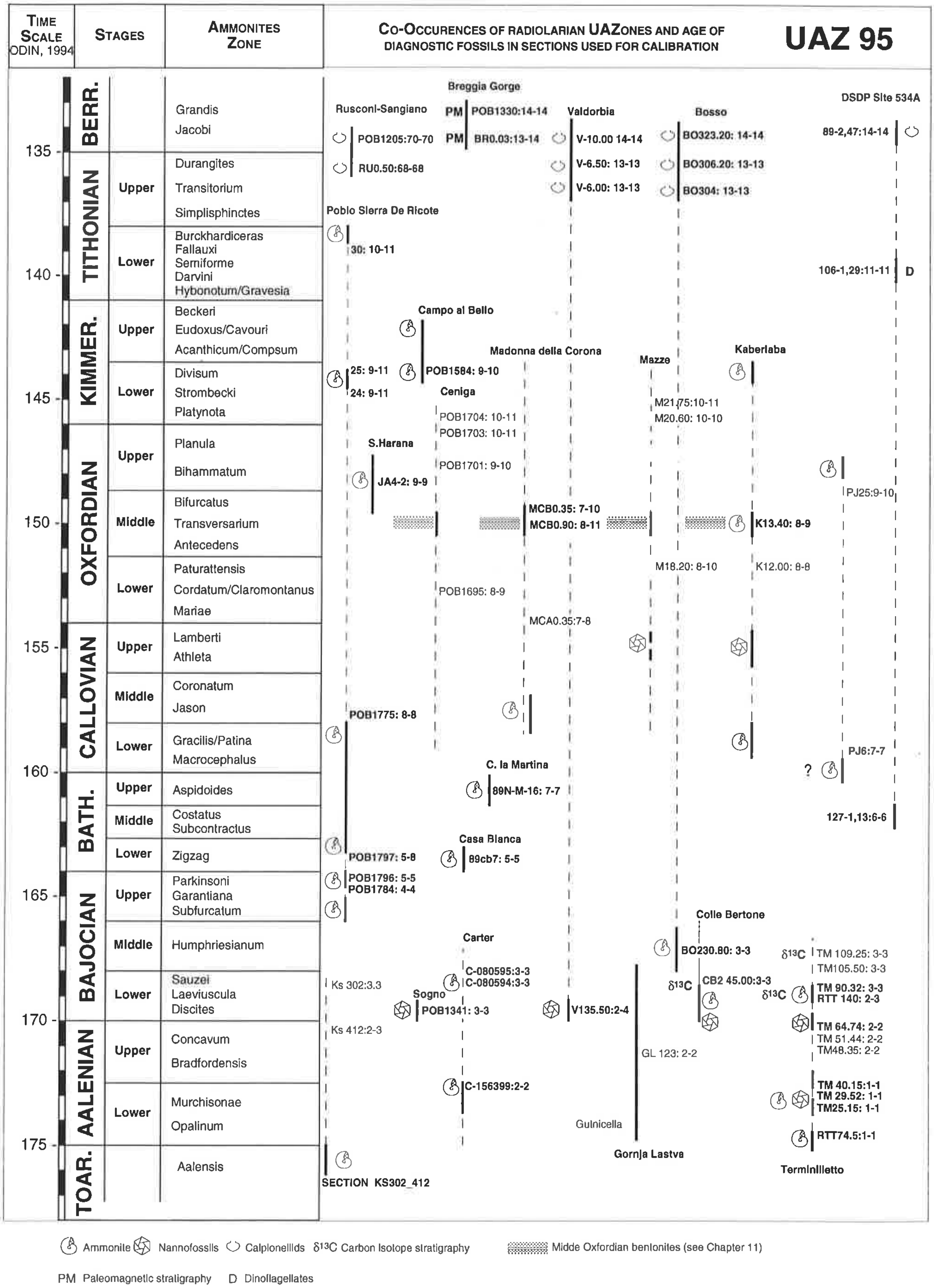


Figure 7. Co-occurrences of UAZones95 and age-diagnostic fossils in the sections used for calibration. Thick vertical lines indicate the range of the fossils shown by a symbol. The sample numbers are positioned at the same level, below or above these fossils indicating the actual stratigraphic relationship. Time scale after Odin (1994), Ammonite Zones after Poitiers Proceedings (1991).

co-occur with 30 species ranging from UAZ. 7 upwards.

Calibration: UAZone 7 is correlated with a late Bathonian-early Callovian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): At Cerro de la Martina (Subbetic, Chapter 8) UAZ. 7 is associated with late Bathonian ammonites. At Pojorita (Rumanian Carpathians, Chapter 24) UAZ. 7 is found above limestones.of late Bathonian - early Callovian age

UAZone 8 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 26 species range up to UAZ. 8 and co-occur with 19 species ranging from UAZ. 8 upwards.

Calibration: UAZone 8 is correlated with a Middle Callovian-early Oxfordian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): In the Sierra de Ricote section (Baumgartner 1987, Chapter 8) UAZ. 8 was found above upper lower or lowest middle Callovian *(Patina* Zone) ammonites. UAZ. 8 occurs at Madonna della Corona and at Kaberlaba (Trento Plateau, Chapter 5) above upper Callovian nannofossils and below middle middle Oxfordian *(Transversarium* Zone) ammonites.

UAZone 9 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 17 species range up to UAZ. 9 and co-occur with 14 species ranging from UAZ. 9 upwards.

Calibration: UAZone 9 is correlated with a Middle-late Oxfordian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): In the Sierra Harana (Subbetic, Chapter 8) UAZ.9 is associated with lower upper Oxfordian ammonites *(Bihammatum* Zone). UAZ. 8-9 are found between Bentonites regionally dated as middle middle Oxfordian *(Transversarium* Zone) samples below the bentonites are restricted to UAZ. 8. On the other hand, UAZ. 9-10 were identified at Pojorita (Romanian Carpathians, Chapter 24) below limestones considered to belong to the lower upper Oxfordian *(Bihammatum* Zone).

UAZone 10 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 27 species range up to UAZ. 10 and co-occur with 10 species ranging from UAZ. 10 upwards.

Calibration: UAZone 10 is correlated with a late Oxfordian-early Kimmeridgian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): At Mazze (Trento Plateau, Chapter 11) UAZ. 10 is found in cherty limestones above the last Bethonite, regionally dated as middle middle Oxfordian *(Transversarium* Zone) and below the base of the Rosso Ammonitico Superiore, regionally dated as lower Kimmeridgian *(Strombecki* and/or *Divisum* Zones) At Campo al Bello (Umbria, Chapter 5) UAZ. 9-10 are associated with upper lower Kimmeridgian (*Divisum* Zone) ammonites. In the Sierra de Ricote Section (Chapter 8), UAZ 10 was found below early Kimmeridgian *(Divisum - Strombecki* Zone) ammonites.

UAZone 11 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): 2 species are characteristic of UAZ. 11: *Parvicingula* sp. aff. *P. elegans* (MRD 3188), and *Emiluvia bisellea* n. sp. (MRD 4018). 48 species range up to UAZ. 11 and co-occur with species ranging from UAZ. 11 upwards.

Calibration: UAZone 11 is tentatively correlated with a late Kimmeridgian-early Tithonian age, based on the following co-occurrence with age-diagnostic fossils (Fig. 7, Chapter 38): At DSDP Site 534A, Sample 106-1, 29 cm, this UAZ. is found just below the Kimmeridgian/Tithonian boundary according to dinoflagellates (Chapter 7). In the Sierra de Ricote Section (Chapter 8), UAZ.10-11 have been found immediately below upper lower Tithonian *(Burckhardiceras* Zone) ammonites.

UAZone 12 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 9 species range up to UAZ. 12 and co-occur with 6 species ranging from UAZ. 12 upwards.

Calibration: UAZone 12 is tentatively correlated with an early-early late Tithonian age, based on the following data (Chapter 38): In the Budva Zone (Gorican, 1994 and Chapter 18) UAZ. 13 is found in the topmost Lastva Radiolarite, immediately below the Praevalis Limestone, dated by calpionellids as late Tithonian at its base. It is found above early Tithonian ammonites at Santa Anna, Sicily (Chapter 17).

UAZone 13 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 12 species range up to UAZ. 13 and co-occur with 50 species ranging from UAZ. 13 upwards. First occurrences (FO) dominate largely over last occurrences (LO) which implies an important diversification of radiolarian faunas during the time interval represented by UAZ. 13.

Calibration: UAZone 13 is equivalent with the upper Zone D1 and the lowermost Zone D2 of Jud (1994, Chapter 12) It is correlated with a latest Tithonian-earliest Berriasian age, because it is correlated to the interval between uppermost M20 and the top of M19. Its base is at or immediately above the FAD of *Tintinnopsella carpathica* , i.e. the first occurrence of hyaline calpionellids. UAZ. 13 includes the calpionellid Zone cA and the cA/cB boundary. UAZ. 13 is above the FADs of the nannofossils *Polycostella beckmannii* and *Microstaurus chiastius*. It includes near its top, in M19n, the Jurassic/Cretaceous boundary.

UAZone 14 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 6 species range up to UAZ. 14 and co-occur with 10 species ranging from UAZ. 14 upwards.

Calibration: UAZone 14 is equivalent to most of Zone D2 of Jud (1994, Chapter 12) except for its base. The zonal boundary UAZ. 13/14 is placed higher than the zonal boundary D1/D2. UAZ. 14 is correlated with an early-early late Berriasian age, because it corresponds to the interval between M18r and lower M16r. Its base is just above the Jurassic/Cretaceous boundary and above the calpionellid cA/cB zonal boundary, It includes the calpionellid Zone cB in M18 and M17, and the calpionellid Zone cC in

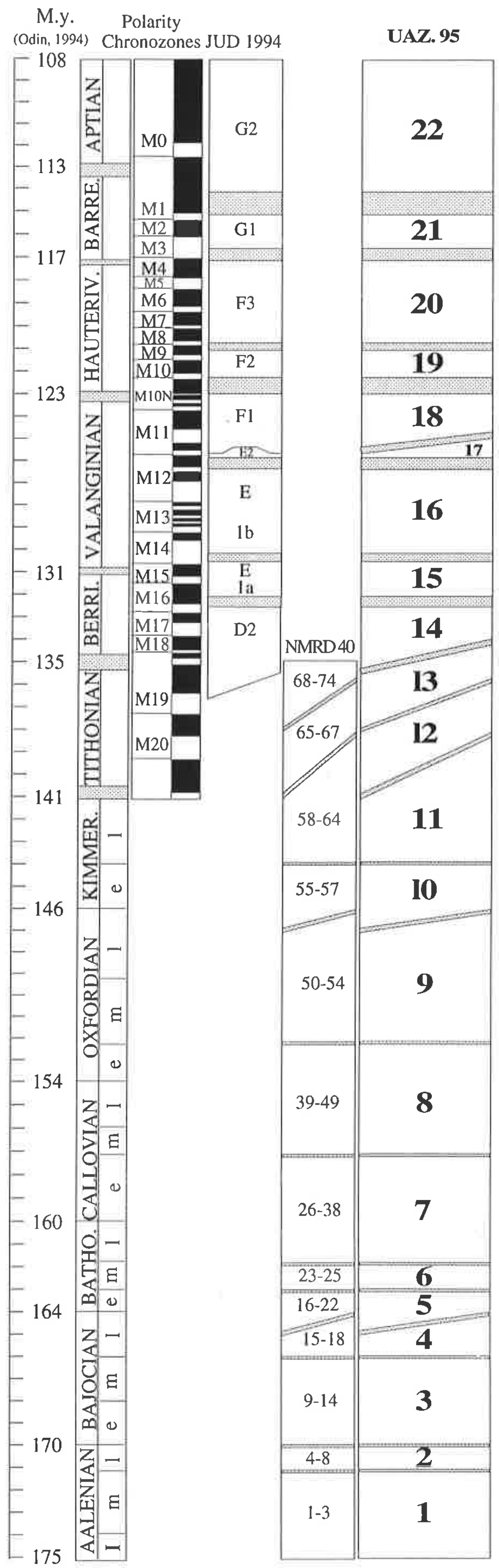


Figure 8. Chronostratigraphic calibration of UAZones 1-22.

M17/M16. The FADs of the nannofossils *Rothelapillus laffitei*, *Nannoconus steinmannii minor* and *Nannoconus steinmannii steinmannii* are also included in UAZ. 14. The upper zonal boundary includes the calpionellid cC/cD zonal boundary.

UAZone 15 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 7 species range up to UAZ. 15 and co-occur with 12 species ranging from UAZ. 15 upwards.

Calibration: UAZone 15 is equivalent of Zone E1a of Jud (1994, Chapter 12). It is correlated with a late Berriasian-earliest Valanginian age, because it is included between lower M16n and M14r. Its lower boundary correlates to the calpionellid cC/cD zonal boundary. UAZ. 15 includes the FADs of the nannofossils *Cretarhabdus angustiforatus*, *Percivalia fenestrata* and *Calcicalathina oblongata* and the LAD of the nannofossil *Umbria granulosa granulosa*. UAZ. 15 includes the calpionellid cD2/cD3 Subzonal boundary.and the UAZ. 15/16 boundary is placed in the calpionellid Subzone cD3.

UAZone 16 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 11 species range up to UAZ. 16 and co-occur with 10 species ranging from UAZ. 16 upwards.

Calibration: UAZone 16 is equivalent of Zone E1b of Jud (1994, Chapter 12). It is correlated with an early Valanginian age, because it corresponds to the interval between M14r and lower M12n and includes at its base the FAD of *Calcicalathina oblongata* and in the middle part of the zone the FAD of *Tubodiscus verenae*.

UAZone 17 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 12 species range up to UAZ. 17 and co-occur with 19 species ranging from UAZ. 17 upwards.

Calibration: UAZone 17 is equivalent of Zone E2 and includes the lowermost portion of Zone F1 (U.A. 22) of Jud (1994, Chapter 12). It is correlated with a late Valanginian age, because it ranges from the top of M12n or the base of M11 to M11r. It includes the LAD of the nannofossil *Tubodiscus verenae* near its top.

UAZone 18 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 7 species range up to UAZ. 18 and co-occur with 10 species ranging from UAZ. 18 upwards.

Calibration: UAZone 18 is equivalent to most of Zone F1 of Jud (1994, Chapter 12) except for its base. The zonal boundary between UAZ. 17 and 18 is placed higher than the zonal boundary E2/F1 of Jud (see comparison of zones below). UAZ. 18 is correlated with a latest Valanginian-earliest Hauterivian age, because it corresponds to the interval between the upper M11r and upper M10N and its base is above the LAD of the nannofossil *Tubodiscus venerae*. The upper zonal boundary is placed below the FAD of *Lithraphidites bollii*..

UAZone 19 is defined by the following characteristic species pairs (Fig. 6a-g, Foldouts 1-7): 6 species range up to UAZ. 19 and co-occur with 9 species ranging from UAZ. 19 upwards.

Calibration: UAZone 19 is equivalent of Zone F2 of Jud (1994, Chapter 12). It is correlated with an early Hauterivian age, because it corresponds to M10 and M9 and includes in its lower part, in M10n, the FAD of *Lithraphidites bollii* and at the upper zonal boundary, in M8, the LAD of the nannofossil *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius*.

UAZone 20 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): *Podobursa multispina* (MRD 5427) is characteristic of UAZ. 20. 18 species range up to UAZ. 20 and co-occur with 8 species ranging from UAZ. upwards.

Calibration: UAZone 20 is equivalent to Zone F3 of Jud (1994, Chapter 12). It is correlated with a late Hauterivian age, because it corresponds to the interval between M8r and M3r and includes in its lower boundary the LAD of the nannofossil *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius*, in the middle of the zone the LAD of the nannofossil *Lithraphidites bollii*, and in its upper boundary the FAD of *Calcicalathina oblongata*. The zonal boundary UAZ.20/UAZ.21 (= F3/G1) corresponds roughly to the Hauterivian-Barremian boundary.

UAZone 21 is defined by the following characteristic species/species pairs (Fig. 6a-g, Foldouts 1-7): *Pseudodictyomitra* sp. aff. *P. lanceloti* (MRD 5642) is characteristic of UAZ. 21. 31 species range up to UAZ. 21 and co-occur with *Stichomitra* (?) sp. aff. *S. euganea* (MRD 5550, UAZ. 21 - 22).

Calibration: UAZone 21 is equivalent to Zone G1 of Jud (1994, Chapter 12). It is correlated with an early Barremian age, because it corresponds to the interval between M3r and lower M1n and is placed between the LADs of the nannofossils *Calcicalathina oblongata* (lower boundary) and *Nannoconus steinmannii* (upper boundary).

UAZone 22 is defined by *Pseudodictyomitra leptoconica* (MRD 5973) which is the only characteristic species of this UAZ. (Fig. 6a-g, Foldouts 1-7).

Calibration: UAZone 22 is equivalent to Zone G2 of Jud (1994, Chapter 12). It is correlated with a late Barremian-early Aptian age, because it is included in the interval between the upper M1n and M0 and reaches into the Middle Cretaceous "Quiet" Zone. This zone contains in its lower part the LAD of the nannofossil *Nannoconus steinmannii* and the FADs of the nannofossils *Chiastozygus litterarius* and *Rucinolithus irregularis*.

Zoning of sections not included in the construction of the zonation.

All sections have been zoned and their zonal assignment is stated in Chapter 38. However, certain sections were not included with the database for the construction of zones, because too many contradictory and strongly connected components would have resulted from their inclusion, rendering the zonation completely unreliable.

The sections not included were run one by one with the numerical list (TGI) representing the UAZones95. In many cases this procedure resulted in contradictions and new U.A. indicating that the added section contains information not represented by the UAZones. The correlation table (TGK) produced by each run of BIOGRAPH lists the UAZ. and the corresponding new U.A. All samples can be therefore recoded in terms of UAZ. However, if samples correspond to a new UA. inserted between two UAZ. (usual case) the UAZ-range is stated as covering the two bracketing UAZ. The resulting zonal assignments are therefore often less precise for these sections. However, the UAZ.-range given contains the actual age of the sample with certainty.

5. Comparison of UAZones95 with other zonations

5.1. General remarks

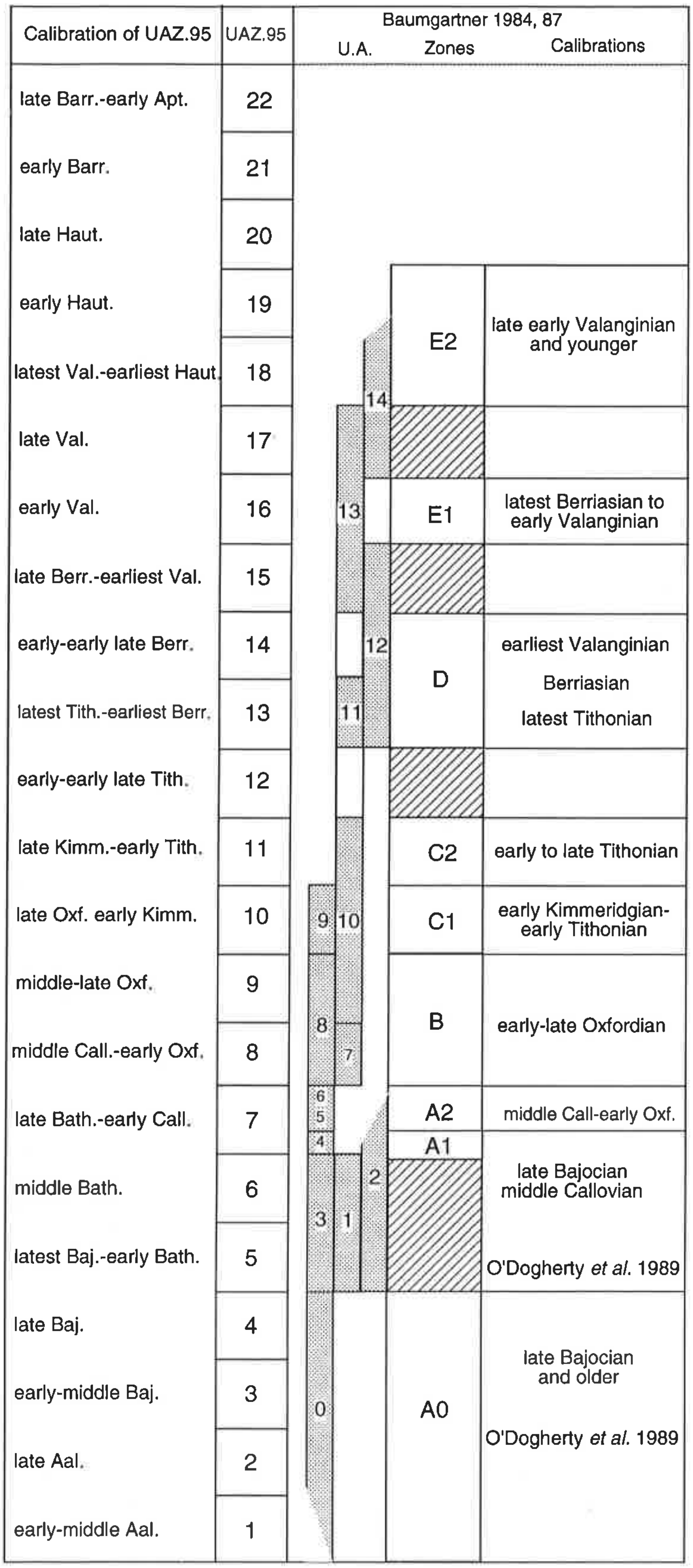
There are several ways of comparing biozonations. The most direct way is to zone the same sample data with the two zonations to compare. All of the data by Dumitrica-Jud (Chapter 12) is included with the present database and a one to one correlation is possible. Most of the data that served to establish the zonation by Gorican (Chapter 18) forms also the core of the data for this chapter. For the correlation we simply compared the zonal assignment of any given sample in Gorican (1994, and *Chapter* 18) and herein *(Chapter* 38).

Another way of correlation is to compare the ranges of characteristic species that define earlier U.A. or assemblages with the ranges in the UAZones95. This method was used in the comparison with Baumgartner 1984. This proved to be more complex, however, as the concept of some species has since changed. Many of the ranges have also been revised and therefore now appear longer in the UAZones95.

For the zonation by Matsuoka (1993) we can apply both methods. 1. We know the position of his sections in terms of UAZones95 (Chapter 38) and we know his zonal assignments of his samples from Chapters 27 and 33). 2. We can look up the position of his zonal marker species in the UAZones95. The result of the two methods is different, because our ranges are generally longer than those defined in one realm by one author. This highlights a fundamental problem of comparing interval zones with assemblage or concurrent range zones (see below).

5.2. Comparison with Baumgartner 1984

The UAZones95 are compared to the zonation by Baumgartner (1984, called "UA84") in Figure 8. The two



scales were compared by looking up each species present in the UA84 and importing their concurrent range into the UAZones95 scale. There is a one to one correlation for UA84/0 which corresponds to UAZ. 4 and older. According to some ranges the limit between A0 and A1 could fall anywhere within UAZ. 5-6, because of overlapping ranges of UA84/1,2 and 3. This is a result of much better known ranges of the species defining these old U.A. The limit A1/A2 is clearly placed within UAZ.7, the upper part of which corresponds to the old A2. UA84/7 and 8 overlap, but Zone B is clearly correlated with UAZ. 8-9. C1 (UA84/9) is correlated with UAZ. 10 and Zone C2 with UAZ. 11 and possibly 12. Zone D is clearly correlated with UAZ. 13 and 14 and possibly part of 15. Zone E2 is clearly correlated with UAZ. 16 and reaches possibly into UAZ. 17. Zone E2 correlates with UAZ. 18 and higher, but may go lower (part of UAZ.17).In comparing the calibrations of the UAZ.95 with the original calibrations of the UA84, we find no major discrepancies except for the UAZ.7 (late Bath. - early Call.) whose upper part correlates with A2 (middle Call.-early Oxf.). For the calibration of the UA84, we used middle Callovian and younger ages of the basal samples at Site 534A (Chapter 7) This calibration placed the limits A1/A2 and A2/B relatively high. These ages are now in clear contradiction with ammonite calibrations from several sections in the Subbetic (Chapter 8, and Fig. 7) and the Carpathians (Chapter 24). The same samples from Site 534A are now assigned to UAZ. 6-7, which confirms the correlation given in Fig. 8.

5.3. Comparison with Gorican (1994)

The comparison is based on the comparison of sample assignments in both zonations. Excellent correlation is achieved in the middle and late Jurassic except for Gorican's UA.2, 5, 9, 10, and 24-27, which include other species not in the UAZ database in their definition. These UA. may fall in either one of the adjacent UAZ's. On the whole, the calibrations compare wery well. In the Cretaceous, the zonation by Gorican appears rather coarse. Owing to an important condensation in the sections of the Budva Zone (Gorican 1994, Chapter 18), the density of samples was low relative to the work of Jud (1994). Therefore, large (time-) intervals were merged to produce a reproducible zonation for

Figure 9. Comparison of UAZones95 and the zonation by Baumgartner (1984, 1987). The figure is not scaled to age. Diagonally hachured fields indicate uncertainties of correlation, i.e. the lower zone and/or the higher zone may share or occupy this field. The most striking difference in age assignment occurs for Zone A2 (middle Call. - early Oxf.) correlative with UAZ. 7 (late Bath.-early Call.). This older age assignment is the result of new ammonite data from the Subbetic (Chapter 8) and the revision of ages at Site 534A (Chapter 7).

Calibration of UAZ.95	UAZ.95	Gorican 1994 U.A.	Gorican 1994 Zonal subdivisions and their calibrations
late Barr.-early Apt.	22		no direct correlation
early Barr.	21		
late Haut.	20		
early Haut.	19		
latest Val.-earliest Haut.	18		
late Val.	17	37, 36, 35	late Valanginian-earliest Aptian
early Val.	16		no direct correlation
late Berr.-earliest Val.	15		
early-early late Berr.	14		
latest Tith.-earliest Berr.	13	34, 33, 32	late Tithonian-early late Valanginian
early-early late Tith.	12	28-31	late Kimmeridgian-early late Tithonian
late Kimm.-early Tith.	11	27, 26	earliest Tithonian
late Oxf. early Kimm.	10	25, 24	Kimmeridgian
		23	latest Oxfordian
middle-late Oxf.	9	19-22	middle-late Oxfordian
middle Call.-early Oxf.	8	18, 17, 16	latest Callovian-middle Oxfordian
late Bath.-early Call.	7	15, 14, 13	latest Bathonian-Callovian
middle Bath.	6	12	earliest Callovian
			Bathonian
latest Baj.-early Bath.	5	11	
late Baj.	4	10, 9, 8	latest Bajocian
		6-7	middle-late Bajocian
early-middle Baj.	3	5, 4, 3	early-middle Bajocian
late Aal.	2	2, 1	Aalenian-earliest Bajocian
early-middle Aal.	1		

Figure 10. Comparison of UAZones95 and the zonation proposed by Gorican (1994, Chapter 18). The figure is not scaled to age. Diagonally hachured fields indicate uncertainties of correlation, i.e. the lower zone and/or the higher zone may share or occupy this field. No direct correlation is possible in part of the Berriasian-Valanginian and in the Hauterivian-early Aptian, because Gorican's zonation is rather condensed for these time intervals.

that area.

5.4. Correlation with Jud (1994)

The correlation with the Neocomian Zonation by Jud (1994, *Chapter* 12, called "RJZones") is given in Figure 10. The present zonation was created by correlating Jud's UA. (called "RJUA") with our protoreferential NMRD482 (see composite "section" UARJRUN93 in Fig. 4) There is a one to one correlation between UA. because the RJUA are complete included with the data of the UAZ95. The zonal boundaries have been slightly displaced to optimise reproducibility of the new UAZ. RJZone C2 was sparsely documented and can be correlated with UAZ.11 and possibly with part of 10 and 13. RJZone D1 is correlated with UAZ. 13 and possibly with the upper part of 12. The limit between UAZ 13 and 14 coincides with the limit between RJUA 5 and 6, but Jud's zonal boundary between RJZones D1 and D2 is placed lower, between RJUA 4 and 5. This happens again for the boundary UAZ 17/18, placed between RJUA 22 and 23 whereas Jud placed her E2/F1 boundary lower, between RJUA 21 and 22. All remaining zonal subdivisions are the same.

5.5. Comparison with Murchey (1984)

The correlation with the zonation by Murchey (1984) is straightforward, since a subset of her data was included with the database to construct the UAZones (Chapter 31). MH-2 can be clearly correlated with UAZ. 1-3 and possibly or partly with 4 in its upper part. MH-3 correlates with UAZ. 4 or 5 in its lower part and with 5 in its upper part. MH-4 corresponds with UAZ. 5 at its base and with UAZ. 6 at its top. If the MH assemblage zones are compared to Carter et al. (1988, Chapter 31, Figure) older ages result for MH2. This could be the result of longer ranges of some of Carters markers species in the Tethyan realm.

5.6. Comments on the comparison with Matsuoka (1992a, 1993)

Matsuoka (Chapter 32, this volume) discusses the correlation between his zonation, based on nine biohorizons and the UAZones. This paragraph summarises and comments his results. As stated above, there are two ways of making the correlation. 1. We know the position of his sections in UAZones95 (Chapter 27, 33, Figure 2 and Chapter 38) and we know his zonal assignments of his samples (Chapters 27, and 33). 2. We can look up the position of his zonal marker species in the UAZones95. The result of the two methods is different, because our ranges are generally longer than those defined in one realm by one author.

In the following we compare the two methods of correlation. "Assemblage = Ass." gives the correlation according to the first method (Chapter 33, Fig. 2). "Marker = Ma." gives the range according to the second.

The base of the *Laxtorum jurassicum* Zone is below UAZ. 3 (Ass.), or at the base of UAZ.2 (Ma.).

The base of the *Tricolocapsa plicarum* Zone is between UAZ. 3 and 4 (Ass.) , or and the base of UAZ. 3 (Ma.).

The base of the *Tricolocapsa conexa* Zone lies within UAZ. 5(Ass.), or at the base of UAZ. 4 (MA.).

The base of the *Stylocapsa spiralis* Zone lies within UAZ.6 (Ass.), or at the base of UAZ. 6 (Ma.).

The base of the *Hsuum maxwelli* Zone lies within UAZ. 7 (Ass.), or at the top of UAZ. 7 (Ma.).

Calibration of UAZ.95	UAZ.95	Jud 1994 and this volume U.A.	Zones	Calibration
late Barr.-early Apt.	22	35	G2	late Barremian-early Aptian
early Barr.	21	34 33	G2	early Barremian
late Haut.	20	29-32	F3	late Hauterivian
early Haut.	19	28 27 26	F2	early Hauterivian
latest Val.-earliest Haut.	18	25 24 23	F1	latest Valanginian-earliest Hauterivian
late Val.	17	22 18-21	E2	early late Valanginian
early Val.	16	13-17	E1b	early Valanginian
late Berr.-earliest Val.	15	9-12	E1a	latest Berrisian-earliest Valanginian
early-early late Berr.	14	8 7 6	D2	latest Tithonian-early late Berrisian
latest Tith.-earliest Berr.	13	5 4 3	D1	early late Tithonian
early-early late Tith.	12			
late Kimm.-early Tith.	11	2	C2	early Tithonian Oxfordian-Kimmeridgian
late Oxf. early Kimm.	10	1		

Figure 11. Correlation of UAZones95 and the zonation proposed by Dumitrica-Jud (1994, Chapter 12). The figure is not scaled to age. Diagonally hachured fields indicate uncertainties of correlation, i.e. the lower zone and/or the higher zone may share or occupy this field. There is a one to one correlation between the protoreferential NMRD40 used to construct UAZ. and the U.A. calculated by Dumitrica-Jud (see Fig. 4). However, our Cretaceous zonal boundaries have been placed in a slightly different position in two cases. For detailed calibrations see Chapter 12. Oxfordian-Tithonian correlation has some uncertainties, because of many more samples and taxa included with the UAZ.95 as compared to Dumitrica-Jud.

The base of the *Pseudodictyomitra primitiva* Zone lies within UAZ. 7-8 (Ass.), or at the top of UAZ.10 (Ma).

The base of the *Pseudodictyomitra carpatica* Zone lies within UAZ. 10-11 (Ass.), or at the base of UAZ. 11 (Ma.).

The base of the *Cecrops septemporatus* Zone lies within UAZ. 17 (Ass.), or at the base of UAZ. 17 (Ma.).

The base of the *Acanthocircus carinatus* Zone lies within UAZ. 18-21 (Ass.), or at the base of UAZ. 18 (Ma.).

Considering the nature of UAZ. these comparisons are in good agreement, except for the *Tricolocapsa plicarum* and *T. conexa* Zones, where the first occurrence of the marker species *Tricolocapsa plicarum* resp. conexa is clearly earlier (UAZ. 3 resp. 4) on worldwide scale than stated in the sections studied by Matsuoka (UAZ. 4 resp.5). This demonstrates the fundamental difficulties of the use of zonal schemes, which are based on intervals of first or last appearances of marker species, for global correlation.

5.7. Comparison with Pessagno *et al.* (1993)

Principally owing to fundamental differences between our zonations based on the assemblage concept and those of Pessagno and his collaborators based on single first and last occurrences (Pessagno 1977a; Pessagno *et al.* 1984, 1987b, 1989, 1993), correlation beween the respective zonal schemes of the Jurassic has been a problem.

Originally, Pessagno (1977a) defindes the base of his zone 2 by the first occurrence of *Mirifusus guadalupensis*. This initial zonal scheme has been revised many times under the aspect of new data and the FO of *Mirifusus*, initially supposed to occur in the upper Kimmeridgian/lower Tithonian was lowered into upperlower/lower upper Kimmeridgian (Pessagno *et al.* 1984), then into the middle Orfordian (Pessagno *et al.* 1989) and finally into the lower Oxfordian (Pessagno *et al.* 1993), as new data became available to the authors. Late Middle Jurassic radiolarian samples from Oregon, studied by the authors during the same time did not contain *Mirifusus* sp. This was a confirmation of a late Jurassic FO of this genus for these authors and the detailed Middle Jurassic zonal scheme established for Eastern Oregon was defined as Superzone 1, placed below zone 2. (Pessagno *et al.* 1987) Until 1989 no section had been published, in which Pessagno *et al.* would have established a physical superposition of their superzones 1 and 2. With the discuvery of well preserved radiolarians above the Josephine Ophiolite along the Middle fork of the Smith river (Pessagno *et al.* 1989, Pessagno and Blome 1990) had found once more a first occurrence of *Mirifusus* that they believed to be the «real» one. Occurrences of *Buchia* spp. in nearby sections, as well as chronostratigraphic arguments based on radiometric ages obtained from the underlying Josephine Ophiolite and cross-cutting dykes were used (Pessagno and

Blome 1990) to consolidate the idea of a middle Oxfordian age of the «*Mirifusus* first occurrence event» In the forementioned paper it is even suggested to displace the Oxfordian/Kimmerdigian boundary by 2 my from 156 my to 154 my! In this context it is worth noting that Odin *et al.* (1992) provided the first K-Ar radiometric age from plagioclases of Middle Jurassi (lower Bathonian) strata directly dated by ammonites: 161 ⁺- 3 my. This age is almost identical with the age of the Josephine ophiolite: 162 ⁺- 1 my.

Meanwhile, we had established since 1984 (Baumgartner 1984, 1987, O'Dogherty *et al.* 1989) clear evidences for Middle Jurassic occurrences of representatives of the Genis *Mirifusus.* We suggested that *Mirifusus* was absent from Middle Jurassic strata of Oregon because of palaeobiogeographic of palecologic reasons and supposed a partial overlap of Pessagnos superzones 1 and 2 (Baumgartner and Murchey 1987, Baumgartner 1987, see also *Chapters* 1, 15, and 31 for frther discussion) The distribution of parvicingulids is affected not only by paleolatitude but also by paleobathymetry. For instance, Pessagno *et al.* (1993) state that *Mirifusus* (a parvicingulid genus) is absent in certain strata of Mexico and California (Coast Range ophiolite) because it may be a "stenobathic abyssal" taxon. Hence, the choice of the first appearance of *Mirifusus* as the definitive biostratigraphic marker (primary marker taxon) for the base of their Zone 2 has created important correlation problems.

In this volume, we present several sections dated by ammonites, nannofossils, and stable isotope stratigraphy, in which *Mirifusus fragilis* first occurs in the lower-middle Bajocian (UAZ. 3) and *M. guadalupensis* first occurs in the the latest Bajocian-middle Bathonain (UAZ. 5).

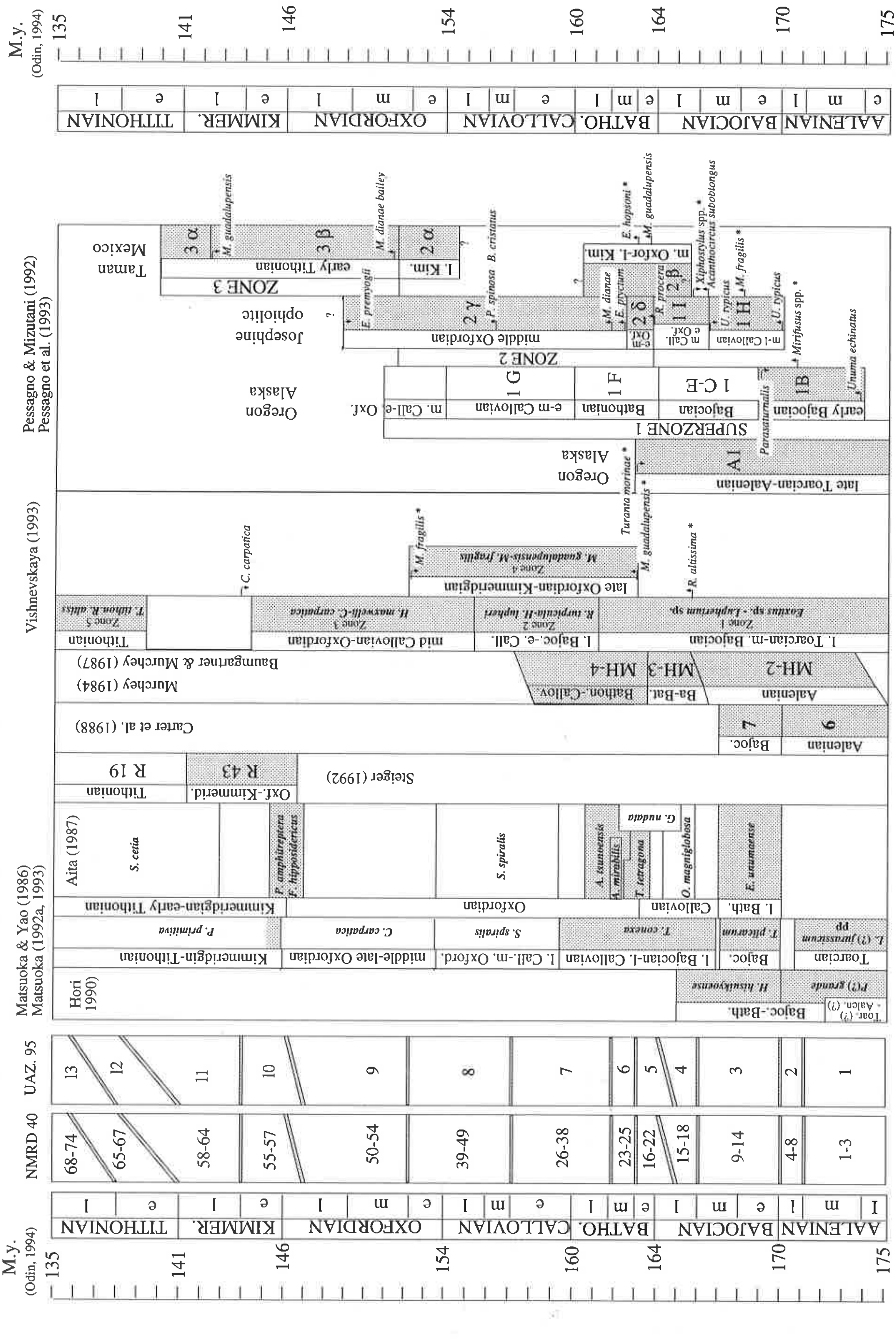
The fact that *M. fragilis* and *M. guadalupensis* first occur together above the Josephine ophiolite (sample JO34, Middle Fork of the Smith River), suggests that part of the lower range of *M. fragilis* (and perhaps of *M. guadalupensis* is missing at this locality (see further discussion in *Chapter* 15).

We fundamentally agree that the very oldest sedimentary strata above the Josephine Ophiolite (Zones 1H, 1I) are correlative with Zones A0 (upper part) and A1 of Baumgartner (1987) or with UAZ. 3 to 6 (*Chapter* 32). Pessagno *et al.* (1993), also correlate the oldest strata in the ophiolites to the *Unuma echinatus* and *older* assemblages in Japan (see comments in Chapter 31). Despite their own correlations, despite the absence of independent megafossil control in the older strata, and despite the radiometric dates on underlying plagiogranites, Pessagno *et al.* (1993) assign late Callovian and early Oxfordian ages to the oldest sedimentary strata above the Josephine Ophiolite.

In order to escape the «*Mirifusus* problem» we have run radiolarian data of Pessagno et al (1993) with our database to obtain direct correlation (Fig. 12). We have established a list of taxa that are discussed in this volume and occur in the Smith River Section based on illustrated taxa of which the

Pessagno et al. (1993)			UAZones95, this Chapter			
Age	Zones	Samples	*hopsoni*	*Trillus*	*Xiphost.*	Ages based on UAZones
lower to middle Oxfordian	2γ	23: JO49	8 -11	8 -11	6 - 6	early Oxf. to late Kimm. or middle Bath.
		22: JO48	8 -10	8 -10	6 - 6	
		21: JO47	7 -10	7 -10	6 - 6	early Call. to late Oxf. or middle Bath.
		20: JO19	7 -10	7 -10	6 - 6	
		19: JO17	7 -10	7 -10	6 - 6	
		18: JO16	6 -10	6 -10	6 - 6	
	2δ	17: JO73	6 - 7	6 - 7	6 - 6	middle Bath.to early Call. or middle Bath.
		16: JO71	6 - 7	6 - 7	6 - 6	
		15: JO70	6 - 7	5 - 5	6 - 6	middle Bath.to early Call. or middle Bath. or latest Baj. - early Bath.
		14: JO69	6 - 7	5 - 5	6 - 6	
		13: JO10.5	6 - 7	5 - 5	5 - 6	
		12: JO67	6 - 7	5 - 5	5 - 6	
		11: JO34	6 - 6	5 - 5	5 - 6	
lower Oxfordian upper Call. ?	1I	10: JO8	6 - 6	3 - 5	3 - 6	middle Bath. or latest Baj. - early Bath.
		9: JO62	6 - 6	3 - 5	3 - 6	
		8: JO61	6 - 6	3 - 5	3 - 6	
		7: JO6	3 - 6	3 - 5	3 - 6	middle Bathonian to early-middle Bajocian
		6: JO60	3 - 6	3 - 5	3 - 6	
upper Callovian	1H	5: JO90	3 - 6	3 - 5	3 - 6	
		4: JO89A-E	3 - 6	3 - 5	3 - 6	
		3: JO88A-E	3 - 6	3 - 5	3 - 6	
		2: JO87A-D	3 - 4	3 - 4	3 - 4	early-middle to late Bajocian
		1: JO86A-E	3 - 4	3 - 4	3 - 4	

Figure 12. Comparison of ages and zones by Pessagno et al. (1993) assigned to the Smith River Section and assignments of UAZones based on the taxa listed by Pessagno et al. (1993). For further explanation see text.


M.y. (Odin, 1994)
135
141
146
154
160
164
170
175
AALENIAN
BAJOCIAN
BATHO.
CALLOVIAN
OXFORDIAN
KIMMER.
TITHONIAN
NMRD 40
1-3
4-8
9-14
15-18
16-22
23-25
26-38
39-49
50-54
55-57
58-64
65-67
68-74
UAZ. 95
Matsuoka & Yao (1986)
Matsuoka (1992a, 1993)
Hori 1990)
Aita (1987)
Steiger (1992)
Carter et al. (1988)
Murchey (1984)
Baumgartner & Murchey (1987)
Vishnevskaya (1993)
Pessagno & Mizutani (1992)
Pessagno et al. (1993)
Oregon
Alaska
Josephine ophiolite
Taman Mexico
SUPERZONE 1
ZONE 2
ZONE 3

synonymy is beyond doubt.. First of all we realised that certain taxon associations of the Smith river section are not represented in the UAZ95 associations, such as: the co-existence of *Trillus* spp. with *Emiluvia hopsoni*, and *Xiphostylus* spp. with *Mirifisus dianae* or with *Podobursa spinosa.* For *Xiphostylus* spp. for instance, we suspect that its range goes really higher in Western North America than in Tethys. These associations not recorded in our Tethyan material point out significant biogeographic differences between the Smith River and Tethyan domnains, that *really* may hamper correlation. Hence, the assignment of UAZ. to the Smith River samples varies slighly if we take into account the presence of either *E. hopsoni,* or *Trillus* spp., or *Xiphostylus* spp. at their Tethyan extent (Fig. 12).The lowest two samples of the Smith River section are invariably assigned to UAZ. 3-4, which would mean a Bajocian age, if Tethyan and Western North American ranges would be strictly the same. the following 5 samples are either assigned to UAZ 3-5 or 3-6. if we take into account the younger end of this range this means that these samples (zones by Pessagno et al as Zone 1H and 1I) are of latest Bajocian to middle Bathonian age, which is in good agreement with the radiometric data of the Josephine ophiolite, if more recent time scales are accepted (see above). This is also in good agreement with the correlation presented in *Chapter* 31 between UAZ 5-6, MH-4 and zone +F of Pessagno *et al.* 1987 in Oregon, dated by ammonites as Bathonian. Pessagno's Superzone 1/2 boundary.(placed between samples JO6 and JO34 in the Smith RiverSection) is likewise assigned either to UAZ 5 or 5-6 or 6 (Fig. 11) and should be correlated with a Bathonian age. Pessago's zone 2δ be of middle Bathonian to early Callovian (UAZ. 6-7) and zone 2γ of early Callovian to late Oxfordian or perhaps even Kimmeridgian age depending on the Tethyan ranges accepted. The latter ages come close to Pessagno's calibration. For the correlation between Pessagno's zones 3 and 4 and UAZ, we refer to *Chapter* 30. Surprisingly, the discrepancies of age assignments to samples by both zonations are much less significant in the Upper Jurassic.

5.8. Conclusions

Correlation between the zonations of Pessagno et al(1993) and the UAZ. presented herein is by no means straightforward, principally because of conceptual differences and radiolarian provincialism. However, The various ways of correlation exposed in *Chapters* 15,. 31 and herein strongly suggest that the base of Pessagno's Superzone 2 has to be placed in the upper middle Jurassic (Bathonian) rather than the lower Oxfordian. In this book we have made an effort to document all available biostratigraphic data to support this view. Further collaborative work should enable us to overcome this decade-long argument.

6. Conclusions and recommendations for the user

The UAZones95 presented in this chapter are based on the recognition of 450 taxa in 800 samples studied by several independent radiolarian specialists over a time period of several years. It is not surprising that the program BIOGRAPH, used to calculate U.A. and UAZones detected thousands of contradictions and several strongly connected components. In this chapter, we have tried to elucidate the nature of the problems and the possible solutions.

The UAZones95 have been created with the principal objective of correlation throughout the Tethyan realm. Sacrifices of vertical resolution were unavoidable. This becomes evident, when we compare taxon ranges and calibration of a more regional protoreferential (NMRD40) with the UAZones95. The regional synthesis has more potential for vertical resolution than the UAZones95.

The user will find many taxa with ranges longer than usually stated in the radiolarian literature. This is for two reasons: 1. We have used rather large species concepts (see Chapters 3 and 4) and therefore transitional early and/or late forms may be included with a species group that would normally not appear on plates or in the taxonomic discussions of the earlier literature. 2. Owing to the highly fragmentary fossil documentation of Mesozoic radiolarians, our knowledge of ranges tends to become more complete as more samples are studied. 3. UAZones are reunions of U.A., i.e. may contain virtual associations of taxa that may never be observed in the actual samples. Some of these associations may artificially lengthen the range of taxa. However, this effect will never be more than a fraction of the duration of the UAZ. in which the taxon first or last occurs. 3. We have not been able to reexamine all samples that presented a large amount of contradictions and strongly connected components. We therefore cannot guarantee that there are no errors (typing errors, misidentifications etc.) in our database.

We think that the presented zonation is interesting for large scale correlation, but its calibration, especially in the Bathonian-early Oxfordian interval needs future improvement.

Figure 13. (Modified from Bartolini, 1995) Comparison of the Jurassic time scale (Odin 1994), the calibration of the protoreferential NMRD40 (1-74) and UAZones95 (1-13). Between the latter there is a one to one correlation, since NMRD40 is contained in UAZ40 (see text). The zonations by Hori (1990), Matsuoka (1992a. 1993), Aita (1987) Carter *et al.* (1988), Murchey (1984), Vishnevskaya (1993) and Pessagno *et al.* (1993) are approximately correlated to UAZones and scaled to time according to the UAZ. calibrations. The ages assigned by the authors to their zones are indicated in the respective columns. Note the overlap of Zones defined by *Mirifusus* spp. in the Zonation by Vishnevskaya and the overlap of Superzones 1 and 2 in the zonation by Pessagno et al (1993). For discussion see text.

REFERENCES

BAUMGARTNER, P., DE WEVER, P. & KOCHER, R. (1980). Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. *Cahiers de Micropaléontologie*, **2**, 23-86.

BAUMGARTNER, P.O. (1984). A Middle Jurassic - Early Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77** (3), 729-841.

BAUMGARTNER, P.O. (1987). Age and genesis of Tehyan Jurassic radiolarites. *Eclogae geologicae Helvetiae*, 73 (3), 831-879.

BAUMGARTNER, P.O. & MURCHEY, B. (1987). Correlation of Tethyan and W-North American Jurassic radiolarian zonations and age of Franciscan terranes. *Terra Cognita*, **7** (2-3), 210.

GORICAN, S. (1994). Jurassic and Cretaceous radiolarian biostratigraphy and sedimentary evolution of the Budva Zone (Dinarides, Montenegro). *Mémoires de Géologie (Lausanne)*, 18, 7-176.

GUEX, J. (1977). Une nouvelle méthode d'analyse biochronologique. *Bulletin de la Société Vaudoise des Science Naturelles*, **73**, 309-322.

GUEX, J. (1987). *Corrélations biochronologiques et associations unitaires* - Presses Polytechniques Romandes, Lausanne. 244 p.

GUEX, J. (1988). Utilisation des horizons maximaux résiduels en biochronologie. *Bulletin de la Société Vaudoise des Sciences Naturelles*, **79** (2), 135-142.

GUEX, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

JUD, R. (1994). Biochronology and systematics of Early Cretaceous Radiolarian of the Western Tethys. *Mémoires de Géologie (Lausanne)*, **19**, 1-147.

MATSUOKA, A. (1992). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MATSUOKA, A. (1993). Localities and biostratigraphy of Jurassic Radiolaria in Japan. In: (Blueford J.R. & Murchey B.L. Eds.) Radiolaria of giant and subgiant fields in Asia. Nazarov Memorial Volume. *Micropaleontology, Special Publication*, **6**, 153-160.

MURCHEY, B. (1984). Biostratigraphy and lithostratigraphy of cherts in the Franciscan Complex, Marin Headlands, California. *In* Blake, M. Ed. *Franciscan Geology of Northern California* - Pacific Section, Society of Economic Paleontologists and Mineralogists, Los Angeles, **43**, 51-70.

O'DOGHERTY, L., SANDOVAL, J., MARTIN-ALGARRA, A. & BAUMGARTNER, P.O. (1989). Las facies con radiolarios del Jurásico subbético (Cordillera Bética, Sur de España). *Revista de la Sociedad Mexicana de Paleontología*, **2** (1), 70-77.

ODIN, G.S., HERNANDEZ, J., LORDKIPANIDZE, M., GILLOT, P.Y. & DERCOURT J. (1992). Première datation radiométrique K-Ar d'un niveau bathonien daté paléontologiquement (Géorgie, URSS); utilisation de la cathodoluminescence pour sélectionner des plagioclases favorables. *Bull. Soc. géol. France*, **163** (1), 37-47.

ODIN, G.S. (1994). Geological Time scale. *C.R. Acad. Sci. Paris*, **318** (II), 59-71.

PESSAGNO, E.A. (1977). Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23** (1), 56-113.

PESSAGNO, E.A. & BLOME, C. (1980). Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. *Micropaleontology*, **26**, (3), 225-273.

PESSAGNO, E.A. & BLOME, C. (1982). Bizarre Nassellariina (Radiolaria) from the Middle and Upper Jurassic of North America. *Micropaleontology*, **28** (3), 289-318.

PESSAGNO, E.A., BLOME, C., CARTER, E.S., MACLEOD, N., WHALEN, P. & YEH, K.Y. (1987). Studies of North American Jurassic Radiolaria; Part II, Preliminary radiolarian zonation for the Jurassic of North America. *Cushman Foundation for Foraminiferal Research, Special Publication*, 1-18.

PESSAGNO, E.A., BLOME, C. & LONGORIA, J. (1984). A revised radiolarian zonation from Upper Jurassic of western North America. *Bulletins of American Paleontology*, **87** (320), 1-51.

PESSAGNO, E.A. & BLOME, C.D. (1986). Faunal affinities and tectonogenesis of Mesozoic rocks in the Blue Mountains of eastern Oregon and western Idaho. *In* Wallier, T.L. & Brooks, H.C. Eds. *Geologic Implications of Paleozoic and Mesozoic Paleontology andBiostratigraphy, Blue Mountains Province, Oregon, Idaho and Washington* - United States Geological Survey, Professional Paper, Report, **1435**, 65-78.

PESSAGNO, E.A. & BLOME, C.D. (1990). Implications of New Jurassic stratigraphic, geochronometric, and paleolatitudinal data from the western Klamath terrane (Smith River and Rogue Valley subterranes). *Geology*,

18, 665-668.

PESSAGNO, E.A., BLOME, C.D., HULL, D.M. & SIX, W.M. (1993). Jurassic Radiolaria from the Josephine ophiolite and overlying strata, Smith River subterrane (Klamath Mountains), northwestern California and southwestern Oregon. *Micropaleontology*, **39** (2), 93-166.

PESSAGNO, E.A. & MIZUTANI, S. (1992). Radiolarian biozones of North America and Japan. In: The Jurassic of the Circum-Pacific. (Westerman, G.E.G., Ed.). Cambridge University Press, New York, 293-295 and 578-585.

PESSAGNO, E.A., SIX, W.M. & YANG, Q. (1989). The Xiphostylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. *Micropaleontology*, **35** (3), 193-255.

PESSAGNO, E.A. & WHALEN, P. (1982). Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, **28** (2), 111-169.

PESSAGNO, E.A., WHALEN, P. & YEH, K.Y. (1986). Jurassic Nassellariina (Radiolaria) from North American geologic terranes. *Bulletins of American Paleontology*, **9** (326), 1-75.

ROBERTS, F. (1976). Discrete mathematical models. Prentice Hall, New Jersey, 559 pp.

SALEEBY, J.B. (1987). Discordance patterns in Pb/U zircon ages of the Sierra Nevada and Klamath Mountains. *EOS, American geophysical Union, Transactions*, **68**, (44), 1514-1515.

SAVARY, J. & GUEX, J. (1991). BioGraph: un nouveau programme de construction des corrélations biochronologiques basées sur les associations unitaires. *Bulletin de la Société Vaudoise des Science Naturelles*, **80** (3), 317-340.

APPENDIX 1. NUMERICAL RANGES (TGI) OF TAXA FOR THE PROTOREFERENTIAL NMRD40

Elodium cameroni	3411: 1 - 4
Homoeoparonaella sp. aff. H. argolidensis	2003: 1 - 5
Paronaella skowkonaensis	2005: 1 - 6
Acaeniotylopsis ghostensis	2001: 1 - 8
Paronaella sp. aff. P. corpulenta	3310: 1 - 8
Tympaneides charlottensis	3408: 1 - 8
Triactoma jacobsae n sp.	3409: 1 - 8
Homoeoparonaella sp. aff. H. elegans	2004: 1 - 9
Hexasaturnalis hexagonus	3502: 1 - 9
Xiphostylus spp.	3414: 1 - 14
Turanta morinae gr.	3247: 1 - 22
Higumastra wintereri n.sp.	3148: 1 - 47
Hsuum sp. 1	2018: 2 - 2
Parashuum cruciferum	2010: 2 - 3
Tetraditryma sp. cf. T. praeplena	3407: 2 - 5
Parasaturnalis diplocyclis	2013: 2 - 9
Parahsuum (?) grande	4031: 2 - 9
Actinomma siciliensis	2008: 2 - 11
Parashuum izensis	2012: 2 - 12
Parahsuum (?) natorensis	3073: 2 - 12
Bernoullius rectispinus rectispinus	4011: 2 - 12
Hexastylus (?) tetradactylus	4027: 2 - 12
Ares cylindricus cylindricus	3001: 2 - 14
Hsuum matsuokai	3195: 2 - 15
Bernoullius furcospinus	4009: 2 - 17
Hexasaturnalis tetraspinus	3089: 2 - 18
Emiluvia lombardensis n. sp.	3253: 2 - 18
Ares cylindricus s.l.	4061: 2 - 23
Orbiculiforma sp. X	2019: 2 - 24
Acaeniotylopsis variatus triacanthus	4066: 2 - 28
Parashuum officerense	2011: 2 - 30
Palinandromeda praepodbielensis	3006: 2 - 37
Bernoullius rectispinus s.l.	4010: 2 - 50
Parashuum sp. M	2015: 3 - 3
Napora nipponica	3410: 3 - 4
Pseudopoulpus acutipodium	2007: 3 - 5
Hexastylus sp. A	2009: 3 - 6
Ristola praemirifusus n.sp.	2014: 3 - 8
Laxtorum (?) hichisoense	4028: 3 - 8
Palinandromeda sognoensis n. sp.	3010: 3 - 10
Eucyrtidiellum (?) quinatum	3048: 3 - 10
Yamatoum spinosum	4077: 3 - 11
Emiluvia splendida	2002: 3 - 12
Angulobracchia sicula	3301: 3 - 12
Trillus spp.	3039: 3 - 14
Tritrabs simplex	3303: 3 - 14
Tetratrabs izeensis	3302: 3 - 22
Unuma echinatus	3231: 3 - 25
Archaeohagiastrum longipes n. sp.	3149: 3 - 27
Tetraditryma praeplena	3125: 3 - 30
Stichocapsa convexa	3055: 3 - 64
Napora pyramidalis	3033: 4 - 45
Acaeniotylopsis variatus s.l.	4063: 4 - 49
Yamatoum caudatum	2016: 5 - 5
Pantanellium sp. L	3042: 5 - 5
Parahsuum (?) magnum	3072: 5 - 10
Parahsuum (?) olorizi	3071: 5 - 14
Bernoullius rectispinus delnortensis	3222: 5 - 36
Archaeohagiastrum munitum	3271: 5 - 40
Yamatoum komamiensis	2020: 6 - 6
Bernoullius rectispinus leporinus	4064: 6 - 6
Transhsuum hisuikyoense	3194: 6 - 14
Bernoullius rectispinus ssp. B	2017: 6 - 28
Laxtorum (?) jurassicum	3151: 7 - 7
Linaresia chrafatensis	3074: 7 - 33
Triactoma jonesi	3096: 7 - 70
Linaresia rifensis	2022: 8 - 9
Parahsuum (?) hiconocosta n. sp.	3011: 8 - 16
Mirifusus proavus	3158: 8 - 17
Palinandromeda murcheyae n. sp.	3004: 9 - 10
Zartus dickinsoni gr.	3041: 9 - 14
Unuma typicus	4059: 9 - 15
Dictyomitrella (?) kamoensis	4014: 9 - 28
Stichomitra (?) sp. A	3192: 9 - 34
Linaresia beniderkoulensis	3813: 9 - 35
Transhsuum medium	3278: 9 - 36
Acanthocircus protoformis	2021: 9 - 41
Parvicingula dhimenaensis ssp. A.	4071: 9 - 41
Eucyrtidiellum unumaense unumaense	3012: 9 - 47
Eucyrtidiellum unumaense s.l.	3052: 9 - 47
Angulobracchia purisimaensis	3144: 9 - 51
Transhsuum maxwelli gr.	3180: 9 - 54
Parvicingula dhimenaensis	3197: 9 - 60
Napora sp. A	3030: 10 - 14
Higumastra gratiosa n.sp.	3109: 10 - 43
Palinandromeda praecrassa	3007: 10 - 54
Emiluvia sedecimporata	3216: 10 - 63
Parvicingula schoolhousensis gr.	3184: 11 - 11
Unuma latusicostatus	4058: 11 - 20
Hsuum sp. cf. H. mirabundum	2006: 11 - 24
Homoeoparonaella (?) pseudoewingi n.sp.	3150: 11 - 38
Mirifusus fragilis s.l.	3159: 11 - 47
Paronaella kotura	3140: 11 - 53
Emiluvia premyogii	3210: 11 - 54
Bernoullius dicera	3223: 11 - 55
Paronaella bandyi	3135: 11 - 56
Mirifusus fragilis praeguadalupensis n.ssp.	2026: 12 - 12
Parvicingula dhimenaensis dhimenaensis	4072: 12 - 30
Palinandromeda depressa	3005: 12 - 35
Parashuum stanleyensis	2023: 12 - 44
Angulobracchia digitata	3147: 12 - 51
Sethocapsa funatoensis	3070: 12 - 62
Zartus imlayi gr.	3040: 13 - 13
Tetraditryma corralitosensis corralitosensis	3124: 14 - 51
Tetraditryma corralitosensis s. l.	3273: 14 - 51
Acanthocircus suboblongus s.l.	3064: 14 - 57
Acanthocircus suboblongus suboblongus	3088: 14 - 62
Tricolocapsa (?) fusiformis	4049: 15 - 15
Cyrtocapsa mastoidea	3307: 15 - 16
Tricolocapsa conexa	3297: 15 - 30
Stichomitra (?) takanoensis gr.	4044: 15 - 32
Triactoma parablakei	3413: 15 - 38
Pseudocrucella adriani	3129: 15 - 54
Tetraditryma pseudoplena	3123: 15 - 63
Unuma sp. A	3309: 16 - 16
Tricolocapsa plicarum s.l.	3051: 16 - 42
Leugeo hexacubicus	3244: 16 - 48
Podobursa helvetica	3169: 16 - 51
Transhsuum brevicostatum gr.	3181: 16 - 64
Protunuma turbo	4034: 17 - 26
Archaeodictyomitra (?) amabilis	3237: 18 - 27
Williriedellum sp. A	4060: 18 - 47
Stylocapsa (?) hemicostata	4045: 19 - 19
Tricolocapsa tetragona	4054: 19 - 21
Ristola altissima major n.ssp.	3238: 19 - 30
Eucyrtidiellum unumaense pustulatum	3013: 19 - 39
Theocapsomma cordis	3277: 19 - 46
Higumastra imbricata	3110: 19 - 48

Ristola altissima s. l.	3164: 19 - 67
Tricolocapsa plicarum plicarum	4053: 20 - 20
Tetraditryma corralitosensis bifida	4048: 20 - 27
Stichocapsa decora	3269: 20 - 36
Podobursa polyacantha	3174: 20 - 44
Monotrabs plenoides gr.	3152: 20 - 47
Guexella nudata	3061: 20 - 48
Acaeniotylopsis variatus variatus	3270: 20 - 49
Stauroloncbe robusta	3220: 20 - 51
Pseudoeucyrtis sp. J	3176: 20 - 55
Triactoma blakei	3095: 20 - 63
Homoeoparonaella argolidensis	3103: 20 - 63
Tetratrabs zealis	3121: 20 - 69
Tritrabs ewingi s.l.	3113: 20 - 78
Stichocapsa japonica	3049: 21 - 45
Palinandromeda podbielensis	3008: 21 - 54
Acanthocircus suboblongus minor n.ssp.	3085: 21 - 59
Mirifusus guadalupensis	3160: 21 - 61
Tritrabs rhododactylus	3118: 21 - 70
Bernoullius cristatus	3221: 22 - 40
Ristola procera	3163: 22 - 52
Triactoma mexicana	3412: 22 - 54
Obesacapsula morroensis	3266: 22 - 77
Ares cylindricus flexuosus	4032: 23 - 23
Theocapsomma cucurbiformis n. sp.	3047: 23 - 38
Archaeodictyomitra (?) sp. A	3235: 23 - 38
Theocapsomma bicornis n. sp.	3276: 23 - 38
Acanthocircus trizonalis angustus n.ssp.	3082: 23 - 54
Emiluvia salensis	3215: 23 - 70
Triactoma tithonianum	3097: 23 - 78
Acanthocircus trizonalis s.l.	3065: 23 - 80
Stylocapsa tecta	4047: 24 - 24
Napora saginata	3032: 24 - 29
Amphipyndax tsunoensis	2025: 24 - 30
Amphipyndax durisaeptum	4005: 24 - 31
Eucyrtidiellum unumaense dentatum n.ssp.	3015: 24 - 38
Turanta flexa	2024: 24 - 44
Emiluvia nana n. sp.	3212: 24 - 51
Homoeoparonaella elegans	3104: 24 - 52
Tritrabs casmaliaensis	3117: 24 - 55
Haliodictya (?) antiqua ssp. B.	3217: 24 - 60
Haliodictya (?) antiqua antiqua	3218: 24 - 60
Spongocapsula palmerae	3199: 24 - 70
Mirifusus chenodes	3162: 24 - 77
Emiluvia hopsoni	3225: 24 - 77
Diacanthocapsa (?) operculi	3054: 25 - 38
Gorgansium spp.	3076: 25 - 47
Paronaella mulleri	3139: 25 - 54
Haliodictya (?) hojnosi	3254: 25 - 55
Spongocapsula perampla	3267: 25 - 58
Gongylothorax sakawaensis	4023: 26 - 26
Stichocapsa robusta	3298: 26 - 30
Stichocapsa naradaniensis	3045: 26 - 34
Stylocapsa catenarum	3044: 26 - 38
Stylocapsa (?) spiralis gr.	3046: 26 - 38
Gongylothorax sp. aff. G. favosus	3279: 26 - 41
Stylocapsa oblongula	3059: 26 - 43
Orbiculiforma (?) catenaria	3205: 26 - 51
Cinguloturris carpatica	3193: 26 - 60
Eucyrtidiellum ptyctum	3017: 26 - 63
Williriedellum carpathicum	4055: 26 - 63
Protunuma (?) ochiensis	3290: 26 - 76
Angulobracchia sp. B	4006: 27 - 30
Perispyridium ordinarium gr.	3100: 27 - 62
Sethocapsa dorysphaeroides	5544: 27 - 77
Parvicingula (?) spinata	3187: 28 - 32
Syringocapsa (?) sp. A	3268: 28 - 32
Napora latissima	3031: 28 - 38
Parvicingula (?) sp. A	3239: 28 - 38
Saitoum trichylum	3021: 28 - 51
Palinandromeda crassa	3009: 28 - 57
Saitoum pagei	3020: 28 - 60
Pantanellium riedeli	3078: 28 - 60
Napora deweveri	3035: 28 - 62
Emiluvia chica s.l.	3213: 28 - 78
Theocapsomma sp A.	3043: 29 - 32
Thetis (?) bernoullii n. sp.	3003: 29 - 34
Saitoum corniculum	3023: 29 - 38
Archaeodictyomitra (?) mirabilis	3236: 29 - 38
Saitoum levium	3024: 29 - 51
Paronaella pygmaea	3133: 29 - 53
Parahsuum sp. S	3240: 29 - 60
Protunuma japonicus	3292: 29 - 67
Sethocapsa sp. Co	3167: 29 - 74
Sethocapsa trachyostraca	3063: 29 - 77
Sethocapsa leiostraca	3062: 29 - 78
Haliodictya (?) antiqua s.l.	3243: 30 - 60
Napora sp. B	3034: 30 - 70
Hilarisirex quadrangularis	3002: 31 - 38
Xitus (?) sp. D	3261: 31 - 51
Orbiculiforma (?) heliotropica n. sp.	3204: 31 - 53
Williriedellum crystallinum	3069: 31 - 63
Mirifusus dianae dianae	3274: 31 - 65
Pseudodictyomitra primitiva	3189: 31 - 66
Mirifusus dianae s.l.	3161: 31 - 80
Poulpus sp. aff. P. oculatus	3028: 32 - 32
Pseudocrucella sanfilippoae	3126: 33 - 55
Eucyrtidiellum semifactum	3016: 34 - 34
Eucyrtidiellum nodosum	3014: 34 - 51
Higumastra inflata	3106: 34 - 51
Paronaella broennimanni	3137: 34 - 53
Tritrabs hayi	3116: 34 - 54
Dibolachras chandrika	3265: 34 - 64
Quinquecapsularia megasphaerica n.sp.	3081: 35 - 60
Tritrabs ewingi worzeli	3115: 35 - 62
Triactoma foremanae	4068: 35 - 62
Ristola altissima altissima	3241: 35 - 67
Crucella theokaftensis	3131: 36 - 60
Acaeniotyle diaphorogona gr.	3090: 36 - 81
Tetratrabs bulbosa	3122: 37 - 64
Tritrabs exotica	3119: 38 - 62
Triactoma cornuta	3166: 39 - 56
Homoeoparonaella (?) giganthea	3105: 40 - 55
Emiluvia orea orea	3224: 41 - 64
Emiluvia orea s.l.	4069: 41 - 64
Podobursa spinosa	3230: 42 - 68
Napora lospensis	3036: 43 - 70
Pseudocrucella sp. B	3127: 44 - 51
Emiluvia pessagnoi multipora	3226: 45 - 77
Emiluvia pessagnoi s.l.	3066: 45 - 78
Archaeodictyomitra apiarium	3263: 46 - 78
Xitus magnus n. sp.	3259: 47 - 63
Wrangellium depressum	3284: 48 - 78
Pseudoeucyrtis reticularis	3177: 49 - 63
Parvicingula mashitaensis	3245: 50 - 60
Angulobracchia biordinalis	3145: 50 - 62
Sethocapsa (?) sphaerica	3168: 50 - 62
Wrangellium okamurai	3179: 50 - 62
Mirifusus dianae baileyi	3406: 50 - 62
Zhamoidellum ovum	4079: 50 - 63
Syringocapsa spinellifera n. sp.	3170: 50 - 67
Podobursa (?) sp. aff. P. quadriaculeata	3289: 50 - 76
Deviatus diamphidius s.l.	4073: 50 - 82
Acanthocircus trizonalis trizonalis	3083: 51 - 51

Higumastra coronaria	3108: 51 - 51
Orbiculiforma(?) sp. aff. O. mclaughlini	3206: 51 - 51
Alievium sp. A	4004: 51 - 51
Acaeniotyle (?) sp. A	3091: 51 - 60
Deviatus diamphidius diamphidius	3112: 51 - 76
Saitoum elegans	3022: 51 - 78
Archaeodictyomitra minoensis	3305: 52 - 67
Podocapsa amphitreptera	3171: 52 - 78
Emiluvia ordinaria	4015: 53 - 62
Mirifusus dianae minor	3286: 53 - 79
Suna echiodes	3094: 54 - 78
Xitus sp. aff. X. spicularius	3295: 55 - 77
Acanthocircus trizonalis dicranacanthos	3087: 56 - 82
Emiluvia orea ultima n.ssp.	4070: 57 - 62
Hsuum sp. aff. H. cuestaense	3182: 58 - 72
Obesacapsula verbana	3202: 58 - 77
Obesacapsula cetia	3203: 59 - 78
Napora boneti	3037: 60 - 60
Paronaella pristidentata	3138: 60 - 60
Xitus sp. aff. X. pulcher	3258: 60 - 60
Parvicingula sp. aff. P. elegans	3188: 60 - 62
Acaeniotyle umbilicata	3092: 60 - 80
Ditrabs sansalvadorensis	3227: 61 - 77
Emiluvia bisellea n. sp.	4018: 62 - 62
Syringocapsa sp. aff. S. coronata	5416: 62 - 78
Xitus gifuensis	3294: 63 - 67
Parvicingula boesii gr.	3185: 64 - 82
Eucyrtidiellum pyramis	3019: 65 - 73
Archaeodictyomitra excellens	3287: 65 - 82
Angulobracchia (?) rugosa	3911: 66 - 77
Cinguloturris arabica	6101: 66 - 78
Pseudodictyomitra carpatica	3293: 66 - 79
Ristola cretacea	3165: 67 - 78
Pantanellium sp. aff. P. cantuchapai	5065: 68 - 75
Pantanellium berriasianum	3280: 68 - 77
Obesacapsula breggiensis	3955: 68 - 77
Canoptum banale	5785: 68 - 77
Parvicingula cosmoconica	3255: 68 - 78
Hsuum raricostatum	3591: 68 - 78
Emiluvia chica decussata	5132: 68 - 78
Cyrtocapsa (?) grutterinki	5506: 68 - 78
Pantanellium squinaboli	5607: 68 - 78
Obesacapsula rusconensis umbriensis	5796: 68 - 78
Obesacapsula rusconensis s.l.	6129: 68 - 78
Bistarkum valdorbiense	3919: 69 - 75
Acanthocircus furiosus	5003: 69 - 75
Syringocapsa agolarium	3291: 69 - 77
Ditrabs (?) osteosa	3912: 69 - 77
Syringocapsa longitubus	5410: 69 - 77
Katroma milloti	5436: 69 - 77
Alievium helenae	3228: 69 - 78
Artocapsa (?) amphorella	3924: 69 - 78
Archaeospongoprunum patricki	5042: 69 - 78
Paronaella (?) tubulata	5183: 69 - 78
Tetratrabs radix	5209: 69 - 78
Mirifusus odoghertyi	5721: 69 - 78
Hsuum feliformis	5824: 69 - 78
Deviatus diamphidius hipposidericus	3111: 70 - 70
Pseudoaulophacus (?) pauliani	5332: 70 - 70
Homoeoparonaella speciosa	5163: 70 - 71
Bistarkum brevilatum	3918: 70 - 75
Parvicingula sphaerica	3717: 70 - 77
Triactoma luciae	5055: 70 - 77
Crucella collina	5194: 70 - 77
Homoeoparonaella sp. aff. H. irregularis	5253: 70 - 77
Pseudoeucyrtis (?) fusus	5408: 70 - 77
Syringocapsa coronata	5417: 70 - 77
Milax adrianae	5453: 70 - 77
Wrangellium columnum	5580: 70 - 77
Acaeniotyle dentata	3281: 70 - 78
Obesacapsula rusconensis rusconensis	3282: 70 - 78
Syringocapsa lucifer	3283: 70 - 78
Angulobracchia (?) portmanni portmanni	3285: 70 - 78
Pseudocrucella (?) elisabethae	3947: 70 - 78
Halesium (?) lineatum	5243: 70 - 78
Syringocapsa vicetina	5409: 70 - 78
Sethocapsa tricornis	5510: 70 - 78
Obesacapsula bullata	5568: 70 - 78
Angulobracchia (?) portmanni s.l.	6121: 70 - 78
Syringocapsa limatum	5426: 70 - 82
Sethocapsa sp. aff. S. kaminogoensis	5481: 70 - 82
Parapodocapsa furcata	5396: 71 - 74
Pseudoeucyrtis sceptrum	5577: 71 - 78
Parvicingula longa	5578: 71 - 78
Xitus (?) alievi	5674: 72 - 77
Sethocapsa (?) concentrica	5433: 72 - 78
Wrangellium puga	5636: 72 - 82
Obesacapsula polyedra	5565: 73 - 78
Sethocapsa uterculus	5462: 74 - 82
Sethocapsa (?) zweilii	5464: 75 - 75
Mirifusus apenninicus	5716: 75 - 75
Parvivacca magna	3288: 76 - 76
Sethocapsa kitoi	3264: 77 - 77
Stylosphaera (?) macroxiphus	5044: 77 - 77
Halesium biscutum	5166: 77 - 77
Savaryella guexi	5193: 77 - 77
Paronaella trifoliacea	5186: 78 - 78
Hemicryptocapsa capita	4026: 79 - 82
Cecrops septemporatus	5229: 79 - 82
Parvicingula usotanensis	5712: 79 - 82
Thanarla pulchra	5073: 80 - 82
Acanthocircus variabilis	5011: 81 - 82
Crucella bossoensis	5204: 82 - 82
Crolanium pythiae	5532: 82 - 82

APPENDIX 2. CORRELATION TABLE (TGK) FOR PROTOREFERENTIAL NMRD40

BIOGRAPH v2.02
(c) 1990 by J.Savary & J.Guex

SECTION
POB30_DSDP_LEG_76_S_534

26:089-2-0.47:	76 - 76
25:106-1-0.29:	60 - 60
24:111-1-0.12:	38 - 38
23:115-1-0.70:	38 - 38
22:117-1-0.32:	38 - 38
21:120-1-0.52:	38 - 38
20:121-1-0.25:	38 - 38
19:121-1-0.52:	36 - 36
18:122-1-042:	34 - 34
17:122-1-131:	34 - 34
16:123-2-037:	34 - 34
15:124-2-0.97:	31 - 34
14:124-1-0.41:	31 - 32
13:124-1-052:	32 - 32
12:125-2-035:	31 - 31
11:125-2-115:	31 - 31
10:125-4-001:	31 - 31
9:125-5-072:	31 - 31
8:125-5-111:	31 - 31
7:125-6-013:	31 - 31
6:125-6-063:	31 - 31
5:126-2-045:	31 - 31

4:126-2-065: 29 - 29
3:126-2-125: 29 - 29
2:126-4-140: 29 - 30
1:76-534A-127-1-13-15: 23 - 23

SECTION 45_POBLO_SIERRA_DE_RICOTE
30:RI H2.70: 59 - 64
29: 54 - 64
28: 54 - 60
27: 54 - 60
26: 54 - 60
25: 54 - 60
24: 54 - 60
23: 54 - 60
22: 54 - 60
21: 55 - 55
20: 46 - 55
19: 46 - 48
18: 46 - 48
17: 42 - 48
16: 42 - 47
15: 42 - 47
14: 42 - 47
13: 42 - 47
12: 42 - 47
11: 42 - 47
10: 42 - 47
9: POB 1775: 42 - 42
8: POB 1797: 21 - 42
7: POB 1796: 20 - 20
6: 20 - 20
5: 20 - 20
4: 20 - 20
3: 16 - 20
2: 16 - 20
1: POB 1784: 16 - 16

SECTION CASA_BLANCA
1: 89cb7: 19 - 20

SECTION 59_LO_S_HARANA_JA4_2
1: 52 - 52

SECTION 60_LO_ELVIRA
4: 90-AA-11: 29 - 30
3: 90-AA-8: 26 - 26
2: 90-AA-7: 26 - 26
1: 90A-C-1a: 19 - 19

SECTION 60A_CERRO_LA_MARTINA
2: 89N-M-16: 64 - 64
1: 89L-M-6: 37 - 37

SECTION 58_LO__CB_7
1: 19 - 20

SECTION POB22_23_RJ9_SANGIANO_RUSCON
9: 70 - 70
8: 68 - 68
7: RK 9: 60 - 64
6: RK48: 56 - 56
5: RK11: 52 - 55
4: RK24: 46 - 46
3: RK30: 43 - 45
2: RK36: 26 - 45
1: RK37: 26 - 45

SECTION POB24_RJ10_BREGGIA_JUR
25:POB1330: 77 - 77
24:BR0.003 RJ: 70 - 75
23:RK B48 2.33: 56 - 63
22:RK B45 5.45: 56 - 63
21:RK B85 14.90: 52 - 55
20:RK 430 17.50: 52 - 55
19:RK B30 20.75: 52 - 55
18:RK 433 24.10: 46 - 53
17:RK B27 26.40: 46 - 52
16:RK B22 30.05: 46 - 52
15:RK B21 32.40: 46 - 47
14:RK B19 35.70: 45 - 47
13:RK B90 40.10: 45 - 45
12:RK B12 42.15: 45 - 45
11:RK B11 42.25: 45 - 45
10:RK B9=B10: 45 - 45
9: RK B2: 43 - 43
8: RK B6=B8: 43 - 43
7: RK B3: 33 - 40
6: RK B4: 33 - 40
5: RK B69: 33 - 33
4: RK B57: 33 - 33
3: RK B72: 26 - 33
2: RK B100=B10: 25 - 25
1: RK B61: 25 - 47

SECTION POB25_SALTRIO
12: 26 - 40
11: 40 - 40
10: 30 - 40
9: 30 - 39
8: 30 - 39
7: 39 - 39
6: 39 - 39
5: 30 - 30
4: 30 - 30
3: 30 - 30
2: 25 - 33
1: 25 - 25

SECTION POB19_TORRE_DE_BUSI
9: 56 - 60
8: 52 - 60
7: 52 - 55
6: 28 - 45
5: 28 - 43
4: 28 - 43
3: 25 - 45
2: 25 - 43
1: POB 1341 10 - 10

SECTION POB44_CENIGA
4: POB 1704: 57 - 62
3: POB 1703: 57 - 57
2: POB 1701: 53 - 54
1: POB 1695: 46 - 51

SECTION 44A_MADONNA_DELLA_CORONA_
3: MCB0.35: 35 - 54
2: MCB0.90: 41 - 60
1: MCA0.35: 48 - 48

SECTION 44B_KABERLABA
2: K13.40: 41 - 54
1: K12.00: 49 - 49

SECTION 44C_MAZZE
3: M21.75: 57 - 62
2: M20.60: 57 - 57
1: M18.20: 41 - 54

SECTION VAJONT_DAM
2:VAJ-FON3: 35 - 35
1:VAJ-FON 0: 35 - 35

SECTION 26_BOSSO_JUR
42:BO323.20 RJ: 75 - 75
41:BO315.50 RJ: 73 - 75
40:BO312.90 RJ: 73 - 75
39:BO312.00 RJ: 70 - 75
38:BO311.20 RJ: 70 - 75
37:RK 1083: 69 - 75
36:RK 1082: 69 - 70
35:BO306.20: 69 - 69
34:BO305.00: 69 - 69
33:BO304.00: 69 - 69
32:RK 1079: 61 - 63
31:RK 1078: 61 - 63
30:RK 1076: 61 - 63
29:BO294.60: 61 - 61
28:BO292.20: 59 - 61
27:BO289.80: 56 - 56
26:RK 1072: 52 - 56
25:BO279.30: 52 - 56
24:RK 1071: 52 - 56
23:W79-223: 52 - 56
22:RK 1070: 43 - 47
21:BO 268.00 43 - 54
20:RK 1065: 43 - 45
19:RK 1064: 26 - 47
18:RK 1062: 23 - 47

17:RK 1059: 26 - 40
16:BO254.50: 26 - 42
15:W79-227: 21 - 25
14:BO234.30: 20 - 25
13:BO 230.80: 14 - 14

SECTION
56_RJ7_VALDORBIA_JUR
37:V-10.00: 78 - 78
36:V-6.50: 74 - 74
35:V-6.20: 72 - 74
34:V-6.00: 72 - 74
33:V0.40 RJ: 71 - 74
32:V2.00 RJ: 71 - 71
31:V5.00: 70 - 75
30:V23.70: 69 - 77
29:V33.00: 69 - 77
28:V41.65: 69 - 77
27:V46.10: 69 - 77
26:V47.60: 69 - 69
25:V51.25: 53 - 64
24:V60.70: 53 - 64
23:V65.90: 53 - 57
22:V71.00: 46 - 55
21:V74.00: 42 - 57
20:V98.00: 21 - 48
19:V102.80: 21 - 35
18:V112.60: 21 - 33
17:V118.50: 21 - 33
16:V130.30: 16 - 17
15:V132.70: 16 - 17
14:V133.60: 11 - 17
13:V135.50: 8 - 17

SECTION
POBRJ6_CAMPO_AL_BELLO
13:POB1584: 54 - 57

SECTION TERMINILLETTO
37:TM 207.34: 62 - 62
36:TM 206.75: 62 - 62
35:TM 197.30: 58 - 59
34:TM 197.03: 58 - 59
33:TM 193.40: 52 - 54
32:TM 192.44: 52 - 54
31:TM 188.50: 50 - 54
30:TM188.45: 50 - 54
29:TM188.18: 50 - 54
28:TM 187.44: 50 - 52
27:TM 187.30: 50 - 52
26:TM 179.20: 41 - 47
25:TM 174.98: 41 - 44
24:TM 174.88: 41 - 44
23:TM 174.86: 41 - 41
22:TM 168.15: 28 - 30
21:TM 166.70: 28 - 30
20:TM 165.80: 28 - 28
19:TM 164.66: 27 - 27
18:TM 164.06: 27 - 27
17:TM 163.05: 24 - 24
16:TM 109.25: 12 - 12
15:TM 105.50: 11 - 11
14:TM 90.32: 9 - 9
13:RTT 140: 8 - 8
12:TM 64.74: 8 - 8
11:RTT 116: 8 - 8
10:TM 51.44: 6 - 6
9:T 115: 5 - 5
8:T 113: 5 - 5
7:TM 48.35: 5 - 5
6:T 106: 3 - 5
5:TM 40.15 3 - 3
4:T96: 3 - 3
3:TM29.52: 3 - 3
2:TM25.15: 2 - 2
1:RTT 74.5: 2 - 3

SECTION 2_VERIGE
5:Ve10: 53 - 62
4:Ve 9: 58 - 58
3:Ve 8: 52 - 58
2:Ve 7: 50 - 58
1:Ve 6: 50 - 63

SECTION 3_1_BIJELA_I
7:Bj 15: 52 - 60
6:Bj 14: 26 - 30
5:Bj 13: 19 - 21
4:Bj 12: 19 - 26
3:Bj 11: 15 - 18
2:Bj 10: 9 - 12
1:Bj 9: 7 - 7

SECTION 3_2_BIJELA_II
2:Bj 15/2: 52 - 63
1:Bj 15/1: 52 - 53

SECTION 3_3_BIJELA_III_IV
3:Bj 17: 80 - 82
2:BjIII 3.00: 58 - 58
1:BjIII 0.40: 58 - 63

SECTION 4_GORNJA_LASTVA
20:GL 214: 81 - 81
19:GL 142: 68 - 73
18:GL 139: 68 - 73
17:GL 138: 67 - 67
16:GL 137: 53 - 62
15:GL 210: 53 - 62
14:GL 209+6.60: 53 - 53
13:GL 209: 41 - 41
12:GL 208+1.00: 26 - 28
11:GL 208: 26 - 28
10:GL 207: 26 - 28
9:GL 135: 19 - 21
8:Gl 134: 18 - 20
7:GL 6: 18 - 18
6:GL 132: 17 - 17
5:ZB 28: 15 - 15
4:GL 128: 13 - 13
3:GL 127: 9 - 10
2:GL 125: 7 - 7
1:GL 123: 7 - 7

SECTION 6_PETROVAC
3:PK 7: 50 - 51
2:PK 9: 46 - 51
1:PK 12: 36 - 47

SECTION 7_CANJ
18:UPC 30: 80 - 80
17:UPC 29: 67 - 67
16:UPC 28: 66 - 67
15:UPC 27: 66 - 66
14:UPC 26: 66 - 66
13:UPC 25: 66 - 66
12:UPC 262.70: 58 - 60
11:UPC 257.10: 52 - 54
10:UPC 251.50: 50 - 51
9:UPC 23: 47 - 47
8:UPC 22: 41 - 47
7:UPC 21: 41 - 47
6:UPC 20: 26 - 30
5:UPC 18: 26 - 27
4:UPC 16: 9 - 14
3:UPC 15: 9 - 12
2:UPC 14: 7 - 10
1:UPC 13: 5 - 10

SECTION 8_DIN_VRH
8:DIN 31.50: 79 - 79
7:DIN 29.30: 72 - 72
6:DIN 24.30: 66 - 67
5:DIN 11.55: 63 - 63
4:DIN 7.00: 53 - 62
3:DIN 4.50: 46 - 63
2:DIN 2.35: 50 - 50
1:DIN 1.50: 37 - 55

SECTION 10_BAR
9:BM 478.60: 82 - 82
8:BM 469.00: 80 - 82
7:BM 466.40: 79 - 80
6:BM 8: 66 - 67
5:BM 7: 65 - 65
4:BM 6: 53 - 62
3:BM 5: 53 - 60
2:BM 106: 58 - 60
1:BM 102: 44 - 50

SECTION CARTER_1_4
9:GSC C-080595: 11 - 11
8:GSC C-080594: 11 - 12
7:GSC C-080592: 9 - 14
6:GSC C-176578: 4 - 4
5:GSC C-176580: 4 - 4
4:GSC C-176577: 4 - 4
3:GSC C-156399: 4 - 4
2:GSC C-176579: 4 - 4
1:GSC C-080586: 3 - 4

33. Middle Jurassic-Lower Cretaceous Radiolarian Zonation in Japan and the Western Pacific, and Age Assignments Based on the Unitary Associations Method

by Atsushi Matsuoka

Department of Geology, Faculty of Science, Niigata University, Niigata 950-21, Japan

ABSTRACT

A radiolarian zonal scheme of the Middle Jurassic to Lower Cretaceous using biostratigraphic data from both land sections in Japan and ocean sections in the the western Pacific is presented. Zonal boundaries are defined by bio-events such as evolutionary first appearance, first occurrence and last occurrence biohorizons. The nine zones presented herein are, in ascending order, *Laxtorum* (?) *Jurassicum*, *Tricolocapsa plicarum*, *Tricolocapsa conexa*, *Stylocapsa spiralis*, *Hsuum maxwelli*, *Pseudodictyomitra primitiva*, *Pseudodictyomitra carpatica*, *Cecrops septemporatus*, and *Acanthocircus carinatus* zones. Age assignments for these zones are given simply by the result of age calibration for the UAZones (*Chapter* 32) which is derived from the present collaborative research.

1. Introduction

Much effort has been made to establish a radiolarian biostratigraphic zonation for the Jurassic and Lower Cretaceous in Japan (Aita, 1982, 1985, 1987; Aoki, 1982; Furukubo *et al.*, 1985; Hori, 1990; Kido *et al.*, 1982; Kishida & Sugano, 1982; Kito, 1987; Kumon *et al.*, 1986; Matsuoka, 1982, 1983, 1988; Matsuoka & Yao, 1985, 1986; Matsuyama *et al.*, 1982; Mizutani *et al.*, 1981, Nakaseko & Nishimura, 1981; Nishizono & Murata, 1983; Okamura, 1992; Sashida, 1988; Sato & Nishizono, 1983; Sato *et al.*, 1986; Teraoka & Kurimoto, 1986; Tumanda, 1989; Yao, 1983, 1984, 1986, 1990; Yao *et al.*, 1982). Many of these works have examined oceanic strata such as chert and siliceous mudstone embedded in accretionary complexes. Because the oceanic strata are fragmented and disturbed by faulting and folding, it is necessary to attempt a reconstruction of the radiolarian succession using data collected from many incomplete sections. As a result of extensive biostratigraphic work by different researchers, and research groups, we have established several zonal schemes for the Jurassic and Lower Cretaceous. Correlation of these zonal schemes has been discussed and summarized in a table by the authors (e.g., Aita, 1987; Matsuoka & Yao, 1986; Tumanda, 1989; Yao, 1986, 1990).

Recently a continuous sequence of Middle Jurassic to Early Cretaceous radiolarites has been successfully recovered from the deep basin in the western Pacific by the Ocean Drilling Program (ODP) Leg 129 (Lancelot *et al.*, 1990; Larson *et al.*, 1992). Radiolarian biostratigraphic research on the ODP material has revealed that the radiolarian zonation established in land sections in Japan can be applied for the western Pacific sections (Matsuoka, 1991, 1992a).

The radiolarian zonation for the Mesozoic erected in Japan is applicable also to coeval sequences in eastern Asia, including the North Palawan in Philippines (Isozaki *et al.*, 1988), Nadanhada Range in Northeast China (Kojima & Mizutani, 1987; Mizutani & Kojima, 1992), and Shikote-Alin in Russia (Tikhomirova, 1988; Kojima *et al.*, 1991; Wakita *et al.*, 1992; Mizutani & Kojima, 1992). This wide application of the zonal scheme has greatly contributed to the assignment of relative ages for various rocks embedded in accretionary complexes and to the understanding of the Mesozoic tectonic evolution of eastern Asia (e.g. Mizutani & Kojima, 1992, Matsuoka 1992b).

However, the Japanese radiolarian zones are insufficiently correlated to the European standard stages, because the oceanic strata in Japan rarely contain any age-diagnostic fossils other than radiolarians. It is an urgent task to correlate the radiolarian zones to the standard stages in order to discuss the tectonic evolution of eastern Asia in the framework of the international time scale.

This is the first time on attempt has been made to apply the Unitary Associations method (Guex, 1991) to Middle Jurassic-Lower Cretaceous radiolarian assemblages from Japan and the western Pacific. A total of 212 samples from 12 sections (Fig. 1) are treated in this work (see also Appendix and *Chapters* 27 and 37). Information about sample lithology, lithostratigraphy for each study section, and an outline of regional and local geology of investigated areas are given in the data chapter of this volume (*Chapter* 27).

A partly revised radiolarian zonation for the Middle Jurassic to middle Lower Cretaceous, largely following the zonation by Matsuoka & Yao (1986) and Matsuoka (1992a), is proposed using the biostratigraphic data from both land sections in Japan and oceanic sections from the ODP sites. Ages of biohorizons which define zonal boundaries are preliminary given by means of the U.A. method.

2. Biohorizons and their age assignments by the Unitary Associations method

Nine biohorizons are selected to erect radiolarian zones for the Middle Jurassic to middle Lower Cretaceous of Japan and the western Pacific. Of these nine biohorizons, seven are recognised in the sections investigated herein (Fig. 2).

In general, a biohorizon is situated between two sample horizons in a certain study section; a sample just below the biohorizon (lower sample) does not contain any specimens of a marker species for the biohorizon, while a sample just above the biohorizon (upper sample) yields at least one specimen of the marker species. A U.A. range of the biohorizon is defined by a range which has a smaller number derived from the lower sample and a larger number derived from the upper sample. For instance, if a sample which is taken from just below a certain biohorizon gives a U.A. range of A-B (A<B) and a sample which is taken from

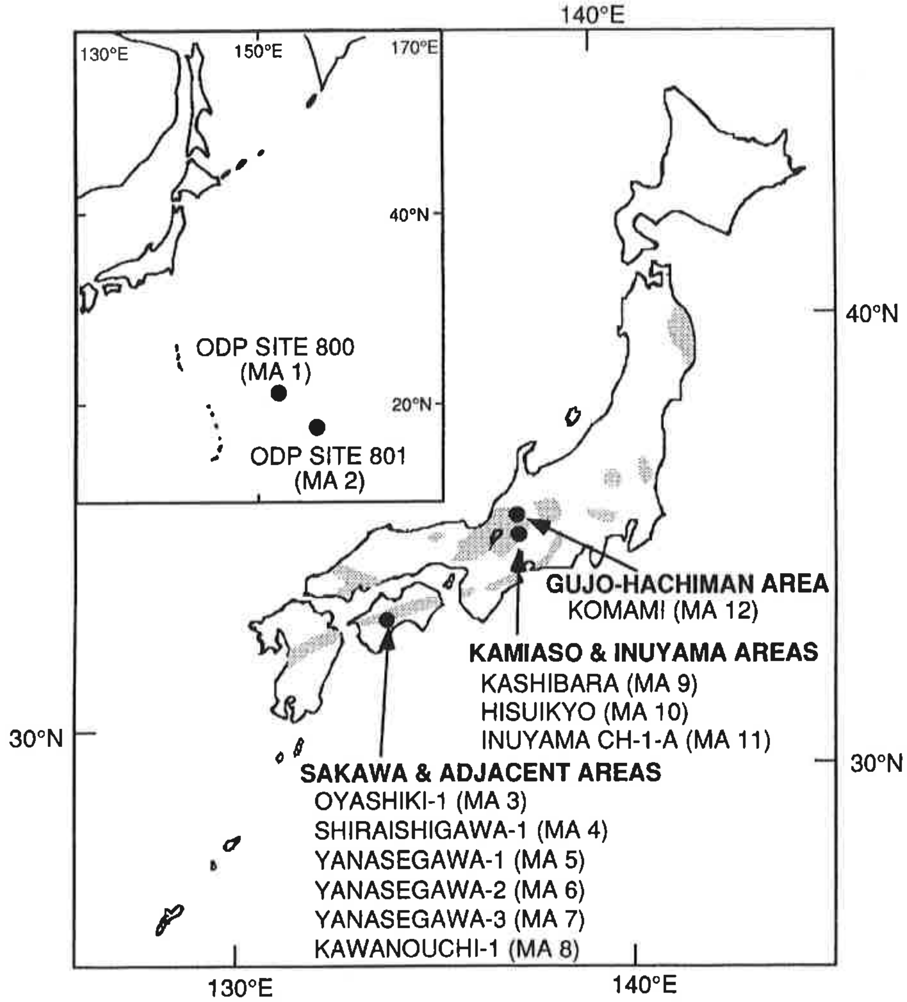


Figure 1. Map showing the location of the study sections.The stippled areas in the Japanese Islands indicate the distribution of Jurassic accretionary complexes.

just above the biohorizon gives a U.A. range of C-D (C<D), then the U.A. range of the biohorizon is expressed as A-D. When A equals D, A (= D) is referred as U.A. number. Generally, U.A. range or number for a biohorizon differ among, study sections, depending on many factors which include sampling density, specific diversity in samples, fossil preservation, and so on.The biohorizons defined in Japan and the western Pacific are correlated to the UAZones in the following manner: if the "lower" and the "upper" sample lie in the same UAZone, the range of the biohorizon is also in this U.A.Zone (example: evolutionary first appearance of *Tricolocapsa conexa*). If the "lower" and the "upper" sample lie in two successive U.A.Zones, we assigned the biohorizon to the upper U.A.Zone for the first appearance of a marker species (example: evolutionary first appearance of *Pseudodictyomitra carpatica*) or to the lower U.A.Zone for the last appearance of a marker species (example: last appearance of *Tricolocapsa conexa*).

Where a biohorizon is recognized in two or more sections, it is discussed which U.A. range or number more reliable. The present collaborative work (this volume, *Chapter* 32) gives the widest range of the UAZone for all species of which bio-events are utilized in drawing zonal boundaries. Irrespective of the U.A. range or number mentioned above, the widest range is applied for giving ages of zonal boundary biohorizons.

2.1 First appearance biohorizon of *Laxtorum* (?) *jurassicum* Isozaki & Matsuda

The first occurrence biohorizon of *Laxtorum* (?) *jurassicum* Isozaki & Matsuda was reported in siliceous mudstone sequence in the Kaiji-1 section, western Kyushu (Matsuoka & Yao, 1986). It is not recognized in continuous sections in the present study. Sample MKM-1 in the Komami Section (MA12), which is correlated to the *Laxtorum* (?) *jurassicum* Zone, is assigned to the UAZone 3 (Fig. 2). Therefore, the first occurrence biohorizon of *L.* (?) *jurassicum* should be situated in or below the U. A. Zone 3. *L.* (?) *jurassicum* ranges from UAZone 2 to 3. The UAZone 2, the first occurrence of this species, is correlated to late Aalenian.

2.2 Evolutionary first appearance biohorizon of *Tricolocapsa plicarum* Yao

Tricolocapsa plicarum Yao evolved from *Stichocapsa tegiminis* gr. Yao by decreasing the number of chambers from four to three (Matsuoka & Yao, 1986). This biohorizon was reported in siliceous mudstone-mudstone sequence in the Kaiji-1 section, western Kyushu (Matsuoka & Yao, 1986). This biohorizon is not recognized in continuous sections in the present study. Sample MIN-1 in the Inuyama Ch-1-A Section (MA11), which is correlated to the *Tricolocapsa plicarum* Zone, is assigned to the UAZone 4 (Fig. 2). The evolutionary first appearance biohorizon of *T. plicarum* should be situated between Sample MKM-1 and MIN-1. Therefore, the biohorizon should be set between the UAZone 3 and 4. *T. plicarum* s.l. ranges from UAZone 3 to 4. The UAZone 3,

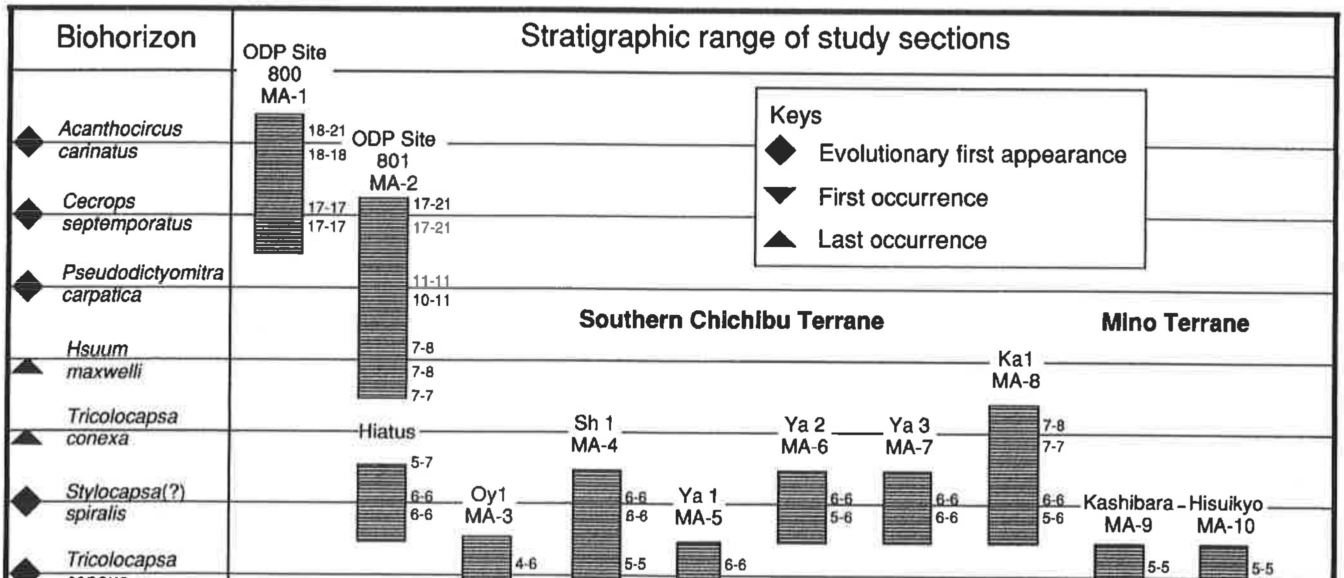


Figure 2. Stratigraphic range of studied sections, indicating UAZone assignments for samples just below and abovethe zonal boundary biohorizons.

the first occurrence of this species, is correlated to early/middle Bajocian.

2.3 Evolutionary first appearance biohorizon of *Tricolocapsa conexa* MATSUOKA

Tricolocapsa conexa MATSUOKA evolved from *Tricolocapsa plicarum* YAO by the addition of transverse ridges between two neighbouring longitudinal plicae (Matsuoka, 1983). This biohorizon was originally reported in chert and sillceous mudstone sequence in the Oyashiki-1, Shiraishigawa-1, and Yanasegawa-1 sections of the Togano Group in western Shikoku, southwest Japan (Matsuoka, 1983). This biohorizon was investigated also in siliceous mudstone sequences in the Mino Terrane, central Japan (Matsuoka, 1986b, 1988).

This biohorizon is recognized between two sample horizons in the following five sections (Fig. 2): between M-54 (UAZone 4-6) and M-54.5 (UAZone 4-6) in the Oyashiki-1 Section (MA3); between 9-1403 (U.A. 5-6 and S-01 (UAZone 5-) in the Shiraishigawa-1 Section (MA4); between Z-22 (UAZone 4-6) and Z-27.5 (UAZone 6-6) in the Yanasegawa-1 Section (MA5); between MKS-9.5b (UAZone 5-5) and MKS-10 (UAZone 5-5) in the Kashibara Section (MA9); between MHS-B (UAZone 5-5) and MHS-C (UAZone 5-5) in the Hisuikyo Section (MA10).

Of these five sections, the Kashibara Section (MA9) is most densely sampled and the phylogenetic lineage from *T. plicarum* to *T. conexa* is well traced (Matsuoka, 1988). Therefore, the UAZone 5 from the section is most reliable for this biohorizon. *T. conexa* ranges from UAZone 4 to 7. The UAZone 4, the first occurrence of this species, is correlated to late Bajocian.

2.4 Evolutionary first appearance biohorizon of *Stylocapsa* (?) *spiralis* gr. MATSUOKA

Stylocapsa (?) *spiralis* gr. MATSUOKA evolved from *Stylocapsa* (?) *hemicostata* MATSUOKA through the change in plicae arrangement from longitudinal to spiral pattern (Matsuoka, 1983). This biohorizon was originally reported in siliceous mudstone sequences in the Shiraishigawa-1, Yanasegawa-2, and Yanasegawa-3 sections of the Togano Group in western Shikoku, southwest Japan (Matsuoka, 1983). This biohorizon is recognized between two sample horizons in the following five sections (Fig. 2): between 801B-34R-CC (UAZone 6-6) and 801B-34R-1, 15-17 (UAZone 6-6) at ODP Site 801 (MA2); between S-14 (UAZone 6-6) and S-14.6 (UAZone 6-6) in the Shiraishigawa-1 Section (MA4); between 7-2912 (UAZone 5-6) and 7-1522 (UAZone 6-6) in the Yanasegawa-2 Section (MA6); between P-6 (UAZone 6-6) and P-5.5 (UAZone 6-6) in the Yanasegawa-3 Section (MA7); between 12-0706 (UAZone 5-6) and 12-0705 (UAZone 6-6) in the Kawanouchi-1 Section (MA8).

Of these five sections, the Shiraishigawa-1 Section (MA4) is most densely sampled and the phylogenetic lineage from *S.* (?) *hemicostata* to *S.* (?) *spiralis* gr. is well traced (Matsuoka, 1983). Therefore, the UAZone **6** is most reliable for this biohorizon. *S.* (?) *spiralis* gr. ranges from UAZone 6 to 7. The UAZone 6, the first occurrence of this species, is correlated to middle Bathonian.

2.5 Last occurrence biohorizon of *Tricolocapsa conexa* MATSUOKA

The last occurrence biohorizon of *Tricolocapsa conexa* MATSUOKA was recognized in siliceous mudstone-mudstone sequence in the Kawanouchi-1 section of the Togano Group in western Shikoku, southwest Japan (Matsuoka & Yao, 1986; Matsuoka, 1986a). This biohorizon is recognized between two sample horizons in the following two sections (Fig. 2): between 801B-33R-1, 8-10 (UAZone 5-7) and 801B-32R-CC (UAZone 7-7) in the ODP Site 801 Section (MA2), between 11-0909 (UAZone 7-7) and 17-0302 (UAZone 7-8) in the Kawanouchi-1 Section (MA8).

A hiatus is inferred in the ODP Site 801 Section (MA2) (Lancelot *et al.*, 1990). Because it is considered that the Kawanouchi-1 Section (MA8) is more complete for biostratigraphic research, the UAZone range 7-8 is more approximate for the biohorizon. *T. conexa* ranges from UAzone 4 to 7. The UAzone 7, the last occurrence of this species, is correlated to late Bathonian-early Callovian.

2.6 Last occurrence biohorizon of *Hsuum maxwelli* gr. PESSAGNO

The last occurrence biohorizon of *Hsuum maxwelli* gr. PESSAGNO is recognized between 801B-30R-CC (UAZone 7-8) and 801B-30R-1, 12-14 (UAZone 7-8) in the ODP Site 801 (Section MA2, Fig. 2). The UAZone 7-8 is obtained for the biohorizon. *Hsuum maxwelli* gr. ranges from UAZone 3 to 10. The UAZone 10, the last occurrence of this species, is correlated to late Oxfordian-early Kimmeridgian.

2.7 Evolutionary first appearance biohorizon of *Pseudodictyomitra carpatica* LOZYNIAK

The evolutionary lineage from *Pseudodictyomitra primitiva* MATSUOKA & YAO to *Pseudodictyomitra carpatica* LOZYNIAK was clarified in radiolarite sequence at ODP Site 801 in the western Pacific (Matsuoka, 1992a). The evolutionary first appearance biohorizon of P. carpatica is recognized between 801B-21R-1, 1-3 (UAZone 10-11) and 801B-20R-CC (UAZone 11) in the ODP Site 801 (Section MA2, Fig. 2). The U.A. range of Zones 10-11 is obtained for the biohorizon. *P. carpatica* ranges from UAZone 11 to 21. The UAZone II, the first occurrence of this species, is correlated to late Kimmeridgian-early Tithonian.

2.8 Evolutionary first appearance biohorizon of *Cecrops septemporatus* (PARONA)

Matsuoka (1992a) pointed out that *Cecrops septemporatus* (PARONA) can be evolved from *Sphaerostylus lanceola* (PARONA) or its related forms. This biohorizon is recognized between two sample horizons in the following two sections (Fig. 2): between 800A-54R-2, 98-100 (UAZone 17 and 800A-54R-2, 50-52 (UAZone 17 in the ODP Site 800 Section (MA1); between 801B-15R-1, 23-25 (UAZone 17-21) and 801B-14R-CC (UAZone 17-21 in the ODP Site 801 Section (MA2). *C. septemporatus* ranges from UAZone 17 to 21. The UAZone 17, the first occurrence of this species, is correlated to late Valanginian. Because the ODP Site 800 (Section 2 MA1, Fig. 2) is better than the ODP Site 801 (section MA2, Fig. 2) for biostratigraphic research around the biohorizon, the U.A. number 17 is taken for the biohorizon.

2.9 Evolutionary first appearance biohorizon of *Acanthocircus carinatus* (Foreman)

Acanthocircus carinatus (Foreman) evolved from its ancestor Acantho*circus variabilis* (Squinabol). The evolutionary first appearance biohorizon of *A. carinatus* is recognized between 800A-52R-CC (UAZone 18-18) and 800A-52R2, 49-51 (UAZone 18-21) in the ODP Site 800 Section (MAl, Fig. 2). *A. carinatus* ranges from UAZone 18 to 22. The UAZone 18, the first occurrence of this species is correlated to latest Valanginian-earliest Hauterivian.

3. Radiolarian zonation for the Middle Jurassic and Lower Cretaceous in Japan and the western Pacific: age assignemets based on the UAZones presented on *Chapter* 32

Radiolarian zones presented herein are defined as an interval between two successive biohorizons and are categorized to interval zones. Age assignments of the zones are only derived from the correlation between UAZones and the standard stages, clarified in this volume (see *Chapter* 32). Figure 3 summarizes zonation, zonal definition, and preliminary age calibration of the zones.

Laxtorum (?) *jurassicum* Zone

Author.- Matsuoka & Yao (1986).

Base.- First occurrence biohorizon of *Laxtorum* (?) *jurassicum.*

Top. Evolutionary first appearance biohorizon of *Tricolocapsa plicarum.*

Remarks.- No zonal boundaries for this zone are recognized in the study sections. Only Sample MKM-l of the Komami Section (MA12) is assigned to this zone.

UAZone assignment.- 2 to 3.

Age.- Late Aalenian to early-middle Bajocian.

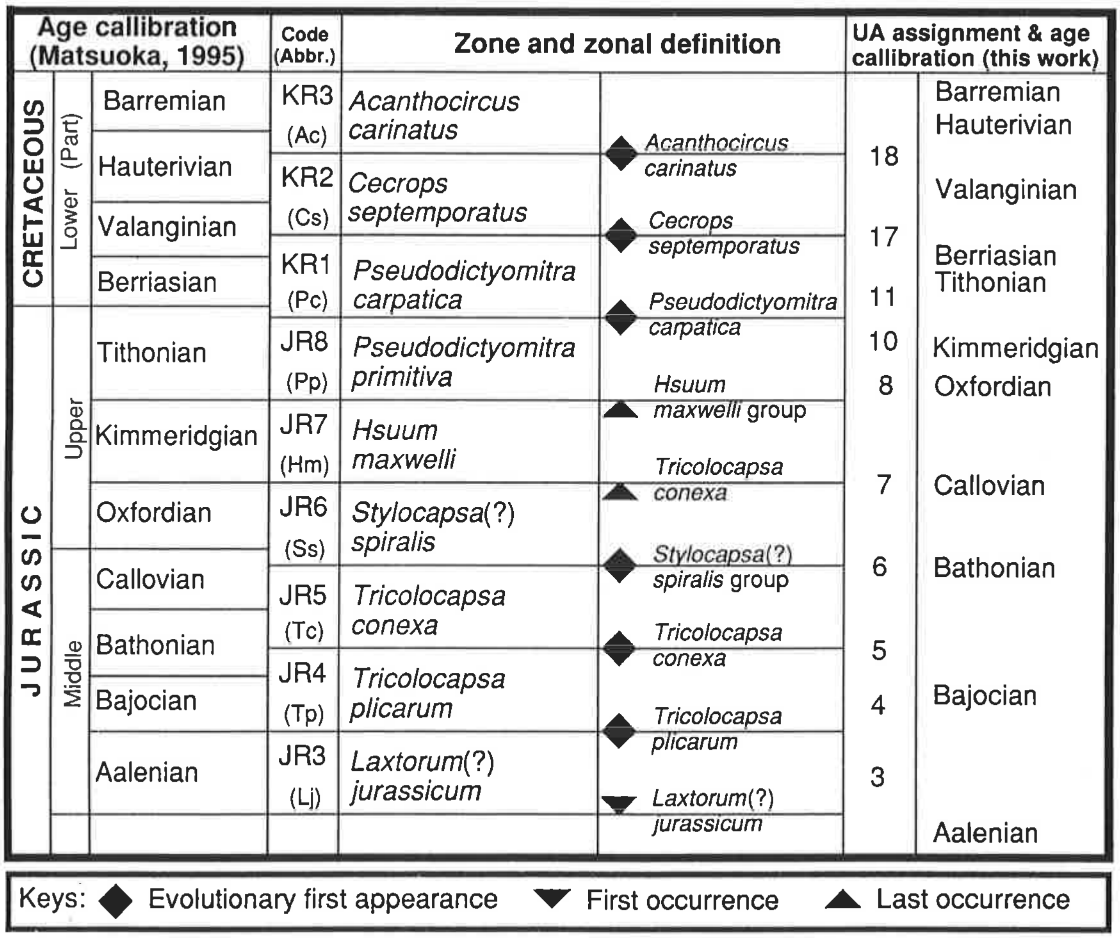


Figure 3. Radiolarian zonation for Middle Jurassic to Lower Cretaceous of Japan and the western Pacific, and preliminary age assignments based on the UAZones presented on *Chapter* 32 (this volume).

Tricolocapsa plicarum Zone
Author.- Matsuoka (1983).
Base.- Evolutionary first appearance biohorizon of *Tricolocapsa plicarum.*
Top.- Evolutionary first appearance biohorizon of *Tricolocapsa conexa.*
Remarks.- The lower limit of this zone is not recognized in the study sections. This zone is recognized in the Oyashiki-1 (MA3), Shiraishigawa-1 (MA4), Yanasegawa-1 (MA5), Kashibara (MA9), and Hisuikyo (MA10) sections.
UAZone assignment.- 3 to 4.
Age.- Early-middle Bajocian to late Bajocian.

Tricolocapsa conexa Zone
Author.- Matsuoka (1983).
Base.- Evolutionary first appearance biohorizon of *Tricolocapsa conexa.*
Top.- Evolutionary first appearance biohorizon of *Stylocapsa* (?) *spiralis* gr.
Remarks.- Both the lower and upper limits of this zone are recognized in the Shiraishigawa-1 Section (MA4). This zone is present in the ODP Site 801 (MA2), Oyashiki-1 (MA3), Yanasegawa-l (MA5), Yanasegawa-2 (MA6), Yanasegawa-3 (MA7), Kawanouchi-1 (MA8), Kashibara (MA9), Hisuikyo (MA10) sections.
UAZone assignment.- 4 to 6.
Age.- Late Bajocian to middle Bathonian.

Stylocapsa (?) *spiralis* Zone
Author.- Matsuoka (1983).
Base.- Evolutionary first appearance biohorizon of *Stylocapsa* (?) *spiralis* gr.
Top.- Last occurrence biohorizon of *Tricolocapsa conexa.*
Remarks.- Both the lower and upper limits of this zone are recognized in the Kawanouchi-1 Section (MA8). This zone is present in the ODP Site 801 (MA2), Shiraishigawa-1 (MA4), Yanasegawa-2 (MA6), Yanasegawa-3 (MA7) sections.
UAZone assignment.- 6 to 7.
Age.- Middle Bathonian to late Bathonian/early Callovian

Hsuum maxwelli Zone
Author.- Matsuoka (1995).
Base.- Last occurrence biohorizon of *Tricolocapsa conexa.*
Top.- Last occurrence biohorizon of *Hsuum maxwelli* gr.
Remarks. This zone is present in the ODP Site 801 (MA2) and Kawanouchi-1 (MA8) sections.
UAZone assignment.- 7 to 10.
Age.- Late Bathonian/early Callovian to late Oxfordian/early Kimmeridgian.

Pseudodictyomitra primitiva Zone
Author.- Matsuoka & Yao (1986).
Base.- Last occurrence biohorizon of *Hsuum maxwelli* gr.
Top.- Evolutionary first appearance biohorizon of *Pseudodictyomitra carpatica.*
Remarks.- Both the lower and upper limits of this zone are recognized in the ODP Site 801 Section (MA2).
UAZone assignment.- 10 to 11.
Age.- Late Oxfordian/early Kimmeridgian. to late Kimmeridgian/early Tithonian.

Pseudodictyomitra carpatica Zone
Author.- Matsuoka (1992a).
Base.- Evolutionary first appearance biohorizon of *Pseudodictyomitra carpatica*
Top.- Evolutionary first appearance biohorizon of *Cecrops septemporatus.*
Remarks.- Both the lower and upper limits of this zone are recognized in the ODP Site 801 Section (MA2). This zone is present in the ODP Site 800 Section (MA1).
UAZone assignment.- 11 to 17.
Age.- Late Kimmeridgian/early Tithonian to late Valanginian

Cecrops septemporatus Zone
Author.- Riedel & Sanfilippo (1974). (= *Staurosphaera septemporata* Zone).
Base.- First evolutionary first appearance biohorizon of *Cecrops septemporatus.*
Top.- First evolutionary appearance biohorizon of *Acanthocircus carinatus.*
Remarks.- Both the lower and upper limits of this zone are recognized in the ODP Site 800 Section (MA1). This zone is present in the ODP Site 801 Section (MA2).
UAZone assignment.- 17 to 18
Age.- Late Valanginian to latest Valanginian-earliest Hauterivian.

Acanthocircus carinatus Zone
Author.- Matsuoka (1995).
Base.- First evolutionary appearance biohorizon of *Acanthocircus carinatus.*
Top.- Not defined.
Remarks.- The lower limit of this zone is present in the ODP Site 800 Section (MA1). The upper limit is not recognized in the study sections. An Albian fauna which is characterised by the occurrence of *Pseudodictyomitra pseudomacrocephala* (SQUINABOL) is clearly distinguished from the fauna of this zone.
UAZone assignment.- 18 and greater.
Age.- Latest Valanginian-earliest Hauterivian to younger

References

AITA, Y. (1982). Jurassic radiolarian biostratigraphy in Irazuyama district, Kochi Prefecture, Japan - a preliminary report. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 255-270. *(in Japanese)*

AITA, Y. (1985). Jurassic radiolarian biostratigraphy of the Irazuyama Formation (Takano Section), Shikoku, Japan. *Scientific and Technical Reports of the Mining College, Akita University*, **6**, 33-41. *(in Japanese)*

AITA, Y. (1987). Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. *Science Reports of the Tohoku University, Series 2: Geology*, **58** (1), 1-91.

AOKI, T. (1982). Upper Jurassic to Lower Cretaceous radiolarians from the Tsukimiyama and Tei Melanges of the northern Shimanto Belt in Kochi Prefecture, Shikoku. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 339-351. *(in Japanese)*

FURUKUBO, M., TONISHI, K., SASHIDA, K. & IGO, H. (1985). Biostratigraphy of the Middle Jurassic Radiolaria in the south zone of the Chichibu Terrain in the Kanto Mountains, Central Japan. *Annual Report of the Institute of Geosciences, the University of Tsukuba*, **11**, 27-31.

GUEX, J. (1991). *Biochronological Correlations* - Springer-Verlag, Berlin/Heidelberg/New York. 250 p.

HORI, R. (1990). Lower Jurassic Radiolarian Zones of SW Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **159**, 562-586.

ISOZAKI, Y., AMISCARAY, E.A. & RILLON, A. (1988). Permian, Triassic and Jurassic bedded radiolarian cherts in North Palawan Block, Philippines; Evidence of Late Mesozoic subduction-accretion. *Pre-Jurassic Evolution of Eastern Asia, Report No. 3 of the IGCP Project 224*, Osaka, Japan, (99-115.

KIDO, S., KAWAGUCHI, I., ADACHI, M. & MIZUTANI, S. (1982). On the *Dictyomitrella* (?) *kamoensis-Pantanellium foveatum* assemblage in the Mino area, central Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 195-210. *(in Japanese)*

KISHIDA, Y. & SUGANO, K. (1982). Radiolarian zonation of Triassic and Jurassic in outer side of southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 271-300. *(in Japanese)*

KITO, N. (1987). Stratigraphic relation between greenstones and clastic sedimentary rocks in the Kamuikotan Belt, Hokkaido, Japan. *Journal of the Geological Society of Japan*, **93** (1), 21-35. *(in Japanese)*

KOJIMA, S. & MIZUTANI, S. (1987). Triassic and Jurassic Radiolaria from the Nadanhada Range, Northeast China. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, **148**, 256-275.

KOJIMA, S., WAKITA, K., OKAMURA, Y., NATAL'IN, B.A., ZYABREV, S.V., QING, L.Z. & JI, A.S. (1991). Mesozoic radiolarians from the Khabarovsk Complex, eastern USSR; their significance in relation to the Mino Terrane, central Japan. *Journal of the Geological Society of Japan*, **97** (7), 549-551.

KUMON, F., MATSUYAMA, H. & NAKAJO, K. (1986). Revised latest Jurassic to Cretaceous radiolarian assemblages from the Hidakagawa Group in the Shimanto Belt, Kii Peninsula. *Fossils*, **41**, 17-27. *(in Japanese)*

LANCELOT, Y., LARSON, R.L. *et al.* (1990). *Proceedings of the Ocean Drilling Program, old Pacific crust; covering Leg 129 of the cruises of the drilling vessel JOIDES Resolution, Apra Harbor, Guam, to Apra Harbor, Guam, sites 800-802, 20 November 1989-18 January 1990.* Proceedings of the Ocean Drilling Program, Initial Reports, **129** - College Station, TX (Ocean Drilling Program). 488 p.

LARSON, R.L., LANCELOT, Y. *et al.* (1992). *Proceedings of the Ocean Drilling Program, old Pacific crust; covering Leg 129 of the cruises of the drilling vessel JOIDES Resolution, Apra Harbor, Guam, to Apra Harbor, Guam, sites 800-802, 20 November 1989-18 January 1990.* Proceedings of the Ocean Drilling Program, Scientific Results, **129** - College Station, TX (Ocean Drilling Program). 745 p.

MATSUOKA, A. (1982). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and the Niyodo areas, Kochi Prefecture, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 237-253. *(in Japanese)*

MATSUOKA, A. (1983). Middle and Late Jurassic radiolarian biostratigraphy in the Sakawa and adjacent areas Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **26** (1), 1-48.

MATSUOKA, A. (1986a). *Tricolocapsa yaoi* Assemblage (Late Jurassic radiolarians) from the Togano Group in Shikoku, Southwest Japan. *Journal of Geosciences, Osaka City University*, **29**, 101-115.

MATSUOKA, A. (1986b). Stratigraphic distribution of two species of *Tricolocapsa* in the Hisuikyo Section of the Kamiaso area, Mino Terrane. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 59-62. *(in Japanese)*

MATSUOKA, A. (1988). First appearance biohorizon of *Tricolocapsa conexa* within Jurassic siliceous mudstone sequences of the Kamiaso area in the Mino Terrane, central Japan; a correlation of radiolarian zones of the Middle Jurassic. *Journal of the Geological Society of Japan*, **94** (8), 583-590.

MATSUOKA, A. (1991). Middle Jurassic radiolarians from the western Pacific. *Proceedings of the International Symposium on Shallow Tethys* - Saito Ho-on Kai Special Publication, Sendai, Japan. **3**, 163-173.

MATSUOKA, A. (1992a). Jurassic and Early Cretaceous radiolarians from Leg 129, Sites 800 and 801, western Pacific Ocean. *In* Larson, R.L., Lancelot, Y. *et al.* Eds. *Proceedings of the Ocean Drilling Program, Scientific Results*, College Station, TX (Ocean Drilling Program), **129**, 203-220.

MATSUOKA, A. (1992b). Jurassic-Early Cretaceous tectonic evolution of the Southern Chichibu terrane, southwest Japan. *In* Aitchison, J.C. & Murchey, B.L. Eds. *Significance and application of Radiolaria to terrane analysis* - Special Issue: Palaeogeography Palaeoclimatology Palaeoecology, Elsevier, Amsterdam, **96** (1-2), 71-88.

MATSUOKA, A. & YAO, A. (1985). Latest Jurassic radiolarians from the Torinosu Group in Southeast Japan. *Journal of Geosciences, Osaka City University*, **28**, 125-145.

MATSUOKA, A. & YAO, A. (1986). A newly proposed radiolarian zonation for the Jurassic of Japan. *Marine Micropaleontology*, **11** (1-3), 91-106.

MATSUYAMA, H., KUMON, F. & NAKAJO, K. (1982). Cretaceous radiolarian fossils from the Hidakagawa Group in the Shimanto Belt, Kii Peninsula, southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 371-382. *(in Japanese)*

MIZUTANI, S., HATTORI, I., ADACHI, M., WAKITA, K., OKAMURA, Y., KIDO, S., KAWAGUCHI, I. & KOJIMA, S. (1981). Jurassic formations in the Mino Area, Central Japan. *Proceedings of the Japan Academy, series B*, **57**, 194-199.

MIZUTANI, S. & KOJIMA, S. (1992). Mesozoic radiolarian biostratigraphy of Japan and collage tectonics along the eastern continental margin of Asia. *In* Aitchison, J.C. & Murchey, B.L. Eds. *Significance and application of Radiolaria to terrane analysis* - Special Issue: Palaeogeography Palaeoclimatology Palaeoecology, Elsevier, Amsterdam, **96** (1-2), 3-22.

NAKASEKO, K. & NISHIMURA, A. (1981). Upper Jurassic and Cretaceous Radiolaria from the Shimanto Group in Southwest Japan. *Science Reports, College of General Education Osaka University*, **30** (2), 133-203.

NISHIZONO, Y. & MURATA, M. (1983). Preliminary studies on the sedimentary facies and radiolarian biostratigraphy of Paleozoic and Mesozoic sediments, exposed along the mid-stream of the Kuma River, Kyushu, Japan. *Kumanto Journal of Science, Geology*, **12**, 1-40. *(in Japanese)*

OKAMURA, M. (1992). Cretaceous Radiolaria from Shikoku, Japan (Part 1). *Memoirs of the Faculty of Science, Kochi University, Series E, Geology*, **13**, 21-164.

RIEDEL, W.R. & SANFILIPPO, A. (1974). Radiolaria from the southern Indian Ocean, DSDP Leg 26. *In* Davies, T.A., Luyendyk, B.P. *et al.* Eds. *Initial Reports of the Deep Sea Drilling Project* - U.S. Government Printing Office, Washington, D.C., **26**, 771-814.

SASHIDA, K. (1988). Lower Jurassic multisegmented Nassellaria from the Itsukaichi area, western part of Tokyo Prefecture, central Japan. *Science Reports of the Institute of Geoscience, University of Tsukuba, Section B: Geological Sciences*, **9**, 1-27.

SATO, T. & NISHIZONO, Y. (1983). Triassic and Jurassic radiolarian assemblages from two continuous sections in the Kuma massif, Kyushu, Japan. *News of Osaka Micropaleontologists*, 33-47. (*in Japanese*)

SATO, T. MURATA, M. & YOSHIDA, H. (1986). Triassic to Jurassic radiolarian biostratigraphy in the southern part of the Chichibu terrain of Kyushu, Japan. I*n* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and radiolarian Terrane of Japan*. News of Osaka Micropaleontologists, **7**, 9-23.

TERAOKA, Y. & KURIMOTO, C. (1986). Cretaceous stratigraphy of the Shimanto Terrane in the Uwajima area, West Shikoku, Southwest Japan, with reference to the stratigraphic distribution of mega- and radiolarian fossils. *Bulletin of the Geological Survey of Japan*, **37** (8), 417-453. (*in Japanese*)

TIKHOMIROVA, L.B. (1988). Radiolarians of the Far East. *Newsletters on Stratigraphy*, **19**, 67-77.

TUMANDA, F. (1989). Cretaceous radiolarian biostratigraphy in the Esashi Mountain area, Northern Hokkaido, Japan. *Science Reports of the Institute of Geoscience,* *University of Tsukuba, Section B: Geological Sciences*, **10**, 1-44.

WAKITA, K., KOJIMA, S., OKAMURA, Y., NATAL'IN, B. & ZYABREV, S.V. (1992). Triassic and Jurassic Radiolaria from the Khabarovsk complex, eastern Russia. *In* Sakai, T. & Aita, Y. Eds. *Proceedings of the Third Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **8**, 9-19. *(in Japanese)*

YAO, A. (1983). Late Paleozoic and Mesozoic radiolarians from southwest Japan. *In* Iijima, A., Hein, J.R. & Siever, R. Eds. *Siliceous Deposits in the Pacific Region* - Developments in Sedimentology, Elsevier, Amsterdam, The Netherlands, **36**, 361-375.

YAO, A. (1984). Subdivision of the Mesozoic complex in Kii-Yura area, southwest Japan and its bearing on the Mesozoic basin development in the southern Chichibu terrane. *Journal of Geosciences, Osaka City University*, **27**, 41-103.

YAO, A. (1986). Geological age of Jurassic radiolarian zones in Japan and their international correlations. *In* Ichikawa, K. Ed. *Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan* - News of Osaka Micropaleontologists, Special Volume, **7**, 63-74. *(in Japanese)*

YAO, A. (1990). Triassic and Jurassic radiolarians. *In* Ichikawa, K.*et al.* Eds. *Pre-Cretaceous Terranes of Japan. Publication of IGCP Project No. 224: Pre-Jurassic Evolution of Eastern Asia* - IGCP Project 224, Osaka, Japan, 329-345.

YAO, A., MATSUOKA, A. & NAKATANI, T. (1982). Triassic and Jurassic radiolarian assemblages in southwest Japan. *In* Nakaseko, K. Ed. *Proceedings of the First Japanese Radiolarian Symposium* - News of Osaka Micropaleontologists, Special Volume, **5**, 27-43. *(in Japanese)*

POSTSCRIPT

After the manuscript of this paper was sent to the editor in February of 1993 the author has continued to work on Mesozoic radiolarian biostratigraphy. The latest version of zonation for the Jurassic and lower Cretaceous in Japan and western Pacific is presented in Matsuoka (1995). The new version includes modifications of zone definition and establishment of new zones (*Hsuum maxwelli* Zone of the middle Upper Jurassic and *Acanthocircus carinatus* Zone of the middle Lower Cretaceous). The manuscript of this chapter is partly updated only for essential contents to keep consistency with the text of Matsuoka (1995). The result of age calibration for the UAZones and U.A. assignments for the author's samples have been finally given to the author in August, 1995. Age assignments for the zonation by the author (Matsuoka, 1995) are different from those by applying age calibration of UA Zones *(Chapter* 32, this volume) presented in this chapter (Fig. 3). The difference is sometime much greater than the author expected. Time limitation does not allow the author to give any detail comments on the result of the age calibration. Further discussions on this matter will be made in the near future.

MATSUOKA, A. (1995). Jurassic and Lower Cretaceous radiolarian zonation in Japan and Western Pacific. *Island Arc*, **4**, (in press).

5

Glossary, data files and listings

34. Glossary of Morphological Terms

Abdomen The third segment in the skeleton of Nassellaria.

Acantharia A group of planktic Protista, classified under the class Actinopoda, which are characterised by possessing a skeleton made of strontium sulphate.

Accessory apertures Smaller apertures occurring near main aperture.

Actine Radial bar inside skeleton. In Nassellaria internal portions of the initial spicule.

Albaillellaria Bilaterally symmetrical Palaeozoic order or suborder of Radiolaria having as basal skeleton a system of three rods crossing to form a triangle. During evolution part of these elements or all became reduced or disappeared.

Aperture Main opening at the antapical part in the shell of Nassellaria.

Apertural ring A poreless protruding ring around aperture of some Nassellaria.

Apical Situated on cephalis, at the apex of nassellarian skeleton.

Apical horn Spine or horn at the apex of cephalis commonly connected internally with the apical spine of the cephalic skeletal elements of Nassellaria.

Apical pores Variable number of large pores situated near apical horn (Nassellaria).

Apical spine (A) In the initial spicule of Nassellaria spine originating at the dorsal end of the median bar (MB), upwards directed (cf. apical horn). An upwards directed spine of the initial spicule of some other Radiolaria (e.g. Palaeoscenidiidae).

Apophyses Lateral processes arising from shell or radial spines of some Radiolaria; sometimes becoming branched and fused at their ends forming a lattice shell.

Appendages Longitudinal or lateral extensions (spines, rays, tubes) arising from the skeletal body of radiolarians.

Arches Curved bars connecting some radial elements of the skeleton of Radiolaria. In the initial skeleton of the cephalis of Nassellaria their position is considered to have a systematic and phylogenetic value.

Arm A branch or radial extension especially in the skeleton of some discoidal Radiolaria. Syn.: ray.

Auxiliary rays Ray originating at a certain level of the saturnalid spongy skeleton, not in microsphere, and merging into ring.

Axial rod Syn.: axobate or axostyle.

Axial section A slice bisecting a radiolarian test in a plane coinciding with its longer axis. Partial Syn.: longitudinal section.

Axial spines In Pyloniacea, spines or radial beams originating in the microsphere and disposed in the three orthogonal axes. According to their position they may be polar, sagittal, lateral or equatorial; in other Radiolaria spine(s) disposed in an axis of the skeleton.

Axobate (Ax) Axial spine downwardly directed and arising, when present, from the ventral end of the median bar (MB) in the cephalis of Nassellaria. It may be very small, or very long and branched in some Cenozoic species. Syn.: axial rod or axostyle.

Axoflagellum A long, thickened, whisker-like projection formed by lateral fusion of several axopodia arising from a specialized pore area in the central capsular wall of some Spumellaria; by its slow movements it seems to explore the environment. Sometimes its position is marked on skeleton by a pylome.

Axoneme A central shaft or bundle of intracytoplasmic microtubules within an axopodium which provides structural support for and stiffness of the axopodium.

Axoplast A specialized region within the cytoplasm of Radiolaria where the microtubules of the axopodia originate; occurring juxtanuclear or embedded within a membrane-lined pocket surrounded by the nucleus.

Axopodia Temporary or semipermanent, stiffened, ray-like pseudopodia radiating outward from the cell body of Radiolaria.

Axostyle Syn.: axobate.

Bar Rodlike structure forming a component part of the polygonal pore frame. See also median bar.

Basal appendage Pored, small, thin-walled, inverted conical or dish-like segment of some nassellarians, closing the aperture. It represents probably a relict segment of species showing a trend to reduce the number of segments, or a segment occurring in a gerontic ontogenetic stage.

Beam Bar, usually in radial direction, in the radiolarian skeleton.

Bilateral symmetry Symmetry in which similar anatomical parts are arranged on opposite sides of a median axis so that only one plane can divide the individual into essentially identical halves.

Bracchiopyle Cylindrical, porous tube extending in a distal direction from the centre of the tip of the primary ray. Known in some rayed Spumellaria: *Halesium*, *Patulibracchium*, etc.

Buttress A projecting latticed structure for supporting or giving stability to the shell. Skeletal structure connecting, for example, in *Quinquecapsularia* (Spumellaria) the second medullary shell to the cortical shell. See also cortical buttresses.

Canal A tubular anatomical passage or channel; e.g. in *Hagiastridae*; the term is used for tubular cavities traversing the entire length of rays. There are primary, secondary, tertiary canals, depending on the distance from the primary beam.

Cap In Pyloniacea, portion of a girdle developed from the previous girdle. Each girdle may have one to six caps.

Capsular wall (membrane) An organic, chitinous or pseudochitinous usually perforated, membrane of a complex structure surrounding the central capsule of Radiolaria. It separates the cytoplasm into an endoplasm and an ectoplasm.

Carena A keel-shaped anatomical part, ridge or process. See also karina.

Cavea Cage-like cavity inside caveal ribs (Albaillellaria).

Caveal ribs Curved paired spines originated in one of the 3 rods of the skeleton of Albaillellaria disposed in a manner similar to that of thoracic ribs.

Central area Central part on the two faces of circular or radial discoidal Spumellaria.

Central capsule A chitinous or pseudochitinous sac enclosing the intracapsular cytoplasm and nucleus. It is the peculiar central organelle of the unicellular body of Radiolaria which separates the cytoplasm into an endoplasm and an ectoplasm and which distinguishes this group of organisms from Rhizopoda. Cf. capsular wall.

Central cavity Central prominent depression on either side of disc-shaped test of members of *Orbiculiforma* (Spumellaria), etc.

Cephalic Pertaining to the cephalis.

Cephalic skeletal elements Basic skeletal framework of cephalis considered to be important in the systematics and interpretation of the phylogeny of Nassellaria. Cf: initial spicule.

Cephalis The first segment of the skeleton of Nassellaria; it may be single, in monocyrtid Nassellaria, or may be followed by other segments.

Cephalocone Massive, hollow, perforate spine in Nassellaria, externally at base of cephalis opposed to where ventral bar joins the interior wall of the test.

Cephalopyle Usually tubular opening placed on the ventral side of cephalis at or near the juncture of vertical cephalic skeletal bar with roof of cephalis.

Cephalothorax A distinctive skeletal body formed by cephalis and thorax, characteristic of some Nassellaria (Williriedellidae, Rotaformidae, etc.). During the evolution of these radiolarians these two segments behave as a single element.

Chamber Term used for segment (Nassellaria).

Circumferential ridge Circular ridge usually continuous internally with planiform segmental partitions; characteristic of the family Parvicingulidae.

Cloverleaf pores A system of 4 pores in a square arrangement around all or some of the main beams, occurring in many Pyloniacea.

Collar Referring to base of cephalis. Sometimes (e.g. in *Saitoum*) it designates a thickened border of base of cephalis.

Collar plate The plane comprising the collar pores.

Collar pores Special pores at the base of cephalis between the median bar (MB), the spines of the initial spicule and basal arches or cephalic wall. Through these pores passes from cephalis the lobes of the central capsule.

Collar stricture External constriction at the boundary between cephalis and thorax.

Collaret (te) (translation from the French "collerette"). Excrescence around the collar of some monocyrtid Nassellaria (e.g. *Saitoum*).

Columella Vertical rod within shell cavity or wall. Used for some Nassellaria and Albaillellaria.

Cortical Referring to the external-most part of spumellarian skeleton.

Cortical beam One of the radial beams on the surface of the hagiastrid skeleton.

Cortical buttresses Latticed protrusions of cortical shell permitting attachment of spines to cortical shell.

Cortical shell The outer-most shell of concentrically arranged shells of Spumellaria; may be latticed or spongy, single or multiple.

Costa, -ae Linear to sublinear, continuous to discontinuous ridges on the surface of the test of some Nassellaria. Syn.: rib, plica.

Costate Having elevated ridges or costae.

Costal projections Distal extensions of costae from those of previous segments; they form framework for secretion of new segments. Common in Archaeodictyomitridae.

Cross section A slice bisecting a radiolarian test in a plane coinciding with its shorter axis. Syn: transverse section.

Cupola Large vaulted dome; one of main anatomical element of the skeleton of Pyloniacea; present also in other radiolarians.

Cusp Region in the plane of the basal triangle (in Albaillellaria) where caveal ribs rejoin.

Cytokalymma A specialized cytoplasmic sheath in Radiolaria that establishes the architecture of the skeleton and secretes the silica during skeletal morphogenesis within its cisterna.

Dentate With small toothlike projections.

Diagonal spines (beams) In Pyloniacea, four or eight beams arising from the microsphere in diagonal directions and forming a kind of columella, especially in species with skeleton consisting of three elliptical mutually perpendicular girdles.

Diclade corner (junction) A corner or junction of two bars in which a radial or laterally directed element originates. Common in Pyloniacea.

Dicyrtid Nassellarian of two segments (cephalis and thorax).

Discoidal Disk-shaped.

Distal Situated away from the point of attachment or origin or a central point of the skeletal body. Ant.: proximal.

Ditreme Double perforation at the base of cephalis in the prolongation of the vertical spine (V); common Poulpinae (Nassellaria).

Dorsal In the skeleton of Nassellaria part of shell in the direction of dorsal spine. Ant.: ventral.

Double triclade In some Pyloniacea, two triclades having a bar in common.

Dorsal spine (D) In the initial spicule of Nassellaria spine originating in the dorsal end of the median bar (MB), usually downwards directed. Opposite to it is the ventral spine (V).

Ectoplasm Cytoplasm surrounding the central capsule. Syn.: extracapsular cytoplasm, extracapsulum.

Endoplasm Syn.: intracapsular cytoplasm, intracapsulum.

Entactinaria By some workers considered an independent suborder of Radiolaria characterised by an inner spicular system homologous with that of Nassellaria and a single, double or multiple shell homologous with that of Spumellaria.

Equatorial section Section in the equatorial plane of a radiolarian test.

External beam Main, continuous longitudinal element (bar) of the rays of the Hagiastridae (Spumellaria).

Extracapsulum Syn.: extracapular cytoplasm, ectoplasm.

Fenestrate (d) Having wide openings.

Filopodia Fine, thread-like pseudopodia, lacking a stiffened central rod or axoneme, radiating outward from the cell body.

Fragmentary thorns Remains of the dissolved spongy or lattice skeleton on spines or rays; they can give information on the number of concentric shells. Common in fossil Saturnalidae and many other spine-bearing Spumellaria with shell dissolved.

Fusule A complex structure of the capsular wall membranes in Radiolaria composed of a strand of cytoplasm connecting intracapsulum with extracapsulum and often passing through a unique collar structure in the capsular membrane.

Galea Conical process on apical part of cephalis.

Gate Wide opening in skeleton; common in the Pyloniacea (Spumellaria).

Girdle One of the multiple shells of the Pyloniacea. The fundamental shape of the girdles varies with family or subfamily and their order in a system.

Girdle zone Circular central region with girdles (shelves).

Groove A long narrow channel or depression between costae or blades of spines. There may exist primary grooves, between the 3 or 4 blades, or secondary grooves, occurring on blades when they forked longitudinally.

Hispid surface Surface rough or covered with minute spines.

Initial spicule Initial spicular skeleton present with several groups of Radiolaria. Its structure is considered to have a high value in systematics. (e.g.: A complete nassellarian initial spicule has a median bar (MB) with eight spines, four at either end.)

Intersector Straight rod of the basal skeleton of some Albaillellaria.

Intracapsular Any part of radiolarian body situated inside the central capsule.

Intracapsulum The cytoplasm within the central capsule of Radiolaria including the nucleus or nuclei, subcellular organelles, food reserve bodies, vacuoles, etc. Syn.: endoplasm, intracapsular cytoplasm.

Joint Juncture between two segments. Some workers (e.g. Campbell, 1954, p. D14) equate joints with segments in Nassellaria.

Karina Peripheral keel.

Lacuna Cavity occurring in the central area of some species of *Crucella* (Spumellaria).

Lateral beam Subsidiary beams typical of higumastrids (i.e. *Angulobracchia*). See subsidiary beams.

Lateral spines In the initial spicule of Nassellaria two pairs of spines arising from the two ends of the median bar (MB), and usually directed laterally downwards. There is a pair of primary lateral spines (L) and a pair of secondary lateral spines (l). Similarly, spines flanking a centrally placed spine in many rayed Spumellaria, etc.

Lattice shell Test formed of a porous meshwork and disposed in a single layer. Ant.: spongy shell.

Longitudinal section A slice bisecting a radiolarian test in a plane coinciding with its longer axis. Cf.: cross section.

Lumbar Referring to boundary between thorax and abdomen.

Lumbar stricture Constriction marking the boundary between thorax and abdomen.

Macrosphere A larger (50 µm or larger) innermost shell concentrically disposed within a single or many shelled cortical test in some Spumellaria; it is always larger than the microsphere and is present in some species lacking microsphere.

Main spine (s) Syn.: primary spines.

Mamma,-ae Cone-like tubercles characteristic of the cortical shells of the Praeconocaryommidae (Spumellaria).

Median bar (MB) Primordial element of the initial spicule of Nassellaria and Entactinaria. It is a short bar from the ends of which radiate a variable number of spines.

Medullar Inside central capsular cavity (medulla).

Medullary shell One or two concentrically arranged inner shells beneath cortical shell of certain Spumellaria. It is usually separated from the cortical shell(s) by a wider empty space. Medullary shell is originally extracapsular but in many species during the growth of central capsule it becomes intracapsular. When two medullary shells exist the innermost represents the microsphere or primary medullary shell, the other the secondary medullary shell.

Meshwork A regular or irregular fabric or structure formed by crossing bars. Syn.: network.

Microsphere The innermost shell (less than 50 µm) within the shell(s) of many Spumellaria. During the ontogeny it is the first shell that is built; it is homologous to the cephalis in Nassellaria, its structure is very conservative for a given group and seems to be the main structural skeletal element at the family level.

Monocyrtid Nassellaria consisting exclusively of cephalis.

Morphogenesis The formation and pattern of development of an organism during ontogeny.

Mouth Term rarely used for aperture.

Multicyrtid Nassellarian consisting of several segments.

Multisegmented Formed of several segments (in Nassellaria). Syn.: multicyrtid.

Nassellaria Group of Polycystina having the central capsule perforated only at one pole. Skeleton originated in an initial spicule with 4-8 spines of peculiar disposition and developed unidirectionally.

Network Syn.: meshwork.

Node A swelling or enlargement on radiolarian skeleton.

Nodular Having nodes.

Nucleo-axoplastic complex Complex structural element in the capsular body of living Radiolaria formed by nucleus and axoplast, and relationships between them that allow to differentiation of the living Radiolaria into several groups (e.g. centroaxoplastidies, periaxoplastidies etc.).

Optique section View of a certain level inside of shell by transparency, under optical microscope.

Oblique section Section through test that is neither parallel nor perpendicular to axes.

Patagium Delicate spongy meshwork surrounding rays or disposed only in the inter-radial zone in many rayed Spumellaria.

Peripolar spines A pair of spines originating in the ring of Saturnalidae in the vicinity of the point of junction between ring and polar rays, not in the prolongation of the latter. See also polar spines.

Peristome The fringe of teeth surrounding the mouth or pylome.

Phaeodaria A group of planktic Protista, classified under the class Actinopoda, which possesses hollow skeletal structure of an admixture of silica and organic matter.

Pillar Latticed or rod-like elements of a cap, in Pyloniacea, laterally developed from the cupolas of the previous girdle and supporting distally a cupola. Each cap may have 2-4 pillars.

Plica, -ae Syn.: costa, rib.

Podocone Internal cone within central capsule of Nassellaria formed by axopodia.

Podome Term, little in use, designating, in vertically oriented Nassellaria, all apophyses *sensu lato* (branches, feet, spines, horns) and other structures surrounding the mouth or pylome.

Polar knob In Saturnalidae protuberance at the ends of the elliptical ring, at base of spines.

Polar ray Ray originating in the initial skeleton (e.g. in Saturnalidae) and connecting it with the ring. Similar ray in any other Spumellaria.

Polar spines Diametrically opposed spines representing external prolongations of the polar rays. Similarly, massive spines occurring on diametrically opposed ends of elongate tests of some Spumellaria. In Saturnaliacea spines outside ring in polar axis.

Polycystina A group of planktic Protista having an opaline skeleton, belonging to the subclass of Radiolaria.

Pore Minute opening in skeleton.

Porous Possessing, or full of, pores.

Pore frame Polygonal structure formed of bars or tabulae and bars usually connected by nodes at vertices.

Porochora (pore field) A specialized portion of the capsular wall in Nassellaria characterised by having closely spaced pores where the fusules occur.

Porta, -ae Large openings situated between aboral radii (in Rotaformidae, Nassellaria).

Post-abdominal segment (s) One or more segments following abdomen in a multisegmented nassellarian test.

Primary beam Usually 2-4 beams arising from the microsphere and forming the axis of the entire hagiastrid ray.

Primary lateral spines (L) In the initial spicule of Nassellaria the pair of lateral spines arising from the ventral end of the median bar (MB) and usually downwardly directed. There is a right (Lr) and a left (Ll) primary lateral spine. See also lateral spines.

Primary pores Pores of certain members of the Archaeodictyomitridae and Pseudodictyomitridae (Nassellaria). Distinguished from relict pores by remaining open and functional during ontogeny.

Primary radial beam Massive radially arranged beams connecting medullary shell(s) to cortical shell(s). Connected directly to primary spines and originate in the microsphere or initial spicule.

Primary ray In *Halesium*, *Patulibracchium*, etc. ray possessing bracchiopyle.

Primary ring A usually square ring uniting in the proximal part the basal rays of an initial spicule and forming 4 large pores or gates. In the Saturnalidae and Hexalonchidae the polar rays and 4 primary spines respectively originate in the border of this ring.

Primary spine (s) Massive spine(s) of cortical shell of certain Spumellaria connected and aligned with radial beams of medullary shells. Syn.: main spines.

Proximal Next to or nearest the point of attachment or origin.

Pseudopodia Cytoplasmic extensions from the body of a protist specialized in locomotion, feeding or attachment. See axopodia and filopodia.

Pylome Larger opening or aperture in spumellarians, usually only in the outermost of concentric shells. In living forms it is the opening through which the axoflagellum comes out from the test.

Quincuncial Syn. hexagonal. Regular disposition of pores in rows intersecting at 60°. When framed such pores are hexagonally framed.

Radial beams Massive, radially arranged beams of some Spumellaria connecting medullary shells and first medullary shell to cortical shell.

Radial symmetry The condition of having similar parts regularly arranged around a central axis.

Radius (i) Rod-like structure (in Rotaformidae, Nassellaria) connecting thorax or central cephalo-thoracic body with thoracic ring.

Ray Radial element. Syn: arm. Rarely used for a spine.

Relict pores Pores that become buried by accretion of later shell material during ontogeny and cease to be functional. Visible only on corroded specimens (e.g. *Dictyomitra*, *Pseudodictyomitra* (Nassellaria)).

Rib Syn.: costa, plica.

Ring Circular, subcircular, elliptical, oval or polygonal skeletal band in the skeleton of many radiolarians; common in Saturnalidae, Acanthodesmiidae (sagittal ring), Rotaformidae (thoracic ring), etc.

Sagittal ring A ring-like component of nassellarian cephalic skeleton lying in a medial sagittal plane and formed by median bar (MB), apical spine (A), ventral spine (V) and a connecting arch AV.

Sagittal section Section in sagittal plane.

Sagittal spine Spine arising in the sagittal plane.

Sarcomatrix The vacuolated, rich layer of cytoplasm immediately surrounding the capsular wall where digestion and other functions occur.

Secondary radial beam Relatively slender beams connecting first medullary shell to cortical shell or any given medullary shell to cortical shell or to adjoining shell of Spumellaria.

Secondary lateral spines (l) In the initial spicule of Nassellaria the pair of lateral spines arising from the dorsal end of the median bar (MB).There is a right (lr) and a left (ll) secondary lateral spine.

Secondary ring External ring in the skeleton of some Saturnalidae (e.g. *Parasaturnalis*).

Secondary spine Spine not aligned with radial beam of medullary shell or one of the spines of the initial spicule.

Segment Chamber of Nassellaria.

Septal partition Imperforate planiform transverse septum with large central aperture separating segments in some families of Nassellaria.

Septum A dividing wall or membrane.

Sieve plate According to Campbell (1954, p. D15). this is a flat circular porous plate characteristic of some Spumellaria.

Spicule A stout or needle-like spine incorporated within or emanating from the radiolarian skeleton.

Spinal tumour Swollen medial portion of a tumidaspina with well-developed triradiate structure and 3 prominent pores.

Spinal tunnel Smooth, hollow, cylindrical proximal portion of a tumidaspina.

Spinal shaft A centrally placed spine representing the distal portion of a tumidaspina.

Spine A rod-like or bar-like skeletal projection.

Spongy A skeletal structure of bars that fuse in a more or less regular pattern forming a foamy or loosely organized tissue. Ant.: lattice.

Spumellaria Radiolaria with central capsule uniformly pierced by fine pores. Skeleton centrifugally developed.

Stricture Contraction of test of Nassellaria at position of joint between two successive segments.

Subsidiary beams Numerous relatively slender beams (in hagiastrids) which extend from the cortical shell inward from the nodes, and meet the vertices of the medullary shell. Homologous of the secondary radial beams occurring in *Emiluvia*.

Subsidiary ray Centripetally directed ray (in saturnalids) connecting the ring and the surface of central spongy skeleton.

Sutural pore Larger pore (in some fossil Nassellaria) situated at collar, lumbar or even post-lumbar suture. It may be simple or sieve-shaped and is considered to have a systematic value. Its role in paleobiology of such fossil forms not known.

System In Pyloniacea, commonly a group of three, rarely one or two or four successively larger and mutually inverted girdles disposed in a well-defined order that can be repeated once or several times in the same order as a result of their peculiar mode of growth.

Tabula Vertical, porous, sheet-like structures occurring within *Halesium* (Spumellaria).

Tabulate With smooth plates.

Teeth Minute thorns on spines, bars, costae or around the pylome.

Terminal segment Last segment of a multisegmented Nassellaria. Usually it differs in structure and shape from the previous segments.

Terminal spine A distally disposed spine in some Nassellaria.

Tholus, -i Domelike structures on the opposite sides of test in *Pseudoaulophacus* (Spumellaria) characterised by possessing markedly larger triangular pore frames.

Thoracic fringe Coarse polygonal meshwork on the margin of the thoracic ring (in Rotaformidae, Nassellaria).

Thoracic ring Ring structure (in Rotaformidae, Nassellaria) connected to thorax by radii.

Thorax The second segment in a skeleton of Nassellaria; it follows the cephalis and ontogenetically is built after the formation of the latter.

Thorn Small, short, sharply pointed triangular or conical surface extension.

Three-bladed Having three longitudinal costae or ridges or blades separated by grooves. Usually the term is applied to spines.

Trabecula, ae Rods or bars in the framework of a skeletal body. Used especially in the description of Albaillellaria.

Transverse section Syn.: cross section.

Transverse septum Internal annular septum (in Amphindacidae) dividing the cephalic cavity into two chambers.

Triclad junction Point of junction of three bars which may be at the origin of a radial or lateral element. Syn.: triple junction.

Tricyrtid Nassellarian with three segments (cephalis, thorax and abdomen).

Triple junction See triclad junction. Such a junction uses a minimum of shell material for a given surface area.

Tripod A component of or the major skeletal structure in Nassellaria composed of three basal feet and a vertical apical spine (e.g. *Tetraplecta*).

Triradiate Having three rays or radiating branches.

Tubercle Knobby prominence or excrescence.

Tuberculate Covered with tubercles or small rounded prominences.

Tumidaspina, -ae Distinctive primary spines of *Capnuchosphaera*.

Veil Variously formed web-like or net-like film.

Velum Cover-plate over mouth of thorax with or without accessory aperture, perforate to imperforate. Similarly, very thin shell covering, in a last ontogenetic stage, the cortical shell of some Spumellaria.

Ventral Disposed or referring to the side of nassellarian skeletal body containing the ventral or vertical spine (V).

Ventral spine (V) In the initial spicule of Nassellaria spine arising obliquely upwards in the sagittal plane from the ventral end of the median bar (MB). This spine is usually called also vertical spine but it is never vertical, the only vertical spine in a nassellarian initial skeleton being the apical spine.

Vertex, vertices Point of intersection of crests between pores. Usually they may bear tiny pores.

Vertical spine Syn.: ventral spine.

Verticil A circle of similar parts (branches, spines, bars) disposed around the same point on an axis.

Verticillate Arranged in verticils.

Wing Solid or fenestrated extension from side wall of nassellarian wall.

35. Alphabetical Listing of Genera, Species and Subspecies with MRD-numbers and UAZone Ranges

EXPLANATORY NOTES

In the listing the age range is stated as follows: The hyphen "**-**" marks the age range of each UAZone, the "**to**" links the age ranges of the early and the late UAZone. By definition, the total possible age range of a taxon goes from the beginning of the earliest to the end of the latest UAZone. The actual range of a taxon, however, can be anywhere from within the range of the earliest to within the range of the latest UAZone.

Example: A range of UAZones 7-9 means that the species makes its first appearance in UAZone 7 and its last in UAZone 9. The age range of UAZ. 7 is late Bathonian-early Callovian. The age range of UAZ. 9 is middle-late Oxfordian. The maximal age range of the taxon is late Bathonian-early Callovian to middle-late Oxfordian.The actual range of the taxon could be for instance early Callovian to middle Oxfordian, etc.

The abbreviations used are as follows: **Aal.** = Aalenian, **Baj.** = Bajocian, **Bath.** = Bathonian, **Call.** = Callovian, **Oxf.** = Oxfordian. **Kimm.** = Kimmeridgian, **Tith.** = Tithonian, **Berr.** = Berriasian, **Val.** = Valanginian, **Haut.** = Hauterivaian, **Barr.** = Barremian, **Apt.** = Aptian and **mid.** = middle

Name	**Genus, species, subspecies**	**MRD**	**UAZ**	**Range**
Acaeniotyle	Acaeniotyle	3600	4-22	late Baj. to late Barr.-early Apt.
Acaeniotyle (?) sp. A	Acaeniotyle (?) sp. A	3091	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
Acaeniotylopsis	Acaeniotylopsis	3701	1-8	early-mid Aal. to mid Call.-early Oxf.
Acanthocircus	Acanthocircus	3601	3-22	early-mid Baj. to late Barr.-early Apt.
Actinomma	Actinomma	3820	1-4	early-mid Aal. to late Baj.
acus	Pseudoeucyrtis acus	5572	15-21	late Berr.-earliest Val. to early Barr.
acutipodium	Pseudopoulpus acutipodium	2007	1-2	early-mid Aal. to late Aal.
adrianae	Milax adrianae	5453	13-20	latest Tith.-earliest Berr. to late Haut.
adriani	Pseudocrucella adriani	3129	4-10	late Baj. to late Oxf.-early Kimm.
agolarium	Syringocapsa agolarium	3291	13-20	latest Tith.-earliest Berr. to late Haut.
alievi	Xitus (?) alievi	5674	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
Alievium	Alievium	3603	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
Alievium sp. A	Alievium sp. A	4004	8-9	mid Call.-early Oxf. to mid-late Oxf.
altiforamina	Stichocapsa altiforamina	5761	18-21	latest Val.-earliest Haut. to early.
altissima	Ristola altissima altissima	3241	7-12	late Bath.-early Call. to early-early late Tith.
altissima	Ristola altissima major	3238	5-7	latest Baj.-early Bath. to late Bath.-early Call.

Name	Genus, species, subspecies	MRD	UAZ	Range
altissima	Ristola altissima s.l.	3164	5-12	latest Baj.-early Bath. to early-early late Tith. .
amabilis	Archaeodictyomitra (?) amabilis	3237	4-7	late Baj. to late Bath.-early Call.
Amphipyndax	Amphipyndax	3605	3-7	early-mid Baj. to late Bath.-early Call.
amphitreptera	Podocapsa amphitreptera	3171	9-18	mid-late Oxf. to latest Val.-earliest Haut.
amphorella	Artocapsa (?) amphorella	3924	13-14	latest Tith.-earliest Berr. to early-early late Berr.
Angulobracchia	Angulobracchia	3607	1-22	early-mid Aal. to late Barr.-early Apt.
Angulobracchia sp. B	Angulobracchia sp. B	4006	7-9	late Bath.-early Call. to mid-late Oxf.
angustus	Acanthocircus trizonalis angustus	3082	6-10	mid Bath. to late Oxf.-early Kimm.
annemariae	Paronaella (?) annemariae	5314	14-21	early-early late Berr. to early Barr.
antiqua	Haliodictya (?) antiqua antiqua	3218	4-11	late Baj. to late Kimm.-early Tith.
antiqua	Haliodictya (?) antiqua s.l.	3243	4-!1	late Baj. to late Kimm.-early Tith.
antiqua	Haliodictya (?) antiqua ssp. B.	3217	6-11	mid Bath. to late Kimm.-early Tith.
apenninicus	Mirifusus apenninicus	5716	14-21	early-early late Berr. to early Barr.
apiarium	Archaeodictyomitra apiarium	3263	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
Archaeodictyomitra	Archaeodictyomitra	3608	4-22	late Baj. to late Barr.-early Apt.
Archaeodictyomitra (?) sp. A	Archaeodictyomitra (?) sp. A	3235	6-7	mid Bath. to late Bath.-early Call.
Archaeohagiastrum	Archaeohagiastrum	3609	1-8	early-mid Aal. to mid Call.-early Oxf.
Archaeospongoprunum	Archaeospongoprunum	3610	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Archaeotritrabs	Archaeotritrabs	3611	16-21	early Val. to early Barr.
Archicapsa	Archicapsa	3612	3-4	early-mid Baj. to late Baj. .
Ares	Ares	3613	1-6	early-mid Aal. to mid Bath.
Ares sp.A	Ares sp.A	4008	1-3	early-mid Aal. to early-mid Baj.
argolidensis	Homoeoparonaella argolidensis	3103	4-11	late Baj. to late Kimm.-early Tith.
argolidensis	Homoeoparonaella sp. aff. H. argolidensis	2003	1-2	early-mid Aal. to late Aal.
Artocapsa	Artocapsa	3801	13-14	latest Tith.-earliest Berr. to early-early late Berr.
asparagus	Ristola asparagus	5575	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
aspera	Pseudoeucyrtis (?) aspera	5576	16-21	early Val. to early Barr.
asymbatos	Stichomitra sp. aff. S. asymbatos	5672	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
baileyi	Mirifusus dianae baileyi	3406	9-11	mid-late Oxf. to late Kimm.-early Tith.
banale	Canoptum banale	5785	13-16	latest Tith.-earliest Berr. to early Val.
bandyi	Paronaella bandyi	3135	3-10	early-mid Baj. to late Oxf.-early Kimm.
barbui	Holocryptocanium barbui	6107	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
barmsteinensis	Pyramispongia barmsteinensis	6109	13-20	latest Tith.-earliest Berr. to late Haut.
beniderkoulensis	Linaresia beniderkoulensis	3813	3-7	early-mid Baj. to late Bath.-early Call.
bernoullii	Thetis (?) bernoullii	3003	7-7	late Bath.-early Call. to late Bath.-early Call.
Bernoullius	Bernoullius	3614	1-22	early-mid Aal. to late Barr.-early Apt.
Berr.um	Pantanellium Berr.um	3280	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
bicornis	Theocapsomma bicornis	3276	6-7	mid Bath. to late Bath.-early Call.
bifida	Tetraditryma corralitosensis bifida	4048	5-7	latest Baj.-early Bath. to late Bath.-early Call.
biordinalis	Angulobracchia biordinalis	3145	9-11	mid-late Oxf. to late Kimm.-early Tith.
biscutum	Halesium biscutum	5166	14-22	early-early late Berr. to late Barr.-early Apt.
bisellea	Emiluvia bisellea	4018	11-11	late Kimm.-early Tith. to late Kimm.-early Tith.
Bistarkum	Bistarkum	3800	13-21	latest Tith.-earliest Berr. to early Barr.
blakei	Triactoma blakei	3095	4-11	late Baj. to late Kimm.-early Tith.
boesii	Parvicingula boesii gr.	3185	9-22	mid-late Oxf. to late Barr.-early Apt.
boneti	Napora boneti	3037	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
bossoensis	Crucella bossoensis	5204	16-22	early Val. to late Barr.-early Apt.
breggiensis	Obesacapsula breggiensis	3955	13-16	latest Tith.-earliest Berr. to early Val.
brevicostatum	Transhsuum brevicostatum gr.	3181	3-11	early-mid Baj. to late Kimm.-early Tith.
brevilatum	Bistarkum brevilatum	3918	13-14	latest Tith.-earliest Berr. to early-early late Berr.
broennimanni	Paronaella broennimanni	3137	4-10	late Baj. to late Oxf.-early Kimm.
bulbosa	Tetratrabs bulbosa	3122	7-11	late Bath.-early Call. to late Kimm.-early Tith.
bullata	Obesacapsula bullata	5568	13-19	latest Tith.-earliest Berr. to early Haut.
cameroni	Elodium cameroni	3411	1-2	early-mid Aal. to late Aal.
Canoptum	Canoptum	3615	13-16	latest Tith.-earliest Berr. to early Val.
cantuchapai	Pantanellium sp. aff. P. cantuchapai	5065	13-21	latest Tith.-earliest Berr. to early Barr.
capita	Hemicryptocapsa capita	4026	17-18	late Val. to latest Val.-earliest Haut.
carinatus	Acanthocircus carinatus	5012	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.

Name	Genus, species, subspecies	MRD	UAZ	Range
carpathicum	Williriedellum carpathicum	4055	7-11	late Bath.-early Call. to late Kimm.-early Tith.
carpatica	Cinguloturris carpatica	3193	7-11	late Bath.-early Call. to late Kimm.-early Tith.
carpatica	Pseudodictyomitra carpatica	3293	11-21	late Kimm.-early Tith. to early Barr.
casmaliaensis	Tritrabs casmaliaensis	3117	4-10	late Baj. to late Oxf.-early Kimm.
catenaria	Orbiculiforma (?) catenaria	3205	7-9	late Bath.-early Call. to mid-late Oxf.
catenarum	Stylocapsa catenarum	3044	6-7	mid Bath. to late Bath.-early Call.
caudatum	Yamatoum caudatum	2016	2-2	late Aal. to late Aal.
Cecrops	Cecrops	6000	17-21	late Val. to early Barr.
cetia	Obesacapsula cetia	3203	10-17	late Oxf.-early Kimm. to late Val.
chalilovi	Archaeodictyomitra chalilovi	5582	20-22	late Haut. to late Barr.-early Apt.
chandrika	Dibolachras chandrika	3265	7-11	late Bath.-early Call. to late Kimm.-early Tith.
channelli	Xitus (?) channelli	5673	16-21	early Val. to early Barr.
charlottensis	Tympaneides charlottensis	3408	1-3	early-mid Aal. to early-mid Baj.
chenodes	Mirifusus chenodes	3162	6-22	mid Bath. to late Barr.-early Apt.
chica	Emiluvia chica decussata	5132	13-18	latest Tith.-earliest Berr. to latest Val.-earliest Haut.
chica	Emiluvia chica s.l.	3213	3-18	early-mid Baj. to latest Val.-earliest Haut.
chrafatensis	Linaresia chrafatensis	3074	2-7	late Aal. to late Bath.-early Call.
cincta	Parvicingula (?) sp. aff. P. cincta	5724	17-18	late Val. to latest Val.-earliest Haut.
Cinguloturris	Cinguloturris	3617	7-17	late Bath.-early Call. to late Val.
collina	Crucella collina	5194	13-21	latest Tith.-earliest Berr. to early Barr.
columbaria	Eucyrtis columbaria	5620	16-22	early Val. to late Barr.-early Apt.
columnum	Wrangellium columnum	5580	13-20	latest Tith.-earliest Berr. to late Haut.
concentrica	Sethocapsa (?) concentrica	5433	13-14	latest Tith.-earliest Berr. to early-early late Berr.
conexa	Tricolocapsa conexa	3297	4-7	late Baj. to late Bath.-early Call.
conoformis	Dicolocapsa (?) conoformis	4013	6-6	mid Bath. to mid Bath.
convexa	Stichocapsa convexa	3055	1-11	early-mid Aal. to late Kimm.-early Tith.
cordis	Theocapsomma cordis	3277	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
corniculum	Saitoum corniculum	3023	7-7	late Bath.-early Call. to late Bath.-early Call.
cornuta	Triactoma cornuta	3166	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.
coronaria	Higumastra coronaria	3108	8-9	mid Call.-early Oxf. to mid-late Oxf.
coronata	Godia coronata	6125	18-20	latest Val.-earliest Haut. to late Haut.
coronata	Spongocapsula sp. aff. S. coronata	5773	17-22	late Val. to late Barr.-early Apt.
coronata	Syringocapsa coronata	5417	13-16	latest Tith.-earliest Berr. to early Val.
coronata	Syringocapsa sp. aff. S. coronata	5416	11-20	late Kimm.-early Tith. to late Haut.
corpulenta	Paronaella sp. aff. P. corpulenta	3310	1-2	early-mid Aal. to late Aal.
corralitosensis	Tetraditryma corralitosensis bifida	4048	5-7	latest Baj.-early Bath. to late Bath.-early Call.
corralitosensis	Tetraditryma corralitosensis corralitosensis	3124	3-10	early-mid Baj. to late Oxf.-early Kimm.
corralitosensis	Tetraditryma corralitosensis s.l.	3273	3-10	early-mid Baj. to late Oxf.-early Kimm.
cosmoconica	Parvicingula cosmoconica	3255	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
crassa	Palinandromeda crassa	3009	7-10	late Bath.-early Call. to late Oxf.-early Kimm.
cretacea	Ristola cretacea	3165	12-17	early-early late Tith. to late Val.
cristatum	Pseudocrolanium cristatum	5521	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
cristatus	Bernoullius cristatus	3221	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
Crolanium	Crolanium	6001	12-17	early-early late Tith. to late Val.
Crolanium spp.	Crolanium spp.	6123	16-22	early Val. to late Barr.-early Apt.
Crucella	Crucella	3619	7-22	late Bath.-early Call. to late Barr.-early Apt.
cruciferum	Parashuum cruciferum	2010	1-1	early-mid Aal.
crystallinum	Williriedellum crystallinum	3069	7-11	late Bath.-early Call. to late Kimm.-early Tith.
cucurbiformis	Theocapsomma cucurbiformis	3047	6-7	mid Bath. to late Bath.-early Call.
cuestaense	Hsuum sp. aff. H. cuestaense	3182	10-13	late Oxf.-early Kimm. to latest Tith.-earliest Berr.
Cyclastrum	Cyclastrum	6002	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
cylindra	Cinguloturris cylindra	6101	12-17	early-early late Tith. to late Val.
cylindricus	Ares cylindricus cylindricus	3001	1-4	early-mid Aal. to late Baj.
cylindricus	Ares cylindricus flexuosus	4032	4-6	late Baj. to mid Bath.
cylindricus	Ares cylindricus s.l.	4061	1-6	early-mid Aal. to mid Bath.
Cyrtocapsa	Cyrtocapsa	3622	3-15	early-mid Baj. to late Berr.-earliest Val.
daneliani	Novixitus (?) daneliani	5524	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
decora	Stichocapsa decora	3269	4-7	late Baj. to late Bath.-early Call.

Name	Genus, species, subspecies	MRD	UAZ	Range
decussata	Emiluvia chica decussata	5132	13-18	latest Tith.-earliest Berr. to latest Val.-earliest Haut.
delnortensis	Bernoullius rectispinus delnortensis	3222	2-7	late Aal. to late Bath.-early Call.
dentata	Acaeniotyle dentata	3281	12-20	early-early late Tith. to late Haut.
dentatum	Eucyrtidiellum unumaense dentatum	3015	6-7	mid Bath. to late Bath.-early Call.
depressa	Palinandromeda depressa	3005	3-7	early-mid Baj. to late Bath.-early Call.
depressa	Palinandromeda sp. aff. P. depressa	3415	3-4	early-mid Baj. to late Baj. .
depressum	Wrangellium depressum	3284	13-18	latest Tith.-earliest Berr. to latest Val.-earliest Haut.
Deviatus	Deviatus	3634	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
deweveri	Napora deweveri	3035	7-11	late Bath.-early Call. to late Kimm.-early Tith.
dhimenaensis	Parvicingula dhimenaensis dhimenaensis	4072	3-11	early-mid Baj. to late Kimm.-early Tith.
dhimenaensis	Parvicingula dhimenaensis s.l.	3197	3-11	early-mid Baj. to late Kimm.-early Tith.
dhimenaensis	Parvicingula dhimenaensis ssp. A	4071	3-8	early-mid Baj. to mid Call.-early Oxf.
Diacanthocapsa	Diacanthocapsa	3623	3-7	early-mid Baj. to late Bath.-early Call.
diamphidius	Deviatus diamphidius s.l.	4073	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
diamphidius	Deviatus diamphidius diamphidius	3112	8-14	mid Call.-early Oxf. to early-early late Berr.
diamphidius	Deviatus diamphidius hipposidericus	3111	9-13	mid-late Oxf. to latest Tith.-earliest Berr.
dianae	Mirifusus dianae baileyi	3406	9-11	mid-late Oxf. to late Kimm.-early Tith.
dianae	Mirifisus dianae dianae	3274	7-12	late Bath.-early Call. to early-early late Tith.
dianae	Mirifusus dianae minor	3286	9-20	mid-late Oxf. to late Haut.
dianae	Mirifusus dianae s.l.	3161	7-20	late Bath.-early Call. to late Haut.
diaphorogona	Acaeniotyle diaphorogona gr.	3090	4-22	late Baj. to late Barr.-early Apt.
Dibolachras	Dibolachras	3624	7-22	late Bath.-early Call. to late Barr.-early Apt.
dicera	Bernoullius dicera	3223	3-10	early-mid Baj. to late Oxf.-early Kimm.
dickinsoni	Zartus dickinsoni gr.	3041	3-4	early-mid Baj. to late Baj. .
Dicolocapsa	Dicolocapsa	3625	6-6	mid Bath. to mid Bath.
dicranacanthos	Acanthocircus trizonalis dicranacanthos	3087	10-17	late Oxf.-early Kimm. to late Val.
Dicroa	Dicroa	6003	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
Dictyomitra	Dictyomitra	6004	17-22	late Val. to late Barr.-early Apt.
Dictyomitrella	Dictyomitrella	3628	3-7	early-mid Baj. to late Bath.-early Call.
digitata	Angulobracchia digitata	3147	3-10	early-mid Baj. to late Oxf.-early Kimm.
diplocyclis	Parasaturnalis diplocyclis	2013	1-3	early-mid Aal. to early-mid Baj.
Ditrabs	Ditrabs	3629	11-21	late Kimm.-early Tith. to early Barr.
dorysphaeroides	Sethocapsa dorysphaeroides	5544	7-22	late Bath.-early Call. to late Barr.-early Apt.
durisaeptum	Amphipyndax durisaeptum	4005	3-7	early-mid Baj. to late Bath.-early Call.
echinatus	Unuma echinatus	3231	1-6	early-mid Aal. to mid Bath.
echiodes	Suna echiodes	3094	9-22	mid-late Oxf. to late Barr.-early Apt.
elegans	Homoeoparonaella elegans	3104	4-10	late Baj. to late Oxf.-early Kimm.
elegans	Homoeoparonaella sp. aff. H. elegans	2004	1-3	early-mid Aal. to early-mid Baj.
elegans	Parvicingula sp. aff. P. elegans	3188	11-11	late Kimm.-early Tith. to late Kimm.-early Tith.
elegans	Saitoum elegans	3022	8-21	mid Call.-early Oxf. to early Barr.
elegantissima	Thanarla elegantissima	5296	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
elisabethae	Pseudocrucella (?) elisabethae	3947	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Elodium	Elodium	3823	1-2	early-mid Aal. to late Aal.
Emiluvia	Emiluvia	3631	1-18	early-mid Aal. to latest Val.-earliest Haut.
espartoensis	Crucella sp. aff. C. espartoensis	5196	17-21	late Val. to early Barr.
Eucyrtidiellum	Eucyrtidiellum	3632	1-13	early-mid Aal. to latest Tith.-earliest Berr.
Eucyrtis	Eucyrtis	3633	16-22	early Val. to late Barr.-early Apt.
euganea	Stichomitra (?) sp. aff. S. euganea	5550	21-22	early Barr. to late Barr.-early Apt.
ewingi	Tritrabs ewingi worzeli	3115	7-12	late Bath.-early Call. to early-early late Tith.
ewingi	Tritrabs ewingi s.l.	3113	4-22	late Baj. to late Barr.-early Apt.
excellens	Archaeodictyomitra excellens	3287	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
exotica	Tritrabs exotica	3119	4-11	late Baj. to late Kimm.-early Tith.
favosus	Gongylothorax favosus	6131	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.
favosus	Gongylothorax sp. aff. G. favosus	3279	7-8	late Bath.-early Call. to mid Call.-early Oxf.
feliformis	Hsuum feliformis	5824	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
flexa	Turanta flexa	2024	6-8	mid Bath. to mid Call.-early Oxf.
flexuosus	Ares cylindricus flexuosus	4032	4-6	late Baj. to mid Bath.
florea	Acaeniotyle (?) florea	5032	17-22	late Val. to late Barr.-early Apt.

Name	Genus, species, subspecies	MRD	UAZ	Range
florealis	Pseudoaulophacus (?) florealis	5334	16-22	early Val. to late Barr.-early Apt.
fluegeli	Pseudocrolanium fluegeli	5522	20-21	late Haut. to early Barr.
foremanae	Triactoma foremanae	4068	7-11	late Bath.-early Call. to late Kimm.-early Tith.
fragilis	Mirifusus fragilis praeguadalupensis	2026	3-3	early-mid Baj. to early-mid Baj. .
fragilis	Mirifusus fragilis s.l.	3159	3-8	early-mid Baj. to mid Call.-early Oxf.
funatoensis	Sethocapsa funatoensis	3070	3-11	early-mid Baj. to late Kimm.-early.
furcata	Parapodocapsa furcata	5396	13-16	latest Tith.-earliest Berr. to early Val.
furcospinus	Bernoullius furcospinus	4009	1-4	early-mid Aal. to late Baj.
furiosus	Acanthocircus furiosus	5003	10-20	late Oxf.-early Kimm. to late Haut.
fusiformis	Tricolocapsa (?) fusiformis	4049	3-5	early-mid Baj. to latest Baj.-early Bath.
fusiformis	Tricolocapsa (?) sp. aff. T. fusiformis	4050	4-6	late Baj. to mid Bath.
fusus	Pseudoeucyrtis (?) fusus	5408	13-17	latest Tith.-earliest Berr. to late Val.
ghostensis	Acaeniotylopsis ghostensis	2001	1-4	early-mid Aal. to late Baj.
gifuensis	Xitus gifuensis	3294	11-18	late Kimm.-early Tith. to latest Val.-earliest Haut.
gigantea	Homoeoparonaella (?) gigantea	3105	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.
glebulosa	Acaeniotyle (?) glebulosa	5033	17-22	late Val. to late Barr.-early Apt.
Godia	Godia	3803	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
Gongylothorax	Gongylothorax	3635	4-10	late Baj. to late Oxf.-early Kimm.
Gorgansium	Gorgansium	3636	3-8	early-mid Baj. to mid Call.-early Oxf.
Gorgansium spp.	Gorgansium spp.	3076	3-8	early-mid Baj. to mid Call.-early Oxf.
gracilis	Archaeotritrabs gracilis	5913	16-21	early Val. to early Barr.
grande	Parahsuum (?) grande	4031	1-3	early-mid Aal. to early-mid Baj.
gratiosa	Higumastra gratiosa	3109	3-8	early-mid Baj. to mid Call.-early Oxf.
grutterinki	Cyrtocapsa (?) grutterinki	5506	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
guadalupensis	Mirifusus guadalupensis	3160	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
Guexella	Guexella	3637	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
guexi	Savaryella guexi	5193	14-21	early-early late Berr. to early Barr.
gutta	Thanarla gutta	5904	20-21	late Haut. to early Barr.
Halesium	Halesium	3639	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Haliodictya	Haliodictya	3640	3-11	early-mid Baj. to late Kimm.-early Tith.
hanni	Pseudoeucyrtis sp.cf. P. hanni	5407	17-18	late Val. to latest Val.-earliest Haut.
hayi	Tritrabs hayi	3116	3-10	early-mid Baj. to late Oxf.-early Kimm.
helenae	Alievium helenae	3228	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
heliotropica	Orbiculiforma (?) heliotropica	3204	3-9	early-mid Baj. to mid-late Oxf.
helvetica	Podobursa helvetica	3169	3-10	early-mid Baj. to late Oxf.-early Kimm.
hemicostata	Stylocapsa (?) hemicostata	4045	5-6	latest Baj.-early Bath. to mid Bath.
Hemicryptocapsa	Hemicryptocapsa	3641	17-18	late Val. to latest Val.-earliest Haut.
hexacubicus	Leugeo hexacubicus	3244	4-8	late Baj. to mid Call.-early Oxf.
hexagonus	Hexasaturnalis hexagonus	3502	1-4	early-mid Aal. to late Baj.
hexaptera	Podocapsa(?) hexaptera	4033	7-7	late Bath.-early Call. to late Bath.-early Call.
Hexapyramis	Hexapyramis	6006	17-22	late Val. to late Barr.-early Apt.
Hexasaturnalis	Hexasaturnalis	3656	1-6	early-mid Aal. to mid Bath.
Hexastylus	Hexastylus	3643	1-4	early-mid Aal. to late Baj.
Hexastylus sp. A	Hexastylus sp. A	2009	1-4	early-mid Aal. to late Baj.
hichisoense	Laxtorum (?) hichisoense	4028	1-4	early-mid Aal. to late Baj.
hiconocosta	Parahsuum (?) hiconocosta	3011	2-4	late Aal. to late Baj. .
Higumastra	Higumastra	3644	1-10	early-mid Aal. to late Oxf.-early Kimm.
Hilarisirex	Hilarisirex	3645	3-7	early-mid Baj. to late Bath.-early Call.
himedaruma	Stichocapsa himedaruma	4038	not zoned	late Mid-early Late Jurassic
hipposidericus	Deviatus diamphidius hipposidericus	3111	9-13	mid-late Oxf. to latest Tith.-earliest Berr.
hisuikyoense	Transhsuum hisuikyoense	3194	2-7	late Aal. to late Bath.-early Call.
hojnosi	Haliodictya (?) hojnosi	3254	3-10	early-mid Baj. to late Oxf.-early Kimm.
Holocryptocanium	Holocryptocanium	6007	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Homoeoparonaella	Homoeoparonaella	3648	1-22	early-mid Aal. to late Barr.-early Apt.
hopsoni	Emiluvia hopsoni	3225	6-15	mid Bath. to late Berr.-earliest Val. .
horridus	Xitus horridus	5725	19-20	early Haut. to late Haut.
Hsuum	Hsuum	3649	1-15	early-mid Aal. to late Berr.-earliest Val.
Hsuum sp. 1	Hsuum sp. 1	2018	1-2	early-mid Aal. to late Aal.

Name	Genus, species, subspecies	MRD	UAZ	Range
hybum	Suna hybum	5049	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
ichikawai	Solenotryma ichikawai	4037	7-21	late Bath.-early Call. to early Barr.
imbricata	Higumastra imbricata	3110	4-8	late Baj. to mid Call.-early Oxf.
imlayi	Zartus imlayi gr.	3040	1-4	early-mid Aal. to late Baj.
imperialis	Podocapsa (?) imperialis	5397	18-20	latest Val.-earliest Haut. to late Haut.
inflata	Higumastra inflata	3106	7-10	late Bath.-early Call. to late Oxf.-early Kimm.
inflexa	Crucella (?) inflexa	5902	17-22	late Val. to late Barr.-early Apt.
infundibuliforme	Cyclastrum infundibuliforme	5261	17-22	late Val. to late Barr.-early Apt.
irazuense	Bistarkum irazuense	5199	14-21	early-early late Berr. to early Barr.
irregularis	Homoeoparonaella sp. aff. H. irregularis	5253	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
italicus	Jacus (?) italicus	5371	15-20	late Berr.-earliest Val. to late Haut.
izeensis	Tetratrabs izeensis	3302	1-5	early-mid Aal. to latest Baj.-early Bath.
izeense	Parashuum izeense	2012	1-3	early-mid Aal. to early-mid Baj.
jacobsae	Triactoma jacobsae	3409	1-4	early-mid Aal. to late Baj.
Jacus	Jacus	3651	15-20	late Berr.-earliest Val. to late Haut.
japonica	Stichocapsa japonica	3049	3-8	early-mid Baj. to mid Call.-early Oxf.
japonicus	Protunuma japonicus	3292	7-12	late Bath.-early Call. to early-early late Tith.
jonesi	Triactoma jonesi	3096	2-13	late Aal. to latest Tith.-earliest Berr. .
jurassicum	Laxtorum (?) jurassicum	3151	2-3	late Aal. to early-mid Baj. .
kaminogoensis	Sethocapsa sp. aff. S. kaminogoensis	5481	13-21	latest Tith.-earliest Berr. to early Barr.
kamoensis	Dictyomitrella (?) kamoensis	4014	3-7	early-mid Baj. to late Bath.-early Call.
Katroma	Katroma	3652	13-19	latest Tith.-earliest Berr. to early Haut.
kisoensis	Cyrtocapsa (?) kisoensis	3050	3-4	early-mid Baj. to late Baj. .
kitoi	Sethocapsa kitoi	3264	13-16	latest Tith.-earliest Berr. to early Val.
komamiensis	Yamatoum komamiensis	2020	2-2	late Aal. to late Aal.
kotura	Paronaella kotura	3140	3-10	early-mid Baj. to late Oxf.-early Kimm.
lacrimalis	Stylocapsa lacrimalis	4046	6-7	mid Bath. to late Bath.-early Call.
lacrimula	Archaeodictyomitra (?) lacrimula	5595	14-22	early-early late Berr. to late Barr.-early Apt.
lanceloti	Pseudodictyomitra lanceloti	5641	20-22	late Haut. to late Barr.-early Apt.
lanceloti	Pseudodictyomitra sp. aff. P. lanceloti	5642	21-21	early Barr. to early Barr.
latissima	Napora latissima	3031	4-7	late Baj. to late Bath.-early Call.
latusicostatus	Unuma latusicostatus	4058	2-5	late Aal. to latest Baj.-early Bath.
Laxtorum	Laxtorum	3654	1-4	early-mid Aal. to late Baj.
leiostraca	Sethocapsa leiostraca	3062	4-20	late Baj. to late Haut.
lenticulata	Godia lenticulata	5287	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
leporinus	Bernoullius rectispinus leporinus	4064	2-6	late Aal. to mid Bath.
leptoconica	Pseudodictyomitra leptoconica	5973	22-22	late Barr.-early Apt. to late Barr.-early Apt.
Leugeo	Leugeo	3807	4-8	late Baj. to mid Call.-early Oxf.
levium	Saitoum levium	3024	4-9	late Baj. to mid-late Oxf.
levium	Saitoum sp. aff. S. levium	3026	3-4	early-mid Baj. to late Baj. .
lilyae	Pseudodictyomitra lilyae	5625	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
limatum	Syringocapsa limatum	5426	11-21	late Kimm.-early Tith. to early Barr.
Linaresia	Linaresia	3811	2-7	late Aal. to late Bath.-early Call.
lineatum	Halesium (?) lineatum	5243	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
lipmanae	Crucella lipmanae	5628	17-19	late Val. to early Haut.
Lithatractus	Lithatractus	6009	14-22	early-early late Berr. to late Barr.-early Apt.
lombardensis	Emiluvia lombardensis	3253	1-4	early-mid Aal. to late Baj.
longa	Parvicingula longa	5578	13-20	latest Tith.-earliest Berr. to late Haut.
longipes	Archaeohagiastrum longipes	3149	1-7	early-mid Aal. to late Bath.-early Call.
longitubus	Syringocapsa longitubus	5410	13-16	latest Tith.-earliest Berr. to early Val.
lospensis	Napora lospensis	3036	8-13	mid Call.-early Oxf. to latest Tith.-earliest Berr. .
luciae	Triactoma luciae	5055	13-21	latest Tith.-earliest Berr. to early Barr.
lucifer	Obesacapsula lucifer	3283	13-16	latest Tith.-earliest Berr. to early Val.
luminosum	Cyclastrum (?) luminosum	5266	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
macroxiphus	Stylosphaera (?) macroxiphus	5044	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
magna	Parvivacca magna	3288	14-20	early-early late Berr. to late Haut.
magnum	Parahsuum (?) magnum	3072	2-5	late Aal. to latest Baj.-early Bath.
magnus	Xitus magnus	3259	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.

Name	Genus, species, subspecies	MRD	UAZ	Range
major	Ristola altissima major	3238	5-7	latest Baj.-early Bath. to late Bath.-early Call.
manica	Bernoullius (?) manica	5357	20-21	late Haut. to early Barr.
martae	Ristola martae	5766	17-20	late Val. to late Haut.
mashitaensis	Parvicingula mashitaensis	3245	8-15	mid Call.-early Oxf. to late Berr.-earliest Val.
mastoidea	Cyrtocapsa mastoidea	3307	3-4	early-mid Baj. to late Baj. .
matsuokai	Hsuum matsuokai	3195	1-5	early-mid Aal. to latest Baj.-early Bath.
maxwelli	Transhsuum maxwelli gr.	3180	3-10	early-mid Baj. to late Oxf.-early Kimm.
mclaughlini	Orbiculiforma(?) sp. aff. O. mclaughlini	3206	8-9	mid Call.-early Oxf. to mid-late Oxf.
medium	Halesium medium	5223	16-21	early Val. to early Barr.
medium	Transhsuum medium	3278	1-7	early-mid Aal. to late Bath.-early Call.
megasphaerica	Quinquecapsularia megasphaerica	3081	3-11	early-mid Baj. to late Kimm.-early Tith.
mexicana	Triactoma mexicana	3412	5-9	latest Baj.-early Bath. to mid-late Oxf.
Milax	Milax	3805	13-20	latest Tith.-earliest Berr. to late Haut.
milloti	Katroma milloti	5436	13-19	latest Tith.-earliest Berr. to early Haut.
minoensis	Archaeodictyomitra minoensis	3305	9-12	mid-late Oxf. to early-early late Tith.
minor	Mirifusus dianae minor	3286	9-20	mid-late Oxf. to late Haut.
minor	Acanthocircus suboblongus minor	3085	3-11	early-mid Baj. to late Kimm.-early Tith.
mirabilis	Archaeodictyomitra (?) mirabilis	3236	7-7	late Bath.-early Call. to late Bath.-early Call.
mirabundum	Hsuum sp. cf. H. mirabundum	2006	3-6	early-mid Baj. to mid Bath.
Mirifisus	Mirifisus	3658	2-21	late Aal. to early Barr.
monoceros	Bernoullius (?) monoceros	5359	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
Monotrabs	Monotrabs	3660	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
morinae	Turanta morinae gr.	3247	1-5	early-mid Aal. to latest Baj.-early Bath.
morroensis	Obesacapsula morroensis	3266	5-21	latest Baj.-early Bath. to early Barr.
mulleri	Paronaella mulleri	3139	6-10	mid Bath. to late Oxf.-early Kimm.
multipora	Emiluvia pessagnoi multipora	3226	8-14	mid Call.-early Oxf. to early-early late Berr.
multispina	Podobursa multispina	5427	20-20	late Haut. to late Haut.
munitum	Archaeohagiastrum munitum	3271	2-8	late Aal. to mid Call.-early Oxf.
murcheyae	Palinandromeda murcheyae	3004	3-6	early-mid Baj. to mid Bath.
nana	Emiluvia nana	3212	6-9	mid Bath. to mid-late Oxf.
Napora	Napora	3661	1-13	early-mid Aal. to latest Tith.-earliest Berr.
Napora sp. A	Napora sp. A	3030	3-3	early-mid Baj. to early-mid Baj. .
Napora sp. B	Napora sp. B	3034	7-13	late Bath.-early Call. to latest.
naradaniensis	Stichocapsa naradaniensis	3045	6-7	mid Bath. to late Bath.-early Call.
natorense	Parahsuum (?) natorense	3073	1-3	early-mid Aal. to early-mid Baj.
nipponica	Napora nipponica	3410	1-4	early-mid Aal. to late Baj.
nodosum	Eucyrtidiellum nodosum	3014	3-10	early-mid Baj. to late Oxf.-early Kimm.
normalis	Diacanthocapsa normalis	4012	3-4	early-mid Baj. to late Baj. .
Novixitus	Novixitus	6013	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
nuda	Pseudodictyomitra nuda	5647	16-22	early Val. to late Barr.-early Apt.
nudata	Guexella nudata	3061	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
obesa	Spongocapsula obesa	5771	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
Obesacapsula	Obesacapsula	3664	5-21	latest Baj.-early Bath. to early Barr.
oblongula	Stylocapsa oblongula	3059	6-8	mid Bath. to mid Call.-early Oxf.
oblongus	Gongylothorax oblongus	4022	4-4	late Baj. to late Baj. .
ochiensis	Protunuma (?) ochiensis	3290	5-14	latest Baj.-early Bath. to early-early late Berr. .
oculatus	Poulpus sp. aff. P. oculatus	3028	3-7	early-mid Baj. to late Bath.-early Call.
odoghertyi	Mirifusus odoghertyi	5721	13-21	latest Tith.-earliest Berr. to early Barr.
officerense	Parashuum officerense	2011	1-7	early-mid Aal. to late Bath.-early Call.
okamurai	Wrangellium okamurai	3179	7-11	late Bath.-early Call. to late Kimm.-early Tith.
olorizi	Parahsuum (?) olorizi	3071	2-4	late Aal. to late Baj. .
operculi	Diacanthocapsa (?) operculi	3054	3-7	early-mid Baj. to late Bath.-early Call.
Orbiculiforma	Orbiculiforma	3665	1-9	early-mid Aal. to mid-late Oxf.
Orbiculiforma (?) sp. X	Orbiculiforma (?) sp. X	2019	1-6	early-mid Aal. to mid Bath.
orca	Sethocapsa (?) orca	5553	19-22	early Haut. to late Barr.-early Apt.
ordinaria	Emiluvia ordinaria	4015	9-11	mid-late Oxf. to late Kimm.-early Tith.
ordinarium	Perispyridium ordinarium gr.	3100	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
orea	Emiluvia orea orea	3224	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.

Name	Genus, species, subspecies	MRD	UAZ	Range
orea	Emiluvia orea ultima	4070	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
orea	Emiluvia orea s.l.	4069	4-i1	late Baj. to late Kimm.-early Tith.
osteosa	Ditrabs (?) osteosa	3912	13-16	latest Tith.-earliest Berr. to early Val.
ovalis	Quarticella ovalis	4078	4-4	late Baj. to late Baj. .
ovum	Phaseliforma ovum	5362	20-22	late Haut. to late Barr.-early Apt.
ovum	Zhamoidellum ovum	4079	9-11	mid-late Oxf. to late Kimm.-early Tith.
pachyderma	Archicapsa (?) pachyderma	4007	3-4	early-mid Baj. to late Baj. .
pagei	Saitoum pagei	3020	4-11	late Baj. to late Kimm.-early Tith.
pagei	Saitoum sp. aff. S. pagei	3027	3-3	early-mid Baj. to early-mid Baj. .
Palinandromeda	Palinandromeda	3606	1-10	early-mid Aal. to late Oxf.-early Kimm.
palmerae	Spongocapsula palmerae	3199	6-13	mid Bath. to latest Tith.-earliest Berr. .
Pantanellium	Pantanellium	3667	2-22	late Aal. to late Barr.-early Apt.
Pantanellium sp. L	Pantanellium sp. L	3042	2-4	late Aal. to late Baj. .
parablakei	Triactoma parablakei	3413	4-7	late Baj. to late Bath.-early Call.
Parahsuum	Parahsuum	3668	1-11	early-mid Aal. to late Kimm.-early Tith.
Parahsuum sp. S	Parahsuum sp. S	3240	7-11	late Bath.-early Call. to late Kimm.-early Tith.
Parapodocapsa	Parapodocapsa	6014	13-16	latest Tith.-earliest Berr. to early Val.
Parasaturnalis	Parasaturnalis	3821	1-3	early-mid Aal. to early-mid Baj.
Parashuum sp. M	Parashuum sp. M	2015	1-1	early-mid Aal.
Paronaella	Paronaella	3671	1-22	early-mid Aal. to late Barr.-early Apt.
Parvicingula	Parvicingula	3672	3-22	early-mid Baj. to late Barr.-early Apt.
Parvicingula (?) sp. A	Parvicingula (?) sp. A	3239	7-7	late Bath.-early Call. to late Bath.-early Call.
Parvivacca	Parvivacca	3673	14-20	early-early late Berr. to late Haut.
patricki	Archaeospongoprunum patricki	5042	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
pauliani	Pseudoaulophacus (?) pauliani	5332	13-21	latest Tith.-earliest Berr. to early Barr.
perampla	Spongocapsula perampla	3267	6-11	mid Bath. to late Kimm.-early Tith.
periosa	Dicroa periosa	5046	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
Perispyridium	Perispyridium	3675	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
pessagnoi	Emiluvia pessagnoi multipora	3226	8-14	mid Call.-early Oxf. to early-early late Berr.
pessagnoi	Emiluvia pessagnoi pessagnoi	4017	9-13	mid-late Oxf. to latest Tith.-earliest Berr.
pessagnoi	Emiluvia pessagnoi s.l.	3066	4-17	late Baj. to late Val.
peteri	Homoeoparonaella peteri	5267	19-22	early Haut. to late Barr.-early Apt.
petzholdti	Mirifusus petzholdti	5703	16-17	early Val. to late Val.
Phaseliforma	Phaseliforma	6130	20-22	late Haut. to late Barr.-early Apt.
planum	Cyclastrum (?) planum	5903	19-22	early Haut. to late Barr.-early Apt.
plenoides	Monotrabs plenoides gr.	3152	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
plicarum	Tricolocapsa plicarum plicarum	4053	4-5	late Baj. to latest Baj.-early Bath.
plicarum	Tricolocapsa plicarum s.l.	3051	3-8	early-mid Baj. to mid Call.-early Oxf.
plicarum	Tricolocapsa plicarum ssp. A	4052	4-5	late Baj. to latest Baj.-early Bath.
podbielensis	Palinandromeda podbielensis	3008	5-9	latest Baj.-early Bath. to mid-late Oxf.
Podobursa	Podobursa	3677	3-20	early-mid Baj. to late Haut.
Podocapsa	Podocapsa	3678	7-20	late Bath.-early Call. to late Haut.
polyacantha	Podobursa polyacantha	3174	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
polyedra	Obesacapsula polyedra	5565	13-17	latest Tith.-earliest Berr. to late Val.
portmanni	Angulobracchia (?) portmanni portmanni	3285	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
portmanni	Angulobracchia (?) portmanni s.l.	6121	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Poulpus	Poulpus	3680	3-7	early-mid Baj. to late Bath.-early Call.
praecrassa	Palinandromeda praecrassa	3007	3-9	early-mid Baj. to mid-late Oxf.
praeguadalupensis	Mirifusus fragilis praeguadalupensis	2026	3-3	early-mid Baj. to early-mid Baj. .
praemirifusus	Ristola praemirifusus	2014	1-2	early-mid Aal. to late Aal.
praeplena	Tetraditryma praeplena	3125	1-7	early-mid Aal. to late Bath.-early Call.
praeplena	Tetraditryma sp. cf. T. praeplena	3407	1-2	early-mid Aal. to late Aal.
praepodbielensis	Palinandromeda praepodbielensis	3006	1-7	early-mid Aal. to late Bath.-early Call.
precedis	Hexapyramis (?) precedis	5069	17-22	late Val. to late Barr.-early Apt.
premyogii	Emiluvia premyogii	3210	3-10	early-mid Baj. to late Oxf.-early Kimm.
primitiva	Pseudodictyomitra primitiva	3189	7-12	late Bath.-early Call. to early-early late Tith.
pristidentata	Paronaella pristidentata	3138	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
proavus	Mirifusus proavus	3158	2-4	late Aal. to late Baj. .

Name	Genus, species, subspecies	MRD	UAZ	Range
procera	Ristola procera	3163	5-9	latest Baj.-early Bath. to mid-late Oxf.
protoformis	Acanthocircus protoformis	2021	3-8	early-mid Baj. to mid Call.-early Oxf.
Protunuma	Protunuma	3682	4-14	late Baj. to early-early late Berr. .
Pseudoaulophacus	Pseudoaulophacus	6026	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Pseudocrolanium	Pseudocrolanium	3806	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
Pseudocrucella	Pseudocrucella	3683	4-22	late Baj. to late Barr.-early Apt.
Pseudocrucella sp. B	Pseudocrucella sp. B	3127	8-9	mid Call.-early Oxf. to mid-late Oxf.
Pseudodictyomitra	Pseudodictyomitra	3684	7-22	late Bath.-early Call. to late Barr.-early Apt.
Pseudoeucyrtis	Pseudoeucyrtis	3685	5-21	latest Baj.-early Bath. to early Barr.
Pseudoeucyrtis sp. J	Pseudoeucyrtis sp. J	3176	5-10	latest Baj.-early Bath. to late Oxf.-early Kimm.
pseudoewingi	Homoeoparonaella (?) pseudoewingi	3150	3-7	early-mid Baj. to late Bath.-early Call.
pseudoplena	Tetraditryma pseudoplena	3123	4-11	late Baj. to late Kimm.-early Tith.
Pseudopoulpus	Pseudopoulpus	3822	1-2	early-mid Aal. to late Aal.
pseudoscalaris	Dictyomitra pseudoscalaris	5927	17-22	late Val. to late Barr.-early Apt.
ptyctum	Eucyrtidiellum ptyctum	3017	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
puga	Wrangellium puga	5636	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
pulchella	Stichocapsa pulchella	5744	17-22	late Val. to late Barr.-early Apt.
pulcher	Xitus sp. aff. X. pulcher	3258	9-11	mid-late Oxf. to late Kimm.-early Tith.
pulchra	Thanarla pulchra	5073	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
purisimaensis	Angulobracchia purisimaensis	3144	3-10	early-mid Baj. to late Oxf.-early Kimm.
pusillus	Lithatractus sp. aff. L. pusillus	5041	14-22	early-early late Berr. to late Barr.-early Apt.
pustulatum	Eucyrtidiellum unumaense pustulatum	3013	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
pygmaea	Paronaella pygmaea	3133	7-9	late Bath.-early Call. to mid-late Oxf.
pyramidalis	Napora pyramidalis	3033	2-11	late Aal. to late Kimm.-early Tith.
pyramis	Eucyrtidiellum pyramis	3019	12-13	early-early late Tith. to latest Tith.-earliest Berr.
Pyramispongia	Pyramispongia	6018	13-20	latest Tith.-earliest Berr. to late Haut.
pythiae	Crolanium pythiae	5532	17-22	late Val. to late Barr.-early Apt.
quadrangularis	Hilarisirex quadrangularis	3002	3-7	early-mid Baj. to late Bath.-early Call.
quadriaculeata	Podobursa (?) sp. aff. P. quadriaculeata	3289	9-17	mid-late Oxf. to late Val.
Quarticella	Quarticella	3808	4-4	late Baj. to late Baj. .
quinatum	Eucyrtidiellum (?) quinatum	3048	1-4	early-mid Aal. to late Baj.
Quinquecapsularia	Quinquecapsularia	3814	3-11	early-mid Baj. to late Kimm.-early Tith.
radix	Tetratrabs radix	5209	12-17	early-early late Tith. to late Val.
raricostatum	Hsuum raricostatum	3591	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
rarum	Cyclastrum rarum	5290	15-21	late Berr.-earliest Val. to early Barr.
rectispinus	Bernoullius rectispinus delnortensis	3222	2-7	late Aal. to late Bath.-early Call.
rectispinus	Bernoullius rectispinus leporinus	4064	2-6	late Aal. to mid Bath.
rectispinus	Bernoullius rectispinus rectispinus	4011	1-4	early-mid Aal. to late Baj.
rectispinus	Bernoullius rectispinus s.l.	4010	1-9	early-mid Aal. to mid-late Oxf.
rectispinus	Bernoullius rectispinus ssp. B	2017	2-7	late Aal. to late Bath.-early Call.
remanei	Crucella remanei	5143	17-21	late Val. to early Barr.
reticularis	Pseudoeucyrtis reticularis	3177	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
rhododactylus	Tritrabs rhododactylus	3118	3-13	early-mid Baj. to latest Tith.-earliest Berr.
riedeli	Pantanellium riedeli	3078	7-12	late Bath.-early Call. to early-early late Tith.
rifensis	Linaresia rifensis	2022	2-3	late Aal. to early-mid Baj. .
Ristola	Ristola	3687	1-20	early-mid Aal. to late Haut.
robusta	Staurolonche robusta	3220	4-10	late Baj. to late Oxf.-early Kimm.
robusta	Stichocapsa robusta	3298	5-7	latest Baj.-early Bath. to late Bath.-early Call.
rugosa	Angulobracchia (?) rugosa	3911	12-16	early-early late Tith. to early Val.
rusconensis	Obesacapsula rusconensis rusconensis	3282	13-19	latest Tith.-earliest Berr. to early Haut.
rusconensis	Obesacapsula rusconensis umbriensis	5796	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
rusconensis	Obesacapsula rusconensis s.l.	6129	13-19	latest Tith.-earliest Berr. to early Haut.
saginata	Napora saginata	3032	3-7	early-mid Baj. to late Bath.-early Call.
Saitoum	Saitoum	3688	3-21	early-mid Baj. to early Barr.
sakawaensis	Gongylothorax sakawaensis	4023	6-7	mid Bath. to late Bath.-early Call.
salensis	Emiluvia salensis	3215	4-13	late Baj. to latest Tith.-earliest Berr. .
sandovali	Xitus sandovali	5668	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
sanfilippoae	Pseudocrucella sanfilippoae	3126	7-10	late Bath.-early Call. to late Oxf.-early Kimm.

Name	Genus, species, subspecies	MRD	UAZ	Range
sansalvadorensis	Ditrabs sansalvadorensis	3227	11-21	late Kimm.-early Tith. to early Barr.
satoi	Spongotripus (?) satoi	5262	19-22	early Haut. to late Barr.-early Apt.
Savaryella	Savaryella	6017	14-21	early-early late Berr. to early Barr.
sceptrum	Pseudoeucyrtis sceptrum	5577	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
schoolhousensis	Parvicingula schoolhousensis gr.	3184	3-3	early-mid Baj. to early-mid Baj. .
sedecimporata	Emiluvia sedecimporata	3216	3-11	early-mid Baj. to late Kimm.-early Tith.
semifactum	Eucyrtidiellum semifactum	3016	5-7	latest Baj.-early Bath. to late Bath.-early Call.
septemporatus	Cecrops septemporatus	5229	17-21	late Val. to early Barr.
Sethocapsa	Sethocapsa	3689	3-22	early-mid Baj. to late Barr.-early Apt.
Sethocapsa sp. A	Sethocapsa sp. A	3167	3-13	early-mid Baj. to latest Tith.-earliest Berr.
sexaspina	Cecrops (?) sexaspina	5068	17-20	late Val. to late Haut.
siciliensis	Actinomma siciliensis	2008	1-4	early-mid Aal. to late Baj.
sicula	Angulobracchia sicula	3301	1-6	early-mid Aal. to mid Bath.
simplex	Sethocapsa simplex	5469	20-22	late Haut. to late Barr.-early Apt.
simplex	Tritrabs simplex	3303	1-6	early-mid Aal. to mid Bath.
siphonofer	Gongylothorax sp. aff. G. siphonofer	4024	4-4	late Baj. to late Baj. .
skowkonaensis	Paronaella skowkonaensis	2005	1-2	early-mid Aal. to late Aal.
sognoensis	Palinandromeda sognoensis	3010	1-3	early-mid Aal. to early-mid Baj.
Solenotryma	Solenotryma	3690	7-21	late Bath.-early Call. to early Barr.
speciosa	Homoeoparonaella speciosa	5163	13-21	latest Tith.-earliest Berr. to early Barr.
spelae	Bernoullius spelae	5369	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
sphaerica	Parvicingula sphaerica	3717	13-16	latest Tith.-earliest Berr. to early Val.
sphaerica	Sethocapsa (?) sphaerica	3168	9-11	mid-late Oxf. to late Kimm.-early Tith.
spicularius	Xitus sp. aff. X. spicularius	3295	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
spinata	Parvicingula (?) spinata	3187	3-10	early-mid Baj. to late Oxf.-early Kimm.
spinellifera	Syringocapsa spinellifera	3170	9-12	mid-late Oxf. to early-early late Tith.
spinosa	Podobursa spinosa	3230	8-13	mid Call.-early Oxf. to latest Tith.-earliest Berr. .
spinosa	Syringocapsa sp. aff. S. spinosa	5711	19-22	early Haut. to late Barr.-early Apt.
spinosum	Yamatoum spinosum	4077	1-4	early-mid Aal. to late Baj.
spiralis	Stylocapsa (?) spiralis gr.	3046	6-7	mid Bath. to late Bath.-early Call.
splendida	Emiluvia splendida	2002	1-3	early-mid Aal. to early-mid Baj.
Spongocapsula	Spongocapsula	3691	6-22	mid Bath. to late Barr.-early Apt.
Spongotripus	Spongotripus	3692	19-22	early Haut. to late Barr.-early Apt.
squinaboli	Pantanellium squinaboli	5607	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
stanleyensis	Parashuum stanleyensis	2023	3-8	early-mid Baj. to mid Call.-early Oxf.
Staurolonche	Staurolonche	3693	4-10	late Baj. to late Oxf.-early Kimm.
Stichocapsa	Stichocapsa	3696	1-22	early-mid Aal. to late Barr.-early Apt.
Stichocapsa sp. E	Stichocapsa sp. E	4042	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
Stichomitra	Stichomitra	3697	3-22	early-mid Baj. to late Barr.-early Apt.
Stichomitra (?) sp. A	Stichomitra (?) sp. A	3192	3-7	early-mid Baj. to late Bath.-early Call.
Stylocapsa	Stylocapsa	3698	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
Stylosphaera	Stylosphaera	3699	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Stylospongia	Stylospongia	3802	20-22	late Haut. to late Barr.-early Apt.
suboblongus	Acanthocircus suboblongus minor	3085	3-11	early-mid Baj. to late Kimm.-early Tith.
suboblongus	Acanthocircus suboblongus suboblongus	3088	3-11	early-mid Baj. to late Kimm.-early Tith.
suboblongus	Acanthocircus suboblongus s.l.	3064	3-11	early-mid Baj. to late Kimm.-early Tith.
Suna	Suna	3810	9-22	mid-late Oxf. to late Barr.-early Apt.
Syringocapsa	Syringocapsa	3630	7-22	late Bath.-early Call. to late Barr.-early Apt.
Syringocapsa (?) sp. A	Syringocapsa (?) sp. A	3268	7-7	late Bath.-early Call. to late Bath.-early Call.
takanoensis	Stichomitra (?) takanoensis gr.	4044	3-7	early-mid Baj. to late Bath.-early Call.
tecta	Godia tecta	5274	19-22	early Haut. to late Barr.-early Apt.
tecta	Stylocapsa tecta	4047	5-6	latest Baj.-early Bath. to mid Bath.
testatum	Zhamoidellum testatum	5511	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
tetradactylus	Hexastylus (?) tetradactylus	4027	1-4	early-mid Aal. to late Baj.
Tetraditryma	Tetraditryma	3638	1-11	early-mid Aal. to late Kimm.-early Tith.
tetragona	Tricolocapsa tetragona	4054	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
tetraspinus	Hexasaturnalis tetraspinus	3089	1-6	early-mid Aal. to mid Bath.
Tetratrabs	Tetratrabs	3642	1-17	early-mid Aal. to late Val.

Name	Genus, species, subspecies	MRD	UAZ	Range
Thanarla	Thanarla	6025	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
Theocapsomma	Theocapsomma	3647	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
Theocapsomma sp A.	Theocapsomma sp A.	3043	7-7	late Bath.-early Call. to late Bath.-early Call.
theokaftensis	Crucella theokaftensis	3131	7-11	late Bath.-early Call. to late Kimm.-early Tith.
Thetis	Thetis	3650	7-7	late Bath.-early Call. to late Bath.-early Call.
Tith.um	Triactoma Tith.um	3097	6-22	mid Bath. to late Barr.-early Apt.
titirez	Stylospongia (?) titirez	5090	20-22	late Haut. to late Barr.-early Apt.
trachyostraca	Sethocapsa trachyostraca	3063	7-22	late Bath.-early Call. to late Barr.-early Apt.
Transhsuum	Transhsuum	3809	1-11	early-mid Aal. to late Kimm.-early Tith.
triacanthus	Acaeniotylopsis variatus triacanthus	4066	1-7	early-mid Aal. to late Bath.-early Call.
Triactoma	Triactoma	3655	1-22	early-mid Aal. to late Barr.-early Apt.
trichylum	Saitoum trichylum	3021	7-9	late Bath.-early Call. to mid-late Oxf.
Tricolocapsa	Tricolocapsa	3657	3-8	early-mid Baj. to mid Call.-early Oxf.
Tricolocapsa sp. M	Tricolocapsa sp. M	4056	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
Tricolocapsa sp. S	Tricolocapsa sp. S	4057	4-5	late Baj. to latest Baj.-early Bath.
tricornis	Sethocapsa tricornis	5510	13-16	latest Tith.-earliest Berr. to early Val.
trifoliacea	Paronaella trifoliacea	5186	14-22	early-early late Berr. to late Barr.-early Apt.
trigonum	Cyclastrum (?) trigonum	5901	16-21	early Val. to early Barr.
Trillus	Trillus	3659	1-5	early-mid Aal. to latest Baj.-early Bath.
Trillus spp.	Trillus spp.	3039	1-5	early-mid Aal. to latest Baj.-early Bath.
tripes	Spongocapsula (?) tripes	5526	19-21	early Haut. to early Barr.
Tritrabs	Tritrabs	3662	1-22	early-mid Aal. to late Barr.-early Apt.
trizonalis	Acanthocircus trizonalis angustus	3082	6-10	mid Bath. to late Oxf.-early Kimm.
trizonalis	Acanthocircus trizonalis dicranacanthos	3087	10-17	late Oxf.-early Kimm. to late Val.
trizonalis	Acanthocircus trizonalis trizonalis	3083	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
trizonalis	Acanthocircus trizonalis s.l.	3065	6-22	mid Bath. to late Barr.-early Apt.
tsunoensis	Amphipyndax tsunoensis	2025	6-7	mid Bath. to late Bath.-early Call.
tuberculatus	Novixitus (?) tuberculatus	5693	19-22	early Haut. to late Barr.-early Apt.
tubulata	Paronaella (?) tubulata	5183	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
Turanta	Turanta	3663	1-8	early-mid Aal. to mid Call.-early Oxf.
turbo	Protunuma turbo	4034	4-7	late Baj. to late Bath.-early Call.
turpicula	Ristola (?) turpicula	3543	5-6	latest Baj.-early Bath. to mid Bath.
Tympaneides	Tympaneides	0007	1-3	early-mid Aal. to early-mid Baj.
typicus	Unuma typicus	4059	3-4	early-mid Baj. to late Baj. .
tytthopora	Dibolachras tytthopora	5422	17-22	late Val. to late Barr.-early Apt.
ultima	Emiluvia orea ultima	4070	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
umbilicata	Acaeniotyle umbilicata	3092	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
umbriensis	Obesacapsula rusconensis umbriensis	5796	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
Unuma	Unuma	3669	1-6	early-mid Aal. to mid Bath.
Unuma sp. A	Unuma sp. A	3309	4-6	late Baj. to mid Bath.
unumaense	Eucyrtidiellum unumaense dentatum	3015	6-7	mid Bath. to late Bath.-early Call.
unumaense	Eucyrtidiellum unumaense pustulatum	3013	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
unumaense	Eucyrtidiellum unumaense unumaense	3012	3-8	early-mid Baj. to mid Call.-early Oxf.
unumaense	Eucyrtidiellum unumaense s.l.	3052	3-8	early-mid Baj. to mid Call.-early Oxf.
usotanensis	Parvicingula usotanensis	5712	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
uterculus	Sethocapsa uterculus	5462	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
valdorbiense	Bistarkum valdorbiense	3919	13-17	latest Tith.-earliest Berr. to late Val.
variabilis	Acanthocircus variabilis	5011	17-20	late Val. to late Haut.
variatus	Acaeniotylopsis variatus triacanthus	4066	1-7	early-mid Aal. to late Bath.-early Call.
variatus	Acaeniotylopsis variatus variatus	3270	3-8	early-mid Baj. to mid Call.-early Oxf.
variatus	Acaeniotylopsis variatus s.l.	4063	1-8	early-mid Aal. to mid Call.-early Oxf.
ventricosum	Zhamoidellum ventricosum	3308	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
verbana	Obesacapsula verbana	3202	11-20	late Kimm.-early Tith. to late Haut.
vicetina	Syringocapsa vicetina	5409	13-17	latest Tith.-earliest Berr. to late Val.
Williriedellum	Williriedellum	3674	4-11	late Baj. to late Kimm.-early Tith.
Williriedellum sp. A	Williriedellum sp. A	4060	4-8	late Baj. to mid Call.-early Oxf.
wintereri	Higumastra wintereri	3148	1-8	early-mid Aal. to mid Call.-early Oxf.
worzeli	Tritrabs ewingi worzeli	3115	7-12	late Bath.-early Call. to early-early late Tith.

Name	Genus, species, subspecies	MRD	UAZ	Range
Wrangellium	Wrangellium	3804	7-22	late Bath.-early Call. to late Barr.-early Apt.
Xiphostylus	Xiphostylus	3700	1-6	early-mid Aal. to mid Bath.
Xiphostylus spp.	Xiphostylus spp.	3414	1-6	early-mid Aal. to mid Bath.
Xitus	Xitus	3676	7-22	late Bath.-early Call. to late Barr.-early Apt.
Xitus (?) sp. D	Xitus (?) sp. D	3261	7-9	late Bath.-early Call. to mid-late Oxf.
Yamatoum	Yamatoum	6024	1-4	early-mid Aal. to late Baj.
Zartus	Zartus	3686	1-4	early-mid Aal. to late Baj.
zealis	Tetratrabs zealis	3121	4-13	late Baj. to latest Tith.-earliest Berr. .
Zhamoidellum	Zhamoidellum	3695	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
zweilii	Sethocapsa (?) zweilii	5464	14-19	early-early late Berr. to early Haut.

36. Numerical Listing according to MRD-numbers of Genera, Species and Subspecies and UAZone Ranges

EXPLANATORY NOTES

In the listing the age range is stated as follows: The hyphen "-" marks the age range of each UAZone, the "**to**" links the age ranges of the early and the late UAZone. By definition, the total possible age range of a taxon goes from the beginning of the earliest to the end of the latest UAZone. The actual range of a taxon, however, can be anywhere from within the range of the earliest to within the range of the latest UAZone.

Example: A range of UAZones 7-9 means that the species makes its first appearance in UAZone 7 and its last in UAZone 9. The age range of UAZ. 7 is late Bathonian-early Callovian. The age range of UAZ. 9 is middle-late Oxfordian. The maximal age range of the taxon is late Bathonian-early Callovian to middle-late Oxfordian.The actual range of the taxon could be for instance early Callovian to middle Oxfordian, etc.

The abbreviations used are as follows: **Aal.** = Aalenian, **Baj.** = Bajocian, **Bath.** = Bathonian, **Call.** = Callovian, **Oxf.** = Oxfordian. **Kimm.** = Kimmeridgian, **Tith.** = Tithonian, **Berr.** = Berriasian, **Val.** = Valanginian, **Haut.** = Hauterivaian, **Barr.** = Barremian, **Apt.** = Aptian and **mid.** = middle

MRD	**Genus, species, subspecies**	**UAZ**	**Range**
0007	Tympaneides	1-3	early-mid Aal. to early-mid Baj.
2001	Acaeniotylopsis ghostensis	1-4	early-mid Aal. to late Baj.
2002	Emiluvia splendida	1-3	early-mid Aal. to early-mid Baj.
2003	Homoeoparonaella sp. aff. H. argolidensis	1-2	early-mid Aal. to late Aal.
2004	Homoeoparonaella sp. aff. H. elegans	1-3	early-mid Aal. to early-mid Baj.
2005	Paronaella skowkonaensis	1-2	early-mid Aal. to late Aal.
2006	Hsuum sp. cf. H. mirabundum	3-6	early-mid Baj. to mid Bath.
2007	Pseudopoulpus acutipodium	1-2	early-mid Aal. to late Aal.
2008	Actinomma siciliensis	1-4	early-mid Aal. to late Baj.
2009	Hexastylus sp. A	1-4	early-mid Aal. to late Baj.
2010	Parashuum cruciferum	1-1	early-mid Aal.
2011	Parashuum officerense	1-7	early-mid Aal. to late Bath.-early Call.
2012	Parashuum izeense	1-3	early-mid Aal. to early-mid Baj.
2013	Parasaturnalis diplocyclis	1-3	early-mid Aal. to early-mid Baj.
2014	Ristola praemirifusus	1-2	early-mid Aal. to late Aal.
2015	Parashuum sp. M	1-1	early-mid Aal.
2016	Yamatoum caudatum	2-2	late Aal. to late Aal.
2017	Bernoullius rectispinus ssp. B	2-7	late Aal. to late Bath.-early Call.

MRD	Genus, species, subspecies	UAZ	Range
2018	Hsuum sp. 1	1-2	early-mid Aal. to late Aal.
2019	Orbiculiforma (?) sp. X	1-6	early-mid Aal. to mid Bath.
2020	Yamatoum komamiensis	2-2	late Aal. to late Aal.
2021	Acanthocircus protoformis	3-8	early-mid Baj. to mid Call.-early Oxf.
2022	Linaresia rifensis	2-3	late Aal. to early-mid Baj. .
2023	Parashuum stanleyensis	3-8	early-mid Baj. to mid Call.-early Oxf.
2024	Turanta flexa	6-8	mid Bath. to mid Call.-early Oxf.
2025	Amphipyndax tsunoensis	6-7	mid Bath. to late Bath.-early Call.
2026	Mirifusus fragilis praeguadalupensis	3-3	early-mid Baj. to early-mid Baj. .
3001	Ares cylindricus cylindricus	1-4	early-mid Aal. to late Baj.
3002	Hilarisirex quadrangularis	3-7	early-mid Baj. to late Bath.-early Call.
3003	Thetis (?) bernoullii	7-7	late Bath.-early Call. to late Bath.-early Call.
3004	Palinandromeda murcheyae	3-6	early-mid Baj. to mid Bath.
3005	Palinandromeda depressa	3-7	early-mid Baj. to late Bath.-early Call.
3006	Palinandromeda praepodbielensis	1-7	early-mid Aal. to late Bath.-early Call.
3007	Palinandromeda praecrassa	3-9	early-mid Baj. to mid-late Oxf.
3008	Palinandromeda podbielensis	5-9	latest Baj.-early Bath. to mid-late Oxf.
3009	Palinandromeda crassa	7-10	late Bath.-early Call. to late Oxf.-early Kimm.
3010	Palinandromeda sognoensis	1-3	early-mid Aal. to early-mid Baj.
3011	Parahsuum (?) hiconocosta	2-4	late Aal. to late Baj. .
3012	Eucyrtidiellum unumaense unumaense	3-8	early-mid Baj. to mid Call.-early Oxf.
3013	Eucyrtidiellum unumaense pustulatum	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3014	Eucyrtidiellum nodosum	3-10	early-mid Baj. to late Oxf.-early Kimm.
3015	Eucyrtidiellum unumaense dentatum	6-7	mid Bath. to late Bath.-early Call.
3016	Eucyrtidiellum semifactum	5-7	latest Baj.-early Bath. to late Bath.-early Call.
3017	Eucyrtidiellum ptyctum	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
3019	Eucyrtidiellum pyramis	12-13	early-early late Tith. to latest Tith.-earliest Berr.
3020	Saitoum pagei	4-11	late Baj. to late Kimm.-early Tith.
3021	Saitoum trichylum	7-9	late Bath.-early Call. to mid-late Oxf.
3022	Saitoum elegans	8-21	mid Call.-early Oxf. to early Barr.
3023	Saitoum corniculum	7-7	late Bath.-early Call. to late Bath.-early Call.
3024	Saitoum levium	4-9	late Baj. to mid-late Oxf.
3026	Saitoum sp. aff. S. levium	3-4	early-mid Baj. to late Baj. .
3027	Saitoum sp. aff. S. pagei	3-3	early-mid Baj. to early-mid Baj. .
3028	Poulpus sp. aff. P. oculatus	3-7	early-mid Baj. to late Bath.-early Call.
3030	Napora sp. A	3-3	early-mid Baj. to early-mid Baj. .
3031	Napora latissima	4-7	late Baj. to late Bath.-early Call.
3032	Napora saginata	3-7	early-mid Baj. to late Bath.-early Call.
3033	Napora pyramidalis	2-11	late Aal. to late Kimm.-early Tith.
3034	Napora sp. B	7-13	late Bath.-early Call. to latest.
3035	Napora deweveri	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3036	Napora lospensis	8-13	mid Call.-early Oxf. to latest Tith.-earliest Berr. .
3037	Napora boneti	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
3039	Trillus spp.	1-5	early-mid Aal. to latest Baj.-early Bath.
3040	Zartus imlayi gr.	1-4	early-mid Aal. to late Baj.
3041	Zartus dickinsoni gr.	3-4	early-mid Baj. to late Baj. .
3042	Pantanellium sp. L	2-4	late Aal. to late Baj. .
3043	Theocapsomma sp A.	7-7	late Bath.-early Call. to late Bath.-early Call.
3044	Stylocapsa catenarum	6-7	mid Bath. to late Bath.-early Call.
3045	Stichocapsa naradaniensis	6-7	mid Bath. to late Bath.-early Call.
3046	Stylocapsa (?) spiralis gr.	6-7	mid Bath. to late Bath.-early Call.
3047	Theocapsomma cucurbiformis	6-7	mid Bath. to late Bath.-early Call.
3048	Eucyrtidiellum (?) quinatum	1-4	early-mid Aal. to late Baj.
3049	Stichocapsa japonica	3-8	early-mid Baj. to mid Call.-early Oxf.
3050	Cyrtocapsa (?) kisoensis	3-4	early-mid Baj. to late Baj. .
3051	Tricolocapsa plicarum s.l.	3-8	early-mid Baj. to mid Call.-early Oxf.
3052	Eucyrtidiellum unumaense s.l.	3-8	early-mid Baj. to mid Call.-early Oxf.
3054	Diacanthocapsa (?) operculi	3-7	early-mid Baj. to late Bath.-early Call.
3055	Stichocapsa convexa	1-11	early-mid Aal. to late Kimm.-early Tith.
3059	Stylocapsa oblongula	6-8	mid Bath. to mid Call.-early Oxf.
3061	Guexella nudata	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3062	Sethocapsa leiostraca	4-20	late Baj. to late Haut.
3063	Sethocapsa trachyostraca	7-22	late Bath.-early Call. to late Barr.-early Apt.
3064	Acanthocircus suboblongus s.l.	3-11	early-mid Baj. to late Kimm.-early Tith.
3065	Acanthocircus trizonalis s.l.	6-22	mid Bath. to late Barr.-early Apt.

MRD	Genus, species, subspecies	UAZ	Range
3066	Emiluvia pessagnoi s.l.	4-17	late Baj. to late Val.
3069	Williriedellum crystallinum	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3070	Sethocapsa funatoensis	3-11	early-mid Baj. to late Kimm.-early.
3071	Parahsuum (?) olorizi	2-4	late Aal. to late Baj. .
3072	Parahsuum (?) magnum	2-5	late Aal. to latest Baj.-early Bath.
3073	Parahsuum (?) natorense	1-3	early-mid Aal. to early-mid Baj.
3074	Linaresia chrafatensis	2-7	late Aal. to late Bath.-early Call.
3076	Gorgansium spp.	3-8	early-mid Baj. to mid Call.-early Oxf.
3078	Pantanellium riedeli	7-12	late Bath.-early Call. to early-early late Tith.
3081	Quinquecapsularia megasphaerica	3-11	early-mid Baj. to late Kimm.-early Tith.
3082	Acanthocircus trizonalis angustus	6-10	mid Bath. to late Oxf.-early Kimm.
3083	Acanthocircus trizonalis trizonalis	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3085	Acanthocircus suboblongus minor	3-11	early-mid Baj. to late Kimm.-early Tith.
3087	Acanthocircus trizonalis dicranacanthos	10-17	late Oxf.-early Kimm. to late Val.
3088	Acanthocircus suboblongus suboblongus	3-11	early-mid Baj. to late Kimm.-early Tith.
3089	Hexasaturnalis tetraspinus	1-6	early-mid Aal. to mid Bath.
3090	Acaeniotyle diaphorogona gr.	4-22	late Baj. to late Barr.-early Apt.
3091	Acaeniotyle (?) sp. A	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3092	Acaeniotyle umbilicata	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
3094	Suna echiodes	9-22	mid-late Oxf. to late Barr.-early Apt.
3095	Triactoma blakei	4-11	late Baj. to late Kimm.-early Tith.
3096	Triactoma jonesi	2-13	late Aal. to latest Tith.-earliest Berr. .
3097	Triactoma Tith.um	6-22	mid Bath. to late Barr.-early Apt.
3100	Perispyridium ordinarium gr.	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
3103	Homoeoparonaella argolidensis	4-11	late Baj. to late Kimm.-early Tith.
3104	Homoeoparonaella elegans	4-10	late Baj. to late Oxf.-early Kimm.
3105	Homoeoparonaella (?) gigantea	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.
3106	Higumastra inflata	7-10	late Bath.-early Call. to late Oxf.-early Kimm.
3108	Higumastra coronaria	8-9	mid Call.-early Oxf. to mid-late Oxf.
3109	Higumastra gratiosa	3-8	early-mid Baj. to mid Call.-early Oxf.
3110	Higumastra imbricata	4-8	late Baj. to mid Call.-early Oxf.
3111	Deviatus diamphidius hipposidericus	9-13	mid-late Oxf. to latest Tith.-earliest Berr.
3112	Deviatus diamphidius diamphidius	8-14	mid Call.-early Oxf. to early-early late Berr.
3113	Tritrabs ewingi s.l.	4-22	late Baj. to late Barr.-early Apt.
3115	Tritrabs ewingi worzeli	7-12	late Bath.-early Call. to early-early late Tith.
3116	Tritrabs hayi	3-10	early-mid Baj. to late Oxf.-early Kimm.
3117	Tritrabs casmaliaensis	4-10	late Baj. to late Oxf.-early Kimm.
3118	Tritrabs rhododactylus	3-13	early-mid Baj. to latest Tith.-earliest Berr.
3119	Tritrabs exotica	4-11	late Baj. to late Kimm.-early Tith.
3121	Tetratrabs zealis	4-13	late Baj. to latest Tith.-earliest Berr. .
3122	Tetratrabs bulbosa	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3123	Tetraditryma pseudoplena	4-11	late Baj. to late Kimm.-early Tith.
3124	Tetraditryma corralitosensis corralitosensis	3-10	early-mid Baj. to late Oxf.-early Kimm.
3125	Tetraditryma praeplena	1-7	early-mid Aal. to late Bath.-early Call.
3126	Pseudocrucella sanfilippoae	7-10	late Bath.-early Call. to late Oxf.-early Kimm.
3127	Pseudocrucella sp. B	8-9	mid Call.-early Oxf. to mid-late Oxf.
3129	Pseudocrucella adriani	4-10	late Baj. to late Oxf.-early Kimm.
3131	Crucella theokaftensis	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3133	Paronaella pygmaea	7-9	late Bath.-early Call. to mid-late Oxf.
3135	Paronaella bandyi	3-10	early-mid Baj. to late Oxf.-early Kimm.
3137	Paronaella broennimanni	4-10	late Baj. to late Oxf.-early Kimm.
3138	Paronaella pristidentata	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
3139	Paronaella mulleri	6-10	mid Bath. to late Oxf.-early Kimm.
3140	Paronaella kotura	3-10	early-mid Baj. to late Oxf.-early Kimm.
3144	Angulobracchia purisimaensis	3-10	early-mid Baj. to late Oxf.-early Kimm.
3145	Angulobracchia biordinalis	9-11	mid-late Oxf. to late Kimm.-early Tith.
3147	Angulobracchia digitata	3-10	early-mid Baj. to late Oxf.-early Kimm.
3148	Higumastra wintereri	1-8	early-mid Aal. to mid Call.-early Oxf.
3149	Archaeohagiastrum longipes	1-7	early-mid Aal. to late Bath.-early Call.
3150	Homoeoparonaella (?) pseudoewingi	3-7	early-mid Baj. to late Bath.-early Call.
3151	Laxtorum (?) jurassicum	2-3	late Aal. to early-mid Baj. .
3152	Monotrabs plenoides gr.	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3158	Mirifusus proavus	2-4	late Aal. to late Baj. .
3159	Mirifusus fragilis s.l.	3-8	early-mid Baj. to mid Call.-early Oxf.
3160	Mirifusus guadalupensis	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.

MRD	Genus, species, subspecies	UAZ	Range
3161	Mirifusus dianae s.l.	7-20	late Bath.-early Call. to late Haut.
3162	Mirifusus chenodes	6-22	mid Bath. to late Barr.-early Apt.
3163	Ristola procera	5-9	latest Baj.-early Bath. to mid-late Oxf.
3164	Ristola altissima s.l.	5-12	latest Baj.-early Bath. to early-early late Tith. .
3165	Ristola cretacea	12-17	early-early late Tith. to late Val.
3166	Triactoma cornuta	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.
3167	Sethocapsa sp. A	3-13	early-mid Baj. to latest Tith.-earliest Berr.
3168	Sethocapsa (?) sphaerica	9-11	mid-late Oxf. to late Kimm.-early Tith.
3169	Podobursa helvetica	3-10	early-mid Baj. to late Oxf.-early Kimm.
3170	Syringocapsa spinellifera	9-12	mid-late Oxf. to early-early late Tith.
3171	Podocapsa amphitreptera	9-18	mid-late Oxf. to latest Val.-earliest Haut.
3174	Podobursa polyacantha	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3176	Pseudoeucyrtis sp. J	5-10	latest Baj.-early Bath. to late Oxf.-early Kimm.
3177	Pseudoeucyrtis reticularis	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3179	Wrangellium okamurai	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3180	Transhsuum maxwelli gr.	3-10	early-mid Baj. to late Oxf.-early Kimm.
3181	Transhsuum brevicostatum gr.	3-11	early-mid Baj. to late Kimm.-early Tith.
3182	Hsuum sp. aff. H. cuestaense	10-13	late Oxf.-early Kimm. to latest Tith.-earliest Berr.
3184	Parvicingula schoolhousensis gr.	3-3	early-mid Baj. to early-mid Baj. .
3185	Parvicingula boesii gr.	9-22	mid-late Oxf. to late Barr.-early Apt.
3187	Parvicingula (?) spinata	3-10	early-mid Baj. to late Oxf.-early Kimm.
3188	Parvicingula sp. aff. P. elegans	11-11	late Kimm.-early Tith. to late Kimm.-early Tith.
3189	Pseudodictyomitra primitiva	7-12	late Bath.-early Call. to early-early late Tith.
3192	Stichomitra (?) sp. A	3-7	early-mid Baj. to late Bath.-early Call.
3193	Cinguloturris carpatica	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3194	Transhsuum hisuikyoense	2-7	late Aal. to late Bath.-early Call.
3195	Hsuum matsuokai	1-5	early-mid Aal. to latest Baj.-early Bath.
3197	Parvicingula dhimenaensis s.l.	3-11	early-mid Baj. to late Kimm.-early Tith.
3199	Spongocapsula palmerae	6-13	mid Bath. to latest Tith.-earliest Berr. .
3202	Obesacapsula verbana	11-20	late Kimm.-early Tith. to late Haut.
3203	Obesacapsula cetia	10-17	late Oxf.-early Kimm. to late Val.
3204	Orbiculiforma (?) heliotropica	3-9	early-mid Baj. to mid-late Oxf.
3205	Orbiculiforma (?) catenaria	7-9	late Bath.-early Call. to mid-late Oxf.
3206	Orbiculiforma(?) sp. aff. O. mclaughlini	8-9	mid Call.-early Oxf. to mid-late Oxf.
3210	Emiluvia premyogii	3-10	early-mid Baj. to late Oxf.-early Kimm.
3212	Emiluvia nana	6-9	mid Bath. to mid-late Oxf.
3213	Emiluvia chica s.l.	3-18	early-mid Baj. to latest Val.-earliest Haut.
3215	Emiluvia salensis	4-13	late Baj. to latest Tith.-earliest Berr. .
3216	Emiluvia sedecimporata	3-11	early-mid Baj. to late Kimm.-early Tith.
3217	Haliodictya (?) antiqua ssp. B.	6-11	mid Bath. to late Kimm.-early Tith.
3218	Haliodictya (?) antiqua antiqua	4-11	late Baj. to late Kimm.-early Tith.
3220	Staurolonche robusta	4-10	late Baj. to late Oxf.-early Kimm.
3221	Bernoullius cristatus	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3222	Bernoullius rectispinus delnortensis	2-7	late Aal. to late Bath.-early Call.
3223	Bernoullius dicera	3-10	early-mid Baj. to late Oxf.-early Kimm.
3224	Emiluvia orea orea	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3225	Emiluvia hopsoni	6-15	mid Bath. to late Berr.-earliest Val. .
3226	Emiluvia pessagnoi multipora	8-14	mid Call.-early Oxf. to early-early late Berr.
3227	Ditrabs sansalvadorensis	11-21	late Kimm.-early Tith. to early Barr.
3228	Alievium helenae	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
3230	Podobursa spinosa	8-13	mid Call.-early Oxf. to latest Tith.-earliest Berr. .
3231	Unuma echinatus	1-6	early-mid Aal. to mid Bath.
3235	Archaeodictyomitra (?) sp. A	6-7	mid Bath. to late Bath.-early Call.
3236	Archaeodictyomitra (?) mirabilis	7-7	late Bath.-early Call. to late Bath.-early Call.
3237	Archaeodictyomitra (?) amabilis	4-7	late Baj. to late Bath.-early Call.
3238	Ristola altissima major	5-7	latest Baj.-early Bath. to late Bath.-early Call.
3239	Parvicingula (?) sp. A	7-7	late Bath.-early Call. to late Bath.-early Call.
3240	Parahsuum sp. S	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3241	Ristola altissima altissima	7-12	late Bath.-early Call. to early-early late Tith.
3243	Haliodictya (?) antiqua s.l.	4-11	late Baj. to late Kimm.-early Tith.
3244	Leugeo hexacubicus	4-8	late Baj. to mid Call.-early Oxf.
3245	Parvicingula mashitaensis	8-15	mid Call.-early Oxf. to late Berr.-earliest Val.
3247	Turanta morinae gr.	1-5	early-mid Aal. to latest Baj.-early Bath.
3253	Emiluvia lombardensis	1-4	early-mid Aal. to late Baj.
3254	Haliodictya (?) hojnosi	3-10	early-mid Baj. to late Oxf.-early Kimm.

MRD	Genus, species, subspecies	UAZ	Range
3255	Parvicingula cosmoconica	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3258	Xitus sp. aff. X. pulcher	9-11	mid-late Oxf. to late Kimm.-early Tith.
3259	Xitus magnus	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3261	Xitus (?) sp. D	7-9	late Bath.-early Call. to mid-late Oxf.
3263	Archaeodictyomitra apiarium	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
3264	Sethocapsa kitoi	13-16	latest Tith.-earliest Berr. to early Val.
3265	Dibolachras chandrika	7-11	late Bath.-early Call. to late Kimm.-early Tith.
3266	Obesacapsula morroensis	5-21	latest Baj.-early Bath. to early Barr.
3267	Spongocapsula perampla	6-11	mid Bath. to late Kimm.-early Tith.
3268	Syringocapsa (?) sp. A	7-7	late Bath.-early Call. to late Bath.-early Call.
3269	Stichocapsa decora	4-7	late Baj. to late Bath.-early Call.
3270	Acaeniotylopsis variatus variatus	3-8	early-mid Baj. to mid Call.-early Oxf.
3271	Archaeohagiastrum munitum	2-8	late Aal. to mid Call.-early Oxf.
3273	Tetraditryma corralitosensis s.l.	3-10	early-mid Baj. to late Oxf.-early Kimm.
3274	Mirifisus dianae dianae	7-12	late Bath.-early Call. to early-early late Tith.
3276	Theocapsomma bicornis	6-7	mid Bath. to late Bath.-early Call.
3277	Theocapsomma cordis	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3278	Transhsuum medium	1-7	early-mid Aal. to late Bath.-early Call.
3279	Gongylothorax sp. aff. G. favosus	7-8	late Bath.-early Call. to mid Call.-early Oxf.
3280	Pantanellium Berr.um	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
3281	Acaeniotyle dentata	12-20	early-early late Tith. to late Haut.
3282	Obesacapsula rusconensis rusconensis	13-19	latest Tith.-earliest Berr. to early Haut.
3283	Obesacapsula lucifer	13-16	latest Tith.-earliest Berr. to early Val.
3284	Wrangellium depressum	13-18	latest Tith.-earliest Berr. to latest Val.-earliest Haut.
3285	Angulobracchia (?) portmanni portmanni	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3286	Mirifusus dianae minor	9-20	mid-late Oxf. to late Haut.
3287	Archaeodictyomitra excellens	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
3288	Parvivacca magna	14-20	early-early late Berr. to late Haut.
3289	Podobursa (?) sp. aff. P. quadriaculeata	9-17	mid-late Oxf. to late Val.
3290	Protunuma (?) ochiensis	5-14	latest Baj.-early Bath. to early-early late Berr. .
3291	Syringocapsa agolarium	13-20	latest Tith.-earliest Berr. to late Haut.
3292	Protunuma japonicus	7-12	late Bath.-early Call. to early-early late Tith.
3293	Pseudodictyomitra carpatica	11-21	late Kimm.-early Tith. to early Barr.
3294	Xitus gifuensis	11-18	late Kimm.-early Tith. to latest Val.-earliest Haut.
3295	Xitus sp. aff. X. spicularius	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
3297	Tricolocapsa conexa	4-7	late Baj. to late Bath.-early Call.
3298	Stichocapsa robusta	5-7	latest Baj.-early Bath. to late Bath.-early Call.
3301	Angulobracchia sicula	1-6	early-mid Aal. to mid Bath.
3302	Tetratrabs izeensis	1-5	early-mid Aal. to latest Baj.-early Bath.
3303	Tritrabs simplex	1-6	early-mid Aal. to mid Bath.
3305	Archaeodictyomitra minoensis	9-12	mid-late Oxf. to early-early late Tith.
3307	Cyrtocapsa mastoidea	3-4	early-mid Baj. to late Baj. .
3308	Zhamoidellum ventricosum	8-11	mid Call.-early Oxf. to late Kimm.-early Tith.
3309	Unuma sp. A	4-6	late Baj. to mid Bath.
3310	Paronaella sp. aff. P. corpulenta	1-2	early-mid Aal. to late Aal.
3406	Mirifusus dianae baileyi	9-11	mid-late Oxf. to late Kimm.-early Tith.
3407	Tetraditryma sp. cf. T. praeplena	1-2	early-mid Aal. to late Aal.
3408	Tympaneides charlottensis	1-3	early-mid Aal. to early-mid Baj.
3409	Triactoma jacobsae	1-4	early-mid Aal. to late Baj.
3410	Napora nipponica	1-4	early-mid Aal. to late Baj.
3411	Elodium cameroni	1-2	early-mid Aal. to late Aal.
3412	Triactoma mexicana	5-9	latest Baj.-early Bath. to mid-late Oxf.
3413	Triactoma parablakei	4-7	late Baj. to late Bath.-early Call.
3414	Xiphostylus spp.	1-6	early-mid Aal. to mid Bath.
3415	Palinandromeda sp. aff. P. depressa	3-4	early-mid Baj. to late Baj. .
3502	Hexasaturnalis hexagonus	1-4	early-mid Aal. to late Baj.
3543	Ristola (?) turpicula	5-6	latest Baj.-early Bath. to mid Bath.
3591	Hsuum raricostatum	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
3600	Acaeniotyle	4-22	late Baj. to late Barr.-early Apt.
3601	Acanthocircus	3-22	early-mid Baj. to late Barr.-early Apt.
3603	Alievium	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
3605	Amphipyndax	3-7	early-mid Baj. to late Bath.-early Call.
3606	Palinandromeda	1-10	early-mid Aal. to late Oxf.-early Kimm.
3607	Angulobracchia	1-22	early-mid Aal. to late Barr.-early Apt.
3608	Archaeodictyomitra	4-22	late Baj. to late Barr.-early Apt.

MRD	Genus, species, subspecies	UAZ	Range
3609	Archaeohagiastrum	1-8	early-mid Aal. to mid Call.-early Oxf.
3610	Archaeospongoprunum	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3611	Archaeotritrabs	16-21	early Val. to early Barr.
3612	Archicapsa	3-4	early-mid Baj. to late Baj. .
3613	Ares	1-6	early-mid Aal. to mid Bath.
3614	Bernoullius	1-22	early-mid Aal. to late Barr.-early Apt.
3615	Canoptum	13-16	latest Tith.-earliest Berr. to early Val.
3617	Cinguloturris	7-17	late Bath.-early Call. to late Val.
3619	Crucella	7-22	late Bath.-early Call. to late Barr.-early Apt.
3622	Cyrtocapsa	3-15	early-mid Baj. to late Berr.-earliest Val.
3623	Diacanthocapsa	3-7	early-mid Baj. to late Bath.-early Call.
3624	Dibolachras	7-22	late Bath.-early Call. to late Barr.-early Apt.
3625	Dicolocapsa	6-6	mid Bath. to mid Bath.
3628	Dictyomitrella	3-7	early-mid Baj. to late Bath.-early Call.
3629	Ditrabs	11-21	late Kimm.-early Tith. to early Barr.
3630	Syringocapsa	7-22	late Bath.-early Call. to late Barr.-early Apt.
3631	Emiluvia	1-18	early-mid Aal. to latest Val.-earliest Haut.
3632	Eucyrtidiellum	1-13	early-mid Aal. to latest Tith.-earliest Berr.
3633	Eucyrtis	16-22	early Val. to late Barr.-early Apt.
3634	Deviatus	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
3635	Gongylothorax	4-10	late Baj. to late Oxf.-early Kimm.
3636	Gorgansium	3-8	early-mid Baj. to mid Call.-early Oxf.
3637	Guexella	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3638	Tetraditryma	1-11	early-mid Aal. to late Kimm.-early Tith.
3639	Halesium	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3640	Haliodictya	3-11	early-mid Baj. to late Kimm.-early Tith.
3641	Hemicryptocapsa	17-18	late Val. to latest Val.-earliest Haut.
3642	Tetratrabs	1-17	early-mid Aal. to late Val.
3643	Hexastylus	1-4	early-mid Aal. to late Baj.
3644	Higumastra	1-10	early-mid Aal. to late Oxf.-early Kimm.
3645	Hilarisirex	3-7	early-mid Baj. to late Bath.-early Call.
3647	Theocapsomma	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3648	Homoeoparonaella	1-22	early-mid Aal. to late Barr.-early Apt.
3649	Hsuum	1-15	early-mid Aal. to late Berr.-earliest Val.
3650	Thetis	7-7	late Bath.-early Call. to late Bath.-early Call.
3651	Jacus	15-20	late Berr.-earliest Val. to late Haut.
3652	Katroma	13-19	latest Tith.-earliest Berr. to early Haut.
3654	Laxtorum	1-4	early-mid Aal. to late Baj.
3655	Triactoma	1-22	early-mid Aal. to late Barr.-early Apt.
3656	Hexasaturnalis	1-6	early-mid Aal. to mid Bath.
3657	Tricolocapsa	3-8	early-mid Baj. to mid Call.-early Oxf.
3658	Mirifisus	2-21	late Aal. to early Barr.
3659	Trillus	1-5	early-mid Aal. to latest Baj.-early Bath.
3660	Monotrabs	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3661	Napora	1-13	early-mid Aal. to latest Tith.-earliest Berr.
3662	Tritrabs	1-22	early-mid Aal. to late Barr.-early Apt.
3663	Turanta	1-8	early-mid Aal. to mid Call.-early Oxf.
3664	Obesacapsula	5-21	latest Baj.-early Bath. to early Barr.
3665	Orbiculiforma	1-9	early-mid Aal. to mid-late Oxf.
3667	Pantanellium	2-22	late Aal. to late Barr.-early Apt.
3668	Parahsuum	1-11	early-mid Aal. to late Kimm.-early Tith.
3669	Unuma	1-6	early-mid Aal. to mid Bath.
3671	Paronaella	1-22	early-mid Aal. to late Barr.-early Apt.
3672	Parvicingula	3-22	early-mid Baj. to late Barr.-early Apt.
3673	Parvivacca	14-20	early-early late Berr. to late Haut.
3674	Williriedellum	4-11	late Baj. to late Kimm.-early Tith.
3675	Perispyridium	5-11	latest Baj.-early Bath. to late Kimm.-early Tith.
3676	Xitus	7-22	late Bath.-early Call. to late Barr.-early Apt.
3677	Podobursa	3-20	early-mid Baj. to late Haut.
3678	Podocapsa	7-20	late Bath.-early Call. to late Haut.
3680	Poulpus	3-7	early-mid Baj. to late Bath.-early Call.
3682	Protunuma	4-14	late Baj. to early-early late Berr. .
3683	Pseudocrucella	4-22	late Baj. to late Barr.-early Apt.
3684	Pseudodictyomitra	7-22	late Bath.-early Call. to late Barr.-early Apt.
3685	Pseudoeucyrtis	5-21	latest Baj.-early Bath. to early Barr.

MRD	Genus, species, subspecies	UAZ	Range
3686	Zartus	1-4	early-mid Aal. to late Baj.
3687	Ristola	1-20	early-mid Aal. to late Haut.
3688	Saitoum	3-21	early-mid Baj. to early Barr.
3689	Sethocapsa	3-22	early-mid Baj. to late Barr.-early Apt.
3690	Solenotryma	7-21	late Bath.-early Call. to early Barr.
3691	Spongocapsula	6-22	mid Bath. to late Barr.-early Apt.
3692	Spongotripus	19-22	early Haut. to late Barr.-early Apt.
3693	Staurolonche	4-10	late Baj. to late Oxf.-early Kimm.
3695	Zhamoidellum	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
3696	Stichocapsa	1-22	early-mid Aal. to late Barr.-early Apt.
3697	Stichomitra	3-22	early-mid Baj. to late Barr.-early Apt.
3698	Stylocapsa	5-8	latest Baj.-early Bath. to mid Call.-early Oxf.
3699	Stylosphaera	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3700	Xiphostylus	1-6	early-mid Aal. to mid Bath.
3701	Acaeniotylopsis	1-8	early-mid Aal. to mid Call.-early Oxf.
3717	Parvicingula sphaerica	13-16	latest Tith.-earliest Berr. to early Val.
3800	Bistarkum	13-21	latest Tith.-earliest Berr. to early Barr.
3801	Artocapsa	13-14	latest Tith.-earliest Berr. to early-early late Berr.
3802	Stylospongia	20-22	late Haut. to late Barr.-early Apt.
3803	Godia	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
3804	Wrangellium	7-22	late Bath.-early Call. to late Barr.-early Apt.
3805	Milax	13-20	latest Tith.-earliest Berr. to late Haut.
3806	Pseudocrolanium	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
3807	Leugeo	4-8	late Baj. to mid Call.-early Oxf.
3808	Quarticella	4-4	late Baj. to late Baj. .
3809	Transhsuum	1-11	early-mid Aal. to late Kimm.-early Tith.
3810	Suna	9-22	mid-late Oxf. to late Barr.-early Apt.
3811	Linaresia	2-7	late Aal. to late Bath.-early Call.
3813	Linaresia beniderkoulensis	3-7	early-mid Baj. to late Bath.-early Call.
3814	Quinquecapsularia	3-11	early-mid Baj. to late Kimm.-early Tith.
3820	Actinomma	1-4	early-mid Aal. to late Baj.
3821	Parasaturnalis	1-3	early-mid Aal. to early-mid Baj.
3822	Pseudopoulpus	1-2	early-mid Aal. to late Aal.
3823	Elodium	1-2	early-mid Aal. to late Aal.
3911	Angulobracchia (?) rugosa	12-16	early-early late Tith. to early Val.
3912	Ditrabs (?) osteosa	13-16	latest Tith.-earliest Berr. to early Val.
3918	Bistarkum brevilatum	13-14	latest Tith.-earliest Berr. to early-early late Berr.
3919	Bistarkum valdorbiense	13-17	latest Tith.-earliest Berr. to late Val.
3924	Artocapsa (?) amphorella	13-14	latest Tith.-earliest Berr. to early-early late Berr.
3947	Pseudocrucella (?) elisabethae	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
3955	Obesacapsula breggiensis	13-16	latest Tith.-earliest Berr. to early Val.
4004	Alievium sp. A	8-9	mid Call.-early Oxf. to mid-late Oxf.
4005	Amphipyndax durisaeptum	3-7	early-mid Baj. to late Bath.-early Call.
4006	Angulobracchia sp. B	7-9	late Bath.-early Call. to mid-late Oxf.
4007	Archicapsa (?) pachyderma	3-4	early-mid Baj. to late Baj. .
4008	Ares sp.A	1-3	early-mid Aal. to early-mid Baj.
4009	Bernoullius furcospinus	1-4	early-mid Aal. to late Baj.
4010	Bernoullius rectispinus s.l.	1-9	early-mid Aal. to mid-late Oxf.
4011	Bernoullius rectispinus rectispinus	1-4	early-mid Aal. to late Baj.
4012	Diacanthocapsa normalis	3-4	early-mid Baj. to late Baj. .
4013	Dicolocapsa (?) conoformis	6-6	mid Bath. to mid Bath.
4014	Dictyomitrella (?) kamoensis	3-7	early-mid Baj. to late Bath.-early Call.
4015	Emiluvia ordinaria	9-11	mid-late Oxf. to late Kimm.-early Tith.
4017	Emiluvia pessagnoi pessagnoi	9-13	mid-late Oxf. to latest Tith.-earliest Berr.
4018	Emiluvia bisellea	11-11	late Kimm.-early Tith. to late Kimm.-early Tith.
4022	Gongylothorax oblongus	4-4	late Baj. to late Baj. .
4023	Gongylothorax sakawaensis	6-7	mid Bath. to late Bath.-early Call.
4024	Gongylothorax sp. aff. G. siphonofer	4-4	late Baj. to late Baj. .
4026	Hemicryptocapsa capita	17-18	late Val. to latest Val.-earliest Haut.
4027	Hexastylus (?) tetradactylus	1-4	early-mid Aal. to late Baj.
4028	Laxtorum (?) hichisoense	1-4	early-mid Aal. to late Baj.
4031	Parahsuum (?) grande	1-3	early-mid Aal. to early-mid Baj.
4032	Ares cylindricus flexuosus	4-6	late Baj. to mid Bath.
4033	Podocapsa(?) hexaptera	7-7	late Bath.-early Call. to late Bath.-early Call.
4034	Protunuma turbo	4-7	late Baj. to late Bath.-early Call.

MRD	Genus, species, subspecies	UAZ	Range
4037	Solenotryma ichikawai	7-21	late Bath.-early Call. to early Barr.
4038	Stichocapsa himedaruma	not zoned	late Mid-early Late Jurassic
4042	Stichocapsa sp. E	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
4044	Stichomitra (?) takanoensis gr.	3-7	early-mid Baj. to late Bath.-early Call.
4045	Stylocapsa (?) hemicostata	5-6	latest Baj.-early Bath. to mid Bath.
4046	Stylocapsa lacrimalis	6-7	mid Bath. to late Bath.-early Call.
4047	Stylocapsa tecta	5-6	latest Baj.-early Bath. to mid Bath.
4048	Tetraditryma corralitosensis bifida	5-7	latest Baj.-early Bath. to late Bath.-early Call.
4049	Tricolocapsa (?) fusiformis	3-5	early-mid Baj. to latest Baj.-early Bath.
4050	Tricolocapsa (?) sp. aff. T. fusiformis	4-6	late Baj. to mid Bath.
4052	Tricolocapsa plicarum ssp. A	4-5	late Baj. to latest Baj.-early Bath.
4053	Tricolocapsa plicarum plicarum	4-5	late Baj. to latest Baj.-early Bath.
4054	Tricolocapsa tetragona	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
4055	Williriedellum carpathicum	7-11	late Bath.-early Call. to late Kimm.-early Tith.
4056	Tricolocapsa sp. M	5-5	latest Baj.-early Bath. to latest Baj.-early Bath.
4057	Tricolocapsa sp. S	4-5	late Baj. to latest Baj.-early Bath.
4058	Unuma latusicostatus	2-5	late Aal. to latest Baj.-early Bath.
4059	Unuma typicus	3-4	early-mid Baj. to late Baj. .
4060	Williriedellum sp. A	4-8	late Baj. to mid Call.-early Oxf.
4061	Ares cylindricus s.l.	1-6	early-mid Aal. to mid Bath.
4063	Acaeniotylopsis variatus s.l.	1-8	early-mid Aal. to mid Call.-early Oxf.
4064	Bernoullius rectispinus leporinus	2-6	late Aal. to mid Bath.
4066	Acaeniotylopsis variatus triacanthus	1-7	early-mid Aal. to late Bath.-early Call.
4068	Triactoma foremanae	7-11	late Bath.-early Call. to late Kimm.-early Tith.
4069	Emiluvia orea s.l.	4-11	late Baj. to late Kimm.-early Tith.
4070	Emiluvia orea ultima	10-11	late Oxf.-early Kimm. to late Kimm.-early Tith.
4071	Parvicingula dhimenaensis ssp. A	3-8	early-mid Baj. to mid Call.-early Oxf.
4072	Parvicingula dhimenaensis dhimenaensis	3-11	early-mid Baj. to late Kimm.-early Tith.
4073	Deviatus diamphidius s.l.	8-22	mid Call.-early Oxf. to late Barr.-early Apt.
4077	Yamatoum spinosum	1-4	early-mid Aal. to late Baj.
4078	Quarticella ovalis	4-4	late Baj. to late Baj. .
4079	Zhamoidellum ovum	9-11	mid-late Oxf. to late Kimm.-early Tith.
5003	Acanthocircus furiosus	10-20	late Oxf.-early Kimm. to late Haut.
5011	Acanthocircus variabilis	17-20	late Val. to late Haut.
5012	Acanthocircus carinatus	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5032	Acaeniotyle (?) florea	17-22	late Val. to late Barr.-early Apt.
5033	Acaeniotyle (?) glebulosa	17-22	late Val. to late Barr.-early Apt.
5041	Lithatractus sp. aff. L. pusillus	14-22	early-early late Berr. to late Barr.-early Apt.
5042	Archaeospongoprunum patricki	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5044	Stylosphaera (?) macroxiphus	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5046	Dicroa periosa	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5049	Suna hybum	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5055	Triactoma luciae	13-21	latest Tith.-earliest Berr. to early Barr.
5065	Pantanellium sp. aff. P. cantuchapai	13-21	latest Tith.-earliest Berr. to early Barr.
5068	Cecrops (?) sexaspina	17-20	late Val. to late Haut.
5069	Hexapyramis (?) precedis	17-22	late Val. to late Barr.-early Apt.
5073	Thanarla pulchra	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5090	Stylospongia (?) titirez	20-22	late Haut. to late Barr.-early Apt.
5132	Emiluvia chica decussata	13-18	latest Tith.-earliest Berr. to latest Val.-earliest Haut.
5143	Crucella remanei	17-21	late Val. to early Barr.
5163	Homoeoparonaella speciosa	13-21	latest Tith.-earliest Berr. to early Barr.
5166	Halesium biscutum	14-22	early-early late Berr. to late Barr.-early Apt.
5183	Paronaella (?) tubulata	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5186	Paronaella trifoliacea	14-22	early-early late Berr. to late Barr.-early Apt.
5193	Savaryella guexi	14-21	early-early late Berr. to early Barr.
5194	Crucella collina	13-21	latest Tith.-earliest Berr. to early Barr.
5196	Crucella sp. aff. C. espartoensis	17-21	late Val. to early Barr.
5199	Bistarkum irazuense	14-21	early-early late Berr. to early Barr.
5204	Crucella bossoensis	16-22	early Val. to late Barr.-early Apt.
5209	Tetratrabs radix	12-17	early-early late Tith. to late Val.
5223	Halesium medium	16-21	early Val. to early Barr.
5229	Cecrops septemporatus	17-21	late Val. to early Barr.
5243	Halesium (?) lineatum	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5253	Homoeoparonaella sp. aff. H. irregularis	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5261	Cyclastrum infundibuliforme	17-22	late Val. to late Barr.-early Apt.

MRD	Genus, species, subspecies	UAZ	Range
5262	Spongotripus (?) satoi	19-22	early Haut. to late Barr.-early Apt.
5266	Cyclastrum (?) luminosum	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5267	Homoeoparonaella peteri	19-22	early Haut. to late Barr.-early Apt.
5274	Godia tecta	19-22	early Haut. to late Barr.-early Apt.
5287	Godia lenticulata	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5290	Cyclastrum rarum	15-21	late Berr.-earliest Val. to early Barr.
5296	Thanarla elegantissima	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5314	Paronaella (?) annemariae	14-21	early-early late Berr. to early Barr.
5332	Pseudoaulophacus (?) pauliani	13-21	latest Tith.-earliest Berr. to early Barr.
5334	Pseudoaulophacus (?) florealis	16-22	early Val. to late Barr.-early Apt.
5357	Bernoullius (?) manica	20-21	late Haut. to early Barr.
5359	Bernoullius (?) monoceros	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5362	Phaseliforma ovum	20-22	late Haut. to late Barr.-early Apt.
5369	Bernoullius spelae	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5371	Jacus (?) italicus	15-20	late Berr.-earliest Val. to late Haut.
5396	Parapodocapsa furcata	13-16	latest Tith.-earliest Berr. to early Val.
5397	Podocapsa (?) imperialis	18-20	latest Val.-earliest Haut. to late Haut.
5407	Pseudoeucyrtis sp.cf. P. hanni	17-18	late Val. to latest Val.-earliest Haut.
5408	Pseudoeucyrtis (?) fusus	13-17	latest Tith.-earliest Berr. to late Val.
5409	Syringocapsa vicetina	13-17	latest Tith.-earliest Berr. to late Val.
5410	Syringocapsa longitubus	13-16	latest Tith.-earliest Berr. to early Val.
5416	Syringocapsa sp. aff. S. coronata	11-20	late Kimm.-early Tith. to late Haut.
5417	Syringocapsa coronata	13-16	latest Tith.-earliest Berr. to early Val.
5422	Dibolachras tytthopora	17-22	late Val. to late Barr.-early Apt.
5426	Syringocapsa limatum	11-21	late Kimm.-early Tith. to early Barr.
5427	Podobursa multispina	20-20	late Haut. to late Haut.
5433	Sethocapsa (?) concentrica	13-14	latest Tith.-earliest Berr. to early-early late Berr.
5436	Katroma milloti	13-19	latest Tith.-earliest Berr. to early Haut.
5453	Milax adrianae	13-20	latest Tith.-earliest Berr. to late Haut.
5462	Sethocapsa uterculus	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
5464	Sethocapsa (?) zweilii	14-19	early-early late Berr. to early Haut.
5469	Sethocapsa simplex	20-22	late Haut. to late Barr.-early Apt.
5481	Sethocapsa sp. aff. S. kaminogoensis	13-21	latest Tith.-earliest Berr. to early Barr.
5506	Cyrtocapsa (?) grutterinki	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
5510	Sethocapsa tricornis	13-16	latest Tith.-earliest Berr. to early Val.
5511	Zhamoidellum testatum	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5521	Pseudocrolanium cristatum	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5522	Pseudocrolanium fluegeli	20-21	late Haut. to early Barr.
5524	Novixitus (?) daneliani	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5526	Spongocapsula (?) tripes	19-21	early Haut. to early Barr.
5532	Crolanium pythiae	17-22	late Val. to late Barr.-early Apt.
5544	Sethocapsa dorysphaeroides	7-22	late Bath.-early Call. to late Barr.-early Apt.
5550	Stichomitra (?) sp. aff. S. euganea	21-22	early Barr. to late Barr.-early Apt.
5553	Sethocapsa (?) orca	19-22	early Haut. to late Barr.-early Apt.
5565	Obesacapsula polyedra	13-17	latest Tith.-earliest Berr. to late Val.
5568	Obesacapsula bullata	13-19	latest Tith.-earliest Berr. to early Haut.
5572	Pseudoeucyrtis acus	15-21	late Berr.-earliest Val. to early Barr.
5575	Ristola asparagus	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5576	Pseudoeucyrtis (?) aspera	16-21	early Val. to early Barr.
5577	Pseudoeucyrtis sceptrum	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
5578	Parvicingula longa	13-20	latest Tith.-earliest Berr. to late Haut.
5580	Wrangellium columnum	13-20	latest Tith.-earliest Berr. to late Haut.
5582	Archaeodictyomitra chalilovi	20-22	late Haut. to late Barr.-early Apt.
5595	Archaeodictyomitra (?) lacrimula	14-22	early-early late Berr. to late Barr.-early Apt.
5607	Pantanellium squinaboli	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
5620	Eucyrtis columbaria	16-22	early Val. to late Barr.-early Apt.
5625	Pseudodictyomitra lilyae	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
5628	Crucella lipmanae	17-19	late Val. to early Haut.
5636	Wrangellium puga	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
5641	Pseudodictyomitra lanceloti	20-22	late Haut. to late Barr.-early Apt.
5642	Pseudodictyomitra sp. aff. P. lanceloti	21-21	early Barr. to early Barr.
5647	Pseudodictyomitra nuda	16-22	early Val. to late Barr.-early Apt.
5668	Xitus sandovali	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5672	Stichomitra sp. aff. S. asymbatos	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5673	Xitus (?) channelli	16-21	early Val. to early Barr.

MRD	Genus, species, subspecies	UAZ	Range
5674	Xitus (?) alievi	11-22	late Kimm.-early Tith. to late Barr.-early Apt.
5693	Novixitus (?) tuberculatus	19-22	early Haut. to late Barr.-early Apt.
5703	Mirifusus petzholdti	16-17	early Val. to late Val.
5711	Syringocapsa sp. aff. S. spinosa	19-22	early Haut. to late Barr.-early Apt.
5712	Parvicingula usotanensis	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
5716	Mirifusus apenninicus	14-21	early-early late Berr. to early Barr.
5721	Mirifusus odoghertyi	13-21	latest Tith.-earliest Berr. to early Barr.
5724	Parvicingula (?) sp. aff. P. cincta	17-18	late Val. to latest Val.-earliest Haut.
5725	Xitus horridus	19-20	early Haut. to late Haut.
5744	Stichocapsa pulchella	17-22	late Val. to late Barr.-early Apt.
5761	Stichocapsa altiforamina	18-21	latest Val.-earliest Haut. to early.
5766	Ristola martae	17-20	late Val. to late Haut.
5771	Spongocapsula obesa	10-22	late Oxf.-early Kimm. to late Barr.-early Apt.
5773	Spongocapsula sp. aff. S. coronata	17-22	late Val. to late Barr.-early Apt.
5785	Canoptum banale	13-16	latest Tith.-earliest Berr. to early Val.
5796	Obesacapsula rusconensis umbriensis	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
5824	Hsuum feliformis	13-15	latest Tith.-earliest Berr. to late Berr.-earliest Val.
5901	Cyclastrum (?) trigonum	16-21	early Val. to early Barr.
5902	Crucella (?) inflexa	17-22	late Val. to late Barr.-early Apt.
5903	Cyclastrum (?) planum	19-22	early Haut. to late Barr.-early Apt.
5904	Thanarla gutta	20-21	late Haut. to early Barr.
5913	Archaeotritrabs gracilis	16-21	early Val. to early Barr.
5927	Dictyomitra pseudoscalaris	17-22	late Val. to late Barr.-early Apt.
5973	Pseudodictyomitra leptoconica	22-22	late Barr.-early Apt. to late Barr.-early Apt.
6000	Cecrops	17-21	late Val. to early Barr.
6001	Crolanium	12-17	early-early late Tith. to late Val.
6002	Cyclastrum	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
6003	Dicroa	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
6004	Dictyomitra	17-22	late Val. to late Barr.-early Apt.
6006	Hexapyramis	17-22	late Val. to late Barr.-early Apt.
6007	Holocryptocanium	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
6009	Lithatractus	14-22	early-early late Berr. to late Barr.-early Apt.
6013	Novixitus	18-22	latest Val.-earliest Haut. to late Barr.-early Apt.
6014	Parapodocapsa	13-16	latest Tith.-earliest Berr. to early Val.
6017	Savaryella	14-21	early-early late Berr. to early Barr.
6018	Pyramispongia	13-20	latest Tith.-earliest Berr. to late Haut.
6024	Yamatoum	1-4	early-mid Aal. to late Baj.
6025	Thanarla	15-22	late Berr.-earliest Val. to late Barr.-early Apt.
6026	Pseudoaulophacus	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
6101	Cinguloturris cylindra	12-17	early-early late Tith. to late Val.
6107	Holocryptocanium barbui	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
6109	Pyramispongia barmsteinensis	13-20	latest Tith.-earliest Berr. to late Haut.
6121	Angulobracchia (?) portmanni s.l.	13-22	latest Tith.-earliest Berr. to late Barr.-early Apt.
6123	Crolanium spp.	16-22	early Val. to late Barr.-early Apt.
6125	Godia coronata	18-20	latest Val.-earliest Haut. to late Haut.
6129	Obesacapsula rusconensis s.l.	13-19	latest Tith.-earliest Berr. to early Haut.
6130	Phaseliforma	20-22	late Haut. to late Barr.-early Apt.
6131	Gongylothorax favosus	8-10	mid Call.-early Oxf. to late Oxf.-early Kimm.

37. Complete Datafile for Calculation of Unitary Association and UAZones

EXPLANATORY NOTES

The sections listed in below have the following synthax (Synthax of BIOGRAPH, see Chapter 31): Each section is preceded by "**SECTION**", the name of the section and the indication of bottom and top sequential sample-numbers. The data of each sample start with "<", the sequential number and the original sample number in {}. All species/subspecies represented in the catalogue (*Chapter* 4) are coded with their MRD-number. The order of sections follows the order of the biostratigraphic chapters (*Chapters* 5-31) in this book. A star "*" in front of the names of sections indicates that the section was not used for the construction of UAZones, but was compared to them by running the section together with the numerical range chart (UAZ95.TGI, see *Chapter* 32 for procedure).

Chapter 5: Towards a Mesozoic radiolarian database by P.O. Baumgartner

SECTION POB39_DSDP_LEG_1_SITE_5: bottom 1-top 1
1 {5A-7-1-top}: 3092, 3066, 3113, 3165, 3171, 3202, 3226, 3227, 3285, 6121

SECTION *POB29_DSDP_LEG_41_SITE_367: bottom 1-top 7
< 7 {32-4-009}: 3112, 3161, 3203, 3230, 3286, 4073
< 6 {34-4-104}: 3087, 3065, 3097, 3112, 3113, 3161, 3171, 3181, 3197, 3203, 3230, 3254, 4073
< 5 {35-2-028}: 3017, 3066, 3095, 3097, 3112, 3161, 3171, 3181, 3203, 3226, 3230, 3254, 3263, 4073
< 4 {35-2-042}: 3017, 3066, 3095, 3097, 3103, 3105, 3112, 3161, 3164, 3166, 3171, 3181, 3203, 3225, 3226, 3230, 3254, 3263, 4069, 4073
< 3 {36-3-049}: 3008, 3017, 3034, 3066, 3090, 3095, 3097, 3100, 3112, 3123, 3161, 3169, 3171, 3181, 3215, 3216, 3225, 3226, 3230, 3254, 3263, 4069, 4073
< 2 {37-1-007}: 3017, 3034, 3095, 3097, 3100, 3112, 3161, 3169, 3171, 3181, 3215, 3216, 3225, 3230, 3254, 3263, 4069, 4073
< 1 {37-1-147}: 3017, 3034, 3064, 3085, 3095, 3100, 3112, 3122, 3129, 3160, 3161, 3169, 3180, 3181, 3215, 3216, 3230, 3254, 3263, 4069, 4073

{MOROCCO EL KADIRI}
SECTION *KS302_412: bottom 1-top 2
< 2 {ks302}: 2002, 3010, 3006, 3071, 3073, 3074, 3089, 3159, 3194, 3195, 3247, 3301, 3414, 3813, 4010, 4011
< 1 {ks412}: 2013, 2022, 3010, 3001, 3007, 3030, 3048, {3052,}3071, 3072, 3073, 3074, 3089, 3149, 3151, 3158, 3167, 3194, 3195, 3247, 3301, 3310, 3414, 3813, 4010, 4011, 4061

SECTION *POB38_VEVEYSE_DE_CH_ST_DE: bottom 1-top 1
< 1 {bed 67-4}: 3062, 3090, 3092, 3161, 3162, 3202, 3228, 3284, 3285, 3286, 3295, 5073, 5229, 5462, 6121

SECTION *POB17_BESOZZO_II: bottom 1-top 3
< 3 {RK101, 3020cm}: 3017, 3062, 3064, 3066, 3085, 3096, 3117, 3118, 3119, 3123, 3144, 3161, 3164, 3171, 3180, 3199, 3215, 3226, 3230, 4069
< 2 {RK92, 2045cm}: 3012, 3033, 3034, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3100, 3104, 3110, 3118, 3152, 3160, 3169, 3210, 3215, 3225, 3267
< 1 {RK95, 605cm}: 3085, 3064, 3110, 3254

SECTION *POB18_MONTE_GENEROSO: bottom 1-top 3
< 3 {A-19}: 3017, 3066, 3121, 3171, 3226
< 2 {A-2}: 3012, 3017, 3020, 3034, 3036, 3052, 3064, 3066, 3085, 3095, 3100, 3103, 3104, 3117, 3118, 3121, 3123, 3126, 3137, 3139, 3140, 3160, 3161, 3169, 3181, 3199, 3216, 3218, 3225, 3226, 3230, 3243, 3263, 3267, 4069
< 1 {BB1}: 3059, 3160, 3277

SECTION *POB20_VALMAGGIORE: bottom 1-top 4
< 4 {RK1085}: 3062, 3065, 3087, 3122, 3171, 3263
< 3 {RK1086}: 3062, 3064, 3085, 3117, 3122, 3171, 3215, 3230, 3267, 4069
< 2 {RK1088}: 3020, 3064, 3085, 3096, 3118, 3144, 3216, 3218, 3230, 3243
< 1 {RK1095}: 3012, 3049, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3160, 3180, 3181, 3210, 3225, 3277

SECTION *POB21_BESOZZO_I: bottom 1-top 5
< 5 {RK115}: 3017, 3049, 3065, 3066, 3087, 3097, 3113, 3118, 3126, 3129, 3137, 3140, 3161, 3162, 3164, 3171, 3215, 3226, 3230, 3263, 4069
< 4 {RK111}: 3017, 3055, 3066, 3113, 3118, 3137, 3140, 3161, 3164, 3171, 3215, 3226, 3230, 3263, 4069
< 3 {RK110}: 3017, 3066, 3113, 3118, 3137, 3161, 3171, 3215, 3226, 3263, 4069
< 2 {RK109}: 3017, 3066, 3095, 3113, 3118, 3119, 3137, 3161, 3171, 3215, 3226, 3263, 4069
< 1 {RK106}: 3012, 3017, 3034, 3036, 3052, 3062, 3066, 3171, 3199, 3210, 3215, 3218, 3225, 3226, 3243, 3263, 4069

SECTION POB22_23_RJ9_SANGIANO_RUSCONI: bottom 1 - top 18
< 18{RU166.00 RJ AU26-27}: 3062, 3065, 3090, 3092, 3094, 3161, 3162, 3202, 3228, 3255, 3263, 3282, 3285, 3286, 3287, 3293, 3295, 5011, 5049, 5073, 5186, 5229, 5426, 5462, 5481, 5607, 5620, 5636, 5693, 5721, 5927, 6121, 6129
< 17{RU 146.50 RJ AU26}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5011, 5012, 5032, 5033, 5046, 5049, 5055, 5065, 5068, 5073, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5261, 5262, 5296, 5314, 5332, 5334, 5369, 5371, 5397, 5426, 5436, 5462, 5464, 5481, 5524, 5532, 5544, 5568, 5575, 5578, 5580, 5607, 5620, 5628, 5636, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5725, 5761, 5766, 5771, 5773, 5901, 5913, 5927, 6121, 6123, 6129
< 16{RU135.50 RJ AU25}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5266, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5436, 5462, 5481, 5524, 5544, 5568, 5575, 5578, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5761, 5773, 5901, 5913, 5927, 6121, 6123, 6129
< 15{RU128.80 RJ AU25}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5042, 5046, 5049, 5055, 5065, 5068, 5132, 5163, 5183, 5186, 5193, 5194, 5229, 5243, 5253, 5332, 5359, 5416, 5426, 5436, 5462, 5481, 5511, 5544, 5568, 5575, 5578, 5580, 5607, 5636, 5672, 5674, 5712, 5716, 5761, 5913, 6121, 6129
< 14{RU107.90 RJ AU11-24}: 3022, 3062, 3065, 3090, 3092, 3097, 3113, 3161, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5042, 5046, 5055, 5065, 5132, 5163, 5183, 5186, 5193, 5194, 5243, 5253, 5332, 5359, 5416, 5426, 5436, 5462, 5481, 5544, 5568, 5578, 5580, 5607, 5674, 5712, 6121, 6129
< 13{RU 91.50 RJ AU19}: 3022, 3062, 3065, 3066, 3090, 3092, 3097, 3113, 3161, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5042, 5046, 5055, 5065, 5132, 5163, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5332, 5359, 5408, 5416, 5426, 5436, 5453, 5462, 5481, 5544, 5568, 5578, 5580, 5607, 5674, 5712, 6121, 6129
< 12{RU50.80 RJ AU10}: 3022, 3062, 3065, 3066, 3090, 3092, 3097, 3113, 3161, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5042, 5046, 5055, 5065, 5132, 5163, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5332, 5408, 5409, 5410, 5416, 5426, 5436, 5453, 5481, 5506, 5544, 5568, 5578, 5580, 5607, 5674, 6121, 6129
< 11{RU38.60 RJ AU 10}: 3022, 3062, 3065, 3066, 3090, 3092, 3097, 3113, 3161, 3171, 3185, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5003, 5046, 5055, 5065, 5132, 5163, 5183, 5194, 5209, 5243, 5253, 5332, 5408, 5409, 5410, 5416, 5426, 5436, 5453, 5481, 5506, 5544, 5568, 5580, 5607, 6121, 6129
< 10{RU10.60 RJ AU10}: 3022, 3062, 3065, 3066, 3090, 3092, 3097, 3113, 3161, 3171, 3185, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3947, 3955, 4073, 5003, 5046, 5055, 5065, 5132, 5163, 5183, 5194, 5209, 5243, 5253, 5332, 5408, 5409, 5410, 5416, 5426, 5436, 5453, 5481, 5506, 5544, 5565, 5568, 5580, 5607, 6101, 6121, 6129
< 9{POB1205 POB7.05.RJ3.50 AU7}: 3022, 3034, 3036, 3062, 3065, 3066, 3087, 3090, 3092, 3094, 3096, 3097, 3111, 3112, 3113, 3118, 3161, 3165, 3171, 3185, 3199, 3202, 3203, 3213, 3215, 3225, 3226,

3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3912, 3924, 3947, 3955, 4073, 5003, 5055, 5065, 5132, 5163, 5183, 5194, 5209, 5243, 5253, 5332, 5408, 5409, 5410, 5417, 5426, 5436, 5453, 5481, 5506, 5510, 5544, 5568, 5580, 5607, 5785, 5824, 6101, 6121, 6129

< 8{RU0.50 RJ AU5}: 3022, 3065, 3097, 3113, 3161, 3185, 3213, 3230, 3255, 3263, 3280, 3284, 3286, 3287, 3293, 3591, 3955, 5065, 5132, 5506, 5607, 5785, 5796, 6101, 6129

< 7{RK9}: 3036, 3055, 3065, 3066, 3087, 3092, 3122, 3162, 3164, 3171, 3203, 3215, 3225, 3226, 3263

< 6{RK48}: 3017, 3036, 3055, 3062, 3065, 3066, 3087, 3122, 3135, 3161, 3162, 3164, 3171, 3215, 3225, 3226, 3263, 4069

< 5{RK11}: 3017, 3036, 3055, 3066, 3117, 3122, 3135, 3162, 3164, 3171, 3215, 3225, 3226, 3263, 4069

< 4{RK24}: 3012, 3017, 3020, 3035, 3036, 3052, 3055, 3064, 3085, 3095, 3096, 3100, 3113, 3117, 3118, 3119, 3122, 3123, 3135, 3140, 3160, 3162, 3164, 3166, 3169, 3180, 3181, 3215, 3223, 3225, 3263, 3267, 3277, 4069

< 3{RK30}: 3012, 3017, 3033, 3036, 3052, 3055, 3061, 3064, 3076, 3085, 3096, 3110, 3113, 3117, 3118, 3123, 3124, 3135, 3152, 3160, 3162, 3169, 3180, 3181, 3210, 3215, 3225, 3230, 3254, 3267, 3273, 3277

< 2{RK36}: 3012, 3017, 3033, 3052, 3055, 3061, 3064, 3076, 3085, 3096, 3103, 3110, 3113, 3117, 3118, 3124, 3152, 3160, 3162, 3169, 3180, 3181, 3199, 3210, 3215, 3225, 3254, 3267, 3273

< 1{RK37}: 3008, 3012, 3017, 3033, 3052, 3055, 3061, 3064, 3076, 3085, 3117, 3124, 3160, 3169, 3180, 3181, 3199, 3210, 3254, 3267, 3273

SECTION POB24_RJ10_BREGGIA_JUR_CRET: bottom 1 - top 36

< 36{POB141.55=BR9.10 RJ UA34}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 4073, 5012, 5033, 5041, 5044, 5046, 5049, 5065, 5069, 5073, 5183, 5186, 5204, 5229, 5243, 5253, 5266, 5274, 5287, 5314, 5362, 5422, 5462, 5481, 5511, 5521, 5524, 5532, 5544, 5553, 5595, 5607, 5620, 5625, 5636, 5641, 5642, 5668, 5672, 5674, 5693, 5712, 5744, 5761, 5773, 5901, 5913, 5927, 6121, 6123

< 35{BR12.40 RJ UA30-31}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3228, 3255, 3263, 3281, 3285, 3287, 3293, 3295, 4073, 5012, 5033, 5041, 5042, 5044, 5046, 5065, 5069, 5073, 5143, 5183, 5186, 5204, 5229, 5243, 5253, 5266, 5274, 5287, 5314, 5422, 5462, 5481, 5511, 5524, 5532, 5544, 5553, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5712, 5744, 5901, 5913, 5927, 6121, 6123

< 34{BR23.00 RJ29-31}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3227, 3228, 3255, 3263, 3281, 3285, 3287, 3288, 3293, 3295, 3947, 4073, 5011, 5032, 5033, 5041, 5042, 5044, 5046, 5065, 5073, 5143, 5163, 5183, 5186, 5204, 5229, 5243, 5253, 5261, 5266, 5274, 5287, 5314, 5422, 5462, 5481, 5532, 5544, 5553, 5595, 5607, 5620, 5636, 5668, 5672, 5674, 5711, 5712, 5744, 5901, 5913, 5927, 6121, 6123

< 33{BR74.80 RJ UA23}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3293, 3295, 3947, 4073, 5003, 5033, 5041, 5042, 5044, 5046, 5065, 5073, 5143, 5166, 5183, 5186, 5229, 5243, 5253, 5287, 5290, 5314, 5359, 5426, 5462, 5481, 5532, 5544, 5568, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5744, 5901, 5913, 5927, 6121, 6123

< 32{BR68.40 RJ UA21-22}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3293, 3295, 3919, 3947, 4073, 5003, 5033, 5041, 5042, 5044, 5046, 5065, 5068, 5073, 5143, 5166, 5183, 5186, 5229, 5243, 5253, 5287, 5290, 5314, 5359, 5462, 5481, 5544, 5568, 5575, 5578, 5580, 5607, 5620, 5636, 5672, 5673, 5674, 5703, 5712, 5716, 5744, 5901, 5913, 6121, 6123

< 31{BR62.80 RJ UA21}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5143, 5166, 5183, 5186, 5193, 5194, 5209, 5229, 5243, 5253, 5287, 5290, 5314, 5359, 5369, 5409, 5416, 5436, 5453, 5462, 5481, 5544, 5568, 5575, 5578, 5580, 5607, 5620, 5636, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5744, 5901, 5902, 5913, 6121, 6123

< 30{BR54.70 RJ UA15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5287, 5290, 5314, 5359, 5369, 5408, 5409, 5416, 5417, 5436, 5453, 5462, 5481, 5544, 5568, 5578, 5580, 5607, 5636, 5672, 5673, 5674, 5703, 5716, 5721, 5785, 5901, 5913, 6121

< 29{BR49.05 RJ UA15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5287, 5290, 5314, 5359, 5369, 5408, 5409, 5416, 5417, 5436, 5453, 5462, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5636, 5672, 5673, 5674, 5703, 5716, 5721, 5785, 5901, 5913, 6121

< 28{BR39.05 RJ UA15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165,

3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5042, 5044, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5287, 5314, 5359, 5369, 5408, 5409, 5416, 5417, 5436, 5453, 5462, 5464, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5636, 5672, 5673, 5674, 5703, 5716, 5721, 5785, 5901, 6121

< 27{BR34.05 RJ UA15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5042, 5044, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5287, 5314, 5359, 5369, 5408, 5409, 5416, 5417, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5568, 5572, 5578, 5580, 5607, 5636, 5672, 5673, 5674, 5703, 5716, 5721, 5785, 5901, 6121

< 26{BR28.85 RJ UA15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 3955, 4073, 5003, 5042, 5044, 5055, 5132, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5287, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5410, 5416, 5417, 5436, 5453, 5481, 5510, 5544, 5565, 5568, 5572, 5578, 5580, 5607, 5636, 5673, 5674, 5703, 5716, 5721, 5785, 5901, 6121, 6129

< 25{POB1330=BR10.50 POB UA11 RJ UA7}: 3062, 3063, 3065, 3066, 3087, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3226, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3924, 3947, 3955, 4073, 5042, 5044, 5055, 5132, 5166, 5183, 5193, 5194, 5209, 5243, 5253, 5408, 5409, 5410, 5417, 5436, 5453, 5481, 5506, 5510, 5544, 5568, 5580, 5607, 5636, 5674, 5721, 5785, 5824, 6101, 6121, 6129

< 24{BR0.03 RJ UA5-6}: 3165, 3161, 3171, 3185, 3203, 3213, 3263, 3266, 3282, 3286, 3591, 3918, 5132, 6101, 6129

< 23{RK B48 2.33 POB UA9-10}: 3017, 3062, 3065, 3066, 3087, 3113, 3161, 3164, 3171, 3215, 3225, 3226, 3263

< 22{RK B45 5.45 POB UA9-10}: 3017, 3062, 3065, 3066, 3087, 3113, 3161, 3164, 3171, 3215, 3225, 3226, 3263

< 21{RK B85 14.90 POB UA8}: 3017, 3062, 3064, 3066, 3085, 3095, 3097, 3113, 3161, 3162, 3164, 3171, 3215, 3223, 3225, 3226, 3263

< 20{RK 430 17.50m POB UA8}: 3017, 3055, 3062, 3064, 3066, 3085, 3095, 3097, 3103, 3113, 3117, 3161, 3162, 3164, 3171, 3215, 3223, 3225, 3226, 3230, 3254, 3263

< 19{RK B30 20.75m POB UA8}: 3017, 3055, 3062, 3064, 3066, 3085, 3095, 3096, 3097, 3103, 3113, 3117, 3122, 3126, 3161, 3162, 3164, 3171, 3199, 3215, 3216, 3218, 3223, 3225, 3226, 3230, 3243, 3254, 3263, 3267

< 18{RK 433 24.10m POB UA7-8}: 3017, 3034, 3055, 3062, 3064, 3066, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3117, 3118, 3122, 3123, 3126, 3140, 3161, 3162, 3164, 3166, 3199, 3215, 3216, 3223, 3225, 3226, 3230, 3254, 3263, 3267, 4069

< 17{RK B27 26.40m POB UA7-8}: 3017, 3020, 3055, 3062, 3064, 3066, 3085, 3095, 3096, 3100, 3103, 3104, 3113, 3117, 3118, 3122, 3123, 3126, 3140, 3161, 3162, 3164, 3166, 3180, 3199, 3215, 3216, 3223, 3225, 3226, 3230, 3254, 3263, 3267, 4069

< 16{RK B 22 30.05m POB UA7-8}: 3017, 3055, 3062, 3064, 3066, 3085, 3095, 3096, 3100, 3103, 3104, 3113, 3117, 3118, 3122, 3123, 3126, 3137, 3139, 3140, 3161, 3162, 3164, 3166, 3180, 3199, 3215, 3216, 3223, 3225, 3226, 3230, 3254, 3263, 3267, 4069

< 15{RK B21 32.40m POB UA7}: 3012, 3017, 3052, 3055, 3062, 3064, 3066, 3085, 3095, 3096, 3100, 3103, 3104, 3113, 3117, 3118, 3122, 3123, 3124, 3126, 3137, 3139, 3140, 3152, 3161, 3162, 3164, 3166, 3180, 3199, 3210, 3215, 3216, 3223, 3225, 3226, 3230, 3254, 3263, 3267, 3273, 4069

< 14{RK B19 35.70M POB UA6}: 3008, 3012, 3017, 3052, 3055, 3062, 3064, 3066, 3076, 3085, 3095, 3096, 3100, 3103, 3104, 3113, 3117, 3118, 3119, 3122, 3123, 3124, 3126, 3137, 3139, 3152, 3160, 3161, 3162, 3164, 3166, 3180, 3181, 3199, 3210, 3215, 3216, 3223, 3225, 3226, 3230, 3254, 3267, 3273

< 13{RK B90 40.10m POB UA6}: 3008, 3012, 3017, 3033, 3052, 3055, 3061, 3062, 3064, 3066, 3076, 3085, 3095, 3096, 3100, 3103, 3113, 3117, 3118, 3119, 3122, 3123, 3124, 3126, 3137, 3139, 3152, 3160, 3161, 3162, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3223, 3225, 3226, 3254, 3267, 3273

< 12{RK B12 42.15m POB UA6}: 3008, 3012, 3017, 3033, 3035, 3036, 3049, 3052, 3055, 3061, 3062, 3064, 3066, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3113, 3117, 3118, 3119, 3122, 3123, 3124, 3126, 3137, 3139, 3152, 3160, 3161, 3162, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3223, 3225, 3226, 3254, 3267, 3273

< 11{RK B11 42.25m POB UA6}: 3008, 3012, 3017, 3033, 3036, 3052, 3055, 3061, 3064, 3066, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3113, 3117, 3119, 3122, 3123, 3124, 3126, 3139, 3152, 3160, 3161, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3223, 3225, 3226, 3254, 3267, 3273

< 10{RK B9=B10 IN BG84 POB UA6}: 3008, 3012, 3017, 3033, 3036, 3052, 3055, 3061, 3064, 3066, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3113, 3117, 3119, 3122, 3123, 3124, 3126, 3135, 3139, 3152, 3160, 3161, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3223, 3225, 3226, 3244, 3254, 3267, 3273

< 9{RK B2 POB UA5}: 3008, 3012, 3033, 3036, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3113, 3117, 3122, 3123, 3124, 3126, 3135, 3139, 3152, 3160, 3161, 3164, 3169,

3180, 3181, 3210, 3215, 3216, 3223, 3225, 3244, 3254, 3267, 3273, 3277
< 8{RK B6=B8 IN BG84 POB AU5}: 3008, 3012, 3033, 3036, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3109, 3110, 3113, 3117, 3122, 3123, 3124, 3126, 3135, 3139, 3152, 3160, 3161, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3225, 3244, 3254, 3267, 3273, 3277
< 7{RK B3 46.05m POB AU4}: 3008, 3012, 3033, 3051, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3113, 3117, 3123, 3124, 3126, 3135, 3139, 3152, 3159, 3160, 3161, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3221, 3225, 3244, 3254, 3267, 3273, 3277
< 6{RK B4 POB AU3-4?}: 3008, 3012, 3033, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3117, 3123, 3124, 3126, 3135, 3139, 3152, 3159, 3160, 3164, 3169, 3181, 3210, 3215, 3216, 3221, 3244, 3254, 3267, 3273, 3277
< 5{RK B69 POB AU3}: 3008, 3012, 3033, 3052, 3055, 3059, 3061, 3064, 3074, 3076, 3085, 3095, 3096, 3100, 3103, 3110, 3117, 3123, 3124, 3126, 3135, 3139, 3152, 3159, 3160, 3164, 3169, 3181, 3210, 3215, 3216, 3221, 3244, 3254, 3267, 3273, 3277
< 4{RK B57 POB AU3}: 3008, 3012, 3013, 3052, 3055, 3059, 3061, 3064, 3074, 3076, 3085, 3096, 3103, 3117, 3123, 3124, 3126, 3135, 3139, 3159, 3160, 3169, 3181, 3215, 3221, 3244, 3254, 3267, 3271, 3273, 3277
< 3{RK B72 POB AU3}: 3008, 3012, 3052, 3059, 3061, 3064, 3074, 3076, 3085, 3096, 3103, 3117, 3123, 3124, 3139, 3159, 3160, 3169, 3181, 3197, 3215, 3221, 3244, 3254, 3267, 3273, 3277
< 2{RK B100=B10 IN BG84 POB AU1}: 3012, 3052, 3054, 3061, 3064, 3074, 3085, 3096, 3103, 3123, 3139, 3197, 3231, 3254, 3267
< 1{RK B61 POB AU1}: 3012, 3052, 3061, 3064, 3085, 3103, 3254, 3267

SECTION POB25_SALTRIO: bottom 1 - top 12
< 12{S51}: 3012, 3033, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3103, 3117, 3118, 3164, 3169, 3215, 3221, 3223, 3225, 3277
< 11{S50}: 3008, 3012, 3020, 3033, 3034, 3035, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3105, 3110, 3117, 3124, 3129, 3135, 3139, 3152, 3159, 3160, 3164, 3169, 3180, 3181, 3210, 3215, 3218, 3221, 3223, 3225, 3243, 3244, 3254, 32:71, 3273, 3277
< 10{S48}: 3008, 3012, 3020, 3033, 3034, 3035, 3049, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3110, 3117, 3124, 3129, 3135, 3139, 3152, 3159, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3223, 3225, 3243, 3244, 3254, 3271, 3273, 3277
< 9{S47}: 3008, 3012, 3013, 3020, 3033, 3034, 3035, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3109, 3110, 3117, 3124, 3129, 3135, 3139, 3152, 3159, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3223, 3225, 3243, 3244, 3254, 3271, 3273, 3277
< 8{S46}: 3008, 3012, 3013, 3020, 3033, 3034, 3035, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3109, 3110, 3117, 3123, 3124, 3129, 3135, 3139, 3152, 3159, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3223, 3225, 3243, 3244, 3254, 3271, 3273, 3277
< 7{S45}: 3008, 3012, 3013, 3020, 3033, 3034, 3035, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3109, 3110, 3117, 3123, 3124, 3129, 3135, 3139, 3152, 3159, 3164, 3166, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3223, 3225, 3243, 3244, 3254, 3271, 3273, 3277
< 6{S43}: 3008, 3012, 3013, 3020, 3033, 3034, 3035, 3051, 3052, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3109, 3110, 3117, 3123, 3124, 3129, 3135, 3159, 3164, 3166, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3225, 3243, 3244, 3254, 3271, 3273, 3277
< 5{S41}: 3008, 3012, 3013, 3020, 3033, 3034, 3051, 3052, 3055, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3109, 3110, 3123, 3124, 3125, 3129, 3135, 3159, 3164, 3169, 3180, 3181, 3210, 3215, 3216, 3218, 3221, 3243, 3244, 3254, 3271, 3273, 327
< 4{S40}: 3008, 3012, 3033, 3051, 3052, 3055, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3103, 3109, 3110, 3123, 3124, 3125, 3129, 3135, 3144, 3159, 3164, 3169, 3181, 3210, 3215, 3216, 3218, 3221, 3243, 3244, 3254, 3273, 3277
< 3{S39}: 3008, 3012, 3033, 3051, 3052, 3055, 3061, 3062, 3064, 3076, 3085, 3095, 3096, 3109, 3110, 3123, 3124, 3125, 3129, 3135, 3159, 3164, 3169, 3181, 3210, 3215, 3216, 3218, 3221, 3243, 3244, 3273, 3277
< 2{S36}: 3007, 3008, 3012, 3033, 3052, 3055, 3061, 3064, 3074, 3076, 3085, 3096, 3110, 3123, 3124, 3129, 3135, 3159, 3164, 3169, 3181, 3210, 3215, 3216, 3221, 3244, 3273, 3277
< 1{S29}: 3007, 3012, 3052, 3055, 3061, 3064, 3074, 3076, 3085, 3096, 3110, 3129, 3135, 3159, 3169, 3181, 3199, 3231, 3244, 3277

SECTION *POB36_GLASENBACH: bottom 1 - top 2
< 2{123}: 3012, 3033, 3035, 3052, 3055, 3059, 3064, 3076, 3085, 3100, 3103, 3109, 3110, 3113, 3118, 3124, 3137, 3139, 3144, 3160, 3181, 3210, 3215, 3223, 3225, 3254, 3273, 3277
< 1{122}: 3012, 3035, 3052, 3055, 3059, 3064, 3085, 3096, 3100, 3104, 3109, 3110, 3117, 3118, 3137, 3139, 3199, 3215, 3223, 3254

SECTION *POB43_TRATTBERG: bottom 1 - top 2
< 2: 3062, 3065, 3087, 3090, 3092, 3094, 3112, 3161, 3203, 3255, 3263, 3280, 3281, 3284, 3286, 3287, 3293, 3295, 4073
< 1: 3087, 3065, 3066, 3092, 3097, 3112, 3113, 3161, 3165, 3171, 3199, 3203, 3226, 3228, 3255, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3293, 4073, 6121, 6129

SECTION *POB27_MONTE_CETONA: bottom 1 - top 9
< 9{RK1051}: 3012, 3017, 3052, 3055, 3064, 3085, 3124, 3273
< 8{RK1049}: 3008, 3012, 3052, 3055, 3059, 3061, 3064, 3076, 3085, 3103, 3110, 3121, 3123, 3124, 3152, 3164, 3169, 3180, 3199, 3215, 3221, 3273, 3277
< 7{RK1048}: 3012, 3052, 3055, 3059, 3064, 3076, 3085, 3103, 3117, 3124, 3152, 3180, 3199, 3215, 3273, 3277
< 6{RK1047}: 3012, 3049, 3052, 3055, 3059, 3064, 3076, 3085, 3103, 3117, 3124, 3152, 3180, 3199, 3210, 3215, 3254, 3273, 3277
< 5{RK1046}: 3012, 3052, 3055, 3059, 3064, 3076, 3085, 3103, 3117, 3124, 3152, 3180, 3199, 3215, 3254, 3273, 3277
< 4{RK1045}: 3012, 3033, 3052, 3055, 3059, 3064, 3076, 3085, 3096, 3103, 3117, 3124, 3180, 3181, 3199, 3215, 3254, 3273, 3277
< 3{RK1043}: 3012, 3052, 3055, 3059, 3064, 3076, 3085, 3096, 3103, 3109, 3117, 3124, 3139, 3199, 3215, 3254, 3273, 3277
< 2{RK1039}: 3012, 3052, 3055, 3059, 3064, 3076, 3085, 3104, 3117, 3139, 3215, 3254
< 1{RK1038}: 3059, 3064, 3085, 3117, 3215, 3254

SECTION POB46_MONTE_CAMPANELLO_ELBA: bottom 1 - top 2
< 2{POB1630}: 3122, 3160, 3161, 4069
< 1{POB1628}: 3085, 3064, 3066, 3103, 3116, 3121, 3122, 3161, 3164, 3181, 3223, 3226, 3263, 4069

SECTION *POB47_S_FELO_NAMIA_ELBA: bottom 1 - top 1
< 1{POB1615}: 3035, 3066, 3095, 3118, 3122, 3161, 3164, 3215, 3226, 3230, 3263, 4069

SECTION *POB48_ROCCHETE_DI_VARA: bottom 1 - top 2
< 2{POB1662}: 3095, 3096, 3123
< 1{POB1661}: 3059, 3095, 3096, 3103, 3118, 3159, 3216, 3244

SECTION 26_BOSSO_JUR_CRET: bottom 1 - top 81
< 81{BO 1mab.sellibase RJ UA35}: 3063, 3090, 3092, 3097, 3228, 3295, 4073, 5032, 5033, 5042, 5046, 5069, 5073, 5166, 5204, 5287, 5296, 5550, 5553, 5575, 5582, 5636, 5674, 5773, 5927, 5973
< 80{BO2 RJ UA35}: 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3228, 3285, 3287, 3295, 4073, 5012, 5032, 5033, 5042, 5046, 5049, 5069, 5073, 5166, 5204, 5261, 5267, 5287, 5296, 5422, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5636, 5674, 5744, 5773, 5927, 5973, 6121
< 79{BO619.90 RJ UA35}: 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3228, 3263, 3285, 3287, 3295, 4073, 5012, 5032, 5033, 5042, 5046, 5049, 5069, 5073, 5166, 5204, 5261, 5262, 5267, 5287, 5296, 5422, 5462, 5511, 5521, 5524, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5672, 5674, 5693, 5711, 5712, 5744, 5773, 5927, 5973, 6121
< 78{BO619.05 RJ UA35}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3295, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5069, 5073, 5166, 5204, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5773, 5902, 5903, 5927, 5973, 6121
< 77{BO617.00 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3295, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5069, 5073, 5090, 5166, 5183, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5927, 6121, 6123
< 76{BO615.20 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3295, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5069, 5073, 5090, 5166, 5183, 5193, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5927, 6121, 6123
< 75{BO606.80 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5927, 6121, 6123
< 74{BO588.20 RJ UA31-33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5927, 6121, 6123
< 73{BO582.80 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5422, 5462, 5511, 5521, 5524, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672,

5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5927, 6121, 6123

< 72{BO581.65 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5046, 5049, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5371, 5422, 5427, 5462, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 71{BO581.60 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5371, 5422, 5427, 5462, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 70{BO580.40 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5003, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5422, 5427, 5462, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 69{BO580.10 RJ UA32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5003, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5357, 5359, 5362, 5369, 5371, 5422, 5426, 5427, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 68{BO575.05 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5003, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5422, 5426, 5427, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 67{BO574.40 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5003, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5422, 5426, 5427, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 66{BO573.00 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5422, 5426, 5427, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 65{BO569.60 RJ UA31}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5427, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5725, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< 64{BO566.50 RJ UA31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5427, 5453, 5462, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5575, 5576, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< 63{BO563.60 RJ UA30-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5575, 5580, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5711, 5712, 5716, 5721, 5725, 5744, 5766, 5771, 5773, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< 62{BO561.80 RJ UA30-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5580, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5711, 5712, 5716, 5721, 5725, 5766, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 61{BO556.40 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5575, 5578, 5580, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5711, 5712, 5716, 5721, 5725, 5766, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 60{BO552.10 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5526, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5711, 5712, 5716, 5721, 5725, 5766, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 59{BO551.05 RJ UA27-30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5287, 5296, 5314, 5334, 5359, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5511, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123

< 58{BO547.50 RJ UA27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5287, 5296, 5314, 5359, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5511, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123, 6129

< 57{BO540.50 RJ UA27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5511, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123, 6129

< 56{BO537.90 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5511, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123, 6129

< 55{BO534.30 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5011, 5012, 5032, 5042, 5046, 5049, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5511, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123, 6129

< 54{BO533.30 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5011, 5012, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314,

5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 5913, 6121, 6123, 6129

< 53{BO529.20 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 52{BO525.30 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 51{BO523.70 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 50{BO520.10 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 49{BO515.05 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 48{BO490.60 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 47{BO488.80 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 46{BO486.50 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5416, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5771, 5773, 5902, 6121, 6123, 6129

< 45{BO482.50 RJ UA22}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5416, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5766, 5773, 5902, 6121, 6123, 6129

< 44{BO482.20 RJ UA22}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5416, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5773, 5902, 6121, 6123, 6129

< 43{BO481.45 RJ UA22}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163,

5166, 5183, 5186, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5314, 5369, 5371, 5416, 5422, 5426, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5773, 5902, 6121, 6123, 6129

< 42{BO479.50 RJ UA22}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5163, 5166, 5183, 5186, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5290, 5369, 5371, 5416, 5422, 5426, 5436, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5773, 5902, 6121, 6123, 6129

< 41{BO449.50 RJ UA20}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5032, 5042, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5290, 5369, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5481, 5532, 5544, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5668, 5672, 5673, 5674, 5703, 5716, 5721, 5902, 6121, 6129

< 40{BO447.50 RJ UA18}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5194, 5199, 5229, 5243, 5253, 5261, 5287, 5290, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5481, 5544, 5565, 5572, 5575, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5716, 5721, 5902, 6101, 6121, 6129

< 39{BO427.20 RJ UA12-18}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5199, 5243, 5253, 5287, 5290, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5481, 5544, 5565, 5572, 5575, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5716, 5721, 6101, 6121, 6129

< 38{BO409.00 RJ UA12}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3919, 3947, 3955, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5199, 5243, 5253, 5287, 5290, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5481, 5544, 5565, 5572, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5716, 5721, 6101, 6121, 6129

< 37{BO391.20 RJ UA10-12}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3919, 3947, 3955, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5183, 5199, 5243, 5253, 5290, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5716, 5721, 5785, 6101, 6121, 6129

< 36{BO382.00 RJ UA10-12}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3919, 3947, 3955, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5183, 5199, 5243, 5253, 5290, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5716, 5721, 5785, 6101, 6121, 6129

< 35{BO370.10 RJ UA10}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3717, 3912, 3919, 3947, 3955, 4073, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5183, 5199, 5209, 5243, 5253, 5290, 5371, 5408, 5409, 5410, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5572, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5716, 5721, 5785, 5824, 6101, 6121, 6129

< 34{BO 361.80 RJ UA10}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3912, 3919, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5073, 5132, 5183, 5209, 5253, 5409, 5410, 5416, 5426, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5572, 5577, 5578, 5580, 5595, 5607, 5716, 5721, 5785, 5824, 6101, 6121, 6129

< 33{BO351.50 RJ UA6-10}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3912, 3919, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5416, 5426, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5716, 5721, 5785, 5824, 6101, 6121, 6129

< 32{BO336.20 RJ UA6-10}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3912, 3919, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5416, 5426, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5716, 5721, 5785, 5824, 6101, 6121, 6129

< 31{BO332.70 RJ UA 6-8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255,

3263, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3912, 3919, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5416, 5426, 5433, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5716, 5721, 5785, 5824, 6101, 6121, 6129

< 30{BO323.20 RJ UA6}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3911, 3912, 3918, 3919, 3924, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5416, 5426, 5433, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5716, 5721, 5785, 5796, 5824, 6101, 6121, 6129

< 29{BO315.50 RJ UA6}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3911, 3912, 3918, 3919, 3924, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5416, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5607, 5721, 5796, 5824, 6101, 6121, 6129

< 28{BO312.90 RJ UA6}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3911, 3918, 3919, 3924, 3947, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5426, 5436, 5481, 5506, 5510, 5544, 5565, 5568, 5607, 5721, 5824, 6101, 6121, 6129

< 27{BO312.00 RJ UA6}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3227, 3228, 3255, 3263, 3280, 3281, 3284, 3285, 3286, 3287, 3291, 3293, 3911, 3918, 3919, 3924, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5426, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5721, 5824, 6101, 6121

< 26{BO311.20 RJ UA6-7}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3911, 3919, 3924, 3955, 4073, 5003, 5042, 5055, 5065, 5132, 5183, 5209, 5409, 5410, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5721, 5824, 6101, 6121, 6129

< 25{RK 1083 309.50m POB UA11}: 3065, 3087, 3255

< 24{RK 1082 308.00m POB UA11}: 3065, 3066, 3087, 3092, 3094, 3096, 3113, 3171, 3202, 3203, 3226, 3227, 3255

< 23{BO306.20 RJ UA3}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3096, 3097, 3113, 3121, 3161, 3165, 3171, 3185, 3203, 3213, 3225, 3227, 3228, 3255, 3263, 3280, 3286, 3287, 3291, 3293, 3911, 3919, 3924, 3955, 4073, 5003, 5042, 5065, 5132, 5183, 5209, 5410, 5436, 5506, 5607, 5721, 5824, 6101

< 22{BO305.00 RJ UA3}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3096, 3097, 3113, 3121, 3161, 3165, 3171, 3203, 3225, 3227, 3228, 3255, 3263, 3280, 3286, 3287, 3291, 3293, 3924, 4073, 5003, 5410, 5607, 6101

< 21{BO304.00 POB UA11 RJ UA3}: 3022, 3062, 3065, 3066, 3087, 3090, 3092, 3094, 3096, 3097, 3113, 3121, 3161, 3165, 3171, 3203, 3225, 3226, 3227, 3228, 3263, 3280, 3286, 3287, 3291, 3293, 5607, 6101

< 20{RK 1079 POB UA10}: 3017, 3065, 3066, 3087, 3094, 3095, 3096, 3103, 3113, 3122, 3161, 3171, 3203, 3225, 3226, 3227, 3263, 4069

< 19{RK 1078 POB UA10}: 3017, 3065, 3087, 3094, 3095, 3096, 3103, 3113, 3122, 3123, 3161, 3171, 3203, 3225, 3227, 3263, 4069

< 18{RK 1076 POB UA10}: 3017, 3065, 3087, 3094, 3095, 3096, 3103, 3113, 3122, 3123, 3161, 3171, 3203, 3225, 3227, 3263, 4069

< 17{BO294.60 POB UA10 RJ UA2}: 3017, 3065, 3087, 3094, 3095, 3096, 3097, 3103, 3113, 3121, 3122, 3123, 3160, 3161, 3171, 3203, 3215, 3227, 3230, 3263, 3286, 4069

< 16{BO292.20 POB UA10 RJ UA1}: 3017, 3065, 3087, 3094, 3095, 3096, 3103, 3113, 3121, 3122, 3123, 3160, 3161, 3164, 3171, 3203, 3215, 3216, 3230, 3241, 3263, 3286, 4069

< 15{BO289.80 POB UA9 RJ UA1}: 3017, 3065, 3087, 3094, 3095, 3096, 3097, 3103, 3113, 3121, 3122, 3123, 3160, 3161, 3164, 3166, 3171, 3215, 3216, 3230, 3241, 3263, 3286, 4069

< 14{RK 1072 POB UA8}: 3017, 3064, 3085, 3095, 3096, 3097, 3103, 3113, 3122, 3123, 3160, 3161, 3164, 3166, 3171, 3215, 3216, 3230, 3263, 4069

< 13{BO279.30 POB UA8}: 3017, 3036, 3064, 3085, 3095, 3096, 3097, 3103, 3113, 3122, 3123, 3160, 3161, 3164, 3166, 3171, 3215, 3216, 3230, 3263, 4069

< 12{RK 1071 POB UA8}: 3017, 3036, 3064, 3085, 3095, 3096, 3097, 3103, 3113, 3118, 3121, 3122, 3123, 3160, 3161, 3164, 3166, 3171, 3199, 3215, 3230, 3263, 4069

< 11{W79-223 POB UA8}: 3017, 3036, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3118, 3121, 3122, 3123, 3160, 3161, 3164, 3166, 3171, 3181, 3199, 3215, 3230, 3263, 4069

< 10{RK 1070 POB UA5-6}: 3017, 3036, 3064, 3076, 3085, 3095, 3096, 3100, 3103, 3117, 3118, 3121, 3122, 3123, 3160, 3161, 3164, 3166, 3181, 3199, 3210, 3215

< 9{BO 268.00 POB UA5-6}: 3017, 3036, 3064, 3085, 3095, 3096, 3103, 3118, 3121, 3122, 3123, 3160, 3164, 3166, 3181, 3210, 3215

< 8{RK1065 POB UA5-6}: 3008, 3017, 3033, 3036, 3064, 3095, 3096, 3103, 3118, 3121, 3123, 3160, 3164, 3166, 3169, 3181, 3210, 3215, 3218, 3223, 3243, 3244

< 7{RK 1064 POB UA4-6}: 3008, 3012, 3017, 3052, 3055, 3064, 3095, 3096, 3103, 3118, 3121, 3123, 3160, 3164, 3169, 3180, 3181, 3210, 3215, 3244

< 6{RK 1062 POB UA3-6}: 3008, 3012, 3052, 3055, 3064, 3095, 3096, 3103, 3110, 3118, 3121, 3123, 3160, 3164, 3169, 3180, 3181, 3210, 3215, 3244
< 5{RK 1059 POB UA3-4}: 3008, 3012, 3049, 3051, 3052, 3055, 3059, 3064, 3095, 3096, 3103, 3118, 3121, 3123, 3124, 3144, 3160, 3164, 3169, 3180, 3181, 3210, 3221, 3244, 3273, 3277
< 4{BO254.50 POB UA3-4}: 3008, 3012, 3049, 3051, 3052, 3055, 3059, 3064, 3096, 3103, 3118, 3124, 3160, 3169, 3181, 3210, 3244, 3273
< 3{W79-227 POB UA1}: 3012, 3049, 3051, 3052, 3055, 3064, 3096, 3103, 3118, 3124, 3169, 3181, 3210, 3231, 3273
< 2{BO234.30 POB UA1}: 3055, 3061, 3074, 3096, 3103, 3124, 3181, 3210, 3231, 3273
< 1{BO230.80 POB UA0 ok19/12/91pob}: 3001, 3006, 3030, 3039, 3041, 3064,3071, 3074, 3088, 3089, 3096, 3124, 3158, 3194, 3210, 3231, 3247, 3253, 3273, 3278, 3303, 3414, 4010, 4061, 4063, 4066

SECTION 56_RJ7_VALDORBIA_JUR_CRET: bottom 1 - top 25
< 25{V-10.00 RJ UA7}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3165, 3171, 3185, 3203, 3213, 3228, 3255, 3263, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3591, 3924, 3947, 4073, 5042, 5132, 5183, 5186, 5209, 5243, 5409, 5416, 5426, 5433, 5506, 5510, 5565, 5568, 5577, 5578, 5607, 5721, 5796, 5824, 6101, 6121, 6129
< 24{V-6.50 RJ UA6-7}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3165, 3167, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3919, 3924, 3947, 4073, 5003, 5042, 5132, 5183, 5209, 5243, 5396, 5409, 5416, 5426, 5433, 5462, 5481, 5506, 5568, 5577, 5578, 5580, 5607, 5721, 5785, 5796, 5824, 6101, 6121, 6129
< 23{V-6.20 RJ UA6-7}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3165, 3167, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3911, 3919, 3924, 3947, 4073, 5003, 5042, 5132, 5183, 5209, 5243, 5396, 5409, 5426, 5433, 5436, 5481, 5506, 5568, 5577, 5578, 5607, 5674, 5721, 5785, 5796, 5824, 6101, 6121, 6129
< 22{V-6.00 POB UA11 RJ UA6}: 3022, 3062, 3065, 3066, 3087, 3090, 3092, 3097, 3113, 3161, 3162, 3165, 3167, 3171, 3185, 3202, 3203, 3213, 3226, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3911, 3912, 3918, 3919, 3924, 3947, 4073, 5003, 5042, 5132, 5183, 5209, 5243, 5396, 5409, 5426, 5436, 5568, 5577, 5578, 5607, 5674, 5721, 5785, 5796, 5824, 6101, 6121, 6129
< 21{V0.40 RJ UA6}: 3022, 3062, 3065, 3066, 3090, 3092, 3097, 3113, 3161, 3162, 3165, 3167, 3171, 3185, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3280, 3281, 3282, 3285, 3286, 3287, 3291, 3293, 3591, 3912, 3918, 3924, 3947, 4073, 5003, 5042, 5132, 5183, 5209, 5243, 5396, 5409, 5426, 5436, 5568, 5577, 5578, 5607, 5721, 5785, 5796, 5824, 6101, 6121, 6129
< 20{V2.00 RJ UA6}: 3022, 3062, 3065, 3090, 3092, 3097, 3113, 3161, 3165, 3167, 3171, 3203, 3213, 3225, 3227, 3228, 3255, 3263, 3280, 3281, 3282, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3918, 3924, 3947, 3955, 4073, 5003, 5042, 5132, 5163, 5183, 5209, 5243, 5396, 5409, 5426, 5436, 5568, 5577, 5578, 5607, 5721, 5796, 5824, 6101, 6121, 6129
< 19{V5.00 RJ UA6}: 3022, 3062, 3065, 3090, 3092, 3097, 3113, 3161, 3165, 3171, 3203, 3213, 3225, 3227, 3228, 3263, 3280, 3281, 3286, 3912, 3918, 3924, 5003, 5042, 5132, 5183, 5209, 5426, 5436, 5607, 5721, 5796, 5824, 6101, 6129
< 18{V23.70 POB UA11}: 3087, 3065, 3113, 3161, 3165, 3171, 3203, 3227, 3286
< 17{V33.00 POB UA11}: 3113, 3161, 3165, 3171, 3203, 3227, 3228, 3286
< 16{V41.65 POB UA11 RJ UA4-7}: 3065, 3090, 3097, 3113, 3161, 3165, 3171, 3203, 3213, 3225, 3227, 3263, 3286, 3912, 3924, 5132, 6101
< 15{V46.10 POB UA11}: 3113, 3161, 3165, 3171, 3203, 3286
< 14{V47.60 RJ UA4}: 3065, 3090, 3097, 3113, 3121, 3161, 3165, 3171, 3203, 3213, 3263, 3286, 3912, 5132, 6101
< 13{V51.25 POB UA10}: 3113, 3122, 3161, 3171, 3286
< 12{V60.70 POB UA10}: 3113, 3122, 3161, 3286
< 11{V65.90 POB UA10 RJ UA1}: 3064, 3095, 3096, 3097, 3113, 3121, 3122, 3161, 3164, 3171, 3230, 3241, 3263, 3286
< 10{V71.00 POB UA7-8 RJ UA1}: 3009, 3036, 3064, 3085, 3096, 3100, 3103, 3113, 3117, 3121, 3122, 3123, 3161, 3164, 3181, 3215, 3230, 3241, 3263, 4069
< 9{V74.00 POB UA7-8}: 3085, 3064, 3103, 3121, 3122, 3164, 3181, 3230, 4069
< 8{V98.00 POB UA4-7}: 3008, 3064, 3085, 3103, 3140, 3164, 3181, 3244
< 7{V102.80 POB UA3-5}: 3005, 3008, 3012, 3051, 3052, 3055, 3061, 3064, 3085, 3103, 3110, 3159, 3164, 3181, 3197, 3277
< 6{V112.60 POB UA3}: 3008, 3012, 3052, 3055, 3064, 3074, 3085, 3103, 3159, 3160, 3181, 3197
< 5{V118.50 POB UA3}: 3008, 3055, 3064, 3074, 3085, 3096, 3103, 3124, 3144, 3152, 3159, 3181, 3197, 3273
< 4{V130.30 POB UA0}: 3006, 3055, 3074, 3096, 3158, 3181
< 3{V132.70 POB UA0}: 3006, 3055, 3074, 3158, 3181, 3231
< 2{V133.60 POB UA0}: 3006, 3074, 3159, 3231
< 1{V135.50 POB UA0}: 3074, 3158, 3231

SECTION 57_RJ5_RANCHI_SUP: bottom 1 - top 4
{< 10{MN47.70 RJ UA32}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3202, 3228, 3255, 3263, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5012, 5032, 5044, 5069, 5073, 5090,

5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5261, 5262, 5267, 5274, 5287, 5296, 5314, 5357, 5359, 5397, 5426, 5427, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5575, 5576, 5580, 5582, 5595, 5607, 5620, 5636, 5668, 5673, 5674, 5711, 5712, 5721, 5744, 5766, 5771, 5773, 5902, 5903, 5913, 5927, 6121

< 9{MN45.50 RJ UA31-32}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3228, 3255, 3263, 3285, 3287, 3291, 3293, 3295, 3947, 4073, 5011, 5032, 5033, 5046, 5073, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5287, 5296, 5359, 5369, 5426, 5462, 5481, 5511, 5521, 5524, 5544, 5575, 5576, 5580, 5582, 5595, 5607, 5620, 5636, 5668, 5674, 5712, 5771, 5902, 5903, 5913, 5927, 6121, 6123

< 8{MN39-40 RJ UA26-27}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3161, 3162, 3185, 3202, 3228, 3255, 3263, 3282, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5011, 5032, 5033, 5041, 5073, 5163, 5183, 5186, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5287, 5290, 5296, 5359, 5426, 5462, 5481, 5521, 5544, 5575, 5576, 5580, 5595, 5607, 5636, 5674, 5712, 5902, 5913, 5927, 6121, 6123, 6129

< 7{MN37.05 RJ UA24}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5003, 5011, 5032, 5033, 5055, 5073, 5183, 5186, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5290, 5296, 5359, 5416, 5426, 5462, 5481, 5521, 5544, 5575, 5576, 5578, 5580, 5595, 5607, 5636, 5672, 5674, 5712, 5716, 5913, 6121, 6123, 6129

< 6{MN30.20 RJ UA18-24}: 3062, 3063, 3065, 3090, 3092, 3113, 3161, 3162, 3185, 3202, 3227, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5003, 5183, 5186, 5194, 5204, 5261, 5359, 5426, 5462, 5481, 5576, 5578, 5580, 5607, 5672, 5712, 6121, 6123, 6129

< 5{MN24.50 RJ UA17}: 3062, 3063, 3065, 3113, 3161, 3185, 3202, 3203, 3227, 3255, 3263, 3266, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 4073, 5183, 5204, 5359, 5409, 5426, 5462, 5481, 5572, 5576, 5578, 5580, 5607, 5672, 5785, 6121, 6123, 6129}

< 4{MN18.70 RJ UA5-15}: 3066, 3161, 3213, 3266, 3282, 3283, 3285, 3286, 3291, 3955, 5132, 5568, 5785, 6121, 6129

< 3{MN7.30 POB UA8-9}: 3171, 3181, 3216, 4069

< 2{MN6.60 POB UA8}: 3161, 3169, 3171, 3181

< 1{MN3.00 POB UA2-3}: 3051, 3055, 3064, 3074, 3085, 3159, 3160, 3164, 3181, 3197, 3244

SECTION POBRJ6_CAMPO_AL_BELLO: bottom 1 - top 4

< 4{POB1592 RJ UA31-33}: 3065, 3090, 3092, 3094, 3162, 3185, 3228, 3285, 3293, 4037, 5012, 5042, 5049, 5069, 5073, 5090, 5163, 5186, 5193, 5194, 5199, 5204, 5261, 5262, 5266, 5267, 5274, 5287, 5314, 5359, 5422, 5469, 5511, 5521, 5532, 5553, 5595, 5607, 5620, 5641, 5674, 5901, 5913, 5927, 6121

< 3{POB1590 RJ UA29-33}: 3065, 3090, 3092, 3094, 3113, 3162, 3228, 3255, 3285, 3295, 3947, 4073, 5012, 5042, 5065, 5069, 5073, 5090, 5166, 5186, 5193, 5196, 5199, 5204, 5243, 5261, 5262, 5266, 5274, 5287, 5422, 5462, 5511, 5553, 5595, 5607, 5620, 5636, 5674, 5901, 5902, 5903, 5913, 5927, 6121

< 2{POB1589 RJ UA29-33}: 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3228, 3255, 3285, 3295, 3947, 4073, 5012, 5042, 5044, 5046, 5055, 5069, 5073, 5090, 5166, 5183, 5186, 5193, 5199, 5204, 5243, 5253, 5261, 5262, 5266, 5274, 5287, 5422, 5511, 5544, 5553, 5595, 5607, 5620, 5674, 5711, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 1{POB1584 sample ch.29/11/91pob}: 3009, 3085, 3094, 3095, 3122, 3161, 3164

SECTION *POB28_SANTA_ANNA: bottom 1-top 4

< 4 {S4}: 3013, 3017, 3034, 3052, 3062, 3090, 3095, 3104, 3118, 3122, 3139, 3161, 3162, 3164, 3181, 3199, 3210, 3215, 3216, 3230, 3254, 3263, 3267, 4069

< 3 {S3}: 3008, 3017, 3036, 3066, 3097, 3111, 3113, 3121, 3122, 3123, 3160, 3161, 3164, 3169, 3171, 3197, 3199, 3225, 3226, 3230, 4069

< 2 {S2}: 3008, 3017, 3036, 3066, 3121, 3123, 3160, 3161, 3164, 3171, 3226, 3230

< 1 {S1}: 3017, 3036, 3064, 3085, 3096, 3123, 3160, 3161, 3164, 3171, 3230

SECTION *POB10_PINDOS: bottom 1-top 3

< 3 {B78-139}: 3284, 3295, 5073

< 2 {B78-76}: 3095, 3118, 3119, 3121, 3122, 3160, 3161, 3163, 3164, 3216, 3230, 3254, 4069

< 1 {B78-54}: 3017, 3113, 3140

SECTION *POB11_MARATHOS: bottom 1-top 6

< 6 {LN80/76}: 3295, 5073

< 5 {LN78/76}: 3286, 3161, 3295, 5073

< 4 {LN58/77}: 3122, 3161, 3164, 3203

< 3{LN54}: 3122, 3161, 3164, 3171, 3215

< 2{LN51/76}: 3161, 3171, 3181, 3215

< 1{LN50a/76}: 3137, 3180

SECTION *POB49_C_31_SIMANTOV: bottom 1-top 1

< 1 {C31}: 3017, 3033, 3051, 3055, 3076, 3103, 3118, 3121, 3124, 3164, 3181, 3197, 3210, 3273

SECTION *POB51_ACHLADI_GREECE: bottom 1-top 1

< 1 {DB45-75}: 3012, 3017, 3052, 3103, 3181, 3197, 3263

SECTION COMPOSITE_ARGOLIS_PENINSU: bottom 1-top 13

< 13{POB668.2-8.ok18/12/91pob}: 3014, 3017, 3064, 3065, 3069, 3078, 3082, 3085, 3096, 3117, 3121, 3122, 3123, 3162, 3164, 3177, 3180, 3181, 3182, 3197, 3213, 3215, 3216, 3224, 3230, 3241, 3263, 4069

< 12{POB1061.2-7.ok18/12/91pob}: 3017, 3022, 3064, 3085, 3096, 3117, 3121, 3122, 3123, 3162, 3164, 3169, 3180, 3181, 3197, 3215, 3216, 3230, 3241, 3263, 3290, 4069 .
< 11{POB154.2-6.ok18/12/91pob}: 3014, 3017, 3020, 3022, 3035, 3064, 3078, 3085, 3095, 3096, 3117, 3118, 3122, 3123, 3124, 3137, 3139, 3160, 3161, 3162, 3164, 3169, 3177, 3180, 3181, 3182, 3187, 3189, 3193, 3197, 3215, 3224, 3230, 3241, 3259, 3263, 3273, 3274, 3290, 4069
< 10{POB770. 4-3}: 3017, 3066, 3095, 3096, 3097, 3113, 3118, 3122, 3160, 3161, 3164, 3167, 3169, 3180, 3181, 3193, 3199, 3213, 3215, 3224, 3226, 3241, 3263, 3267, 3274, 4069
< 9{POB774. 4-2}: 3017, 3034, 3064, 3085, 3096, 3097, 3118, 3121, 3122, 3124, 3160, 3161, 3162, 3164, 3169, 3180, 3181, 3197, 3199, 3215, 3241, 3263, 3273, 4069
< 8{POB783. 4-1}: 3017, 3020, 3034, 3036, 3064, 3065, 3083, 3085, 3096, 3097, 3103, 3118, 3119, 3122, 3137, 3160, 3161, 3162, 3164, 3166, 3180, 3181, 3193, 3197, 3199, 3213, 3215, 3216, 3218, 3230, 3241, 3243, 3258, 3263, 4004, 4069
< 7{POB137.2-5ok18/12/91pob}: 3014, 3017, 3022, 3034, 3035, 3064, 3065, 3069, 3078, 3082, 3085, 3095, 3096, 3103, 3111, 3112, 3117, 3118, 3121, 3122, 3123, 3124, 3126, 3137, 3139, 3140, 3160, 3161, 3162, 3164, 3166, 3167, 3168, 3169, 3177, 3180, 3181, 3189, 3193, 3197, 3206, 3213, 3215, 3216, 3224, 3230, 3241, 3245, 3259, 3263, 3273, 3274, 3290, 4069, 4073
< 6{ABV124.1-3}: 3017, 3020, 3034, 3036, 3062, 3096, 3111, 3112, 3116, 3118, 3122, 3124, 3161, 3162, 3164, 3169, 3216, 3230, 3263, 3273, 4069, 4073
< 5{ABV123.1-2}: 3017, 3020, 3035, 3062, 3065, 3083, 3111, 3112, 3118, 3161, 3216, 3230, 3263, 4073
< 4{POB899.2-4. ok18/12/91pob}: 3009, 3014, 3017, 3021, 3022, 3024, 3034, 3035, 3036, 3062, 3064, 3065, 3069, 3070, 3078, 3081, 3082, 3083, 3085, 3090, 3091, 3095, 3096, 3097, 3100, 3103, 3104, 3105, 3106, 3108, 3112, 3113, 3116, 3117, 3118, 3119, 3121, 3122, 3123, 3124, 3126, 3127, 3129, 3131, 3133, 3135, 3137, 3139, 3140, 3144, 3147, 3160, 3161, 3162, 3163, 3164, 3166, 3167, 3169, 3180, 3181, 3185, 3189, 3193, 3197, 3199, 3204, 3205, 3206, 3210, 3212, 3213, 3215, 3216, 3217, 3218, 3220, 3223, 3224, 3225, 3230, 3240, 3241, 3243, 3245, 3254, 3259, 3261, 3263, 3265, 3273, 3274, 3290, 4004, 4006, 4069, 4073
< 3{POB144.2-3ok18/12/91pob}: 3017, 3034, 3035, 3036, 3062, 3064, 3065, 3070, 3078, 3082, 3085, 3095, 3096, 3103, 3104, 3105, 3113, 3116, 3118, 3119, 3121, 3122, 3123, 3127, 3129, 3131, 3135, 3139, 3140, 3147, 3160, 3161 , 3164, 3167, 3169, 3180, 3181, 3199, 3210, 3213, 3215, 3223, 3224, 3230, 3240, 3241, 3245, 3254, 3261, 3263, 3265, 3274, 3290, 4004, 4069
< 2{POB28.2-2ok18/12/91pob}: 3008, 3014, 3017, 3034, 3035, 3036, 3062, 3064, 3065, 3070, 3078, 3081, 3082, 3085, 3090, 3095, 3096, 3097, 3100, 3103, 3104, 3105, 3106, 3112, 3113, 3116, 3117, 3118, 3119, 3121, 3122, 3123, 3126, 3129, 3131, 3133, 3135, 3137, 3139, 3140, 3144, 3147, 3160, 3161, 3164, 3167, 3169, 3180, 3181, 3193, 3197, 3199, 3210, 3212, 3213, 3215, 3216, 3217, 3218, 3223, 3224, 3225, 3230, 3240, 3241, 3243, 3245, 3254, 3259, 3261, 3263, 3265, 3274, 3290, 3412 , 4004, 4069, 4073
< 1{POB22.2-1ok18/12/91pob}: 3013, 3022, 3052, 3095, 3096, 3103, 3104, 3118, 3121, 3123, 3140, 3160, 3161, 3163, 3164, 3166, 3180, 3181, 3189, 3193, 3199, 3223, 3224, 3241, 3263, 3274, 4069

SECTION POB7_8_THEOKAFTA_KOLIAKI_COM: bottom 1-top 5
< 5{POB986. 8.1}: 3017, 3020, 3034, 3064, 3066, 3085, 3090, 3092, 3094, 3095, 3096, 3097, 3100, 3103, 3104, 3111, 3112, 3113, 3115, 3116, 3118, 3121, 3122, 3123, 3124, 3135, 3037, 3139, 3144, 3161, 3168, 3171, 3176, 3177, 3181, 3187, 3197, 3203, 3215, 3216, 3226, 3254, 3258, 3263, 3265, 3273, 3406, 4069, 4073
< 4 {POB1261}: 3012, 3017, 3052, 3066, 3096, 3116, 3118, 3121, 3123, 3161, 3179, 3181, 3216, 3226, 3263, 4069
< 3 {POB325}: 3012, 3017, 3020, 3033, 3051, 3052, 3054, 3055, 3059, 3064, 3076, 3085, 3103, 3123, 3124, 3159, 3160, 3164, 3169, 3179, 3180, 3181, 3194, 3197, 3218, 3221, 3223, 3243, 3273, 3277
< 2 {POB1262}: 3012, 3039, 3040, 3048, 3050, 3051, 3052, 3054, 3064, 3085, 3181, 3192, 3194, 3231, 4049, 4052
< 1 {POB1263}: 3006, 3012, 3039, 3048, 3052, 3064, 3074, 3085, 3231

SECTION *POB1_DHIMAINA: bottom 1-top 9
< 9 {ABV 134}: 3012, 3017, 3052, 3111, 3161, 4073
< 8 {ABV 133}: 3012, 3017, 3052, 3111, 3161, 3263, 4073
< 7 {ABV 132}: 3012, 3017, 3052, 3054, 3111, 3161, 3263, 4073
< 6 {ABV 131}: 3017, 3096, 3111, 3161, 3263, 4073
< 5 {ABV 129}: 3017, 3062, 3096, 3111, 3161, 3164, 3263, 4073
< 4 {ABV 127}: 3017, 3062, 3096, 3111, 3161, 3164, 3230, 3263, 4073
< 3 {ABV 124}: 3017, 3020, 3034, 3036, 3062, 3096, 3111, 3112, 3116, 3118, 3122, 3124, 3161, 3162, 3164, 3169, 3216, 3230, 3263, 3273, 4069, 4073
< 2 {ABV 123}: 3017, 3020, 3035, 3062, 3065, 3083, 3111, 3112, 3118, 3161, 3216, 3230, 3263, 4073
< 1 {ABV 122}: 3062, 3065, 3078, 3083, 3095, 3118, 3123, 3216, 3218, 3230, 3243, 3263

SECTION *POB3_PROSIMNI: bottom 1-top 3
< 3 {ABV 272}: 3017, 3034, 3065, 3078, 3083, 3161, 3164, 3213, 3216, 3218, 3224, 3230, 3243, 3263, 4069
< 2 {ABV 267}: 3017, 3066, 3161, 3216, 3226, 3230, 3263, 4069
< 1 {ABV 266}: 3017, 3062, 3065, 3078, 3083, 3095, 3096, 3122, 3160, 3161, 3162, 3213, 3215, 3216, 3224, 3230, 3254, 3263, 4069

SECTION *POB5_KANDHIA: bottom 1-top 2
< 2 {POB284.5}: 3017, 3034, 3036, 3064, 3078, 3085, 3095, 3096, 3097, 3105, 3113, 3117, 3118, 3122, 3123, 3161, 3164, 3167, 3168, 3169, 3171, 3181, 3193, 3197, 3213, 3215, 3216, 3224, 3230, 3241, 3258, 3259, 3263, 3274, 4069
< 1 {POB1050}: 3017, 3034, 3035, 3066, 3090, 3095, 3096, 3097, 3105, 3119, 3122, 3161, 3164, 3168, 3169, 3171, 3181, 3188, 3193, 3197, 3215, 3216, 3224, 3226, 3230, 3241, 3254, 3259, 3263, 3274, 4069

SECTION *POB9_RHADON: bottom 1-top 1
< 1 {POB926}: 3013, 3015, 3016, 3020, 3042, 3052, 3096, 3118, 3160, 3180, 4044

SECTION *POB13_LACU_ROSU: bottom 1-top 1
< 1 {LEAN ROSU, HAGHIMAS MOUNTAINS, ROMANIA, 1}: 3008, 3013, 3020, 3035, 3052, 3096, 3121, 3160, 3180, 3181

SECTION *POB14_PIATRA_SOIMULUI: bottom 1-top 1 {also inChapter 24: by P. Dumitrica}
< 1 {R 102}: 3013, 3017, 3069, 3070, 3085, 3095, 3100, 3103, 3118, 3119, 3121, 3122, 3123, 3129, 3137, 3139, 3160, 3161, 3163, 3181, 3182, 3187, 3193, 3210, 3224, 3241, 3245, 3259, 3263, 3267, 3279, 3292, 3298, 3305, 4023, 4060, 4072
{R 102 old}: 3013, 3017, 3052, 3096, 3103, 3118, 3119, 3121, 3122, 3161, 3164, 3181, 3223, 3244, 3263, 3267, 4069}

SECTION POB15_GOMIELOR_VALLEY: bottom 1-top 1
< 1 {KO 1981}: 3121, 3123, 3160, 3223

SECTION *POB50_JEBEL_AL_HASI_OMAN: bottom 1-top 1
< 1 {DB6214}: 3054, 3064, 3074, 3085, 3096, 3125, 3126, 3159, 3169, 3181, 3197, 3231, 3244

SECTION *POB42_SUR_OMAN: bottom 1-top 2
< 2 {OM191}: 3087, 3065, 3092, 3094, 3096, 3228, 3287, 3291, 3295, 5073, 5229, 5462
< 1 {OM200}: 3087, 3065, 3066, 3161, 3171, 3203, 3226, 3286, 3287, 3291

SECTION *POB31_DSDP_LEG_17: bottom 1-top 6
< 6 {167-69-3-36}: 3087, 3065, 3161, 3203, 3286, 3287, 3293, 5073, 5229, 5462
< 5 {167-74-2-65}: 3087, 3065, 3161, 3254, 3267, 3286, 3287, 3293, 5073, 5229
< 4 {167-76-2-65}: 3087, 3065, 3161, 3254, 3267, 3286, 3287, 3293, 5073, 5229
< 3 {167-88-CC}: 3087, 3065, 3092, 3097, 3112, 3161, 3227, 3254, 3255, 3267, 3286, 3287, 3293, 4073, 5073
< 2 {167-93-2-22}: 3087, 3065, 3111, 3112, 3118, 3161, 3171, 3254, 3255, 3267, 3286, 3287, 3293, 4073
< 1 {167-94-2-40}: 3020, 3161, 3171, 3230, 3254, 3267, 3286

SECTION *POB32_DSDP_LEG_32_SITE_306: bottom 1-top 7
< 7 {306-14-CC}: 3090, 3092, 3094, 3112, 3228, 3263, 3293, 4073
< 6 {306-16-CC}: 3090, 3092, 3094, 3112, 3161, 3228, 3263, 3286, 3293, 4073
< 5 {306-21-CC}: 3090, 3092, 3094, 3112, 3161, 3203, 3263, 3286, 3293, 4073
< 4 {306-40-1-119}: 3062, 3065, 3087, 3090, 3092, 3094, 3097, 3112, 3113, 3161, 3171, 3202, 3203, 3255, 3263, 3286, 3293, 4073
< 3 {306-41-CC}: 3062, 3065, 3087, 3090, 3092, 3094, 3097, 3112, 3161, 3165, 3171, 3202, 3203, 3255, 3263, 3284, 3285, 3286, 3287, 3293, 3295, 4073, 6121
< 2 {306-42-1-103}: 3062, 3065, 3087, 3090, 3092, 3097, 3112, 3161, 3165, 3171, 3202, 3203, 3227, 3255, 3263, 3280, 3284, 3285, 3286, 3293, 3295, 4073, 6121
< 1 {306-42-1-116}: 3062, 3065, 3087, 3090, 3092, 3097, 3112, 3161, 3171, 3202, 3203, 3255, 3263, 3286, 4073

SECTION *POB33_DSDP_LEG_32_SITE_307: bottom 1-top 6
< 6 {307-6-CC}: 3087, 3065, 3092, 3094, 3228, 3293, 5229
< 5 {307-7-1-75}: 3087, 3065, 3090, 3092, 3094, 3111, 3112, 3228, 3263, 3287, 3293, 3295, 4073, 5073, 5229, 5462
< 4 {307-8-CC}: 3062, 3065, 3087, 3090, 3092, 3094, 3161, 3202, 3203, 3228, 3255, 3263, 3281, 3286, 3287, 3293, 3295, 5229, 5462
< 3 {307-9-1-80}: 3062, 3065, 3087, 3090, 3092, 3094, 3161, 3202, 3203, 3228, 3255, 3263, 3286, 3293, 5229
< 2 {307-10-1-119}: 3062, 3065, 3087, 3090, 3092, 3097, 3161, 3202, 3203, 3255, 3263, 3286, 3293
< 1 {307-12-1-120}: 3087, 3065, 3097, 3161, 3203, 3255, 3263, 3286, 3293

SECTION *POB34_DSDP_LEG_20_SITE_195: bottom 1-top 4
< 4 {195-3-CC}: 3112, 3228, 3255, 3293, 4073
< 3 {195-4-CC}: 3062, 3090, 3092, 3228, 3255, 3291, 3293, 5229
< 2 {195-B1-CC}: 3062, 3090, 3092, 3202, 3255, 5229
< 1 {195-B2-CC}: 3062, 3090, 3092, 3202, 3255, 5229

SECTION *POB35_DSDP_LEG_20_SITE_196: bottom 1-top 3
< 3 {196-3-1}: 3062, 3065, 3087, 3090, 3092, 3094, 3112, 3202, 3228, 3291, 3293, 4073, 5229
< 2 {196-4-1-P3}: 3062, 3065, 3087, 3090, 3092, 3094, 3111, 3112, 3202, 3228, 3285, 3291, 3293, 3295, 4073, 5229, 6121
< 1 {196-5-CC}: 3062, 3065, 3066, 3087, 3090, 3092, 3097, 3112, 3113, 3161, 3171, 3202, 3203, 3226, 3255, 3263, 3280, 3285, 3286, 3287, 3293, 4073, 6121

SECTION *POB37_POINT_SAL: bottom 1-top 3
< 3 {NFS 909}: 3036, 3096, 3117, 3137, 3161, 3180, 3199, 3225
< 2 {NFS 908}: 3017, 3020, 3034, 3036, 3064, 3066, 3085, 3095, 3096, 3097, 3100, 3104, 3113, 3116, 3117, 3119,

3123, 3124, 3126, 3135, 3137, 3139, 3161, 3163, 3164, 3180, 3199, 3215, 3225, 3226, 3230, 3263, 3273

< 1 {NFS 907}: 3008, 3017, 3020, 3034, 3036, 3064, 3085, 3095, 3096, 3100, 3103, 3104, 3105, 3111, 3113, 3116, 3117, 3118, 3119, 3121, 3123, 3124, 3126, 3137, 3140, 3144, 3152, 3160, 3161, 3162, 3163, 3164, 3166, 3169, 3180, 3199, 3210, 3215, 3218, 3225, 3230, 3243, 3254, 3263, 3267, 3273

SECTION ∗POB41_GUATEMALA_NICOYA: bottom 1-top 1

< 1 {2-18-1-79}: 3051, 3055, 3061, 3064, 3085, 3160, 3169, 3181, 3244

Chapter 6: Jurassic Radiolarians from the Lesser Caucasus (Koshuni River Basin) by V.S. Vishneskaya

SECTION ∗VV1_Zod_Pass: bottom 1-top 1

< 1 {Sample 0}: 3614, 3659

SECTION ∗VV2_Mt_Karawul: bottom 1-top 7

< 7 {Sample 011-4}: 3161, 3286, 5462, 5422, 3293, 5296, 3063

< 6 {Sample 011-3}: 3165, 3174, 3255, 3227, 3280, 3286, 5674

< 5 {Sample 011-2}: 3094, 3097, 3164, 3181, 3287, 3216

< 4 {Sample 139-37}: 3185, 3150, 3181, 3180, 3161, 3159, 3169, 3139, 3197, 3096, 3160, 3036, 3035, 3203, 3265, 3266, 3241, 3224, 3223, 3230

< 3 {Sample 07}: 3100, 3210, 3105, 3113, 3119, 3159, 3161, 3169, 3180, 3266, 3096, 3241, 3193

< 2 {Sample 05}: 3065, 3076, 3263, 3241, 3104, 3169, 5703, 3180, 3119

< 1 {Sample 146}: 3180, 3278, 3231, 4058

SECTION ∗VV3_Site_22: bottom 1-top 7

< 7 {Sample 3419}: 3017

< 6 {Sample 3421}: 3017, 3036, 3182, 3184, 3139, 3197

< 5 {Sample 3428}: 3035, 3116, 3273, 3278, 5012

< 4 {Sample 3429 T}: 3116, 3033, 2002, 3039, 2011

< 3 {Sample 3429}: 3033, 3064, 3096, 3116, 3144, 3180, 3307

< 2 {Sample 3430 T}: 3039, 2010

< 1 {Sample 3430}: 3649

Chapter 7: DSDP Site 535, Blake Bahama Basin, Central Northern Atlantic by P.O. Baumgartner

SECTION POBMA30_DSDP_LEG_76_S_534: bottom 1-top 28

{sample 12 did not exist in BG84 > only 27 samples}

< 28 {081-2-003}: 3062, 3063, 3065, 3087, 3092, 3245, 3263, 3281, 3284, 3287, 3289, 3291, 3293, 3294, 3295

< 27 {081-2-064}: 3062, 3063, 3065, 3087, 3090, 3092, 3255, 3263, 3284, 3287, 3289, 3291, 3293, 3294, 3295, 5073

< 26 {089-2-047}: 3062, 3065, 3087, 3094, 3112, 3171, 3225, 3227, 3255, 3263, 3280, 3281, 3282, 3283, 3284, 3285, 3288, 3289, 3290, 3291, 4073, 6121, 6129

< 25 {106-1-029}: 3020, 3037, 3063, 3066, 3078, 3081, 3090, 3091, 3092, 3094, 3095, 3096, 3097, 3100, 3113, 3131, 3138, 3161, 3164, 3167, 3168, 3170, 3171, 3177, 3182, 3188, 3193, 3197, 3213, 3215, 3216, 3217, 3218, 3224, 3226, 3230, 3240, 3243, 3245, 3258, 3263, 3265, 3290, 4069

< 24 {111-1-012}: 3002, 3012, 3013, 3015, 3021, 3023, 3031, 3047, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3064, 3076, 3085, 3109, 3121, 3124, 3150, 3164, 3169, 3180, 3181, 3213, 3220, 3223, 3235, 3240, 3244, 3273, 3276, 3277, 3279,3290, 3292

< 23 {115-1-070}: 3013, 3047, 3051, 3052, 3059, 3061, 3062, 3063, 3064, 3085, 3096, 3110, 3118, 3150, 3277, 3279, 3290

< 22 {117-1-032}: 3013, 3017, 3044, 3046, 3051, 3052, 3064, 3078, 3085, 3096, 3124, 3169, 3189, 3204, 3210, 3236, 3239, 3244, 3273, 3276, 3279

< 21 {120-1-052}: 3008, 3012, 3017, 3049, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3085, 3096, 3103, 3110, 3113, 3121, 3139, 3140, 3147, 3150, 3152, 3160, 3163, 3167, 3169, 3176, 3180, 3181, 3193, 3199, 3266, 3267, 3413

< 20 {121-1-025}: 3013, 3033, 3044, 3052, 3064, 3085, 3096, 3113, 3117, 3118, 3119, 3121, 3124, 3131, 3135, 3150, 3152, 3160, 3180, 3199, 3205, 3210, 3215, 3216, 3223, 3235, 3244, 3254, 3273, 3276

< 19 {121-1-052}: 3031, 3044, 3051, 3062, 3064, 3065, 3076, 3082, 3085, 3090, 3096, 3103, 3113, 3116, 3117, 3118, 3121, 3123, 3124, 3131, 3133, 3135, 3137, 3140, 3150, 3152, 3159, 3160, 3167, 3169, 3197, 3204, 3210, 3213, 3215, 3220, 3222, 3244, 3254, 3267, 3269, 3273, 3278, 3290, 3292, 4010

< 18 {122-1-042}: 3003, 3013, 3014, 3016, 3017, 3020, 3024, 3031, 3033, 3044, 3045, 3046, 3051, 3052, 3055, 3061, 3062, 3063, 3064, 3078, 3085, 3116, 3117, 3118, 3121, 3139, 3147, 3150, 3152, 3169, 3180, 3181, 3189, 3192, 3193, 3210, 3212, 3216, 3222, 3235, 3236, 3240, 3244, 3276, 3279, 3292, 4010

< 17 {122-1-131}: 3008, 3012, 3013, 3052, 3055, 3064, 3085, 3103, 3113, 3124, 3137, 3140, 3150, 3163, 3169, 3176, 3181, 3216, 3217, 3236, 3240, 3243, 3265, 3273, 3290, 3413

< 16 {123-2-037}: 3008, 3013, 3044, 3049, 3052, 3061,

3064, 3085, 3106, 3121, 3150, 3169, 3176, 3181, 3277
< 15 {124-2-097}: 3031, 3033, 3044, 3055, 3061, 3076, 3078, 3103, 3121, 3124, 3147, 3150, 3152, 3160, 3161, 3169, 3176, 3181, 3210, 3213, 3244, 3273, 3274, 3292, 3413
< 14 {124-1-041}: 3012, 3031, 3044, 3045, 3051, 3052, 3055, 3059{2}, 3061, 3076, 3078, 3124, 3160, 3181, 3210, 3240, 3244, 3268, 3273, 3276, 3277, 3279, 3290, 3292, 3413, 4044
< 13 {124-1-052}: 3002, 3003, 3012, 3013, 3028, 3031, 3033, 3043, 3044, 3045, 3046, 3051, 3052, 3059{2}, 3061, 3076, 3078, 3097, 3104, 3118, 3124, 3152, 3159, 3169, 3187, 3189, 3210, 3215, 3221, 3222, 3239, 3240, 3244, 3254, 3271, 3273, 3276, 3279{1}, 3292, 3413, 4010
< 12 {125-2-035}: 3003, 3012, 3015, 3020, 3023, 3031, 3033, 3043, 3047, 3051, 3052, 3059, 3062, 3064, 3076, 3078, 3085, 3110, 3118, 3121, 3124, 3150, 3160, 3169, 3180, 3181, 3189, 3204, 3210, 3213, 3215, 3221, 3222, 3239, 3244, 3273, 3276, 3290, 3292, 3413, 4005, 4010
< 11 {125-2-115}: 3003, 3008, 3012, 3013, 3015, 3020, 3024, 3031, 3033, 3043, 3051, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3085, 3096, 3118, 3121, 3124, 3150, 3159, 3160, 3169, 3180, 3189, 3197, 3204, 3210, 3212, 3213, 3215, 3223, 3235, 3236, 3240, 3244, 3267, 3269, 3270, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4063
< 10 {125-4-001}: 3008, 3012, 3013, 3020, 3021, 3031, 3043, 3047, 3051, 3052, 3055, 3059, 3061, 3064, 3070, 3076, 3078, 3085, 3110, 3118, 3124, 3150, 3164, 3180, 3181, 3187, 3189, 3197, 3210, 3215, 3221, 3223, 3235, 3244, 3269, 3273, 3276, 3277, 3278, 3292, 3413
< 9 {125-5-072}: 3012, 3013, 3031, 3047, 3051, 3052, 3054, 3055, 3059, 3061, 3063, 3064, 3070, 3076, 3078, 3085, 3096, 3100, 3110, 3118, 3121, 3124, 3150, 3174, 3180, 3181, 3189, 3193, 3197, 3204, 3205, 3210, 3215, 3216, 3220, 3221, 3222, 3223, 3235, 3240, 3244, 3267, 3268, 3269, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4010, 4044, 4071
< 8 {125-5-111}: 3002, 3008, 3012, 3013, 3015, 3020, 3023, 3024, 3031, 3033, 3045, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3063, 3064, 3069, 3070, 3076, 3078, 3085, 3096, 3118, 3139, 3150, 3159, 3169, 3180, 3181, 3187, 3192, 3197, 3204, 3235, 3239, 3240, 3244, 3261, 3270, 3271, 3277, 3292, 3413, 4063
< 7 {125-6-013}: 3008, 3012, 3051, 3052, 3061, 3110, 3150, 3160, 3161, 3164, 3167, 3169, 3181, 3197, 3244, 3274, 4044
< 6 {125-6-063}: 3002, 3008, 3012, 3013, 3020, 3021, 3024, 3031, 3033, 3047, 3049, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3063, 3064, 3078, 3085, 3096, 3110, 3121, 3124, 3150, 3164, 3169, 3180, 3181, 3187, 3197, 3213, 3215, 3222, 3223, 3235, 3240, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3278, 3292, 3413, 4005, 4010, 4044, 4063
< 5 {126-2-045}: 3002, 3008, 3012, 3021, 3031, 3047, 3051, 3052, 3055, 3061, 3064, 3065, 3082, 3085, 3096, 3110, 3117, 3118, 3121, 3124, 3133, 3140, 3150, 3159, 3164, 3180, 3181, 3215, 3220, 3221, 3235, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3290, 3413, 4005, 4063
< 4 {126-2-065}: 3008, 3012, 3013, 3015, 3020, 3021, 3031, 3032, 3047, 3052, 3054, 3055, 3061, 3064, 3074, 3076, 3078, 3085, 3096, 3100, 3110, 3118, 3121, 3124, 3150, 3180, 3181, 3187, 3197, 3210, 3213, 3216, 3220, 3221, 3223, 3235, 3239, 3244, 3268, 3270, 3271, 3273, 3277, 3279, 3290, 3413, 4063
< 3 {126-2-125}: 3003, 3007, 3008, 3012, 3013, 3015, 3020, 3023, 3024, 3031, 3032, 3033, 3043, 3047, 3049, 3051, 3052, 3055, 3061, 3062, 3063, 3064, 3065, 3076, 3078, 3082, 3085, 3096, 3097, 3100, 3109, 3110, 3117, 3118, 3124, 3125, 3133, 3150, 3159, 3164, 3167, 3169, 3180, 3181, 3187, 3197, 3210, 3213, 3215, 3220, 3235, 3236, 3240, 3244, 3268, 3269, 3270, 3271, 3273, 3277, 3292, 3413, 4005, 4044, 4063
< 2 {126-4-140}: 3031, 3043, 3045, 3047, 3051, 3055, 3061, 3064, 3078, 3085, 3125, 3180, 3197, 3235, 3244, 3268, 3276, 3290, 3413, 4005
< 1 {76-534A-127-1-13-15}: 3276, 3012, 3047, 3052, 3055, 3061, 3064, 3065, 3082, 3085, 3088, 3096, 3097, 3113, 3124, 3140, 3164, 3169, 3197, 3215, 3221, 3223, 3235, 3238, 3244, 3270, 3273, 3277, 3412, 3413, 4032, 4061, 4063, 4072

Chapter 8: Jurassic radiolarian from the Subbetic Realm (Southern Spain) by L. O'Dogherty *et al.*

SECTION LO_CASA_BLANCA: bottom 1-top 1
< 1 {89cb7}: 3051, 3064, 3192, 3197, 3231, 3297, 4044, 4054, 4058

SECTION 59_LO_S_HARANA_JA4_2: bottom 1-top 1
< 1 {JA4.2}: 3017, 3064, 3065, 3069, 3082, 3104, 3122, 3161, 3162, 3163, 3164, 3193, 3230, 3241, 3263, 3274, 3305, 3171, 3176, 4055,4069, 4073

SECTION 60_LO_ELVIRA: bottom 1-top 4
< 4 {90-AA-11}: 3051, 3193, 3279, 3292, 3297, 3298, 4044, 4055, 4060
< 3 {90-AA-8}: 3044, 3051, 3176, 3193, 3297, 3298, 4023, 4034, 4044, 4055
< 2 {90-AA-7}: 3044, 3045, 3051, 3061, 3164, 3169, 3176, 3193, 3197, 3238, 3290, 3297, 4010, 4014, 4023, 4044, 4060
< 1 {90A-C-1a}: 3013, 3051, 3052, 3064, 3164, 3192, 3197, 3231, 3237, 3238, 3277, 3297, 4014, 4034, 4044, 4045, 4054, 4058, 4060

SECTION LO_60A_CERRO_LA_MARTINA: bottom 1-top 2
< 1 {89L-M-6}: 3122, 3006, 3064, 3085, 3095, 3096, 3121, 3159, 3160, 3163, 3164, 3167, 3169, 3181, 3241, 3266
< 2 {89N-M-16. 0.5m below 16}: 3241, 3161, 3164, 3167, 3171, 3181, 3185, 3224, 3230, 3265, 3274, 4069

SECTION 58_LO__CB_7: bottom 1-top 1
1{CB-7}: 3051, {3084,} 3192, 3197, 3231, 3297, 4044, 4054, 4058

SECTION 45_POBLO_SIERRA_DE_RICOTE: bottom 1-top 30
< 30 {RI H 2.70}: 3171, 3161, 3203, 3286, 4069
< 29 {POB1768}: 3094, 3097, 3161, 3171, 3286, 4069
< 28 {POB1766}: 3094, 3097, 3100, 3161, 3171, 3177, 3218, 3243, 4069
< 27 {POB1760}: 3094, 3097, 3100, 3113, 3161, 3171, 3177, 3218, 3243, 4069
< 26 {POB1757}: 3094, 3097, 3100, 3103, 3113, 3122, 3161, 3171, 3177, 3218, 3243, 4069
< 25 {POB1755}: 3094, 3097, 3100, 3103, 3113, 3122, 3161, 3171, 3177, 3218, 3243, 3263, 4069
< 24 {POB1779}: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3218, 3230, 3243, 3263, 4069
< 23 {POB1778}: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 22 {POB1754}: 3094, 3095, 3097, 3100, 3103, 3113, 3122, 3161, 3164, 3171, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 21 {POB1777}: 3069, 3095, 3097, 3100, 3103, 3113, 3122, 3160, 3161, 3162, 3164, 3176, 3181, 3193, 3197, 3199, 3215, 3218, 3230, 3241, 3243, 3263, 3295, 4055, 4069
< 20 {POB1776}: 3095, 3097, 3100, 3103, 3113, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3215, 3218, 3230, 3243, 3263, 4069
< 19 {POB1753}: 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3121, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3215, 3218, 3230, 3243, 3244, 3263, 4069
< 18 {POB1750}: 3017, 3064, 3069, 3085, 3095, 3096, 3097, 3100, 3103, 3113, 3121, 3122, 3160, 3161, 3162, 3164, 3176, 3181, 3193, 3197, 3199, 3210, 3215, 3223, 3241, 3244, 3263, 3292, 4010, 4055, 4069
< 17 {POB1746}: 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3164, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 16 {POB1770}: 3012, 3052, 3064, 3065, 3082, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3164, 3176, 3181, 3197, 3199, 3210, 3215, 3230, 3244, 4069
< 15 {POB1771}: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 14 {POB1772}: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3122, 3160, 3161, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 13 {POB1773}: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3160, 3163, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 12 {POB1732}: 3012, 3052, 3064, 3085, 3095, 3096, 3097, 3100, 3103, 3121, 3160, 3164, 3166, 3181, 3197, 3199, 3210, 3215, 3244
< 11 {POB1731}: 3008, 3012, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3121, 3160, 3164, 3166, 3169, 3181, 3197, 3199, 3210, 3215, 3244
< 10 {POB1730}: 3008, 3012, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3121, 3160, 3164, 3166, 3169, 3181, 3197, 3199, 3210, 3215, 3244, 4069
< 9 {POB1775}: 3008, 3012, 3051, 3052, 3064, 3085, 3095, 3096, 3100, 3103, 3110, 3121, 3124, 3160, 3162, 3164, 3166, 3169, 3176, 3181, 3193, 3197, 3199, 3210, 3215, 3230, 3244, 3273, 4010, 4060, 4069
< 8 {POB1797}: 3007, 3008, 3012, 3052, 3055, 3064, 3085, 3095, 3096, 3103, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 7 {POB1796}: 3006, 3012, 3051, 3052, 3055, 3061, 3064, 3095, 3096, 3103, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273, 3297, 4044, 4053, 4054, 4058
< 6 {POB1792}: 3012, 3051, 3052, 3055, 3061, 3064, 3095, 3096, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 5 {POB1789}: 3051, 3055, 3061, 3064, 3095, 3096, 3110, 3121, 3124, 3159, 3164, 3169, 3181, 3197, 3210, 3244, 3273
< 4 {POB1788}: 3051, 3055, 3061, 3064, 3096, 3110, 3124, 3159, 3169, 3181, 3197, 3210, 3231, 3244, 3273
< 3 {POB1786}: 3051, 3064, 3096, 3124, 3159, 3169, 3181, 3197, 3210, 3231, 3244, 3273
< 2 {POB1785}: 3051, 3064, 3096, 3124, 3159, 3169, 3181, 3197, 3210, 3244, 3273
< 1 {POB1784}: 3005, 3011, 3051, 3064, 3089, 3096, 3124, 3149, 3159, 3169, 3181, 3192, 3197, 3231, 3244, 3273, 3307, 3309, 4058

SECTION *52_LO_BERMEJA: bottom 1-top 35
< 35 {LOB87-35}: 3017, 3055, 3062, 3095, 3097, 3103, 3113, 3126, 3161, 3162, 3171, 3180, 3215, 3230, 3263
< 34 {LOB87-34}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3126, 3160, 3161, 3162, 3163, 3171, 3180, 3181, 3199, 3215, 3230, 3263
< 33 {LOB87-33}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3126, 3160, 3161, 3162, 3180, 3181, 3199, 3215, 3230, 3263
< 32 {LOB87-32}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 31 {LOB87-31}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 30 {LOB87-30}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 29 {LOB87-29}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 28 {LOB87-28}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 27 {LOB87-27}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 26 {LOB87-26}: 3013, 3017, 3052, 3055, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3160, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263

< 25 {LOB87-25}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3139, 3160, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3230, 3263
< 24 {LOB87-24}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3139, 3160, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3263
< 23 {LOB87-23}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3139, 3160, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3263
< 22 {LOB87-22}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3097, 3103, 3113, 3119, 3126, 3139, 3160, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 21 {LOB87-21}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3139, 3160, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 20 {LOB87-20}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3119, 3121, 3126, 3139, 3160, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 19 {LOB87-19}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3119, 3121, 3126, 3139, 3160, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 18 {LOB87-18}: 3013, 3017, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3119, 3121, 3126, 3139, 3160, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 17 {LOB87-17}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 16 {LOB87-16}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 15 {LOB87-15}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 14 {LOB87-14}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 13 {LOB87-13}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 12 {LOB87-12}: 3013, 3052, 3055, 3061, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3139, 3159, 3160, 3164, 3180, 3181, 3197, 3199, 3215
< 11 {LOB87-11}: 3055, 3061, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197, 3215
< 10 {LOB87-10}: 3055, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 9 {LOB87-9}: 3055, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 8 {LOB87-8}: 3055, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 7 {LOB87-7}: 3055, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 6 {LOB87-6}: 3055, 3062, 3095, 3096, 3103, 3121, 3126, 3159, 3164, 3169, 3180, 3181, 3197
< 5 {LOB87-5}: 3055, 3062, 3095, 3096, 3103, 3121, 3159, 3164, 3169, 3180, 3181, 3197
< 4 {LOB87-4}: 3055, 3062, 3095, 3096, 3103, 3121, 3159, 3164, 3169, 3180, 3181, 3197
< 3 {LOB87-3}: 3055, 3062, 3095, 3096, 3164, 3169, 3180, 3181, 3197
< 2 {LOB87-2}: 3055, 3062, 3096, 3169, 3180, 3197
< 1 {LOB87-1}: 3055, 3062, 3169, 3180, 3197

SECTION *53_LO_MARTINA: bottom 1-top 14
< 14 {LOM87-14}: 3017, 3062, 3097, 3103, 3113, 3126, 3161, 3162, 3163, 3180, 3181, 3199, 3215, 3230, 3263
< 13 {LOM87-13}: 3017, 3062, 3097, 3103, 3113, 3126, 3161, 3162, 3163, 3180, 3181, 3199, 3215, 3230, 3263
< 12 {LOM87-12}: 3013, 3017, 3052, 3062, 3097, 3103, 3113, 3126, 3161, 3162, 3163, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 11 {LOM87-11}: 3013, 3017, 3052, 3062, 3097, 3103, 3113, 3126, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 10 {LOM87-10}: 3013, 3017, 3052, 3061, 3062, 3097, 3103, 3113, 3119, 3126, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 9 {LOM87-9}: 3013, 3017, 3052, 3061, 3062, 3097, 3103, 3113, 3119, 3126, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3230, 3263
< 8 {LOM87-8}: 3013, 3017, 3052, 3061, 3062, 3097, 3103, 3113, 3119, 3126, 3139, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3230, 3263
< 7 {LOM87-7}: 3013, 3017, 3052, 3061, 3062, 3097, 3103, 3113, 3119, 3126, 3139, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215
< 6 {LOM87-6}: 3013, 3017, 3052, 3061, 3062, 3097, 3103, 3113, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 5 {LOM87-5}: 3013, 3017, 3052, 3061, 3062, 3096, 3097, 3103, 3113, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 4 {LOM87-4}: 3013, 3017, 3052, 3061, 3062, 3096, 3097, 3103, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 3 {LOM87-3}: 3013, 3017, 3052, 3061, 3062, 3096, 3097, 3103, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 2 {LOM87-2}: 3013, 3017, 3052, 3061, 3062, 3096, 3097, 3103, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 1 {LOM87-1}: 3013, 3017, 3052, 3061, 3062, 3096, 3097, 3103, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215

SECTION *54_LO_JARROPA: bottom 1-top 32
< 32 {LOJ87-32}: 3017, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3161, 3162, 3163, 3171, 3180, 3181, 3263
< 31 {LOJ87-31}: 3017, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3161, 3162, 3163, 3171, 3180, 3181, 3199, 3263
< 30 {LOJ87-30}: 3013, 3017, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3160, 3161, 3162, 3169, 3171, 3180, 3181, 3199, 3263
< 29 {LOJ87-29}: 3013, 3017, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3160, 3161, 3162, 3164, 3169, 3171, 3180, 3181, 3199, 3263

< 28 {LOJ87-28}: 3013, 3017, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3160, 3161, 3162, 3164, 3169, 3171, 3180, 3181, 3197, 3199, 3263
< 27 {LOJ87-27}: 3013, 3017, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3160, 3161, 3162, 3164, 3169, 3171, 3180, 3181, 3197, 3199, 3263
< 26 {LOJ87-26}: 3013, 3017, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3119, 3121, 3126, 3160, 3161, 3164, 3169, 3171, 3180, 3181, 3197, 3199
< 25 {LOJ87-25}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3161, 3164, 3169, 3180, 3181, 3197, 3199
< 24 {LOJ87-24}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 23 {LOJ87-23}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 22 {LOJ87-22}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 21 {LOJ87-21}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 20 {LOJ87-20}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 19 {LOJ87-19}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 18 {LOJ87-18}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 17 {LOJ87-17}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 16 {LOJ87-16}: 3013, 3052, 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197, 3199
< 15 {LOJ87-15}: 3055, 3062, 3095, 3096, 3097, 3103, 3113, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 14 {LOJ87-14}: 3055, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 13 {LOJ87-13}: 3055, 3062, 3095, 3096, 3097, 3103, 3121, 3126, 3159, 3160, 3164, 3169, 3180, 3181, 3197
< 12 {LOJ87-12}: 3055, 3062, 3095, 3096, 3097, 3103, 3121, 3159, 3164, 3169, 3180, 3181, 3197
< 11 {LOJ87-11}: 3055, 3062, 3095, 3096, 3097, 3103, 3121, 3159, 3164, 3169, 3180, 3181, 3197
< 10 {LOJ87-10}: 3055, 3062, 3095, 3096, 3097, 3103, 3121, 3159, 3164, 3169, 3180, 3181, 3197
< 9 {LOJ87-9}: 3055, 3062, 3095, 3096, 3097, 3169, 3180, 3197
< 8 {LOJ87-8}: 3055, 3062, 3097, 3169, 3180, 3197
< 7 {LOJ87-7}: 3055, 3062, 3097, 3169, 3180, 3197
< 6 {LOJ87-6}: 3055, 3062, 3097, 3169, 3180, 3197
< 5 {LOJ87-5}: 3055, 3062, 3097, 3169, 3180, 3197
< 4 {LOJ87-4}: 3055, 3062, 3097, 3169, 3180, 3197
< 3 {LOJ87-3}: 3055, 3062, 3097, 3169, 3180, 3197
< 2 {LOJ87-2}: 3055, 3062, 3097, 3169, 3180, 3197
< 1 {LOJ87-1}: 3055, 3062, 3097, 3169, 3180, 3197

SECTION *55_LO_PELADA: bottom 1-top 8
< 8 {LOP87-8}: 3013, 3017, 3052, 3095, 3103, 3113, 3119, 3126, 3161, 3162, 3164, 3180, 3181, 3199, 3215, 3263
< 7 {LOP87-7}: 3013, 3017, 3052, 3095, 3103, 3113, 3119, 3126, 3139, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3263
< 6 {LOP87-6}: 3013, 3017, 3052, 3095, 3103, 3113, 3119, 3126, 3139, 3161, 3162, 3164, 3180, 3181, 3197, 3199, 3215, 3263
< 5 {LOP87-5}: 3013, 3017, 3052, 3095, 3103, 3119, 3126, 3139, 3161, 3164, 3180, 3181, 3197, 3199, 3215
< 4 {LOP87-4}: 3013, 3052, 3095, 3103, 3126, 3139, 3159, 3180, 3181, 3197, 3199, 3215
< 3 {LOP87-3}: 3013, 3052, 3095, 3103, 3126, 3139, 3159, 3180, 3181, 3197, 3199, 3215
< 2 {LCP87-2}: 3013, 3052, 3095, 3103, 3126, 3139, 3159, 3180, 3181, 3197, 3199, 3215
< 1 {LOP87-1}: 3095, 3103, 3126, 3159, 3169, 3180, 3181, 3197

Chapter 9: Radiolarians from the Schistes Lustrés Formation in the Alps (France and Italy) by P. De Wever and P.O. Baumgartner

SECTION DW2_ALPES_QUEYRAS_DW81: bottom 1-top 1
< 1 {DW2_ALPES_QUEYRAS_DW81}: 3020, 3022, 3078, 3090, 3100, 3117, 3123, 3126, 3129, 3131, 3133, 3160, 3169, 3171, 3185, 3215, 3223, 3230, 3273

SECTION DW3_ALPES_ITALIE_TRAVERSIERA_DWPOB: bottom 1- top 1
< 1 {DW3_ALPES_ITALIE_TRAVERSI}: 3005, 3096, 3103, 3110, 3113, 3117, 3123, 3140, 3144, 3152, 3169, 3181, 3210, 3063,3215, 3225, 3273

Chapter 10: Postophiolite Radiolarites from Alpine Corsica (France) by P. De Wever and T. Danelian

SECTION DW4_CORSE_KM59: bottom 1-top 4
< 4 {85c35}: 3017, 3180, 3181
< 3 {85c36}: 3180, 3181, 3298
< 2 {85c37}: 3180, 3298
< 1 {85c40}: 3008, 3181

SECTION DW5_CORSE_SAN_COLOMBANO_IIB_LATER: bottom 1-top 2
< 2 {85c48-50}: {85c48&50} 3096, 3103, 3113, 3117, 3119, 3180, 3181, 3298
< 1 {85c47-49}: {85c47&49} 3017, 3113, 3117, 3121, 3131, 3139, 3140, 3180, 3181, 3199, 3210, 3273, 3298

SECTION DW6_CORSE_SAN_COLOMBANO_IIA: bottom 1- top 6
< 6 {85-5-56}: {85C56} 3122, 3181, 3215, 3230, 3263, 4069
< 5 {85-5-57}: {85C57} 3161, 4069
< 4 {85-5-58}: {85c58} 3161, 3162, 3199, 3267, 4069
< 3 {85-5-59}: {85c59} 3230, 4069
< 2 {85-5-60}: {85c60} 3096, 3161, 3164, 3267, 4069
< 1 {85-5-64}: {85c64} 3017, 3263

Chapter 11: Jurassic radiolarian from Southern Alps (Northern Italy) by P.O. Baumgartner *et al.*

SECTION POB19_TORRE_DE_BUSI: bottom 1-top 9
< 9 {RK 187}: 3020, 3036, 3055, 3065, 3087, 3171, 3263
< 8 {RK 332}: 3020, 3036, 3055, 3164, 3171
< 7 {RK 199}: 3017, 3020, 3036, 3055, 3066, 3105, 3126, 3161, 3162, 3164, 3171, 3226, 4069
< 6 {RK 206}: 3008, 3012, 3020, 3033, 3035, 3052, 3055, 3061, 3064, 3085, 3103, 3160, 3164, 3181, 3199, 3223, 3254
< 5 {RK 403}: 3012, 3020, 3033, 3035, 3052, 3055, 3059, 3061, 3064, 3085, 3103, 3181, 3223, 3254, 3277
< 4 {RK 207}: 3012, 3020, 3033, 3035, 3052, 3055, 3059, 3061, 3064, 3085, 3103, 3139, 3181, 3215, 3223, 3254, 3277
< 3 {RK 208}: 3012, 3033, 3052, 3055, 3061, 3064, 3085, 3103, 3181, 3215, 3254, 3277
< 2 {RK 414}: 3012, 3033, 3052, 3055, 3064, 3076, 3085, 3103, 3109, 3180, 3181, 3254
< 1 {POB1341}: {POB1341.ok18/12/91pob} 3001, 3004, 3006, 3007, 3010, 3011, 3030, 3039, 3041, 3048, 3071, 3072, 3073, 3074, 3089, 3096, 3109, 3125, 3148, 3149, 3194, 3195, 3216, 3231, 3247, 3253, 3278, 3302, 4061, 4063, 4066

SECTION 6_SERRADA: bottom 1-top 1
< 1 {POB1403: 3009, 3022, 3062, 3064, 3085, 3095, 3097, 3161, 3167, 3168, 3171, 3215, 3230, 3263, 3265, 3274, 4069

SECTION 44_CENIGA: bottom 1-top 4
< 4 {POB1704sample ch. 29/12/91pob}: 3095, 3161, 3171, 3181 , 3215, 3230, 3265, 4069, 4070
< 3 {POB1703sample ch. 29/12/91pob}: 3081, 3064, 3085, 3090, 3095, 3096, 3122, 3161, 3168, 3171, 3181, 3213, 3215, 3230, 3265, 3274, 3305, 4069, 4070
< 2 {POB1701 sample ch.29/12/91pob}: 3009, 3035, 3036, 3064, 3065, 3066, 3081, 3082, 3085, 3088, 3095, 3096, 3097 , 3103, 3117 , 3118, 3122, 3161, 3164 , 3168, 3171, 3177 , 3181, 3193 , 3210, 3213 , 3215, 3224, 3226, 3230, 3241, 3265 , 3274, 4015, 4069
< 1 {POB1695 sample ch. 29/12/91pob}: 3008, 3035, 3036, 3062, 3064, 3065, 3070, 3081, 3082, 3085, 3088, 3095, 3100, 3103, 3116, 3121, 3122, 3123, 3160 , 3161 , 3164, 3167, 3180, 3181, 3213, 3217, 3220, 3223, 3224, 3230, 3241, 3243, 3263, 3265, 3274, 4069

SECTION 44A_MADONNA_DELLA_CORONA_A: bottom 1-top 3
< 3 {MCB0.35}: 3113, 3009, 3065, 3082, 3103, 3115
< 2 {MCB0.90}: 3131, 3095, 3096, 3103, 3122, 3161, 3224, 4069
< 1 {MCA0.35}: 3008, 3061, 3064, 3085, 3110, 3117, 3121, 3123, 3161, 3169, 3180, 3181, 3215, 3244, 3270, 3274, 4063

SECTION 44B_KABERLABA: bottom 1-top 2
< 2 {K13.40 det 1/1/92pob:rads F sponges A ca. 90%}: 3008{R}, 3065{C}, 3082, 3095{A}, 3103{F}, 3113{VR}, 3181{R}, 3217, 3224, 3243{VR}, 4069{C}
< 1 {K12.00 det 1/1/92pob:rads only a few specs. sponge spics and raxes >>99%}: 3121, 3065, 3082, 3177, 3181, 3230, 3270, 4063

SECTION 44C_MAZZE: bottom 1-top 3
< 3 {21.75}: 3274, 3017, 3095{C}, 3161{R. COULD BE MINOR3286}, 3230{A}, 3265{C}, 3305, 4069{R}, 4070
< 2 {M20.60}:, 3009, 3095{R}, 3161{VR}, 3181{R}, 3230{A}, 3265{C}, 3274, 4069{R}, 4070
< 1 {M18.20}: 3082, 3064{R}, 3065{A}, 3085, 3224, 3265{F}, 4069{F}

SECTION VAJONT_DAM: bottom 1-top 2
< 2 {VAJ-FON3}: 3005, {TURANTA FLEXA PESS & BLOME 1982}, 3008, 3009, 3064, 3081, 3085, 3100, 3103, 3110, 3113, 3115, 3116, 3121, 3123, 3124, 3159, 3160, 3164, 3167, 3169, 3176, 3180, 3210, 3215, 3220, 3241, 3244, 3270, 3273, 3412, 3413, 3813, 4063
< 1 {VAJ-FON 0}: 3005, {TURANTA FLEXA PESS & BLOME 1982}, 3008, 3024, 3064, 3081, 3085, 3103, 3110, 3113, 3121, 3124, 3150, 3159, 3161, 3164, 3169, 3176, 3210, 3220, 3241, 3244, 3270, 3273, 3274, 3412, 4063, 4068

SECTION ∗VAL_ARDO: bottom 1-top 2
< 2 {VA C3.90}: 3008, 3009, 3065, 3082, 3095, 3096, 3103, 3106, 3113, 3115, 3117, 3118, 3121, 3123, 3129, 3160, 3161, 3163, 3164, 3166, 3169, 3176, 3180, 3181, 3215, 3224, 3230, 3241, 4068, 4069
< 1 {VA A10.60}: 3008, 3055, 3062, 3095, 3113, 3160, 3161, 3167, 3169, 3176, 3181, 3218, 3243, 3267, 3274, 4015, 4068

SECTION *PONTE_SERRA: bottom 1-top 2

< 2 {PS C15.00}: 3036, 3066, 3081, 3094, 3096, 3097, 3122, 3161, 3164, 3167, 3171, 3181, 3213, 3215, 3216, 3226, 3241, 3259, 3263, 3265, 3274, 3406, 4015, 4068, 4069, 4070

< 1 {PS B14.60}: 3122, 3160, 3161, 3164, 3181, 3224, 3241, 3259, 3263, 3267, 3274, 3305, 4068, 4069

Chapter 12: Early Cretaceous radiolarian biostratigraphy (Italy, Switzerland and Oman) by R. Dumitrica-Jud

Cretacous data of Ruth Jud (Chapter 12.) in the composite sections POB22_23_RJ9_SANGIANO_RUSCONI, POB24_RJ10_BREGGIA_JUR_CRET, POB26_RJ1_BOSSO_JUR_CRET, POB56_RJ7_VALDORBIA, POB57RJ5_RANCHI_SUP, and POBRJ_CAMPO_AL_BELLO are listed under Chapter 5, where the Jurassic part of these sections is discussed.

SECTION RJ2_PIEIA: bottom 1-top 42

< 42{PI97.35 RJ UA13-17}: 3065, 3066, 3090, 3092, 3161, 3165, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3282, 3285, 3286, 3287, 3291, 4073, 5042, 5073, 5132, 5183, 5290, 5464, 5481, 5544, 5565, 5568, 5578, 5607, 5703, 5785, 6121, 6129

< 41{PI95.50 RJ UA13-17}: 3065, 3066, 3090, 3092, 3113, 3161, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 4073, 5042, 5073, 5132, 5183, 5209, 5243, 5290, 5464, 5481, 5544, 5565, 5568, 5578, 5607, 5672, 5703, 5721, 5785, 6121, 6129

< 40{PI94.30 RJ UA13-17}: 3062, 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 4073, 5042, 5044, 5073, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5290, 5408, 5409, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5607, 5672, 5674, 5703, 5721, 5785, 5913, 6121, 6129

< 39{PI91.45 RJ UA13-17}: 3062, 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5042, 5044, 5073, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5290, 5408, 5409, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6121, 6129

< 38{PI89.40 RJ UA13-17}: 3062, 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5042, 5044, 5073, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5290, 5408, 5409, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6121, 6129

< 37{PI86.60 RJ UA13-17}: 3062, 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5042, 5044, 5073, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5290, 5408, 5409, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6121, 6129

< 36{PI84.75 RJ UA13-17}: 3062, 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3947, 4073, 5042, 5044, 5073, 5132, 5163, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5290, 5408, 5409, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6121, 6129

< 35{PI82.75 RJ UA13}: 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5290, 5396, 5408, 5409, 5416, 5436, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 34{PI81.60 RJ UA13}: 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5290, 5396, 5408, 5409, 5416, 5436, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 33{PI81.00 RJ UA13}: 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5290, 5396, 5408, 5409, 5416, 5436, 5453, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 32{PI78.50 RJ UA13}: 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5290, 5369, 5396, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464,

5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 31{PI77.20 RJ UA13}: 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 30{PI75.60 RJ UA13}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5703, 5716, 5721, 5785, 5913, 6101, 6121, 6129

< 29{PI74.90 RJ UA9-13}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5166, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5416, 5426, 5436, 5462, 5481, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 6101, 6121, 6129

< 28{PI74.60 RJ UA9-13}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5166, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5416, 5426, 5436, 5462, 5481, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 6101, 6121, 6129

< 27{PI71.50 RJ UA9-13}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5166, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5410, 5416, 5426, 5436, 5462, 5481, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 6101, 6121, 6129

< 26{PI69.10 RJ UA9-13 }: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5166, 5183, 5186, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5410, 5416, 5426, 5436, 5462, 5481, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 6101, 6121, 6129

< 25{PI67.70 RJ UA9}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3947, 3955, 4073, 5042, 5044, 5055, 5073, 5132, 5166, 5183, 5186, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5410, 5416, 5426, 5436, 5462, 5481, 5510, 5544, 5565, 5568, 5575, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 5796, 6101, 6121, 6129

< 24{PI66.60 RJ UA9}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3912, 3947, 3955, 4073, 5042, 5044, 5055, 5065, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5369, 5396, 5408, 5409, 5410, 5416, 5426, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5672, 5674, 5716, 5721, 5785, 5796, 6101, 6121, 6129

< 23{PI64.70 RJ UA8}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3912, 3947, 3955, 4073, 5042, 5044, 5055, 5065, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5396, 5408, 5409, 5410, 5416, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5674, 5716, 5721, 5785, 5796, 6101, 6121, 6129

< 22{PI63.00 RJ UA8}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3912, 3947, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5186, 5199, 5209, 5243, 5253, 5396, 5408, 5409, 5410, 5416, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5595, 5607, 5674, 5716, 5721, 5785, 5796, 6101, 6121, 6129

< 21{PI62.20 RJ UA8}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3912, 3955, 4073, 5003, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 20{PI61.10 RJ UA8}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 19{PI59.35 RJ UA8}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5314, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 18{PI59.00 RJ UA8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 17{PI58.10 RJ UA8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 16{PI57.50 RJ UA8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5055, 5065, 5132, 5183, 5194, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 5824, 6101, 6121, 6129

< 15{56.00 RJ UA8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5065, 5132, 5183, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 5824, 6101, 6121, 6129

< 14{PI40.20 RJ UA8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5041, 5042, 5044, 5065, 5132, 5183, 5199, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 5824, 6101, 6121, 6129

< 13{PI37.60 RJ UA6-8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3912, 3955, 4073, 5042, 5044, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5674, 5716, 5785, 5796, 6101, 6121, 6129

< 12{PIBiB2 RJ UA6-8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3912, 3955, 5042, 5044, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5577, 5580, 5607, 5674, 5785, 5796, 6101, 6121, 6129

< 11{PI16.20 RJ UA6-8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3912, 3955, 5042, 5044, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5577, 5580, 5607, 5674, 5785, 5796, 6101, 6121, 6129

< 10{PI13.25 RJ UA6-8}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3955, 5042, 5044, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5577, 5580, 5607, 5674, 5785, 5796, 6101, 6121, 6129

< 9{PI4mSL RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3955, 5042, 5044, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 8{PI18.70 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3955, 5042, 5044, 5132, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426,

5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 7{PI17.90 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3955, 5042, 5044, 5132, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 6{PI17.50 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3924, 3955, 5042, 5044, 5132, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 5{PI17.40 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3924, 3955, 5132, 5209, 5396, 5408, 5409, 5416, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 4{PI17.15 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3591, 3924, 3955, 5132, 5209, 5396, 5409, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 3{PI16.80 RJ UA5}: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3282, 3283, 3285, 3286, 3287, 3293, 3591, 3924, 3955, 5132, 5209, 5396, 5409, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 2{PI16.04 RJ UA5}: 3022, 3062, 3065, 3066, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3230, 3255, 3266, 3282, 3285, 3286, 3287, 3591, 3924, 3955, 5132, 5209, 5409, 5426, 5433, 5436, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

< 1{PI10.00 coll. pob83 RJ UA5}: 3022, 3062, 3065, 3066, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3230, 3255, 3266, 3282, 3285, 3286, 3287, 3591, 3918, 3924, 3955, 5132, 5209, 5409, 5426, 5433, 5436, 5506, 5510, 5544, 5568, 5607, 5674, 5796, 6101, 6121, 6129

SECTION RJ3_GORGO_A_CERBARA: bottom 1 - top 25

< 25{GC911.35 RJ UA33-35}: 3065, 3090, 3092, 3094, 3162, 3295, 3947, 5046, 5069, 5183, 5204, 5274, 5287, 5550, 5582, 5636, 5641, 5672, 6121

< 24{GC911.10 RJ UA33-35}: 3065, 3090, 3092, 3094, 3162, 3295, 3947, 4073, 5046, 5069, 5183, 5204, 5274, 5287, 5550, 5582, 5636, 5641, 5672, 6121

< 23{GC902.40 RJ UA35}: 3065, 3090, 3092, 3094, 3097, 3162, 3295, 3947, 4073, 5046, 5049, 5069, 5073, 5183, 5204, 5274, 5287, 5296, 5550, 5582, 5625, 5636, 5641, 5672, 5693, 5903, 5973, 6121

< 22{GC901.30 RJ UA35}: 3065, 3090, 3092, 3094, 3097, 3162, 3285, 3295, 3947, 4073, 5046, 5049, 5069, 5073, 5183, 5204, 5274, 5287, 5296, 5544, 5550, 5582, 5625, 5636, 5641, 5672, 5693, 5903, 5973, 6121

< 21{GC893.30 RJ UA35}: 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3285, 3295, 3947, 4073, 5012, 5046, 5049, 5069, 5073, 5183, 5204, 5243, 5261, 5274, 5287, 5296, 5334, 5422, 5462, 5544, 5550, 5553, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5672, 5674, 5693, 5903, 5973, 6121

< 20{GC 889.30 RJ UA35}: 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3285, 3295, 3947, 4073, 5012, 5046, 5049, 5069, 5073, 5090, 5183, 5186, 5204, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5369, 5422, 5462, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5672, 5674, 5693, 5711, 5903, 5973, 6121

< 19{GC887.00 RJ UA35}: 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3285, 3295, 3947, 4073, 5012, 5044, 5046, 5049, 5069, 5073, 5090, 5183, 5186, 5204, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5369, 5422, 5462, 5469, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5672, 5674, 5693, 5711, 5744, 5771, 5773, 5903, 5973, 6121, 6123

< 18{GC882.40 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3285, 3287, 3295, 3947, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5334, 5359, 5369, 5422, 5462, 5469, 5511, 5524, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5927, 6121, 6123

< 17{GC874.65 RJ UA 33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3285, 3287, 3295, 3947, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5334, 5359, 5369, 5422, 5462, 5469, 5511, 5524, 5526, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 16{GC869.80 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3285, 3287, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5511, 5526, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607,

5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 15{GC867.20 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3266, 3285, 3287, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 14{GC859.75 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3291, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5913, 5927, 6121, 6123

< 13{GC846.35 RJ UA31-32} 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3291, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 12{GC840.30 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3291, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 11{GC837.15 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3291, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 10{GC832.10 RJ UA31-32}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3291, 3295, 3947, 4037, 4073, 5012, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5422, 5462, 5469, 5481, 5511, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 9{GC821.45 RJ UA32}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3263, 3285, 3287, 3288, 3291, 3295, 3947, 4037, 4073, 5011, 5012, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5357, 5359, 5362, 5369, 5397, 5422, 5427, 5462, 5469, 5481, 5511, 5521, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5721, 5744, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< 8{GC819.75 RJ UA31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3263, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5012, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5362, 5369, 5397, 5422, 5426, 5427, 5462, 5469, 5481, 5511, 5521, 5522, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5721, 5744, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< 7{GC817.90 RJ UA31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5362, 5369, 5397, 5422, 5426, 5427, 5453, 5462, 5481, 5511, 5521, 5522, 5526, 5532, 5544, 5553, 5575, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5721, 5725, 5744, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< 6{GC814.80 RJ UA30-31} 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5462, 5481, 5511, 5521, 5522, 5532, 5544, 5553, 5575, 5580, 5595, 5607, 5620, 5668, 5672, 5673,

5674, 5711, 5712, 5721, 5725, 5744, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123
< 5{812.25 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5462, 5481, 5511, 5521, 5522, 5532, 5544, 5553, 5575, 5578, 5580, 5595, 5607, 5620, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5725, 5744, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123
< 4{GC801.20 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5267, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5462, 5481, 5511, 5521, 5522, 5532, 5544, 5553, 5575, 5578, 5580, 5595, 5607, 5620, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5725, 5744, 5766, 5771, 5901, 5902, 5903, 5904, 5913, 5927, 6121
< 3{GC799.00 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5462, 5481, 5511, 5521, 5522, 5532, 5544, 5553, 5575, 5578, 5580, 5595, 5607, 5620, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5725, 5744, 5766, 5901, 5902, 5903, 5904, 5913, 5927, 6121
< 2{GC791.70 RJ UA30}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5032, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5274, 5287, 5290, 5296, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5462, 5481, 5511, 5521, 5522, 5532, 5544, 5553, 5575, 5578, 5580, 5595, 5607, 5620, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5725, 5744, 5766, 5901, 5902, 5903, 5904, 5913, 5927, 6121
< 1{GC786.70 RJ UA28}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5011, 5044, 5049, 5073, 5143, 5163, 5166, 5183, 5186, 5204, 5229, 5243, 5253, 5261, 5262, 5287, 5296, 5314, 5334, 5426, 5462, 5532, 5544, 5575, 5578, 5580, 5595, 5620, 5628, 5672, 5673, 5674, 5711, 5712, 5721, 5901, 5902, 5903, 5913, 5927, 6121

SECTION RJ4_PRESALE: bottom 1 - top 10
< 10{PR238.80 RJ UA33-34}: 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3228, 3255, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5033, 5044, 5046, 5049, 5069, 5073, 5090, 5163, 5166, 5183, 5193, 5194, 5204, 5261, 5262, 5274, 5287, 5296, 5334, 5359, 5422, 5462, 5469, 5481, 5511, 5521, 5532, 5544, 5550, 5553, 5582, 5595, 5607, 5620, 5636, 5641, 5668, 5672, 5673, 5674, 5711, 5712, 5744, 5771, 5901, 5902, 5903, 5927, 6121
< 9{PR225.30 RJ UA34}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5012, 5033, 5041, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5163, 5166, 5183, 5193, 5194, 5204, 5229, 5261, 5262, 5266, 5274, 5287, 5296, 5332, 5334, 5359, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5532, 5544, 5550, 5553, 5595, 5607, 5620, 5625, 5636, 5641, 5642, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5744, 5761, 5771, 5901, 5902, 5903, 5904, 5927, 6121, 6123
< 8{PR221.05 RJ UA33}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5042, 5044, 5046, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5357, 5359, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5532, 5544, 5550, 5553, 5575, 5595, 5607, 5620, 5636, 5641, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5744, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123
< 7{PR220.75 RJ UA33}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5042, 5044, 5046, 5055, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5359, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5522, 5532, 5544, 5550, 5553, 5575, 5595, 5607, 5620, 5636, 5641, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123
< 6{PR211.35 RJ UA31}: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3281, 3285, 3287, 3293, 3295, 3947, 4073, 5012, 5032, 5033, 5042, 5044, 5046, 5055, 5068, 5069, 5073, 5090, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5359, 5369, 5422, 5426, 5427, 5462, 5469, 5481, 5511, 5522, 5526, 5532, 5544, 5553, 5575, 5595, 5607, 5620, 5636, 5641, 5668, 5672, 5673, 5674, 5711, 5712, 5721, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123
< 5{PR204.30 RJ UA29}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3227, 3228, 3255, 3263, 3285, 3286, 3287, 3288, 3291, 3295, 3947, 4073, 5011, 5032, 5033, 5042, 5044, 5055, 5073, 5090, 5163, 5166, 5183, 5186, 5193, 5194,

5199, 5204, 5229, 5243, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5362, 5369, 5397, 5416, 5422, 5426, 5427, 5462, 5469, 5481, 5511, 5522, 5526, 5532, 5544, 5553, 5575, 5580, 5607, 5620, 5636, 5668, 5673, 5674, 5711, 5712, 5721, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< 4{PR197.30 RJ UA29-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3161, 3162, 3185, 3227, 3228, 3255, 3263, 3285, 3286, 3287, 3288, 3291, 3295, 4073, 5011, 5073, 5183, 5193, 5194, 5199, 5204, 5229, 5261, 5262, 5274, 5296, 5426, 5462, 5469, 5481, 5526, 5532, 5544, 5553, 5575, 5580, 5607, 5620, 5636, 5668, 5673, 5674, 5773, 5901, 6121, 6123

< 3{PR187.15 RJ UA22-31}: 3062, 3063, 3065, 3113, 3161, 3185, 3227, 3255, 3263, 3285, 3286, 3287, 3295, 4073, 5193, 5194, 5204, 5426, 5462, 5481, 5544, 5607, 5636, 5674, 5773, 5901, 6121, 6123

< 2{PR180.10 RJ UA17-27}: 3062, 3063, 3065, 3113, 3161, 3185, 3202, 3227, 3255, 3263, 3266, 3282, 3285, 3286, 3287, 3295, 4073, 5193, 5194, 5204, 5426, 5462, 5481, 5544, 5607, 5636, 5674, 5901, 6121, 6123, 6129

< 1{PR174.80 RJ UA17}: 3062, 3063, 3065, 3113, 3161, 3185, 3202, 3203, 3227, 3255, 3263, 3266, 3283, 3284, 3285, 3286, 3287, 3295, 4073, 5409, 5426, 5544, 5578, 5607, 5636, 5674, 5785, 5901, 6121, 6123

SECTION RJ8_BOTTACIONE: bottom 1 - top 1

< 1{POB1602 RJ UA31-32}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3228, 3255, 3263, 3285, 3291, 3295, 3947, 4073, 5012, 5032, 5033, 5042, 5046, 5055, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5196, 5204, 5229, 5243, 5261, 5262, 5267, 5274, 5287, 5359, 5397, 5426, 5427, 5469, 5511, 5522, 5532, 5544, 5553, 5575, 5580, 5582, 5595, 5607, 5620, 5672, 5673, 5674, 5712, 5766, 5902, 5903, 5904, 5913, 6121

SECTION RJ11_CAPRIOLO: bottom 1 - top 27

< 27{CA10.60 RJ UA28-34}: 3065, 3092, 3228, 3285, 5012, 5065, 5183, 5229, 5287, 5314, 5553, 5607, 6121

< 26{CA15.40 RJ UA28-34}: 3065, 3090, 3092, 3094, 3228, 3255, 3285, 5012, 5065, 5073, 5183, 5204, 5229, 5287, 5314, 5553, 5607, 6121

< 25{CA18.40 RJ UA29-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3185, 3227, 3228, 3255, 3285, 3288, 3291, 3293, 4037, 5003, 5011, 5012, 5032, 5033, 5042, 5044, 5049, 5055, 5065, 5068, 5073, 5090, 5183, 5204, 5229, 5261, 5287, 5314, 5334, 5422, 5481, 5532, 5553, 5580, 5607, 5620, 5636, 5672, 5913, 6121, 6123

< 24{CA28.80 RJ UA30-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3161, 3185, 3202, 3227, 3228, 3255, 3285, 3286, 3288, 3291, 3293, 4037, 5003, 5011, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5073, 5183, 5186, 5204, 5229, 5253, 5261, 5287, 5314, 5334, 5397, 5422, 5426, 5481, 5532, 5553, 5580, 5595, 5607, 5620, 5636, 5672, 5904, 5913, 6121, 6123

< 23{CA37.50 RJ UA28}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 4037, 4073, 5003, 5011, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5073, 5163, 5166, 5183, 5186, 5204, 5229, 5253, 5261, 5262, 5287, 5314, 5334, 5359, 5369, 5397, 5422, 5426, 5481, 5532, 5544, 5553, 5580, 5607, 5620, 5628, 5636, 5668, 5672, 5674, 5771, 5773, 5901, 5902, 5903, 5913, 6121, 6123

< 22{CA44.35 RJ UA28-31}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 4073, 5003, 5011, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5073, 5166, 5183, 5186, 5204, 5229, 5253, 5261, 5287, 5314, 5334, 5359, 5369, 5426, 5481, 5532, 5544, 5553, 5580, 5607, 5620, 5636, 5672, 5674, 5901, 5913, 6121, 6123

< 21{CA46.60 RJ UA28-31}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 4073, 5003, 5011, 5032, 5033, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5073, 5166, 5183, 5186, 5199, 5204, 5229, 5253, 5261, 5266, 5287, 5296, 5314, 5334, 5359, 5369, 5426, 5481, 5532, 5544, 5553, 5580, 5607, 5620, 5636, 5672, 5674, 5901, 5913, 6121, 6123

< 20{CA57.85 RJ UA28-31}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3947, 4073, 5003, 5011, 5032, 5033, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5166, 5183, 5186, 5199, 5204, 5229, 5253, 5266, 5287, 5314, 5334, 5359, 5369, 5426, 5481, 5532, 5544, 5553, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5913, 6121, 6123

< 19{CA64.30 RJ UA20-25}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3213, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3947, 4073, 5003, 5032, 5033, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5132, 5166, 5183, 5186, 5199, 5204, 5229, 5253, 5287, 5314, 5334, 5359, 5369, 5426, 5481, 5544, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5913, 6121, 6123

< 18{CA84.90 RJ UA20-25}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3185, 3202, 3213, 3227, 3228, 3255, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3947, 4073, 5003, 5032, 5033, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5132, 5166, 5183, 5186, 5199, 5229, 5243, 5253, 5287, 5314, 5334, 5359, 5369, 5426, 5481, 5544, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5913, 6121, 6123

< 17{CA99.75 RJ UA22}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3281, 3284, 3285,

3286, 3287, 3288, 3291, 3293, 3919, 3947, 4073, 5003, 5033, 5042, 5044, 5046, 5055, 5065, 5068, 5069, 5073, 5132, 5166, 5183, 5186, 5199, 5229, 5243, 5253, 5287, 5314, 5334, 5359, 5369, 5426, 5481, 5544, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5721, 5766, 5913, 6121, 6123

< 16{CA100.00 RJ UA20}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3919, 3947, 4073, 5003, 5033, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5132, 5166, 5183, 5186, 5199, 5229, 5243, 5253, 5287, 5314, 5334, 5359, 5369, 5371, 5409, 5426, 5481, 5544, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5721, 5913, 6121, 6123

< 15{CA109.60 RJ UA16}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5193, 5199, 5209, 5243, 5253, 5287, 5290, 5334, 5359, 5369, 5371, 5408, 5409, 5426, 5481, 5544, 5568, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5721, 5913, 6121

< 14{CA114.30 RJ UA16}: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5199, 5209, 5243, 5253, 5290, 5359, 5371, 5408, 5409, 5436, 5481, 5510, 5544, 5568, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5721, 5913, 6121

< 13{CA118.40 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5166, 5183, 5186, 5194, 5199, 5209, 5243, 5253, 5290, 5359, 5371, 5408, 5409, 5410, 5436, 5453, 5481, 5544, 5568, 5580, 5607, 5620, 5636, 5672, 5674, 5712, 5716, 5721, 5913, 6121

< 12{CA120.10 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5253, 5290, 5359, 5371, 5408, 5409, 5410, 5416, 5436, 5453, 5481, 5544, 5568, 5572, 5580, 5607, 5620, 5636, 5672, 5712, 5721, 5913, 6121, 6129

< 11{CA129.80 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5436, 5453, 5481, 5544, 5568, 5572, 5580, 5607, 5620, 5636, 5672, 5712, 5721, 5913, 6121, 6129

< 10{CA137.60 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 4073, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5436, 5453, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5620, 5636, 5672, 5712, 5721, 5913, 6121, 6129

< 9{CA139.80 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 5003, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5436, 5453, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5620, 5636, 5672, 5712, 5721, 5913, 6121, 6129

< 8{CA144.60 RJ UA16}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5436, 5453, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5620, 5636, 5647, 5672, 5712, 5721, 5913, 6121, 6129

< 7{CA145.60 RJ UA11-15}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3919, 3947, 5003, 5042, 5046, 5055, 5065, 5073, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5417, 5436, 5453, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5636, 5672, 5712, 5721, 5785, 6121, 6129

< 6{CA146.20 RJ UA11}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3225, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3591, 3912, 3947, 5003, 5042, 5046, 5055, 5065, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290, 5359, 5371, 5408, 5409, 5410, 5417, 5436, 5453, 5481, 5544, 5568, 5572, 5578, 5580, 5607, 5636, 5672, 5712, 5721, 5785, 5824, 6121, 6129

< 5{CA146.50 RJ UA11}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3225, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3947, 5003, 5042, 5055, 5065, 5132, 5183, 5186, 5194, 5199, 5209, 5243, 5290,

5359, 5371, 5408, 5409, 5410, 5417, 5436, 5453, 5481, 5544, 5568, 5578, 5580, 5607, 5636, 5672, 5712, 5721, 5785, 5824, 6121, 6129

< 4{CA146.60 RJ UA11}: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3225, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3912, 3947, 5003, 5042, 5055, 5065, 5132, 5183, 5186, 5194, 5209, 5243, 5290, 5371, 5408, 5409, 5410, 5417, 5436, 5453, 5462, 5481, 5544, 5568, 5578, 5580, 5607, 5636, 5672, 5712, 5721, 5785, 5824, 6121, 6129

< 3{CA154.00 RJ UA9-11}: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3161, 3162, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3717, 3912, 3955, 5003, 5042, 5055, 5065, 5132, 5183, 5186, 5194, 5209, 5243, 5290, 5371, 5396, 5408, 5409, 5410, 5436, 5453, 5462, 5481, 5565, 5568, 5580, 5607, 5672, 5721, 5785, 5824, 6121, 6129

< 2{CA162.80 RJ UA7-10}: 3022, 3065, 3090, 3092, 3094, 3097, 3113, 3171, 3185, 3213, 3227, 3228, 3255, 3263, 3264, 3280, 3282, 3284, 3285, 3287, 3291, 3293, 3955, 5003, 5042, 5055, 5065, 5132, 5183, 5186, 5194, 5209, 5409, 5410, 5436, 5453, 5462, 5506, 5607, 5824, 6121, 6129

< 1{CA163.00 RJ UA7-10}: 3022, 3065, 3090, 3092, 3094, 3097, 3113, 3171, 3185, 3213, 3227, 3228, 3255, 3263, 3280, 3284, 3285, 3291, 3293, 3955, 5042, 5055, 5132, 5194, 5209, 5409, 5410, 5436, 5453, 5462, 5607, 6121

SECTION RJ12_PFAFFENGRAT: bottom 1-top 13

< 13 {PF67.50 RJ UA7-17}: 3062, 3065, 3090, 3113, 3202, 3203, 3213, 3228, 3293, 5132, 5183, 5194, 5416, 5436, 5565, 5607, 6121

< 12 {PF64.40 RJ UA7-17}: 3065, 3113, 3202, 3203, 3213, 3228, 3255, 3263, 3291, 3293, 3947, 5132, 5183, 5186, 5416, 5565, 5607, 6121

< 11 {PF61.00 RJ UA7-17}: 3065, 3113, 3202, 3203, 3213, 3228, 3255, 3263, 3293, 3947, 5132, 5183, 5186, 5416, 5565, 5607, 6121

< 10 {PF54.00 RJ UA7-17}: 3065, 3113, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3287, 3293, 3947, 5132, 5183, 5186, 5416, 5464, 5481, 5565, 5607, 6121

< 9 {PF49.50 RJ UA7-17}: 3065, 3113, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3287, 3293, 3947, 5132, 5183, 5186, 5416, 5565, 5607, 6121

< 8 {PF49.40 RJ UA7-17}: 3065, 3113, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3287, 3293, 3947, 5132, 5183, 5186, 5416, 5565, 5607, 6121

< 7 {PF45.20 RJ UA7-15}: 3065, 3113, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3287, 3293, 3947, 3955, 5132, 5183, 5186, 5193, 5243, 5253, 5416, 5565, 5568, 5607, 6121

< 6 {PF41.75 RJ UA7-13}: 3065, 3094, 3113, 3161, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3284, 3286, 3287, 3293, 3295, 3947, 3955, 5132, 5183, 5186, 5396, 5416, 5565, 5568, 5607, 5785, 6121

< 5 {PF35.00 RJ UA7-10}: 3065, 3094, 3113, 3161, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3280, 3284, 3286, 3287, 3293, 3295, 3947, 3955, 5132, 5183, 5186, 5565, 5568, 5607, 5785, 6121

< 4 {PF33.00 RJ UA8-12}: 3065, 3066, 3092, 3094, 3113, 3161, 3162, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3282, 3284, 3286, 3287, 3293, 3295, 3591, 3947, 3955, 5042, 5132, 5183, 5186, 5314, 5426, 5565, 5568, 5607, 5785, 6121, 6129

< 3 {PF30.50 RJ UA8-15}: 3065, 3066, 3094, 3113, 3161, 3162, 3171, 3185, 3202, 3203, 3213, 3228, 3255, 3263, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3293, 3947, 3955, 5042, 5132, 5183, 5186, 5453, 5565, 5568, 5595, 5607, 5785, 6101, 6121, 6129

< 2 {PF28.80 RJ UA7-15}: 3065, 3094, 3113, 3171, 3185, 3202, 3213, 3255, 3263, 3266, 3283, 3284, 3285, 3293, 3955, 5042, 5132, 5186, 5453, 5568, 5607, 5674, 6101, 6121

< 1 {PF20.00 RJ UA7-15}: 3065, 3094, 3171, 3202, 3213, 3263, 3266, 3283, 3285, 3955, 5132, 5186, 5607, 6101, 6121

SECTION RJ13_WAHRAH_FM__AL_HAMMAH_RANGE: bottom 1-top 19

< 19 {OM20 RJ UA31-34}: 3063, 3065, 3090, 3228, 3293, 3295, 5049, 5287, 5296, 5521, 5595, 5607, 5641, 5674, 5693, 6121

< 18 {OM19 RJ UA25-34}: 3063, 3065, 3090, 3185, 3228, 3287, 3293, 3295, 5049, 5073, 5296, 5521, 5595, 5607, 5712, 6121

< 17 {OM18 RJ UA28-34}: 3063, 3065, 3090, 3185, 3228, 3287, 3293, 3295, 5073, 5296, 5462, 5521, 5553, 5595, 5607, 5712, 6121

< 16 {OM17 RJ UA24-34}: 3063, 3065, 3090, 3185, 3228, 3287, 3293, 3295, 5041, 5073, 5261, 5296, 5462, 5481, 5595, 5607, 5712, 6121

< 15 {OM16 RJ UA25-31}: 3063, 3065, 3090, 3094, 3161, 3185, 3228, 3255, 3263, 3286, 3287, 3293, 3295, 5073, 5261, 5296, 5462, 5481, 5595, 5607, 5636, 5712, 5761, 6121

< 14 {OM15 RJ UA30-31}: 3063, 3065, 3090, 3161, 3185, 3228, 3255, 3263, 3286, 3287, 3293, 3295, 5073, 5296, 5462, 5481, 5595, 5607, 5625, 5636, 5712, 6121

< 13 {OM14 RJ UA30-31}: 3063, 3065, 3090, 3161, 3185, 3228, 3255, 3263, 3286, 3287, 3293, 3295, 5073, 5462, 5481, 5595, 5607, 5625, 5636, 5712, 6121

< 12 {OM13 RJ UA30-31}: 3063, 3065, 3090, 3161, 3185, 3228, 3255, 3263, 3286, 3287, 3293, 3295, 5073, 5462, 5481, 5595, 5607, 5625, 5636, 5647, 5712, 6121

< 11 {OM12 RJ UA30-31}: 3063, 3065, 3090, 3161, 3185, 3228, 3255, 3263, 3286, 3287, 3293, 3295, 5073, 5462, 5481, 5595, 5607, 5625, 5636, 5712, 6121

< 10 {OM11 RJ UA11-25}: 3063, 3065, 3090, 3161, 3185, 3213, 3228, 3255, 3263, 3286, 3287, 3291, 3293, 3295, 5073, 5132, 5462, 5464, 5481, 5595, 5607, 5636, 5712, 6121

< 9 {OM10 RJ UA11-25}: 3063, 3065, 3090, 3161, 3185, 3213, 3228, 3255, 3263, 3286, 3287, 3291, 3293, 3295, 5046, 5073, 5132, 5462, 5464, 5481, 5595, 5607, 5636, 5712, 6121

< 8 {OM3 RJ UA11-14}: 3063, 3065, 3090, 3161, 3185,

3213, 3228, 3255, 3263, 3264, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3911, 5046, 5132, 5462, 5464, 5481, 5595, 5607, 5712, 6101, 6121

< 7 {OM2 RJ UA11-15}: 3063, 3065, 3066, 3090, 3092, 3113, 3161, 3185, 3213, 3228, 3255, 3263, 3264, 3281, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 5042, 5046, 5132, 5453, 5462, 5464, 5481, 5580, 5595, 5607, 5712, 6101, 6121

< 6 {OM1 RJ UA14-15}: 3065, 3092, 3161, 3185, 3213, 3228, 3255, 3263, 3264, 3266, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 4073, 5042, 5046, 5132, 5453, 5462, 5464, 5481, 5580, 5595, 5607, 5673, 5712, 6101, 6121

< 5 {OM9 RJ UA11-15}: 3065, 3092, 3161, 3171, 3185, 3202, 3213, 3228, 3255, 3263, 3264, 3284, 3285, 3286, 3287, 3293, 3295, 4073, 5042, 5046, 5132, 5453, 5462, 5464, 5481, 5580, 5595, 5607, 5712, 6101, 6121

< 4 {OM7 RJ UA10-12}: 3065, 3161, 3185, 3213, 3228, 3255, 3263, 3264, 3284, 3285, 3286, 3287, 3293, 3295, 3591, 4073, 5042, 5046, 5132, 5183, 5462, 5464, 5481, 5580, 5595, 5607, 6101, 6121

< 3 {OM6 RJ UA8-12}: 3065, 3161, 3185, 3213, 3228, 3255, 3263, 3284, 3285, 3286, 3287, 3293, 3295, 3591, 5132, 5481, 5580, 5595, 5607, 6101, 6121

< 2 {OM5 RJ UA8-12}: 3065, 3161, 3185, 3213, 3228, 3263, 3286, 3287, 3293, 3295, 3591, 5132, 5481, 5580, 5595, 5607, 6101, 6121

< 1 {OM4 RJ UA8-31}: 3065, 3161, 3228, 3286, 3287, 5481, 5595, 5607, 6121

SECTION UARJRUN93: bottom 1-top 35

< {RJ UA} 35: 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5166, 5183, 5186, 5204, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5369, 5422, 5462, 5469, 5511, 5521, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5927, 5973, 6121, 6123

< {RJ UA} 34: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3228, 3255, 3263, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5065, 5069, 5073, 5090, 5163, 5166, 5183, 5186, 5193, 5194, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5642, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5721, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {RJ UA} 33: 3022, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3227, 3228, 3255, 3263, 3266, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5357, 5359, 5362, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {RJ UA} 32: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3285, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5357, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5427, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {RJ UA} 31: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5427, 5453, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {RJ UA} 30: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5422, 5426, 5427, 5453, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5625, 5636, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {RJ UA} 29: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5090, 5143, 5163, 5166,

5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5362, 5369, 5371, 5397, 5416, 5422, 5426, 5427, 5453, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< {RJ UA} 28: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5524, 5532, 5544, 5553, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123

< {RJ UA} 27: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5453, 5462, 5481, 5511, 5521, 5524, 5532, 5544, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< {RJ UA} 26: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5511, 5521, 5524, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< {RJ UA} 25: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5266, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5511, 5521, 5524, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5744, 5761, 5766, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< {RJ UA} 24: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5521, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5744, 5766, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< {RJ UA} 23: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5744, 5766, 5773, 5901, 5902, 5913, 5927, 6121, 6123

< {RJ UA} 22: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4037, 4073, 5003, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5744, 5766, 5773, 5901, 5902, 5913, 6121, 6123

< {RJ UA} 21: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4037, 4073, 5003, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334,

5359, 5369, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5744, 5901, 5902, 5913, 6121, 6123

< {RJ UA} 20: 3022, 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4037, 4073, 5003, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5901, 5902, 5913, 6121, 6123

< {RJ UA} 19: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4037, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5901, 5902, 5913, 6121, 6123

< {RJ UA} 18: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5544, 5565, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5901, 5902, 5913, 6101, 6121, 6123

< {RJ UA} 17: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3919, 3947, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5544, 5565, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5785, 5901, 5913, 6101, 6121, 6123

< {RJ UA} 16: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3912, 3919, 3947, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5410, 5416, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5785, 5901, 5913, 6101, 6121

< {RJ UA} 15: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5785, 5901, 5913, 6101, 6121

< {RJ UA} 14: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5359, 5369, 5371, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5785, 5913, 6101, 6121

< {RJ UA} 13: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5359, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5674, 5703, 5712, 5716, 5721, 5785, 5913, 6101, 6121

< {RJ UA} 12: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5359, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5577, 5578,

5580, 5595, 5607, 5636, 5668, 5672, 5674, 5712, 5716, 5721, 5785, 6101, 6121
< {RJ UA} 11: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5290, 5314, 5332, 5359, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5674, 5712, 5716, 5721, 5785, 5824, 6101, 6121
< {RJ UA} 10: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5290, 5314, 5332, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5572, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5674, 5716, 5721, 5785, 5824, 6101, 6121
< {RJ UA} 9: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5290, 5314, 5332, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5672, 5674, 5716, 5721, 5785, 5796, 5824, 6101, 6121
< {RJ UA} 8: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4073, 5003, 5041, 5042, 5044, 5055, 5065, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5314, 5332, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5595, 5607, 5636, 5674, 5716, 5721, 5785, 5796, 5824, 6101, 6121
< {RJ UA} 7: 3022, 3062, 3063, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3295, 3591, 3717, 3911, 3912, 3919, 3924, 3947, 3955, 4073, 5003, 5042, 5044, 5055, 5065, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5209, 5243, 5253, 5332, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5636, 5674, 5716, 5721, 5785, 5796, 5824, 6101, 6121
< {RJ UA} 6: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3717, 3911, 3912, 3918, 3919, 3924, 3947, 3955, 4073, 5003, 5042, 5044, 5055, 5065, 5132, 5163, 5183, 5209, 5243, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5674, 5716, 5721, 5785, 5796, 5824, 6101, 6121
< {RJ UA} 5: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3162, 3165, 3171, 3185, 3202, 3203, 3225, 3227, 3228, 3230, 3255, 3263, 3264, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 3287, 3291, 3293, 3591, 3911, 3912, 3918, 3919, 3924, 3955, 4073, 5003, 5042, 5044, 5065, 5132, 5183, 5209, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5481, 5506, 5510, 5544, 5568, 5607, 5674, 5721, 5785, 5796, 5824, 6101, 6121
< {RJ UA} 4: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3097, 3113, 3121, 3162, 3165, 3171, 3185, 3203, 3225, 3227, 3228, 3230, 3255, 3263, 3280, 3286, 3287, 3291, 3293, 3591, 3911, 3912, 3919, 3924, 3955, 4073, 5003, 5042, 5065, 5132, 5183, 5209, 5410, 5436, 5506, 5607, 5721, 5824, 6101
< {RJ UA} 3: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3096, 3097, 3113, 3121, 3162, 3165, 3171, 3185, 3203, 3225, 3227, 3228, 3230, 3255, 3263, 3280, 3286, 3287, 3291, 3293, 3591, 3911, 3919, 3924, 3955, 4073, 5003, 5042, 5065, 5132, 5183, 5209, 5410, 5436, 5506, 5607, 5721, 5824, 6101
< {RJ UA} 2: 3022, 3062, 3065, 3066, 3090, 3092, 3094, 3095, 3096, 3097, 3113, 3121, 3122, 3162, 3171, 3203, 3225, 3227, 3230, 3263, 3286, 4073
< {RJ UA} 1: 3022, 3062, 3064, 3065, 3066, 3090, 3092, 3094, 3095, 3096, 3097, 3113, 3121, 3122, 3162, 3171, 3203, 3225, 3230, 3241, 3263, 3286, 4073

Chapter 13: Radiolarian biostratigraphy of cherts of the Apenninic ophiolites (Italy) by M. Marcucci and M. Conti

SECTION *MM_Monte_Vitalba: bottom 1-top 1
< 1 {0.35 m above the base}: 3216, 3171, 3139

SECTION *MM_Riparbella: bottom 1-top 3
< 3 {3 metres above the preceding sample}: 3087, 3064, 3624, 3171, 3116
< 2 {upper level}: 3092, 3064, 3215, 3160, 3171, 3022, 3115, 3117
< 1 {lower chert level at Il Terriccio}: 3064, 3013, 3111, 3106, 3104, 3181, 3682, 3055, 3118

SECTION *MM_Quercianella: bottom 1-top 2
< 2 {1.6 metres below the top}: 3087, 3624, 3215, 3112, 3171, 3097
< 1 {Near the base}: 3106, 3160, 3161, 3658, 3642, 3096, 3117, 3113

SECTION *MM_MONTEROSSOLA: bottom 1-top 1
< 1 {Sample RS3}: 3008, 3210, 3215, 3633, 3636, 3254, 3110, 3181, 3180, 3035, 3661, 3667, 3135, 3139, 3133, 3197, 3100, 3169, 3244, 3020, 3062, 3697, 3124, 3123, 3096, 3117

SECTION *MM_IL_CONVENTINO: bottom 1-top 7
< 7 {CC 1}: 3624, 3160, 3658, 3161.
< 6 {CC 4}: 3608, 3624, 3017, 3103, 3180, 3242.
< 5 {CC 10}: 3263, 3624, 4069, 3014, 3017, 3160, 3164
< 4 {CC 12}: 3088, 3263, 3624, 4069, 3017, 3634, 3181, 4062, 3677, 3241, 3689, 3697, 3122, 3655, 3242.
< 3 {CC 28}: 3263, 4069, 3017, 3112, 3292, 3164, 3697, 3642, 3117.
< 2 {CC 26}: 3263, 3677, 3241.
< 1 {CC 23}: 3263, 3658, 3171, 3681, 4034.

SECTION *CT01_02_MONTE_CETONA: bottom 1-top 6
{CT= Conti Maurizio}
< 6 {CT14}: 3144, 3203, 3263
< 5 {CT15}: 3013, 3052, 3094, 3096, 3163, 3292
< 4 {CT16}: 3013, 3021, 3052, 3117, 3292
< 3 {CT17-CET107}: 3013, 3015, 3021, 3052, 3117, 3180, 3181, 3197, 3292
< 2 {CET110}: 3013, 3021, 3052, 3063, 3076, 3180, 3181, 3197, 3292
< 1 {CT18}: 3021, 3103, 3180, 3197

SECTION *MCCT_01_COSTA_SCANDELLA: bottom 1-top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {AI3+AI4}: 3008, 3013, 3052, 3059, 3064, 3088, 3117, 3159, 3163, 3164, 3180, 3181, 3244

SECTION *MC_01_CAPANNELLE: bottom 1-top 1
{MC= Marcucci Marta}
< 1 {C1}: 3215, 3095, 3112, 3113, 3171, 3181, 4073

SECTION *MCCT_01_MONTE_VOLTERRAIO: bottom 1-top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {VOL1}: 3017, 3013, 3052, 3181

SECTION *MCCT_01_MURLO: bottom 1-top 2
{MC= Marcucci Marta. CT= Conti Maurizio}
< 2 {B4}: 3181, 3118 {Stichocapsa sp. 1, 3160, 3161, 3164, 3241, 3267
{Podobursa sp. 1 not codified}
< 1 {B1+B2}: 3263, 3017, 3116, 3122, 3160, 3161, 3164, 3181, 3241

SECTION *MCCT_01_ROCCHETTA_DI_VARA: bottom 1-top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {RV11}: 3161, 3095, 3118, 3197, 3230, 3267, 4072

SECTION *MCCT_01_TIMPA_DELLE_MURGE: bottom 1-top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {LC18}: 3008, 3013, 3052, 3095, 3159, 3161, 3166, 3180, 3181, 3244

SECTION *MCCT_01_VAL_GRAVEGLIA: bottom 1-top 1
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {GR6}: 3008, 3017, 3033, 3035, 3062, 3063, 3064, 3088, 3096, 3100, 3103, 3110, 3113, 3117, 3121, 3123, 3133, 3135, 3139, 3140, 3159, 3160, 3161, 3166, 3169, 3176, 3180, 3181, 3210, 3216, 3218, 3221, 3230, 3243, 3267, 3274, 4006, 4010, 4027{, 4033}, 4064

SECTION *MC_01_ROMITO: bottom 1-top 1
{MC= Marcucci Marta}
< 1 {SO3+SO5}: 3008, 3096, 3104, 3112, 3113, 3117, 3147, 3160, 3166, 3225, 3254, 3263, 4073

SECTION *MC_01_SOVANA_ELMO: bottom 1-top 2
{MC= Marcucci Marta}
< 2 {SOV6}: 3008, 3090, 3160, 3180, 3181, 3263
< 1 {SOV3}: 3088, 3064, 3096, 3097, 3117, 3121, 3139, 3160, 3166, 3180, 3181, 3216, 4069

Chapter 14: Radiolarian of the Tuscan Cherts from Val di Lima, Tuscany, Apennines (Italy) by G. Cortese

SECTION *CS01_VAL_DI_LIMA: bottom 1-top 5
{CS= Cortese Giuseppe}
< 5 {P6}: 3052, 3062, 3161, 3180, 3230, 3263, 3267, 3292
< 4 {P5}: 3090, 3033, 3095, 3117, 3161, 3164, 3166, 3169, 3241, 3292, 3911
< 3 {P4}: 3012, 3015, 3017, 3020, 3024, 3033, 3051, 3052, 3055, 3063, 3064, 3078, 3088, 3096, 3100, 3103, 3110, 3113, 3117, 3123, 3125, 3126, 3129, 3135, 3144, 3147, 3159, 3180, 3181, 3193, 3197, 3204, 3205, 3210, 3213, 3228, 3231, 3254, 3273, 3277, 3285, 3290, 3
< 2 {P3}: 3065, 3028, 3063, 3078, 3096, 3116, 3117, 3118, 3125, 3126, 3139, 3140, 3193, 3204, 3210, 3212, 3213, 3216, 3223, 3254, 4009, 4010
< 1 {P2}: 3092, 3062, 3096, 3116, 3117, 3123, 3159, 3164, 3181, 3193, 3230, 3241, 4055

Chapter 15: Jurassic radiolarian biostratigraphy (Appennines, Central Italy) by A. Bartolini *et al.*

SECTION TERMINILLETTO: bottom 1-top 37
< 37 {TM 207.34}: 3035, 3065, 3070, 3095, 3100, 3115, 3118, 3145, 3168, 3171, 3179, 3202, 3213, 3216, 3230, 3241, 3265, 3289, 4068, 5416
< 36 {TM 206.75}: 3035, 3062, 3088, 3094, 3095, 3096, 3100, 3119, 3122, 3145, 3168, 3171, 3179, 3188, 3202, 3213, 3230, 3241, 3259, 3265, 3406, 4015, 4018, 4068, 4070, 5416
< 35 {TM 197.30}: 3085, 3122, 3202, 3230, 3274, 4068, 4070, 5544
< 34 {TM 197.03}: 3035, 3036, 3094, 3095, 3122, 3145, 3179, 3202, 3213, 3224, 3230, 3241, 3245, 3259, 3265, 3286, 3289, 3406, 4068, 5544
< 33 {TM 193.40}: 3007, 3008, 3035, 3070, 3082, 3085, 3096, 3100, 3103, 3113, 3115, 3116, 3118, 3119, 3121, 3122, 3123, 3129, 3181, 3217, 3224, 3230, 3241, 3259, 3265, 3274, 3305, 3406, 3412, 4068, 5544
< 32 {TM 192.44}: 3007, 3008, 3009, 3122, 3160, 3180, 3181, 3217, 3241, 3245, 3259, 3265, 3305, 5544
< 31 {TM 188.50}: 3113, 3122, 3160, 3181, 3193, 3223, 3224, 3225, 3265, 4068
< 30 {TM 188.45}: 3161, 3224, 3263, 3265
< 29 {TM 188.18}: 3121, 3265, 3096, 3254, 3103, 3241, 4068, 3116, 3126
< 28 {TM 187.44}: 3008, 3009, 3070, 3085, 3097, 3103, 3113, 3118, 3121, 3123, 3163, 3166, 3168, 3180, 3181, 3199, 3215, 3224, 3241, 3245, 3274, 3289, 3406, 4068, 5544
< 27 {TM 187.30}: 3008, 3070, 3085, 3097, 3163, 3168, 3180, 3181, 3224, 3241, 3245, 3265, 4068
< 26 {TM 179.20}: 3085, 3096, 3103, 3148, 3159, 3160, 3163, 3166, 3217, 3224, 3266, 4068
< 25 {TM 174.98}: 2023, 2024, 3007, 3008, 3017, 3065, 3070, 3104, 3106, 3113, 3121, 3152, 3159, 3160, 3163, 3166, 3174, 3180, 3210, 3266, 3270, 4068
< 24 {TM 174.88}: 2023, 2024, 3007, 3008, 3065, 3070, 3096, 3121, 3152, 3159, 3160, 3163, 3166, 3180, 3181, 3210, 3213, 3225, 3266, 3270, 4068, 5544
< 23 {TM 174.86}: 2021, 2023, 2024, 3008, 3070, 3085, 3096, 3110, 3117, 3121, 3152, 3159, 3160, 3163, 3166, 3180, 3181, 3210, 3218, 3224, 3266, 4071, 5544
< 22 {TM 168.15}: 2011, 2023, 2024, 2025, 3005, 3006, 3008, 3017, 3035, 3055, 3065, 3070, 3085, 3100, 3104, 3110, 3117, 3118, 3121, 3124, 3147, 3150, 3152, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3210, 3218, 3220, 3238, 3244, 3269, 3270, 4006, 4071, 4072
< 21 {TM 166.70}: 3113, 3121, 3140, 3147, 3159, 3160, 3169, 3174, 3266, 3270, 3413
< 20 {TM 165.80}: 2011, 2017, 2021, 2024, 3005, 3006, 3007, 3008, 3009, 3035, 3055, 3070, 3085, 3096, 3100, 3103, 3104, 3110, 3113, 3117, 3118, 3140, 3147, 3150, 3152, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3199, 3210, 3215, 3220, 3238, 3244, 3266, 3269, 3413, 4005, 4014, 4066, 4072
< 19 {TM 164.66}: 2021, 2023, 2024, 3005, 3008, 3055, 3059, 3064, 3070, 3085, 3088, 3096, 3100, 3103, 3104, 3110, 3113, 3118, 3121, 3123, 3124, 3147, 3149, 3150, 3152, 3159, 3160, 3162, 3163, 3164, 3169, 3174, 3176, 3180, 3181, 3210, 3215, 3217, 3220, 3222, 3225, 3237, 3238, 3244, 3266, 3267, 3269, 3273, 3413, 4006, 4014, 4044, 4048, 4071, 4072, 5544
< 18 {TM 164.06}: 2011, 2023, 3007, 3008, 3055, 3070, 3110, 3121, 3124, 3140, 3150, 3159, 3160, 3163, 3169, 3174, 3176, 3180, 3181, 3220, 3238, 3266, 3267, 4006, 4044
< 17 {TM 163.05}: 2006, 2011, 2019, 2024, 2025, 3008, 3015, 3032, 3055, 3070, 3104, 3109, 3110, 3113, 3117, 3118, 3121, 3124, 3140, 3144, 3149, 3150, 3152, 3159, 3160, 3162, 3169, 3174, 3176, 3180, 3181, 3199, 3210, 3212, 3215, 3217, 3218, 3220, 3221, 3223, 3225, 3238, 3244, 3266, 3269, 3273, 4005, 4014, 4044, 4047, 4048, 4071, 4072
< 16 {TM 109.25}: 2002, 2006, 2011, 2012, 2017, 2019, 2023, 2026, 3005, 3006, 3007, 3011, 3070, 3071, 3073, 3074, 3089, 3096, 3135, 3140, 3144, 3147, 3150, 3158, 3159, 3180, 3194, 3195, 3222, 3231, 3247, 3278, 3301, 3414, 3813, 4011, 4014, 4027, 4058, 4059, 4066, 4071, 4072
< 15 {TM 105.50 = To 170}: 2002, 2006, 2008, 2011, 2012, 2017, 2019, 3006, 3011, 3071, 3073, 3074, 3096, 3109, 3125, 3135, 3140, 3144, 3150, 3158, 3159, 3180, 3195, 3197, 3222, 3223, 3231, 3247, 3278, 3301, 3302, 3303, 3813, 4010, 4011, 4014, 4058, 4063, 4066, 4071, 4077
< 14 {TM 90.32}: 2004, 2011, 2012, 2013, 2017, 2021, 2022, 3004, 3011, 3012, 3048, 3052, 3071, 3073, 3074, 3089, 3096, 3144, 3158, 3180, 3194, 3195, 3197, 3231, 3247, 3253, 3278, 3301, 3502, 3813, 4010, 4011, 4014, 4031, 4059, 4071, 4077

< 13 {RTT 140}: 3006, 3089, 3149, 3158, 3247, 3408, 3502, 4009
< 12 {TM 64.74 = To 130}: 2001, 2004, 2008, 2011, 2014, 2017, 2022, 3010, 3011, 3072, 3073, 3074, 3158, 3194, 3195, 3310, 3409, 3414, 4011, 4027, 4028, 4031
< 11 {RTT 116}: 3006, 3089, 3158, 3247, 3502, 4009, 4063
< 10 {TM 51.44}: 2001, 2004, 2005, 2008, 2009, 2011, 2012, 2014, 2017, 2020, 3048, 3055, 3195, 3231, 3302, 3310, 3409, 3414, 4009, 4064, 4066, 4077
< 9 {T 115}: 3001, 3006, 3407, 3414, 4009, 4010, 4011, 4061
< 8 {T 113}: 3414, 4009
< 7 {TM 48.35 = To 112}: 2002, 2003, 2005, 2007, 2008, 2011, 2012, 2013, 2014, 2016, 3010, 3039, 3042, 3071, 3072, 3073, 3089, 3125, 3149, 3195, 3222, 3231, 3247, 3271, 3301, 3302, 3303, 3310, 3409, 3414, 3502, 4009, 4011, 4077
< 6 {T 106}: 2013, 3414, 3089, 3149, 3247, 3408, 4009
< 5 {TM 40.15 = To 104}: 2001, 2002, 2003, 2005, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 3010, 3048, 3089, 3125, 3149, 3195, 3231, 3253, 3301, 3302, 3303, 3407, 3408, 3409, 3410, 3502, 4011, 4027, 4028, 4031, 4061, 4066, 4077
< 4 {T 96}: 3001, 3073, 3089, 3414, 3502, 4061
< 3 {TM 29.52}: 2010, 2012, 2014, 3039, 3089, 3195, 3310, 3407, 3409, 3414, 3502, 4011, 4031
< 2 {TM 25.15}: 2001, 2003, 2008, 2010, 2011, 2012, 2013, 2018, 2019, 3195, 3247, 3253, 3310, 3409, 3502, 4009, 4011, 4027, 4031, 4066
< 1 {RTT 74.5}: 2001, 2010, 3247, 3001, 3006, 3073, 3089, 3407, 3414, 3502, 4010, 4011, 4061

SECTION COLLE_BERTONE: bottom 1-top 1
< 1 {CB2 45.0}: 3010, 3005, 3006, 3011, 3055, 3064, 3071, 3073, 3074, 3088, 3089, 3124, 3158, 3159, 3167, 3181, 3194, 3197, 3231, 3247, 3253, 3271, 3273, 3301, 3302, 3303, 3414, 3502, 3813, 4010, 4011, 4063, 4066

Chapter 16: Jurassic radiolarians from the Campofiorito and Peloritan zones, Sicily (Italy)

by N. Kito and P. De Wever

SECTION KI1_GALATI: bottom 1-top 9
< 9 {S58}: 3119, 3124, 3210, 3273, 3301
< 8 {S57}: 3096, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3225, 3244, 3273
< 7 {S59}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3244, 3273
< 6 {S63}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3244, 3273
< 5 {S64}: 3095, 3096, 3103, 3110, 3117, 3119, 3124, 3144, 3210, 3213, 3215, 3218, 3243, 3244, 3273
< 4 {S66}: 3095, 3096, 3103, 3110, 3117, 3119, 3121, 3124, 3144, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3303, 2001, 2008
< 3 {S68}: 3090, 3096, 3103, 3110, 3117, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 2008
< 2 {S69}: 3096, 3103, 3110, 3117, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3409 {see Kito's thesis}, 4069, 2009, 2008
< 1 {S70}: 3096, 3103, 3110, 3118, 3121, 3124, 3210, 3213, 3215, 3218, 3243, 3244, 3273, 3302, 3303, 3409, 2001, 2008

SECTION KI2_CONTRADA_LA_FERTA: bottom 1-top 9
< 9 {S34}: 3083, 3065, 3087, 3090, 3097, 3111, 3113, 3171, 3185, 3193, 3203, 3213, 3225, 3228, 3263, 3287, 3293, 3305, 5607
< 8 {S33}: 3083, 3065, 3087, 3090, 3097, 3113, 3115, 3164, 3171, 3185, 3197, 3203, 3213, 3228, 3241, 3263, 3287, 3292, 3305, 4069, 4072, 5607, 5674
< 7 {S32}: 3083, 3065, 3087, 3097, 3113, 3164, 3171, 3185, 3197, 3203, 3213, 3241, 3263, 3287, 4072, 5426, 5607
< 6 {S31}: 3012, 3052, 3064, 3088, 3089, 3096, 3113, 3144, 3159, 3180, 3197, 3213, 3221, 3223, 3231, 3270, 3303, 4010, 4063, 4064, 4072
< 5 {S30}: 3008, 3012, 3039, 3052, 3055, 3072, 3089, 3096, 3113, 3144, 3159, 3180, 3215, 3231, 3270, 3271, 3301, 3303, 4010, 4063, 4064
< 4 {S29}: 3001, 3006, 3012, 3024, 3033, 3039, 3048, 3050, 3052, 3055, 3072, 3089, 3096, 3104, 3113, 3118, 3123, 3125, 3137, 3144, 3194, {3198, DOES NOT EXIST. ERROR??}3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4061, 4063, 4064
< 3 {S28}: 3001, 3006, 3012, 3033, 3039, 3050, 3052, 3055, 3072, 3089, 3096, 3104, 3113, 3123, 3125, 3137, 3144, 3194, {3198, DOES NOT EXIST ERROR?} 3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064
< 2 {S27}: 3001, 3006, 3012, 3033, 3039, 3050, 3052, 3055, 3072, 3089, 3096, 3103, 3104, 3110, 3113, 3123, 3125, 3137, 3144, 3194, 3215, 3231, 3270, 3271, 3301, 3302, 3303, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064
< 1 {S25}: 3001, 3006, 3039, 3050, 3066, 3072, 3089, 3096, 3104, 3113, 3116, 3121, 3123, 3125, 3144, 3194, 3215, 3231, 3270, 3301, 3302, 3303, 3502, 4009, 4010, 4028, 4032, 4059, 4061, 4063, 4064

Chapter17: Radiolarians from the Sciacca Zone, Santa Anna, Sicily (Italy) by P. De Wever

SECTION DW1_SANTA_ANNA_SICILY: bottom 1-top 10
{REMOVED: KOTURA ARGOLIDENSIS BROENNIMANNI IN SA94, ROBUSTA IN SA96, COSMOCONICA IN SA111-106}
< 10 {sa94}: 3066, 3065, 3087, 3090, 3092,{ 3103,} 3113, 3115,{ 3140,} 3213,{ 3220,} 3227, 3228, {dentata}3281,{radicus} 5209
< 9 {sa96}: 3066, 3065, 3078, 3087, 3090, 3092,{ 3103,} 3113, 3115,{ 3137,}{ 3140,} 3161,{ 3220, 3227, 3228, 3266, 4069,} {radicus}5209
< 8 {sa104}: 3036, 3066, 3090, 3092, 3096, 3097, 3100, 3103, 3104, 3106, 3113, 3116, 3117, 3122, 3131, 3137, 3138, 3139, 3147, 3161, 3171, 3185, 3210, 3213, 3215, 3220, 3230, 4069
< 7 {sa105}: 3035, 3036, 3066, 3096, 3097, 3100, 3104, 3113, 3122, 3147, 3164, 3166, 3171, 3185, 3210, 3215, 3230, 3263, 4069
< 6 {sa106}: 3035, 3036, 3066, 3096, 3097, 3103, 3104, 3106, 3113, 3116, 3118, 3119, 3121, 3122, 3140, 3147, 3164, 3166, 3169, 3180, 3185, 3199, 3215, 3230,{ 3255,} 3263, 3267, 4069
< 5 {sa107}: 3035, 3036, 3063, 3066, 3096, 3097, 3113, 3116, 3118, 3121, 3122, 3129, 3140, 3147, 3161, 3164, 3169, 3180, 3185, 3199, 3210, 3213, 3225, 3230, 3263, 3267, 4069
< 4 {sa108}: 3035, 3036, 3066, 3090, 3096, 3103, 3104, 3113, 3116, 3117, 3119, 3121, 3122, 3126, 3129, 3140, 3161, 3169, 3185, 3210, 3215, 3225, 3230, 3267, 4069, 5003
< 3 {sa109}: 3035, 3036, 3066, 3078, 3090, 3096, 3100, 3103, 3104, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3131, 3139, 3140, 3147, 3160, 3161, 3164, 3169, 3180, 3185, 3210, 3215, 3225, 3230,{ 3255,} 3267, 4069
< 2 {sa110}: 3035, 3036, 3066, 3078, 3096, 3100, 3103, 3104, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3129, 3139, 3140, 3147, 3160, 3161, 3162, 3185, 3210, 3225, 3230,{ 3255,} 3263, 3267, 3273, 4069
< 1 {sa111}: 3008, 3035, 3036, 3066, 3096, 3103, 3106, 3113, 3117, 3118, 3119, 3121, 3122, 3126, 3129, 3140, 3160, 3164, 3180, 3185, 3210, 3213, 3215, 3230,{ 3255,} 3267, 4069

Chapter 18: Middle Jurassic-Early Cretaceous radiolarians biochronology of the Budva Zone by S. Gorican

SECTION 2_VERIGE: bottom 1-top 5
< 5 {Ve 10}:{ 1114,} 3164, 3170, 3171, 3216, 3241, 3292, 4015, 4073
<4 {Ve 9}:{ 1040,}{ 1054,} 3017, 3145, 3161, 3164, 3170, 3171, 3182, 3224, 3241, 3263, 3267, 3274, 3292, 4015, 4069
< 3 {Ve 8}:{ 1040,}{ 1114,}{ 1116,} 3017, 3065, 3069, 3145, 3161, 3164, 3170, 3171, 3241, 3263, 3274, 3292
< 2 {Ve 7}: 3161,3164, 3224, 3241, 3267, 3274 ,4069
< 1 {Ve 6}: 3069, 3164, 3241, 3292, 4073

SECTION 3_1_BIJELA_I: bottom 1-top 7
< 7 {Bj 15}: 3065, 3069, 3090, 3122, 3164, 3181, 3193, 3199, 3224, 3241, 3263, 3292, 3305, 4055, 4069, 4079
< 6 {Bj 14}: 3046, 3110, 3117, 3121, 3176, 3180, 3199, 3210, 3215, 3297, 3298
< 5 {Bj 13}: 3237, 3273, 4044, 4054, 4060
< 4 {Bj 12}:{ 1117,} 3096, 3110, 3181, 3192, 3197, 3210, 3237, 3271, 4010, 4034, 4044, 4063
< 3 {Bj 11}:{ 1079,} 2011, 3052, 3089, 3192, 3197, 3231, 4010, 4044, 4058
< 2 {Bj 10}:{ 1117,}{1120,} 3039, 3041, 3073, 3074, 3089, 3096, 3194, 3195, 3253, 4059
< 1 {Bj 9}: 3006, 3010, 3048, 3072, 3074, 3151, 3194, 3195

SECTION 3_2_BIJELA_II: bottom 1-top 2
< 2 {Bj 15/2}: 3161, 3164, 3171, 3177, 3241, 3274
< 1 {Bj 15/1}:{ 1116,} 3017, 3065, 3069, 3100, 3137, 3181, 3193, 3210, 3224, 3243, 3305, 4055, 4069, 4079

SECTION 3_3_BIJELA_III_IV: bottom 1-top 3
< 3 {Bj 17}: 3087, 3185, 4026, 5073, 5229, 5426, 5462, 5481, 5636, 5712
< 2 {BjIII 3.00}:{ 1114,}{ 1117,} 3069, 3161, 3164, 3170, 3171, 3177, 3182, 3216, 3241, 3243, 3267, 3274, 3292, 4015, 4055, 4073, 4079
< 1 {BjIII 0.40}:{ 1054,}{ 1114,}{ 1116,} 3017, 3066, 3122, 3161, 3164, 3170, 3171, 3182, 3216, 3224, 3241, 3274, 3292, 4069, 4073

SECTION 4_GORNJA_LASTVA: bottom 1-top 20
< 20 {GL 214}: 3087, 3090, 3185, 4026, 5011, 5229
< 19{GL 142}:{ 1050,}{ 1104,} 3019, 3065, 3087, 3090, 3092, 3185, 3255, 3263, 3284, 3293, 6101
< 18 {GL 139}:{ 1014,}{ 1104,} 3065, 3087, 3171, 3255, 3263, 3287
< 17 {GL 138}:{ 1014,}{ 1050,}{ 1054,}{ 1104,}{ 1124,} 3019, 3065, 3087, 3161, 3164, 3165, 3170, 3171, 3185, 3241, 3263, 3286, 3287, 3292, 3294, 3305, 3293, 6101
< 16 {GL 137}: 3145, 3161, 3170, 3171, 4015
< 15 {GL 210}:{ 1114,}{ 1116,} 3145, 3161, 3170, 3171, 3216, 3274, 3292, 4073
< 14 {GL 209+6.60}:{ 1040,}{ 1114,}{ 1116,}{ 1117,} 3017, 3065, 3069, 3090, 3095, 3103, 3117, 3121, 3122, 3129, 3133, 3137, 3139, 3140, 3145, 3161, 3162, 3164, 3170, 3181, 3193, 3197, 3199, 3204, 3210, 3215, 3216, 3224, 3225, 3230, 3241, 3243, 3263, 3267, 3274, 3292, 3305, 4015, 4055, 4069, 4073, 4079
< 13 {GL 209}:{ 1032,}{ 1037,}{ 1116,} 3008, 3014, 3017, 3052, 3095, 3100, 3103, 3117, 3121, 3137, 3139, 3193,

3205, 3210, 3215, 3223, 3224, 3243, 3279, 3292, 4055, 4060, 4069
< 12 {GL 208+1.00}:{ 1113,}{ 1117,} 3046, 3052, 3176, 3180, 3193, 3297, 3298, 4014, 4060
< 11 {GL 208}: 3117, 3273, 3298
< 10 {GL 207}:{ 1113,} 3110, 3117, 3180, 3181, 3197, 3210, 3215, 3221, 3223, 3273, 3277, 3279, 3297, 4010, 4014, 4044
< 9 {GL 135}:{ 1117,} 3052, 3180, 3181, 3197, 3237, 4014, 4034, 4044, 4054
< 8 {GL 134}: 3052, 3096, 3181, 3197, 3210, 3223, 3271, 3273, 4010, 4034, 4044, 4058
< 7 {GL 6}:{ 1079,}{ 1119,} 3089, 3096, 3181, 3192, 3197, 3210, 3237, 3253, 4014, 4044, 4058, 4060
< 6 {GL 132}:{ 1079,} 3052, 3192, 3197, 3231, {3558,}4009, 4010, 4034, 4044
< 5 {ZB 28}:{ 1079,}{ 1117,}{ 1120,}{ 1128,} 3006, 3052, 3074, 3089, 3096, 3123, 3129, 3192, 3195, 3197, 3231, 3247, 3253, 3273, 3297, 3307, 3413, {3558,}4009, 4010, 4044, 4049, 4058, 4059, 4063
< 4 {GL 128}:{ 1117,} 3039, 3040, 3041, 3052, 3192, 3194, 3223, 3231, 3253
< 3 {GL 127}:{ 1117,}{ 1128,} 3010, 3039, 3041, 3048, 3052, 3072, 3074, 3089, 3096, 3192, 3194, 3195, 3197, 3231, 3253, 4010, 4061
< 2 {GL 125}:{ 1117,} 3010, 3039, 3048, 3072, 3074, 3151, 3194, 3195, 3231, 4010
< 1 {GL 123}:{ 1117,} 3006, 3039, 3048, 3072, 3073, 3089, 3096, 3151, 3310, 4010, 4031

SECTION 6_PETROVAC: bottom 1-top 3
< 3 {PK 7}:{ 1114,}{ 1117,} 3145, 3161, 3164, 3181, 3199, 3205, 3224, 3230, 3241, 3263, 3292, 4069
< 2 {PK 9}:{ 1037,}{ 1116,} 3014, 3017, 3065, 3100, 3103, 3117, 3121, 3133, 3181, 3193, 3197, 3199, 3204, 3223, 3224, 3243, 3263, 3292, 4069
< 1 {PK 12}:{ 1117,} 3052, 3065, 3090, 3096, 3103, 3117, 3181, 3193, 3223, 3292, 4060

SECTION 7_CANJ: bottom 1-top 18
< 18 {UPC 30}:{ 2025,} 3065, 3087, 3092, 3161, 3287, 5073, 4026, 5462, 5636
< 17 {UPC 29}:{ 1014,} 3065, 3087, 3161, 3165, 3170, 3263, 3286
< 16 {UPC 28}:{ 1014,}{ 1102,} 3019, 3065, 3087, 3164, 3170, 3171, 3225, 3241, 3263, 3305, 6101
< 15 {UPC 27}:{ 1014,}{ 1054,}{ 1102,} 3019, 3065, 3066, 3087, 3161, 3164, 3171, 3185, 3189, 3241, 3263, 3286, 3287, 3292, 3305, 3911
< 14 {UPC 26}:{ 1014,} 3065, 3087, 3164, 3171, 3241, 3263
< 13 {UPC 25}:{ 1014,}{ 1054,} 3019, 3065, 3161, 3164, 3170, 3171, 3241, 3292, 6101
< 12 {UPC 262.70}:{ 1014,}{ 1040,}{ 1054,}{ 1102,}{ 1116,} 3017, 3090, 3100, 3145, 3161, 3164, 3170, 3171, 3179, 3182, 3189, 3193, 3199, 3215, 3216, 3241, 3263, 3274, 3292, 4015, 4073
< 11 {UPC 257.10}:{ 1116,}{ 1117,} 3017, 3069, 3139, 3161, 3164, 3171, 3179, 3215, 3216, 3224, 3230, 3241, 3263, 3274, 4055, 4069, 4079
< 10 {UPC 251.50}:{ 1037,}{ 1116,}{ 1117,} 3017, 3065, 3069, 3090, 3100, 3117, 3121, 3133, 3137, 3145, 3180, 3181, 3193, 3197, 3199, 3205, 3210, 3223, 3224, 3243, 3259, 3263, 3292, 4055, 4069, 4073, 4079
< 9 {UPC 23}:{ 1037,}{ 1114,} 3008, 3065, 3100, 3103, 3104, 3117, 3122, 3127, 3129, 3133, 3137, 3139, 3140, 3180, 3181, 3193, 3199, 3205, 3223, 3224, 3243, 3259, 3263, 4055, 4060, 4069
< 8 {UPC 22}:{ 1032,} 3017, 3095, 3133, 3137, 3139, 3140, 3180, 3181, 3199, 3205, 3223, 3224, 3243, 4055, 4069
< 7 {UPC 21}:{ 1116,} 3096, 3100, 3117, 3121, 3139, 3180, 3181, 3193, 3197, 3199, 3205, 3215, 3223, 3224, 3225, 3243, 3273, 4069
< 6 {UPC 20}:{ 1113,}{ 1117,} 3044, 3046, 3197, 3297, 3298
< 5 {UPC 18}:{ 1113,}{ 1117,}{ 1126,} 3008, 3017, 3044, 3045, 3046, 3121, 3160, 3176, 3180, 3181, 3193, 3199, 3205, 3210, 3237, 3297, 3298, 3413, 4060
< 4 {UPC 16}:{ 1117,} 3041, 3096, 3197, 3231
< 3 {UPC 15}: 3006, 3039, 3041, 3073, 3074, 3096, 3194, 3195, 3253, 4061
< 2 {UPC 14}:{ 1117,} 3010, 3048, 3072, 3073, 3074, 3194, 3195, 3253
< 1 {UPC 13}:{ 1117,} 3006, 3010, 3048, 3072, 3195, 3247, 3253, 4061

SECTION 8_DIN_VRH: bottom 1-top 8
< 8 {DIN 31.50}:{ 2025,} 3065, 3087, 3090, 3161, 3286, 4026, 3293, 5229, 5462, 5481, 5636, 5712
< 7 {DIN 29.30}:{ 1102,}{ 1104,} 3019, 3182, 3185, 3293, 5636, 6101
< 6 {DIN 24.30}:{ 1014,}{ 1050,} 3019, 3065, 3161, 3171, 3182, 3263, 3287, 3292, 3305, 3911, 3293, 4073
< 5 {DIN 11.55}:{ 1054,}{ 1102,}{ 1114,} 3017, 3066, 3069, 3123, 3161, 3171, 3177, 3182, 3216, 3259, 3263, 3274, 3292, 3294, 3305, 4055, 4079
< 4 {DIN 7.00}:{ 1054,} 3171, 4015, 4055
< 3 {DIN 4.50}: 3017, 3069, 3164, 3224, 3230, 3241, 4055, 4069
< 2 {DIN 2.35}:{ 1040,}{ 1114,}{ 1116,}{ 1117,} 3069, 3100, 3103, 3117, 3121, 3122, 3139, 3145, 3161, 3164, 3170, 3179, 3181, 3199, 3210, 3215, 3216, 3224, 3230, 3241, 3243, 3263, 3274, 4010, 4069
< 1 {DIN 1.50}: 3017, 3117, 3122, 3161, 3164, 3181, 3193, 3241, 3274, 3292

SECTION 10_BAR: bottom 1-top 9
< 9 {BM 478.60}:{ 2025,} 3087, 3185, 3287, 4026, 4073, 5011, 5073, 5204, 5229, 5426, 5462, 5481, 5532, 5636, 5712
< 8 {BM 469.00}: 3087, 3287, 4026, 5073, 5229, 5462, 5636
< 7 {BM 466.40}:{ 2025,} 3065, 3087, 4026, 4073, 5229, 5462, 5481
< 6 {BM 8}:{ 1014,}{ 1050,} 3065, 3066, 3087, 3161, 3170, 3171, 3185, 3263, 3286, 3287, 3292, 4073, 6101
< 5 {BM 7}:{ 1014,}{ 1102,} 3019, 3065, 3087, 3161, 3164, 3170, 3171, 3241, 3263, 3274, 3287, 3292
< 4 {BM 6}: 3017, 3065, 3161, 3164, 3170, 3171, 3241,

3263, 3274, 3292, 4015
< 3 {BM 5}:{ 1054,}{ 1114,} 3069, 3161, 3164, 3171, 3177, 3197, 3241, 3274, 4015
< 2 {BM 106}:{ 1040,}{ 1054,}{ 1102,}{ 1116,}{ 1117,} 3065, 3066, 3122, 3145, 3161, 3170, 3171, 3177, 3182, 3193, 3197, 3199, 3215, 3274, 3292, 4015, 4079
< 1 {BM 102}:{ 1032,}{ 1037,}{ 1114,}{ 1116,}{ 1117,} 3008, 3014, 3017, 3065, 3090, 3095, 3096, 3100, 3104, 3117, 3121, 3123, 3127, 3129, 3137, 3139, 3147, 3160, 3162, 3176, 3180, 3181, 3193, 3197, 3199, 3204, 3205, 3210, 3215, 3223, 3224, 3225, 3230, 3243, 3273, 3292, 4010, 4055, 4069

Chapter 19: Middle to Upper Jurassic Radiolarian Ionian & Maliac Zones (Greece) by T. Danelian

SECTION *TD1_ANO_KOUKLESSI: bottom 1-top 2
< 2 {587}: 3090, 3092, 3161, 3202, 3227, 3286, 6121
< 1 {ASAX-4}: 3074, 3055, 3180, 3197

SECTION *TD2_KATO_KOUKLESSI: bottom 1-top 5
< 5 {ASB1-7}: 3090, 3065, 3087, 3092, 3112, 3161, 3203, 3213, 3228, 3255, 3263, 3286, 4073, 6121
< 4 {ASB1-6}: 3090, 3065, 3087, 3213
< 3 {ASB1-4}: 3090, 3096, 3118, 3121, 3125, 3137, 3139, 3147, 3161, 3168, 3171, 3189, 3215, 3230,
< 2 {ASB1-3}: 4015, 3139, 3168, 4069
< 1 {ASB1-1}: 3090, 3062, 3064, 3085, 3092, 3096, 3103, 3118, 3122, 3125, 3137, 3139, 3145, 3147, 3161, 3164, 3171, 3215, 3216, 3230, 3243, 3254, 3263, 4015, 4018, 4069

SECTION *TD3_VATHY: bottom 1-top 1
< 1 {3A}: 3221, 3096, 3117, 3124, 3169, 3210, 3213, 3222, 3273, 4009, 4010

SECTION *TD4_KHIONISTRA: bottom 1-top 1
< 1 {BSA4-1}: 6121, 3097, 3171, 3203, 3213, 3263

SECTION *TD5_PALIAMBELA: bottom 1-top 5
< 5 {BSB-15}: 3263, 3171
< 4 {BSB-11}: 3215, 3216
< 3 {BSB-10}: 4015, 3096, 3137, 3139, 3215, 3254
< 2 {BB9-7,7}: 4069, 3164, 3215, 3230
< 1 {BB5-1,3}: 3085, 3020, 3035, 3055, 3061, 3062, 3064, 3096, 3103, 3110, 3113, 3116, 3117, 3118, 3121, 3124, 3144, 3152, 3166, 3169, 3210, 3215, 3216, 3225, 3230, 3244, 3273

SECTION *TD7_SKANDHALON: bottom 1-top 15
< 15 {CSA10-1}: 3087, 3065, 3097, 3161, 3171, 3225, 3263, 3286
< 14 {CSA9-6}: 3090, 3065, 3087, 3092, 3097, 3161, 3171, 3225, 3263, 3286
< 13 {CSA9-4}: 3225, 3097, 3171, 4015
< 12 {CSA9-3}: 3225, 3097, 3171
< 11 {CSA9-2}: 3092, 3097, 3164, 3171, 3177, 3202, 3203, 3225, 3227, 3241, 3263, 4015
< 10 {CSA9-1}: 3263, 3097, 3171, 3203
< 9 {CSA8-1}: 3215, 3171, 3177, 3216
< 8 {CSA7-1}: 3090, 3118, 3137, 3147, 3168, 3171, 3243, 4015, 4018, 4069, 4073
< 7 {CSA6-2}: 3090, 3064, 3085, 3161, 3164, 3171, 3215, 3230, 4018, 4069, 5199
< 6 {CSA6-1}: 3085, 3064, 3118, 3139, 3147, 3164, 3215, 3263, 4069
< 5 {CSA4-2}: 3085, 3064, 3215, 4069
< 4 {CSA4-1}: 3104
< 3 {CSA3-5}: 3008
< 2 {CSA3-2}: 3085, 3005, 3008, 3020, 3055, 3064, 3103, 3121, 3164, 3169, 3180, 3197, 3238, 3244, 3277, 3298
< 1 {CSA3-1}: 3005, 3008, 3020, 3055, 3061, 3064, 3085, 3096, 3103, 3110, 3124, 3164, 3169, 3195, 3197, 3210, 3221, 3238, 3244, 3271, 3273, 3277, 3297

SECTION *TD8_TSIBOURIKI: bottom 1-top 10
< 10 {TD 84-91}: 3160
< 9 {TD 84-90}: 3085, 3008, 3020, 3055, 3062, 3064, 3096, 3117, 3118, 3121, 3124, 3135, 3139, 3140, 3144, 3160, 3166, 3169, 3180, 3199, 3210, 3215, 3222, 3223, 3230, 3243, 3244, 3254, 3273, 4010, 4069
< 8 {TD 84-88}: 3180
< 7 {TD 84-87}: 3085, 3064, 3117, 3121, 3210, 3215, 3221, 3222, 3243, 3254, 4009, 4010
< 6 {TD 84-86}: 3008, 3117, 3180, 3210
< 5 {TD 84-83}: 3238, 3164
< 4 {TD 84-81}: 3085, 3064
< 3 {TD 84-79}: 3085, 3005, 3064
< 2 {TD 84-78}: 3222, 3116, 3117, 3124, 3197, 3199, 3273, 4010
< 1 {TD 84-73}: 3222, 4010

SECTION *MIGDALIA: bottom 1-top 6
< 6 {TD93-21}: 3012, 3055, 3180, 3221, 3277, 3297, 3298
< 5 {TD93-19}: 3298
< 4 {TD93-16}: 3052
< 3 {TD92-14}: 3052, 3277
< 2 {TD93-13}: 3052, 3277
< 1 {TD93-12}: 3012, 3197, 3276, 3277, 3298, 4014

Chapter 20: Radiolarians overlying ophiolites of the Almopias domain (Macedonia, Greece) by P. De Wever

SECTION *DW7_GRECE_ALMOPIAS_UNIVRI: bottom 1-top 1
< 1 {ALM1}: 3197, 3263

SECTION *DW8_GRECE_ALMOPIAS_UNIVRI: bottom 1-top 1
< 1 {ALM2}: 3103, 3199

Chapter 21: Radiolarians from the Pindos Olonos Zone (Greece): Bajocian (?) to Tithonian by P. De Wever and F. Cordey

SECTION *DW9_GRECE_PINDE_OLONOS_CO: bottom 1-top 4
< 4 {fc19}: 3110, 3117, 3118, 3215
< 3 {fc10}: 3135, 3197, 3231
< 2 {fc5}: 3041, 3231
< 1 {fc3}: 3231

SECTION *DW1O_GRECE_PINDE_OLONOS_COUPE_B: bottom 1-top 2
< 2 {fc47}: 3117, 3118
< 1 {fc35}: 3231, 3197, 4072

SECTION *DW14_GRECE_PINDE_OLONOS_COUPE_C1: bottom 1- top 5
< 5 {fc144}: 3022, 3103, 3122, 3164, 3180
< 4 {id93}: 3008, 3017, 3022, 3078, 3105, 3126, 3163, 3199
< 3 {fc133}: 3123, 3180, 3213, 3215, 3273
< 2 {fc127}: 3006, 3096, 3103, 3197, 3231
< 1 {fc121}: 3115, 3113, 3231

SECTION *DW13_GRECE_PINDE_OLONOS_COUPE_C2: bottom 1- top 3
< 3 {id99}: 3036, 3092, 3103, 3104, 3113, 3118, 3121, 3133, 3139, 3161, 3164, 3185, 3230, 3255, 3919, 4069, 5003, 5426
< 2 {id98}: 3020, 3022, 3062, 3066, 3078, 3096, 3100, 3106, 3117, 3118, 3121, 3126, 3137, 3139, 3180, 3230, 3266, 4004, 4069
< 1 {id96}: 3017, 3022, 3023, 3036, 3180, 3185, 4004

SECTION *DW11_GRECE_PINDE_OLONOS_COUPE_D: bottom 1-top 1
< 1 {id214}: 3022, 3036, 3161, 3164, 3171, 3185, 3255, 4069

SECTION *DW12_GRECE_PINDE_OLONOS_COUPE_E: bottom 1- top 2
< 2 {id192}: 3017, 3020, 3022, 3066, 3078, 3103, 3113, 3117, 3126, 3199, 3210, 3215, 3255
< 1 {id200}: 3062, 3090, 3117, 3185, 3210, 3255, 3263, 4069

Chapter 22: Upper Jurassic radiolarites in the Pieniny Klippen Belt, Carpathians by K. Birkenmayer and D. Widz

SECTION *WI1_CZ_SKALA: bottom 1-top 4
< 4 {2/15}: 3083, 3064, 3065, 3088, 3113, 3117, 3121, 3122, 3164, 3174, 3180, 3205, 3215, 3216, 3224, 3230, 3241, 3263, 4069
< 3 {2/11}: 3083, 3064, 3065, 3088, 3090, 3103, 3113, 3117, 3119, 3121, 3122, 3164, 3180, 3181, 3185, 3215, 3216, 3224, 3230, 3241, 3263, 4069
< 2 {2/9-10}: 3083, 3064, 3065, 3088, 3103, 3113, 3117, 3119, 3121, 3122, 3164, 3180, 3181, 3215, 3216, 3224, 3230, 3241, 3263, 4069
< 1 {2/2}: 3009, 3064, 3065, 3083, 3088, 3113, 3117, 3121, 3161, 3164, 3169, 3181, 3215, 3224, 3230, 3241, 3263, 3406, 4069

SECTION *WI2_PODMAJ: bottom 1-top 5
< 5 {1/34}: 3088, 3064, 3215, 3216, 3230
< 4 {1/37}: 3009, 3064, 3065, 3083, 3088, 3161, 3171, 3215, 3216, 3230, 3406
< 3 {1/39-40}: 3083, 3064, 3065, 3088, 3161, 3171, 3215, 3216, 3224, 3230, 3406, 4069
< 2 {1/45}: 3022, 3064, 3065, 3083, 3088, 3113, 3161, 3164, 3171, 3215, 3216, 3224, 3230, 3241, 3406, 4069
< 1 {1/57}: 3090, 3117, 3119, 3131, 3161, 3193, 3204, 3205, 3210, 3216, 3224, 3230, 3263, 3406, 4018, 4069

SECTION *WI3_SZAFL: bottom 1-top 21
< 21 {4/79}: 3113, 3181, 3224, 4069
< 20 {4/74}: 3113, 3161, 3181, 3224, 3225, 3230, 3259, 3406, 4069
< 19 {4/71}: 3113, 3161, 3164, 3181, 3193, 3224, 3225, 3230, 3241, 3406, 4069
< 18 {4/69}: 3009, 3103, 3111, 3113, 3117, 3121, 3122, 3131, 3133, 3139, 3147, 3161, 3164, 3169, 3181, 3185, 3193, 3224, 3225, 3230, 3241, 3406, 4069
< 17 {4/64}: 3009, 3017, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3147, 3161, 3164, 3169, 3181, 3185, 3193, 3204, 3215, 3224, 3225, 3230, 3241, 3406, 4069
< 16 {4/62}: 3009, 3017, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3147, 3161, 3164, 3169, 3181, 3185, 3193, 3204, 3215, 3224, 3225, 3230, 3241, 3263, 3406, 4069
< 15 {4/60}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3123, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3164, 3169, 3181, 3185, 3193, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3241, 3243, 3263, 3406, 4069
< 14 {4/54}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3164, 3169, 3181, 3185, 3193, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3241, 3243, 3263, 3406, 4069
< 13 {4/53}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139,

3140, 3147, 3161, 3164, 3169, 3180, 3181, 3185, 3193, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3241, 3243, 3263, 3406, 4069
< 12 {4/52}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3164, 3169, 3180, 3181, 3185, 3193, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3241, 3243, 3245, 3263, 3406, 4069
< 11 {4/49-50}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3164, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3241, 3243, 3263, 3406, 4069
< 10 {4/44}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3243, 3263, 3406, 4069
< 9 {4/39}: 3009, 3017, 3022, 3064, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3122, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3210, 3215, 3218, 3224, 3225, 3230, 3243, 3263, 3406, 4069
< 8 {4/37}: 3009, 3017, 3022, 3064, 3076, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3210, 3215, 3216, 3218, 3224, 3225, 3230, 3243, 3263, 3406, 4069
< 7 {4/35}: 3009, 3017, 3022, 3064, 3076, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3210, 3215, 3216, 3218, 3224, 3225, 3230, 3243, 3263, 3406, 4069
< 6 {4/34}: 3009, 3017, 3022, 3064, 3076, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3131, 3133, 3138, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3205, 3210, 3215, 3216, 3218, 3223, 3224, 3225, 3230, 3243, 3263, 3406, 4069
< 5 {4/33}: 3009, 3017, 3022, 3064, 3076, 3088, 3103, 3111, 3113, 3117, 3119, 3121, 3131, 3133, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3205, 3210, 3215, 3216, 3218, 3223, 3224, 3230, 3243, 3263, 3406, 4069
< 4 {4/26}: 3009, 3017, 3022, 3064, 3076, 3088, 3090, 3103, 3104, 3111, 3113, 3117, 3119, 3121, 3126, 3131, 3133, 3135, 3139, 3140, 3147, 3161, 3169, 3180, 3181, 3185, 3193, 3199, 3204, 3205, 3210, 3215, 3216, 3218, 3223, 3224, 3243, 3263, 3406, 4069
< 3 {4/16}: 3009, 3064, 3088, 3103, 3111, 3113, 3119, 3121, 3131, 3161, 3180, 3181, 3185, 3193, 3210, 3218, 3224, 3243, 3263, 3406, 4069
< 2 {4/3}: 3009, 3064, 3088, 3103, 3111, 3113, 3119, 3121, 3131, 3161, 3180, 3181, 3185, 3193, 3218, 3224, 3243, 3406, 4069
< 1 {4/1}: 3009, 3064, 3065, 3069, 3083, 3088, 3103, 3111, 3113, 3119, 3121, 3131, 3161, 3163, 3180, 3181, 3185, 3193, 3218, 3224, 3243, 3406, 4069

SECTION *WI4_SZCZWYZ: bottom 1-top 13
< 13 {3/11-13}: 3083, 3065, 3094, 3161, 3170, 3171, 3185, 3193, 3216, 3263, 3406
< 12 {3/21-23}: 3083, 3065, 3094, 3108, 3111, 3145, 3161, 3170, 3171, 3177, 3185, 3193, 3215, 3216, 3224, 3263, 3406, 4069
< 11 {3/27}: 3083, 3065, 3092, 3094, 3108, 3111, 3112, 3122, 3145, 3161, 3170, 3171, 3177, 3185, 3193, 3199, 3215, 3216, 3224, 3263, 3406, 4069, 4073
< 10 {3/29-31}: 3094, 3108, 3111, 3112, 3122, 3145, 3161, 3170, 3171, 3177, 3185, 3193, 3215, 3216, 3224, 3263, 3406, 4069, 4073
< 9 {3/33}: 3108, 3111, 3112, 3122, 3145, 3161, 3170, 3171, 3177, 3180, 3185, 3193, 3215, 3216, 3224, 3263, 3406, 4018, 4069, 4073
< 8 {3/34}: 3017, 3108, 3122, 3145, 3161, 3170, 3171, 3177, 3180, 3185, 3193, 3216, 3224, 3263, 3406, 4018, 4069
< 7 {3/36}: 3108, 3122, 3145, 3161, 3164, 3170, 3171, 3180, 3185, 3193, 3216, 3224, 3241, 3263, 3406, 4069
< 6 {3/39}: 3122, 3145, 3161, 3164, 3171, 3180, 3185, 3193, 3224, 3230, 3241, 3263, 3406, 4069
< 5 {3/40}: 3009, 3113, 3122, 3145, 3161, 3164, 3180, 3185, 3193, 3224, 3230, 3241, 3263, 3406, 4069
< 4 {3/41}: 3009, 3064, 3066, 3069, 3088, 3090, 3103, 3113, 3119, 3121, 3122, 3140, 3145, 3161, 3164, 3180, 3181, 3185, 3193, 3224, 3230, 3241, 3263, 3406, {4017,}4069
< 3 {3/43}: 3009, 3064, 3069, 3088, 3103, 3113, 3119, 3121, 3122, 3164, 3180, 3181, 3193, 3224, 3230, 3241, 3263, 4069
< 2 {3/44}: 3009, 3064, 3088, 3103, 3113, 3117, 3119, 3122, 3180, 3181, 3193, 3224, 3263, 4069
< 1 {3/47}: 3103, 3113, 3169, 3180, 3224, 4069

Chapter 23: Upper Jurassic and Lower Cretaceous radiolarians at Svinita, Romania by P. Dumitrica

SECTION *DU1_SVINITA: bottom 1-top 28
< 28 {Mo.54}: 3090, 3094, 3174, 3287, 5032, 5163, 5229, 5262, 5267, 5553, 5647, 5903, 5927, 6121
< 27 {Mo.52}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3113, 3174, 3228, 3287, 3288, 3289, 5032, 5033, 5049, 5186, 5229, 5407, 5426, 5462, 5511, 5553, 5625, 5674, 5711, 5913, 5927, 6121
< 26 {Mo.146}: 3062, 3063, 3065, 3090, 3092, 3094, 3097, 3162, 3185, 3255, 3287, 3288, 3291, 3293, 3912, 4073, 5011, 5033, 5044, 5049, 5065, 5073, 5143, 5163, 5166, 5186, 5193, 5229, 5243, 5261, 5262, 5267, 5287, 5296, 5334, 5369, 5371, 5397, 5407, 5416, 5422, 5426, 5453, 5462, 5511, 5524, 5532, 5544, 5575, 5580, 5620, 5625, 5647, 5668, 5673, 5674, 5703, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5771, 5901, 5904, 5913, 5927, 6121, 6123
< 25 {Mo.45}: 3062, 3063, 3065, 3090, 3092, 3094, 3113, 3162, 3185, 3202, 3287, 3288, 3289, 3291, 3293,

3912, 5011, 5032, 5033, 5055, 5163, 5229, 5243, 5261, 5267, 5407, 5426, 5511, 5544, 5625, 5636 5668, 5672, 5673, 5674, 5721, 5725, 5744, 5913, 5927.
< 24 {Mo.44}: 3065, 3090, 3097, 3288, 4073, 5163, 5193, 5229, 5243, 5261, 5290, 6121.
< 23 {Mo.43}: 3065, 3090, 3113, 3227, 3228, 3284, 3285, 3287, 3947, 4073, 5011, 5033, 5055, 5068, 5193, 5229, 5243, 5290, 5407, 5426, 5453, 5580, 5607, 5674, 5721, 5913, 6121.
< 22 {Mo.42}: 3065, 3094, 3097, 3161, 3202, 3286, 3288, 5011, 5055, 5068, 5163, 5186, 5229, 5243, 5261, 5397, 5407, 5453, 5625, 5672, 5673, 6121.
< 21 {Mo.41}: 3063, 3065, 3090, 3097, 3113, 3161, 3185, 3227, 3228, 3284, 3285, 3286, 3287, 3288, 3295, 5011, 5143, 5186, 5193, 5229, 5261, 5290, 5453, 5462, 5481, 5544, 5580, 5636, 5672, 6121.
< 20 {Mo.39}: 3063, 3065, 3090, 3097, 3113, 3161, 3202, 3285, 3286, 3288, 5011, 5032, 5163, 5183, 5204, 5229, 5261, 5266, 5673, 5901., 6121
< 19 {Mo.38}: 3065, 3090, 3227, 3285, 3947, 4073, 5193, 5229, 5290, 5607, 5901, 6121.
< 18 {Mo.37}: 3062, 3065, 3090, 3161, 3162, 3185, 3227, 3228, 3263, 3284, 3285, 3286, 3287, 3294, 3947, 5003, 5011, 5055, 5068, 5229, 5416, 5422, 5453, 5462, 5481, 5511, 5544, 5568, 5578, 5580, 5607, 5672, 5712, 5721, 5725, 5744, 5913, 6121, 6123.
< 17 {Mo.36}: 3063, 3065, 3090, 3092, 3094, 3113, 3161, 3202, 3284, 3285, 3286, 3295, 3947, 5033, 5055, 5068, 5186, 5193, 5243, 5290, 5416, 5426, 5453, 5544, 5607, 5673, 5904, 6121.
< 16 {Mo.35.5}: 3065, 3202, 5290, 5913.
< 15 {Mo.34}: 3022, 3065, 3161, 3185, 3202, 3285, 3286, 3287, 3289, 3947, 5055, 5193, 5243, 5290, 5409, 5453, 5481, 5607, 5672, 5721., 6121
< 14 {Mo.33}: 3062, 3065, 3066, 3090, 3092, 3171, 3213, 3288, 5055, 5132, 5243, 5290, 5409, 5453, 5607, 5703, 5721, 5913, 6121.
< 13 {Mo.29}: 3062, 3065, 3066, 3165, 3213, 3227, 3284, 3287, 3289, 3293, 3947, 5132, 5243, 5607, 5674.
< 12 {Mo.27}: 3065, 3066, 3090, 3092, 3094, 3171, 3202, 3213, 3228, 3281, 3285, 3287, 3947, 5003, 5132, 5290, 5408, 5607, 5901, 5913, 6121.
< 11 {Mo.26}: 3063, 3065, 3066, 3090, 3113, 3161, 3171, 3174, 3202, 3213, 3225, 3227, 3255, 3263, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3289, 3291, 3293, 3294, 3295, 3947, 5132, 5193, 5607, 5703, 5721, 5913., 6121, 6129
< 10 {Mo.25}: 3090, 3092, 3174, 3184, 3213., 3263, 3284, 3289, 3291, 3293, 3294, 3295, 5065, 5132
< 9 {Mo.24}: 3066, 3090, 3092, 3094, 3113, 3171, 3213, 3227, 3228, 3263, 3285, 5003, 5132, 5183, 5243, 5436, 5510, 5568, 5607, 5913., 6121
< 8 {Mo.23}: 3065, 3066, 3090, 3113, 3171, 3213, 3227, 3255, 3281, 3284, 3285, 3289, 3294, 3295, 5055, 5132, 5243, 5409, 5453, 5544, 5568, 5578, 5607, 5703, 5721, 6121
< 7 {Mo.22}: 3062, 3063, 3065, 3066, 3092, 3094, 3165, 3185, 3202, 3213, 3225, 3227, 3228, 3255, 3263, 3281, 3284, 3289, 3291, 3293, 3294, 3295, 5003, 5044, 5055, 5132, 5183, 5436, 5462, 5481, 5544, 5568, 5572, 5607, 5913.
< 6 {Mo.21}: 3062, 3065, 3066, 3090, 3113, 3161, 3171, 3202, 3213, 3227, 3281, 3282, 3285, 3286, 3289, 5042, 5055, 5132, 5193, 5243, 5607, 5913, 6121., 6129
< 5 {Mo.20}: 3065, 3090, 3113, 3213, 3227, 3263, 3282, 3289, 5055, 5132, 5416, 5453, 5607, 5703, 5913., 6129
< 4 {Mo.19}: 3062, 3063, 3065, 3066, 3090, 3113, 3161, 3171, 3213, 3227, 3228, 3255, 3263, 3281, 3282, 3286, 3288, 3289, 3295, 4073, 5003, 5042, 5055, 5132, 5183, 5193, 5408, 5409, 5416, 5436, 5453, 5575, 5607, 5674, 5703, 5721, 5913, 6121., 6129
< 3 {Mo.18}: 3062, 3065, 3066, 3090, 3092, 3161, 3165, 3171, 3203, 3213, 3227, 3228, 3263, 3282, 3284, 3285, 3286, 3289, 3947, 4073, 5003, 5055, 5132, 5193, 5243, 5436, 5568, 5607, 5721, 5913, 6121., 6129
< 2 {Mo.17}: 3062, 3065, 3066, 3092, 3113, 3161, 3165, 3171, 3185, 3203, 3213, 3225, 3227, 3263, 3282, 3284, 3285, 3286, 3289, 3295, 3947, 5003, 5055, 5132, 5243, 5332, 5409, 5416, 5436, 5544, 5568, 5607, 5703, 5721, 5913, 6121., 6129
< 1 {Mo.16.5}: 3065, 3066, 3090, 3092, 3113, 3161, 3171, 3202, 3203, 3213, 3227, 3282, 3285, 3286, 3289, 3947, 4073, 5003, 5042, 5055, 5132, 5186, 5193, 5243, 5332, 5408, 5409, 5436, 5510, 5544, 5565, 5568, 5572, 5607, 5703, 5721, 5785, 5913, 6121., 6129

Chapter 24: Biostratigraphy of the Radiolarites at Pojorita (Rarau Syncline, East Carpathians) by P. Dumitrica

SECTION *DU2_POJORITA: bottom 1-top 20
< 20 {PJ25}: 3017, 3020, 3085, 3088, 3095, 3117, 3122, 3189, 3193, 3213, 3224, 3225, 3292, 3305, 4052, 4060, 5544.
< 19 {PJ24}: 3069, 3078, 3085, 3095, 3112, 3119, 3122, 3181, 3189, 3193, 3216, 3224, 3241, 3245, 3263, 3279, 3287, 3292, 3298, 3305, 4052, 4060, 4068, 4072.
< 18 {PJ23}: 3009, 3013, 3017, 3069, 3085, 3095, 3119, 3122, 3139, 3162, 3210, 3215, 3224, 3225, 3226, 3228, 3241, 3263, 3267, 3279, 3305, 3406, 4023.
< 17 {PJ22}: 3017, 3069, 3094, 3095, 3193, 3213, 3226, 3241, 3263, 3264, 3279, 3292, 3305, 3406, 4072.
< 16 {PJ21}: 3069, 3094, 3095, 3112, 3122, 3162, 3189, 3218, 3224, 3226, 3241, 3279, 3287, 3406, 4060.
< 15 {PJ20}: 3069, 3085, 3094, 3122, 3193, 3224, 3226, 3241, 3279, 3406, 4060.
< 14 {PJl9}: 3017, 3069, 3085, 3094, 3117, 3123, 3139, 3193, 3216, 3224, 3226, 3241, 3259, 3263, 3264, 3279, 3287, 3305, 3406.

< 13 {PJ18}: 3017, 3055, 3069, 3088, 3094, 3095, 3112, 3121, 3122, 3139, 3193, 3216, 3224, 3226, 3241, 3263, 3298, 3305.
< 12 {PJ17}: 3017, 3069, 3094, 3119, 3122, 3180, 3193, 3216, 3224, 3226, 3241, 3259, 3263, 3279, 3305, 3406, 4015, 4060.
< 11 {PJ16}: 3069, 3119, 3139, 3193, 3224, 3225, 3241, 3245, 3259, 3263, 3279, 3305, 4060, 4072.
< 10 {PJ15}: 3008, 3017, 3055, 3069, 3088, 3094 3095, 3111, 3117, 3122, 3123, 3193, 3224, 3225, 3226, 3228, 3230, 3241, 3259, 3263, 3279, 3298, 3305, 3406, 4023, 4037, 4052, 4060.
< 9 {PJ14}: 3008, 3013, 3017, 3044, 3055, 3088, 3150, 3160, 3163, 3169, 3180, 3181, 3185, 3193, 3238, 3298, {3308,} 3411, 4023, 4052, 4058, 4060.
< 8 {PJ13}: 3008, 3013, 3044, 3055, 3059, 3078, 3095, 3169, 3180, 3181, 3193, 3238, 3298, 4023, 4052.
< 7 {PJ12}: 3013, 3017, 3055, 3062, 3095, 3139, 3150, 3160, 3180, 3181, 3193, 3202, 3210, 3223, 4052, 4060, 4072.
< 6 {PJll}: 3013, 3017, 3020 3123, 3150, 3160, 3180, 3185, 3187, 3193, 3210, 4052, 4060.
< 5 {PJ10}: 3008, 3013, 3017, 3110, 3123, 3162, 3163, 3181, 3193, 3221, 3223, 3298, 4023, 4052, 4060, 4072.
< 4 {PJ 9}: 3005, 3008, 3013, 3017, 3044, 3046, 3055, 3059, 3062, 3085, 3095, 3103, 3110, 3121, 3123, 3139, 3150, 3160, 3162, 3180, 3181, 3193, 3210, 3237, 3238, 3254, 3269, 3298, 4052, 4060.
< 3 {PJ. 8}: 3005, 3008, 3013, 3017, 3044, 3055, 3085, 3160, 3163, 3169, 3180, 3181, 3202, 3210, 3223, 3238, 3298, 3411, 4023, 4048, 4052, 4060.
< 2 {PJ. 7}: 3008, 3013, 3044, 3117, 3121, 3123, 3160, 3169, 3180, 3193, 3237, 3238, 3269, 3290, 3298, 3411, 4037, 4052, 4060.
< 1 {PJ. 6}: 3008, 3013, 3017, 3044, 3117, 3160, 3169, 3180, 3238, 3245, 3297, 3298, 3411, 4037, 4052, 4060.

Chapter 26: Upper Jurassic to Lower Cretaceous stratigraphy of Hokkaido, Japan by N. Kito

SECTION ∗KI3_20_RINPAN: bottom 1-top 7
< 7 {82090101}: 5042
< 6 {82090112}: 5607, 3092, 3113
< 5 {82090111}: 5607
< 4 {82090110}: 3287, 3065, 3083, 3092, 3185, 3228, 5607
< 3 {82090109}: 5607, 3092, 3113, 3115
< 2 {82090108}: 3228, 3092, 5607
< 1 {82090104}: 3284, 3090, 3213, 3228, 3263, 3287, 5607

SECTION ∗KI4_SOASHIBETSUKITA: bottom 1-top 7
< 7 {90090405}: 3185, 3090, 3092, 3263, 3285, 3295, 5073, 5607, 5636, 6121
< 6 {90090407}: 3284
< 5 {90090409}: 5607, 3293
< 4 {90090410}: 5042
< 3 {90090411}: 5073, 3092, 3228, 3295, 5042, 5049, 5407, 5595, 5607
< 2 {90090412}: 5607, 3131, 3162, 5042, 5462
< 1 {90090413}: 3185, 3131, 3228, 3295, 5407, 5462, 5607, 5744

SECTION ∗KI5_ASHIBETSU: bottom 1-top 13
< 13 {90090701}: 5595, 3092, 3269, 3287, 3293, 5073, 5407
< 12 {90090703}: 5595, 3090, 3092, 3293, 3295, 5042, 5073, 5407, 5607, 5636
< 11 {90090704}: 3269, 3293, 5073, 5407
< 10 {90090705}: 5595, 3287, 3295, 5636
< 9 {90090706}: 5073, 3185, 3295
< 8 {90090707}: 5595, 5073, 5261
< 7 {90090708}: 5595, 3090, 3131, 3285, 3287, 3293, 3295, 5042, 5073, 5186, 5481, 5607, 6121
< 6 {90090709}: 5595, 3092, 3131, 3287, 3295, 5049, 5073, 5462, 5607, 5712, 5744
< 5 {90090710}: 5407, 3090, 3092, 3113, 3131, 3228, 3287, 3293, 3295, 5183, 5186, 5903
< 4 {90090711}: 3092, 3185
< 3 {90090712}: 5073, 3090, 3092, 3112, 3131, 3185, 3228, 3293, 3295, 4026, 4073, 5042, 5407, 5462, 5712
< 2 {90090716}: 5073, 3284, 3295
< 1 {90090717}: 5073, 3185, 3213, 3228, 3255, 3263, 3284, 3287, 3293, 3295, 4026, 5462, 5469, 5481, 5607, 5636, 5744

SECTION ∗KI6_SOASGIBETSU: bottom 1-top 9
< 9 {89081002}: 5407
< 8 {90090505}: 5073
< 7 {89081006}: 5407, 3092, 5012
< 6 {89081007}: 5407, 3092, 3293, 5042, 5607, 5744
< 5 {89081010}: 5407, 3090, 3092, 3228, 3263, 3293, 3295, 5073, 5462, 5607, 5674, 5712, 5744
< 4 {89081009}: 3293, 3263, 3295, 4026, 5073, 5532, 5607
< 3 {89081008}: 5712
< 2 {90090510}: 3295, 3284
< 1 {90090509}: 3087, 3065, 3263, 3284, 3293, 3295, 5607, 5636

SECTION ∗KI7_SHUPARO: bottom 1-top 28
< 28 {82073022}: 5607, 3063, 3090, 3092, 3131, 3228, 3287, 5229, 5712
< 27 {82073019}: 3090, 3092, 3185, 3228, 3287, 5674, 5744
< 26 {82073016}: 5607, 3090, 3092
< 25 {82073015}: 5607, 3293, 5229, 5462, 5712
< 24 {82073013}: 3228, 3063, 3185, 3287, 3293, 5620, 5712
< 23 {82073011}: 5607, 3090, 3092, 3131, 3228, 3284
< 22 {82073010}: 3185, 3287
< 21 {82072803}: 3286, 3161, 3228
< 20 {82072804}: 3286, 3161
< 19 {82072805}: 4026, 3263
< 18 {82072807}: 5607, 3019, 3090, 3161, 3228, 3263, 3286, 3287, 4026, 5462
< 17 {82072808}: 3019, 3287, 4026
< 16 {82072809}: 5607, 4026

< 15 {82072810}: 3287
< 14 {82072814}: 3019, 3063, 3161, 3228, 3263, 3284, 3286, 3287, 4026
< 13 {82072816}: 5607, 3161, 3185, 3213, 3228, 3263, 3284, 3286
< 12 {82072817}: 5607, 3019, 3113, 3161, 3185, 3213, 3228, 3263, 3284, 3286, 3287, 4026, 5426
< 11 {82072818}: 5607, 3063, 3213, 3228
< 10 {82072819}: 5607, 3019, 3065, 3087, 3090, 3092, 3161, 3185, 3213, 3228, 3284, 3286, 4026, 5462
< 9 {82072820}: 3019, 3065, 3087, 3092, 3161, 3185, 3213, 3228, 3255, 3263, 3286, 3287, 4026, 5462
< 8 {82072821}: 5607, 3019, 3063, 3065, 3087, 3213, 3228, 3263, 3264, 3284, 3287, 5426, 5462
< 7 {82072822}: 5607, 3065, 3087, 3185, 3213, 3228, 3284
< 6 {82072823}: 3263, 3284
< 5 {82072824}: 3263, 3284, 3287
< 4 {82072825}: 3293, 3263, 3284, 3287
< 3 {82072826}: 3263
< 2 {LJ37}: 5607, 3019, 3161, 3228, 3286, 3287
< 1 {82072838}: 3305, 3090, 3263, 5607

SECTION *KI8_YUFURE: bottom 1-top 5
< 5 {82090403}: 3293, 3090, 3092, 3131, 3185, 3228, 3287, 5229, 5712, 5744
< 4 {82090404}: 3284, 3063, 3161, 3164, 3185, 3228, 3241, 3263, 3286, 3287, 3293, 4026, 5229, 5462, 5712, 5744
< 3 {82090405}: 5462, 3090, 3092, 3113, 3115, 3161, 3185, 3228, 3286, 3287, 3293, 4026, 5042, 5229, 5607, 5712, 5744
< 2 {82090406}: 5462, 3090, 3092, 3185, 3228, 3263, 3287, 3293, 4026, 5229, 5607, 5712, 5744
< 1 {82090407}: 5532, 3090, 3092, 3161, 3164, 3241, 3263, 3284, 3286, 3287, 3293, 4026, 5426, 5462, 5712

SECTION *KI9_FUKINOSAWA: bottom 1-top 3
< 3 {82090312}: 5744, 3090, 3092, 3228, 3263, 3287, 4026, 5462, 5607
< 2 {82090316}: 3131, 3090, 3092, 3113, 3121, 3228, 5407, 5607, 5744
< 1 {82090315}: 3087, 3065, 3090, 3092, 3118, 3131, 3185, 3228, 3287, 5229, 5462, 5607, 5712, 5744

SECTION *KI10_NIJUGOSEN: bottom 1-top 6
< 6 {82090920}: 5712, 3092, 3293, 5073, 5462
< 5 {82090318}: 3293
< 4 {82090317}: 3293, 5073
< 3 {81062901}: 5712, 3063, 3090, 3092, 3185, 3228, 3287, 4026, 5229, 5607
< 2 {81062902}: 3287, 3063, 3065, 3087, 3090, 3092, 3112, 3121, 3161, 3185, 3228, 3286, 4026, 4073, 5229, 5462, 5607, 5744
< 1 {82052601}: 5712, 3090, 3092, 3185, 3228, 3287, 5229, 5607

SECTION *KI11_SHUPARO1: bottom 1-top 1
< 1 {82073012}: 3017, 3065, 3087, 3092, 3185, 3213, 3218, 3228, 3243, 3263, 3264, 3284, 3293, 4026, 5462, 5607, 5712, 5744

SECTION *KI12_NUNOBE: bottom 1-top 1
< 1 {81062827}: 3115, 3113, 3131, 3185, 3228, 3287, 3293, 4026, 5042, 5229, 5407, 5426, 5462, 5481, 5607, 5625, 5712

SECTION *KI13_NAE: bottom 1-top 4
< 4 {81071309}: 3090, 3185, 4026, 5229, 5462, 5607
< 3 {81071310}: 5229, 3185, 3228, 5042, 5462
< 2 {81071317}: 3228, 3185, 3293, 4026, 5462
< 1 {81072501}: 3092, 3065, 3087, 3090, 3113, 3115, 3161, 3164, 3185, 3213, 3228, 3241, 3255, 3264, 3286, 4026, 5462, 5607, 6101

SECTION *KI14_SATOZAWA: bottom 1-top 9
< 9 {81071802}: 3092, 3063, 3090, 3228, 5462
< 8 {81071803}: 3092, 3063, 3090, 3131, 3161, 3185, 3228, 3286, 5042, 5229, 5462, 5607
< 7 {81071806}: 3090, 3063, 3065, 3087, 3161, 3185, 3228, 3286, 5229, 5462, 5607
< 6 {81071807}: 3092, 3063, 3065, 3087, 3113, 3115, 3131, 3185, 3228, 3293, 4026, 5042, 5229, 5462, 5532
< 5 {81071811}: 3228, 3185, 3293, 4026
< 4 {81071812}: 3092, 3185, 3228, 3293, 5042, 5229, 5426, 5607
< 3 {81071813}: 3092, 3063, 3090, 3113, 3116, 3131, 3185, 3228, 5462
< 2 {81071824}: 3092, 3161, 3213, 3228, 3286, 5607
< 1 {81071836}: 3185, 3263, 3284

SECTION *KI15_PENKE: bottom 1-top 8
< 8 {81072408}: 5042
< 7 {81072410}: 3112, 3161, 3286, 3293, 4026, 4073, 5462
< 6 {81072412}: 3092, 3090, 3131, 3161, 3185, 3228, 3286, 3293, 4026, 5426, 5462
< 5 {81072413}: 3228, 3063, 5426
< 4 {81072417}: 5607, 3185, 3228, 4026, 5462
< 3 {81072420}: 5607, 5229
< 2 {81072423}: 5607, 3287, 4026
< 1 {81072425}: 3092, 3063, 3065, 3083, 3112, 3161, 3185, 3213, 3228, 3255, 3286, 4073, 5462, 5607

SECTION *KI16_PANKE1: bottom 1-top 5
< 5 {81082801}: 5607, 3131, 3228, 5595
< 4 {81082802}: 3092, 3090, 3131, 5042, 5595
< 3 {81082805}: 5607, 3227, 3269
< 2 {81082806}: 3090, 5595, 5607
< 1 {81082812}: 3269, 3263, 3293, 4026

SECTION *KI17_PANKE2: bottom 1-top 2
< 2 {81083103}: 3228, 3185, 4026
< 1 {81083104}: 3092, 3161, 3185, 3213, 3228, 3286, 4026, 5607

SECTION *KI18_HORIMOTO: bottom 1-top 5
< 5 {81090701}: 5607, 3065, 3087
< 4 {81090702}: 3286, 3161, 5462
< 3 {81090704}: 3164
< 2 {81082904}: 3293, 3185, 4026
< 1 {81082906}: 5607, 3164, 3185, 3228, 3241, 3269, 3293

SECTION ∗KI19_SAKUGAWA: bottom 1-top 8
< 8 {82092805}: 3228, 3090, 3092, 5042 , 5595
< 7 {82092808}: 3115, 3092, 3113, 3185, 3228, 3293, 5462, 5595
< 6 {82092806}: 5607, 3063, 3092, 3185, 3228, 3284, 3293, 5042, 5462, 5595
< 5 {82092811}: 3293, 3228, 5073, 5462
< 4 {82092813}: 3286, 3090, 3092, 3161, 3228, 3263, 3287, 4026, 5229, 5426, 5607, 5712, 5744
< 3 {82092816}: 5607, 3090, 3092, 3113, 3115, 3228, 3284, 3287, 3293, 5229, 5712
< 2 {82092817}: 3213, 3113, 3115, 3161, 3286, 5607
< 1 {82092819}: 3213

Chapter 27: Middle Jurassic to Early Cretaceous radiolarian (Japan -Western Pacific) by A. Matsuoka

SECTION MA1_LEG129_SITE_800A: bottom 1-top 18
< 18 {51R-1-30-31}: 3065, 3293, 5012, 5073, 5595
< 17 {51R-CC}: 3065, 3092, 3228, 5012, 5073, 5229, 5462, 5595, 5625, 5636, 5927
< 16 {52R-1- 57-59}: 3065, 3092, 3228, 3287, 3293, 5012, 5073, 5422, 5595
< 15 {52R-2- 49-51}: 3065, 3092, 3185, 3228, 3287, 4073, 5012, 5073, 5229, 5422, 5462, 5625, 5647, 5927
< 14 {52R-CC}: 3065, 3090, 3185, 3228, 3287, 4026, 5229, 5462, 5625, 5647
< 13 {53R-1- 53-55}: 3065, 3228, 3287, 3291, 5073, 5229, 5407, 5426, 5462, 5625, 5636, 5647
< 12 {53R-2- 17-19}: 3065, 3092, 3162, 3185, 3228, 3287, 3291, 4026, 5073, 5229, 5407, 5426, 5625, 5636, 5927
< 11 {53R-CC}: 3065, 3090, 3092, 3161, 3162, 3185, 3228, 3287, 3291, 3293, 4026, 4073, 5073, 5229, 5296, 5407, 5426, 5462, 5532, 5580, 5625, 5636, 5647, 5744, 5927
< 10 {54R-1- 54-56}: 3065, 3090, 3161, 3185, 3228, 3287, 3293, 4026, 5073, 5229, 5426, 5462, 5636, 5744, 5927
< 9 {54R-1- 140-142}: 3065, 3090, 3092, 3161, 3162, 3203, 3228, 3287, 3293, 4026, 4073, 5073, 5229, 5426, 5462, 5580, 5636, 5647, 5927
< 8 {54R-2- 50-52}: 3065, 3090, 3092, 3161, 3228, 3263, 3287, 3293, 4026, 4073, 5073, 5229, 5407, 5426, 5462, 5580, 5636, 5647, 5927
< 7 {54R-2- 98-100}: 3065, 3090, 3185, 3228, 3293, 4026, 5073, 5426, 5636, 5647, 5927
< 6 {54R-CC}: 3065, 3090, 3161, 3185, 3228, 3255, 3287, 3293, 4026, 4073, 5073, 5426, 5462, 5636, 5647, 5927
< 5 {55R-1- 70-72}: 3065, 3185, 3228, 3263, 3287, 3293, 4026, 5073, 5462, 5927
< 4 {55R-1- 137-139}: 3065, 3090, 3092, 3185, 3228, 3287, 3293, 4026, 5073, 5636, 5927
< 3 {55R-2- 44-46}: 3065, 3185, 3203, 3228, 3263, 3287, 3293, 4026, 5073, 5426, 5462, 5927
< 2 {55R-2- 133-135}: 3065, 3185, 3263, 3287, 3291, 3293, 4026, 5073, 5927
< 1 {55R-CC}: 3065, 3090, 3092, 3185, 3228, 3255, 3263, 3287, 3291, 3293, 4073, 5073, 5426, 5462, 5636, 5647, 5927

SECTION MA2_LEG129_SITE_801B: bottom 1-top 59
< 59 {14R-CC}: 3228, 3287, 5073, 5229, 5927
< 58 {15R-1- 23-25}: 3065, 3185, 3263, 3287, 3293, 5073, 5462
< 57 {16R-1- 9-11}: 3065, 3293, 5073, 5927
< 56 {16R-1- 32-34}: 3065, 3228, 3263, 3293
< 55 {16R-1- 37-39}: 3065, 5462
< 54 {16R-CC}: 3065, 3092, 3228, 3293
< 53 {17R-1- 22-25}: 3065, 3228, 3263, 3287, 3291, 3293, 5073, 5462, 5927
< 52 {17R-CC}: 3065, 5462
< 51 {18R-1- 7-9}: 3065, 3161, 3185, 3228, 3287, 3293, 5073, 5462, 5927
< 50 {18R-1- 34-36}: 3287, 3293, 5927
< 49 {18R-CC}: 3065, 3161, 3171, 3185, 3203, 3228, 3255, 3287, 3293, 4073, 5073, 5462, 5927
< 48 {19R-CC}: 3293
< 47 {20R-1- 7-9}: {corr 3033} 3189, 3263, 3293, 4037, 5771
< 46 {20R-1- 16-18}: 3033, 3189, 4037, 5462
< 45 {20R-CC}: 3033, 3090, 3161, 3185, 3263, 3293, 4037
< 44 {21R-1- 1-3}: 3189, 4037, 5771
< 43 {21R-1- 13-15}: 3189, 4037, 5771
< 42 {21R-CC}: 3189, 3193, 4037, 5771
< 41 {22R-CC- 0-2}: 3033, 3161, 3189, 4037, 5771
< 40 {22R-CC}: 3189, 4037, 4073
< 39 {23R-CC- 7-9}: 3033, 3090, 3161, 3189, 3193, 4037, 5771
< 38 {23R-CC- 14-16}: 3193, 4037, 4073, 5771
< 37 {23R-CC}: 3193, 4037, 4073, 5771
< 36 {24R-1- 22-23}: 3033, 3090, 3189, 3193, 4037, 4073, 5771
< 35 {24R-1- 66-68}: 3017, 3033, 3100, 3161, 3189
< 34 {24R-CC}: 3033, 3100, 3161, 4037
< 33 {25R-1- 10-12}: 3100, 3189, 4037
< 32 {25R-1- 32-35}: 3033, 3090, 3100, 3193, 3292, 4037
< 31 {25R-1- 65-68}: 3033, 3090, 3100, 3161, 3193, 4037, 5771
< 30 {25R-CC}: 3033, 3100, 3189, 4037, 5771
< 29 {26R-CC- 11-13}: 3033, 3100, 4037
< 28 {26R-CC}: 3033, 3189, 4037
< 27 {27R-1- 99-101}: 3033, 3090, 3193, 4037
< 26 {27R-CC}: 3100, 3193, 4073
< 25 {28R-1- 6-7}: 3254, 4037
< 24 {28R-CC}: 3090, 3100, 3189, 3193, 3213, 3254, 3279, 3292, 4037
< 23 {29R-1- 16-17}: 3254, 3279, 4037, 4055, 4060
< 22 {29R-CC}: 3014, 3017, 3100, 3131, 3193, 3199, 3292, 4037, 4060
< 21 {30R-1- 1-2}: 3090, 3100, 3131, 3193, 3254, 4037
< 20 {30R-1- 12-14}: 3199, 3254, 4037, 4060
< 19 {30R-CC}: 3017, 3090, 3100, 3160, 3180, 3193, 3199, 3213, 3254, 3279, 4037, 4055
< 18 {31R-1- 1-3}: 3014, 3090, 3100, 3193, 3199, 3213, 3254, 3279, 4037

< 17 {31R-1- 21-22}: 3100, 3193, 3254, 4014, 4037
< 16 {31R-CC}: 3014, 3017, 3180, 3193, 3254, 4055
< 15 {32R-CC}: 3014, 3017, 3064, 3100, 3159, 3180, 3181, 3193, 3213, 3225, 3279, 4014, 4055, 4060
< 14 {33R-1- 8-10}: 3014, 3017, 3169, 3181, 3213, 3297, 3298, 4060
< 13 {33R-1- 131-133}: 3014, 3044, 3046, 3180, 3297, 3298
< 12 {33R-2- 14-17}: 3017, 3044, 3046, 3169, 3180, 3181, 3213, 3297, 3298, 4060
< 11 {33R-CC}: 3004, 3046, 3064, 3121, 3159, 3164, 3169, 3180, 3181, 3213, 3297, 3298, 4023
< 10 {34R-1- 15-17}: 3044, 3046, 3052, 3213, 3297, 3298, 4047
< 9 {34R-CC}: 3044, 3052, 3059, 3061, 3181, 3297, 3298, 4047, 4060
< 8 {35R-1- 43-45}: 3061, 3180, 3181, 3213, 3277, 3297, 3298, 4047
< 7 {35R-1- 76-80}: 3052, 3061, 3181, 3213, 3297, 3298, 4047
< 6 {35R-2- 95-98}: 3059, 3169, 3297, 3298, 4013
< 5 {35R-2- 138-140}: 3052, 3061, 3297, 3298
< 4 {35R-3- 24-26}: 3014, 3044, 3052, 3059, 3061, 3139, 3159, 3180, 3181, 3254, 3277, 3297, 3298, 4014, 4047
< 3 {35R-CC}: 3059, 3277, 3297, 3298, 4013, 4047
< 2 {36R-CC}: 3180, 3297, 4014, 4047
< 1 {37R-1- 16-20}: 3052, 3061, 3064, 3164, 3180, 3181, 3197, 3237, 3254, 3297, 3298, 4014, 4034, 4050

SECTION MA3_OYASHIKI_1: bottom 1-top 13
< 13 {M-64}: 3061, 3290, 3297, 4013, 4046, 4050, 4060
< 12 {M-63}: 3059, 3061, 3290, 3297, 4013, 4046, 4050, 4060
< 11 {M-61}: 3297, 4050, 4060
< 10 {M-60}: 3051, 3297, 4034, 4050, 4060
< 9 {M-57}: 3051, 3297, 4034, 4050, 4060
< 8 {M-55}: 3051, 3297, 4034, 4050, 4060
< 7 {M-54.5}: 3051, 3297, 4034, 4050, 4060
< 6 {M-54}: 3051, 4034, 4050
< 5 {M-53.5}: 3051, 4050
< 4 {M-53}: 3051, 4050
< 3 {M-52.5}: 3051, 4050
< 2 {M-52}: 3051, 3307, 4050
< 1 {M-50}: 3051, 3307, 4049

SECTION MA4_SHIRAISHIGAWA_1: bottom 1-top 25
< 25 {S-25}: 3044, 3046, 3297, 4046
< 24 {S-24}: 3044, 3046, 3290, 3297, 4046, 4050, 4060
< 23 {S-21}: 3044, 3046, 3051, 3290, 3297, 4046, 4050, 4060
< 22 {S-20}: 3044, 3046, 3051, 3290, 3297, 4046, 4050, 4060
< 21 {S-18}: 3044, 3046, 3051, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 20 {S-17}: 3044, 3046, 3051, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 19 {S-15}: 3044, 3046, 3051, 3061, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 18 {S-14.6}: 3046, 3051, 3061, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 17 {S-14}: 3051, 3061, 3290, 3297, 4045, 4046, 4047, 4050, 4060
< 16 {S-13.5}: 3051, 3061, 3290, 3297, 4045, 4046, 4047, 4050, 4060
< 15 {S-13}: 3051, 3061, 3290, 3297, 4047, 4050, 4060
< 14 {S-12}: 3051, 3061, 3290, 3297, 4050, 4060
< 13 {S-10}: 3051, 3061, 3290, 3297, 4050, 4060
< 12 {S-8}: 3051, 3061, 3290, 3297, 4050, 4060
< 11 {S-6}: 3051, 3061, 3290, 3297, 4050, 4060
< 10 {S-3}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 9 {S-2}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 8 {S-1}: 3051, 3061, 3290, 3297, 4034, 4050, 4054, 4060
< 7 {IX-1403}: 3051, 3290, 4034, 4050, 4060
< 6 {T-15}: 3051, 4034, 4050, 4060
< 5 {T-11}: 3051, 4050, 4060
< 4 {T-8}: 3051, 4049, 4050
< 3 {T-5}: 3051, 4049, 4050
< 2 {XI-1404}: 3051, 3307, 4049
< 1 {T-01}: 3050, 4049

SECTION MA5_YANASEGAWA_1: bottom 1-top 8
< 8 {Z-40}: 3297, 4047
< 7 {Z-36}: 3051, 3059, 3061, 3290, 3297, 4046, 4047, 4050, 4060
< 6 {Y-07}: 3051, 3059, 3061, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 5 {Z-32}: 3051, 3059, 3061, 3290, 3297, 4046, 4047, 4050, 4060
< 4 {Z-27.5}: 3051, 3059, 3061, 3290, 3297, 4050, 4060
< 3 {Z-22}: 3051, 4050
< 2 {XI-1800}: 3051, 4049, 4050
< 1 {Z-20.2}: 3051, 4049, 4050

SECTION MA6_YANASEGAWA_2: bottom 1-top 16
< 16 {VII-3110}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 15 {VII-3109}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 14 {VII-2922}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 13 {VII-2921}: 3044, 3046, 3290, 3297, 4023, 4046, 4060
< 12 {VII-3108}: 3044, 3046, 3290, 3297, 4023, 4046, 4050, 4060
< 11 {VII-2919}: 3044, 3046, 3290, 3297, 4046, 4050, 4060
< 10 {VII-3107}: 3044, 3046, 3290, 3297, 4013, 4046, 4050, 4060
< 9 {VII-2917}: 3044, 3046, 3290, 3297, 4013, 4045, 4046, 4047, 4050, 4060
< 8 {VII-1522}: 3046, 3290, 3297, 4013, 4046, 4047, 4050, 4060
< 7 {VII-2912}: 3061, 3290, 3297, 4050, 4060
< 6 {VII-2911}: 3061, 3290, 3297, 4034, 4050, 4060
< 5 {VII-3104}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 4 {VII-2910}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 3 {VII-2909}: 3051, 3061, 3290, 3297, 4034, 4050, 4060
< 2 {VII-3103}: 3051, 3290, 3297, 4050, 4060
< 1 {VII-3102}: 3290, 3297, 4050, 4060

SECTION MA7_YANASEGAWA_3: bottom 1-top 10
< 10 {P-3}: 3297
< 9 {P-3.5}: 3297, 4046, 4060
< 8 {P-5.5}: 3044, 3046, 3290, 3297, 4045, 4046, 4047, 4060

< 7 {P-6}: 3059, 3061, 3290, 3297, 4046, 4050, 4060
< 6 {P-7}: 3059, 3061, 3290, 3297, 4046, 4050, 4060
< 5 {P-11}: 3051, 3061, 3290, 3297, 4050, 4060
< 4 {P-13}: 3051, 3061, 3297, 4034, 4050, 4060
< 3 {P-16}: 3051, 3297, 4034, 4050, 4054, 4060
< 2 {P-18}: 3051, 3297, 4034, 4050, 4054, 4060
< 1 {P-21}: 3051, 3297, 4034, 4050, 4054, 4060

SECTION MA8_KAWANOUCHI_1: bottom 1-top 14
< 14 {12-0702}: 3017, 3180, 4055
< 13 {12-0701}: 3017, 3180, 4055
< 12 {17-0302}: 3017, 3180, 4055, 4060
< 11 {11-0909}: 3017, 3045, 3180, 3297, 4055, 4060
< 10 {17-0301}: 3017, 3045, 3180, 3297, 4060
< 9 {11-0905}: 3017, 3045, 3180, 3297, 4060
< 8 {11-0906}: 3017, 3045, 3046, 3180, 3297, 4060
< 7 {11-0908}: 3017, 3044, 3045, 3046, 3180, 3297, 3298, 4060
< 6 {17-0304}: 3017, 3044, 3045, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 5 {17-0303}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 4 {18-2701}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4046, 4060
< 3 {12-0704}: 3017, 3044, 3046, 3180, 3290, 3297, 3298, 4013, 4046, 4047, 4050, 4060
< 2 {12-0705}: 3017, 3044, 3046, 3061, 3180, 3290, 3297, 3298, 4013, 4045, 4046, 4047, 4050, 4060
< 1 {12-0706}: 3061, 3180, 3290, 3297, 3298, 4045, 4050, 4060

SECTION MA9_KASHIBARA: bottom 1-top 35
< 35 {MKS-27}: 3061, 3297, 3298, 4047
< 34 {MKS-26}: 3059, 3297, 3309, 4047, 4060
< 33 {MKS-25}: 3052, 3051, 3297, 3309, 4047, 4052
< 32 {MKS-23}: 3016, 3017, 3051, 3052, 3297, 4050, 4052, 4060
< 31 {MKS-21}: 3016, 3051, 3052, 3297, 3298, 3309, 4050, 4052, 4060
< 30 {MKS-19}: 3052, 3051, 3297, 4050, 4052, 4056, 4057, 4060
< 29 {MKS-18}: 3017, 3051, 3052, 3297, 4050, 4052, 4054, 4056, 4057, 4060
< 28 {MKS-17}: 3297, 3051, 4050, 4052, 4056, 4057, 4060
< 27 {MKS-16}: 3052, 3051, 3055, 3297, 3298, 3309, 4050, 4052, 4054, 4056, 4057, 4058, 4060
< 26 {MKS-15}: 3052, 3051, 3297, 4050, 4052, 4054, 4056, 4058, 4060
< 25 {MKS-14}: 3016, 3017, 3051, 3052, 3297, 3309, 4050, 4052, 4054, 4056, 4057, 4058, 4060
< 24 {MKS-13}: 3055, 3051, 3297, 3309, 4050, 4052, 4054, 4058, 4060
< 23 {MKS-12}: 3052, 3051, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 22 {MKS-11}: 3055, 3051, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 21 {MKS-10.5}: 3052, 3051, 3055, 3297, 4050, 4052, 4054, 4057, 4060
< 20 {MKS-10}: 3016, 3051, 3052, 3055, 3297, 4050, 4052, 4054, 4057, 4060
< 19 {MKS-9.5b}: 3055, 3051, 4050, 4052, 4054, 4057, 4058
< 18 {MKS-9b}: 3055, 3051, 3309, 4050, 4052, 4054, 4057
< 17 {MKS-8b}: 3016, 3051, 4052, 4054, 4057, 4060
< 16 {MKS-7b}: 4052, 3051, 4054, 4057
< 15 {MKS-6b}: 3052, 3051, 3055, 3309, 4052, 4054, 4057, 4060
< 14 {MKS-9.5a}: 3016, 3049, 3051, 3052, 3055, 3309, 4050, 4052, 4057
< 13 {MKS-8a}: 3016, 3051, 3052, 4050, 4052, 4057
< 12 {MKS-7.5a}: 3016, 3049, 3051, 3052, 3055, 4042, 4050, 4052, 4057
< 11 {MKS-7a}: 3052, 3051, 3055, 3309, 4042, 4052, 4057, 4058
< 10 {MKS-6a}: 3052, 3051, 4049, 4050, 4052, 4057
< 9 {MKS-5}: 3016, 3049, 3051, 3052, 3309, 4050, 4052, 4057
< 8 {MKS-4}: 3052, 3051, 3055, 4050, 4052, 4057
< 7 {MKS-3}: 3049, 3051, 3052, 3055, 4050, 4052, 4057
< 6 {MKS-2}: 3052, 3051, 3055, 4050, 4052, 4057
< 5 {MKS-1}: 3055, 3051, 4050, 4052, 4057
< 4 {MKS-0}: 3052, 3051, 3055, 4049, 4050, 4052, 4057
< 3 {MKS-Z}: 4050, 3051, 4053, 4057
< 2 {MKS-Y}: 3052, 3051, 3307, 3309, 4049, 4050, 4053, 4057
< 1 {MKS-X}: 3055, 3051, 3307, 4050, 4053, 4057

SECTION MA10_HISUIKYO: bottom 1-top 12
< 12 {MHS-}: 3052, 3051, 3055, 3297, 3309, 4050, 4052, 4054, 4056, 4060
< 11 {MHS-C}: 3052, 3051, 3055, 3297, 3309, 4050, 4052, 4054, 4057, 4060
< 10 {MHS-B}: 3016, 3051, 3052, 3055, 3309, 4050, 4052, 4054, 4057, 4060
< 9 {MHS-A}: 3052, 3051, 3309, 4050, 4052, 4057, 4058, 4060
< 8 {MHS-13.8}: 3049, 3051, 3052, 3055, 3309, 4052, 4057, 4060
< 7 {MHS-12}: 3052, 3051, 3055, 3309, 4042, 4050, 4052, 4057, 4058, 4060
< 6 {MHS-10}: 3052, 3051, 3309, 4052, 4057, 4060
< 5 {MHS-08}: 3016, 3051, 3052, 3055, 3309, 4042, 4050, 4052, 4057
< 4 {MHS-06}: 3052, 3051, 3055, 4042, 4050, 4052, 4057, 4058
< 3 {MHS-04}: 3052, 3051, 3055, 3309, 4042, 4049, 4050, 4052
< 2 {MHS-02}: 3052, 3055, 4049, 4050, 4060
< 1 {MHS-00}: 3052, 3051, 3055, 4049, 4053

SECTION MA11_INUYAMA_CH1A: bottom 1-top 1
< 1 {MIN-1}: 3001, 3012, 3020, 3026, 3031, 3033, 3039, 3040, 3041, 3049, 3050, 3051, 3052, 3064, 3076, 3088, 3195, 3197, 3204, 3231, 3244, 4007, {4022, 4024,}4027, 4049, 4053, 4059, 4061, 4063, 4066, 4071, 4072, 4077

SECTION MA12_KOMAMI: bottom 1-top 1
< 1 {MKM-1, compl.POB7/95$}: 2002, 2008, 2009, 2021, 3001, 3033, 3039, 3040, 3041, 3050, 3072, 3076, 3081, 3089, 3125, 3151, 3194, 3195, 3204, 3231, 3271, {3280,}3302, 3410, 4007, 4027, 4061, 4063, 4066, 4077

Chapter 28: Middle Jurassic manganese nodules of the Inuyama area, Japan by A. Yao and P.O. Baumgartner

SECTION POB40_IN_UNUMA: bottom 1-top 2
< 2: {IN 1. after SEM. A.Yao 9/92} 3020, 3001, 3005, 3006, 3011, 3012, 3041, 3042, 3049, 3051, 3052, 3054, 3055, 3064, 3071, 3076, 3088, 3089, 3096, 3109, 3110, 3124, 3125, 3135, 3149, 3158, 3159, 3169, 3180, 3192, 3195, 3204, 3220, 3231, 3247, 3253, 3269, 3271, 3273, 3303, 3307, 3410, 3502, 4007, 4009, 4010, 4011, 4044, 4049, 4050, 4052, 4058, 4059, 4061, 4063, 4077, 4078
< 1: {IN 7 check18/12/91pob} 2013, 2021, 3001, 3002, 3005, 3006, 3007, 3011, 3012, 3026, 3027, 3028, 3032, 3041, 3042, 3049, 3050, 3051, 3052, 3054, 3055, 3064, 3071, 3076, 3085, 3088, 3089, 3096, 3109, 3116, 3118, 3124, 3125, 3135, 3148, 3149, 3150, 3158, 3159, 3169, 3184, 3187, 3192, 3197, 3204, 3210, 3213, 3222, 3231, 3247, 3254, 3270, 3273, 3303, 3307, 3502, 4005, 4008, 4010, 4044, 4049, 4059, 4061, 4063

SECTION HK_UNUMA: bottom 1 top 1
< 1: {HK-140. after SEM. A. Yao. 9/92} 3033, 3012, 3014, 3039, 3041, 3042, 3052, 3055, 3076, 3089, 3125, 3151, 3158 {check!}, 3194, 3195, 3231, 3302, 3303, 4007, 4010, 4011, 4028, 4059, 4061

SECTION RH1_KS: bottom 1-top 15
< 15 {KS 20}: 3502, 3151, 3194
< 14 {KS 19}: 3039, 3041, 3151, 3194
< 13 {KS 18}: 3502, 3151, 3195, 4031, 2018
< 12 {KS 16}: 3039, 4031
< 11 {KS 15}: 3502, 2018
< 10 {KS 14}: 4031
< 9 {KS 13}: 3039, 3151, 3502, 2018
< 8 {KS 10}: 3039, 3502, 4031, 2018
< 7 {KS 9}: 3502
< 6 {KS 7}: 3502
< 5 {KS 6}: 3039, 3502
< 4 {KS 5}: 3502
< 3 {KS 4}: 3039, 2015
< 2 {KS 3}: 3039, 3502
< 1 {KS 2}: 3039, 3502, 2015

SECTION RH2_UF: bottom 1-top 4
< 4 {UF 22}: 4031, 3151, 3194
< 3 {UF 21}: 3039, 3502, 4031
< 2 {UF 20}: 4008, 3502, 2015
< 1 {UF 19}: 3039, 3502

SECTION RH3_IY: bottom 1-top 14
< 14 {IY 24}: 3502, 3194, 4031, 2018
< 13 {IY 23}: 4031, 3010, 2018
< 12 {IY 22}: 3502, 4031, 2015
< 11 {IY 21}: 3010
< 10 {IY 20}: 3278, 4031
< 9 {IY 19}: 3502, 4031
< 8 {IY 18}: 3502, 4031
< 7 {IY 17}: 3502, 3278
< 6 {IY 16}: 3502
< 5 {IY 15}: 3502
< 4 {IY 14}: 3039, 3502
< 3 {IY 13}: 3502, 2015
< 2 {IY 12}: 3502
< 1 {IY 11}: 3502

SECTION RH4_PT: bottom 1-top 8
< 8 {PT 8}: 4008, 3010, 3151, 3502, 4028, 4031
< 7 {PT 7}: 4031, 3010, 2018
< 6 {PT 6}: 3502
< 5 {PT 5}: 3502, 4031
< 4 {PT 4}: 3502
< 3 {PT 3}: 3502
< 2 {PT 2}: 3502
< 1 {PT 1}: 4008, 3039, 3502

SECTION RH5_UC: bottom 1-top 2
< 2 {UC 17}: 3039, 3502, 4031, 2015
< 1 {UC 15}: 3039, 3502

SECTION RH6_NKS: bottom 1-top 2
< 2 {NK 4}: 3039
< 1 {NK 3}: 4008, 3040

SECTION RH7_KD: bottom 1-top 6
< 6 {KD 21}: 3194
< 5 {KD 20}: 3502, 3151, 3194
< 4 {KD 18}: 3502, 3151
< 3 {KD 17}: 4031
< 2 {KD 16}: 3502, 4031, 2015
< 1 {KD 15}: 4031, 2015

Chapter 30: Stratigraphic Study of Stanley Mountain, California by D.M. Hull and E.A. Pessagno

SECTION *DH_STANLEY_MOUNTAIN_COMPO: bottom 1-top 15
< 15 {SM-51. 106.1 m above base. 4 alpha. SECTION 2}: 5055
< 14 {SM-50. 105.0 m above base. 4 alpha. SECTION 2}: 3083, 3065, 3111, 3119, 3144, 3225, 5464
< 13 {SM-29. 100.1 m above base. 4 beta. SECTION 2}: 3406, 3161, 5055
< 12 {SA-43B. 99.1 m above base. 4 beta. SECTION 1}: 3144, 3033, 3117, 3171, 3224, 4069
< 11 {SM-49. 98.9 m above base.4 beta. SECTION 2}: {5012,}3119, 3225, 5055
< 10 {SM-75. 96.8 m above base. 4 beta. SECTION 3}: {5012,}3161, 3406, 5055

< 9 {SM-48. 91.3 m above base. 4 beta. SECTION 2}: 3092, 3033, 3065, 3076, 3078, 3083, 3095, 3104, 3105, 3113, 3117, 3118, 3119, 3135, 3139, 3161, 3180, 3199, 3230, 3274, 3406, 4027, 5055, 5464
< 8 {SM-69. 86.5 m above base. 4 beta. SECTION 3}: 3406, 3124, 3161, 3273
< 7 {SM-68. 80.7 m above base. 4 beta SECTION 3}: 3406, 3161, 4027
< 6 {SM-67. 80.0 m above base. 3 alpha. SECTION 3}: 3087, 3065
< 5 {SA-35. 79.6 m above base. 3 alpha. SECTION 1}: {5012,}3033, 3065, 3076, 3087, 3171, 3182, 3224, 4069
< 4 {SM-11. 75.5 m above base. 3 alpha. SECTION 2}: 3406, 3161
< 3 {SA-34. 75.3 m above base. 3 alpha. SECTION 1}: 3406, 3161
< 2 {NSF 973. 45.6 m above base. 2 beta. SECTION 1}: 3008, 3017, 3051, 3131, 3159, 3161, 3176, 3274, 4052, 5544
< 1 {SM105}: 3088, 3005, 3008, 3013, 3046, 3051, 3052, 3064, 3076, 3100, 3110, 3121, 3123, 3124, 3140, 3159, 3160, 3161, 3163, 3164, 3166, 3169, 3181, 3197, 3199, 3204, 3210, 3213, 3221, 3223, 3225, 3231, 3238, 3244, 3269, 3273, 3274, 4052, 4072, 5544

Chapter 31: Middle Jurassic Radiolarians in the Franciscan Complex, California by B.L. Murchey and P.O. Baumgartner

SECTION BM_POB1_GEYSERS: bottom 1-top 15
< 15 {716}: 3045, 3055, 3064, 3088, 3100, 3160, 3163, 3169, 3180, 3181, 3414, 3543
< 14 {715}: 3055, 3061, 3064, 3088, 3100, 3169, 3180, 3181, 3414, 3543
< 13 {714}: 3055, 3064, 3088, 3100, 3159, 3169, 3180, 3181, 3414, 3543
< 12 {713}: 3002, 3055, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3414, 3543, 4014
< 11 {712}: 3055, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3414, 3543, 4014
< 10 {711}: 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3271, 3414, 3543, 4014
< 9 {710}: 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3180, 3181, 3195, 3414, 3543, 4014
< 8 {709}: 3005, 3033, 3055, 3062, 3064, 3088, 3100, 3124, 3159, 3169, 3181, 3195, 3197, 3414, 4014
< 7 {708}: 3005, 3055, 3062, 3064, 3088, 3124, 3159, 3181, 3195, 3197, 3414, 4014
< 6 {707}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3414, 4014
< 5 {706}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3210, 3220, 3231, 3247, 3414, 4014
< 4 {705}: 3005, 3055, 3062, 3064, 3088, 3123, 3124, 3159, 3181, 3195, 3197, 3210, 3414, 4014
< 3 {704}: 3005, 3039, 3194, 3195, 3303, 3414, 3502
< 2 {703}: 3005, 3073, 3414, 3502, 2001
< 1 {702}: 3073, 3414, 3502, 4063, 4066, 2001, 2005

SECTION BM_MARIN_HEADLANDS: bottom 1-top 12
< 12 {16}: 3055, 3124, 3169, 3180, 3181, 3210, 3414, 3543
< 11 {15}: 3055, 3124, 3169, 3180, 3181, 3210, 3414
< 10 {14}: 3039, 3055, 3062, 3064, 3088, 3118, 3124, 3169, 3180, 3181, 3197, 3210, 3414
< 9 {13}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 8 {12B}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 7 {12A}: 3039, 3055, 3062, 3064, 3088, 3169, 3180, 3181, 3197, 3414
< 6 {11}: 3039, 3055, 3064, 3088, 3148, 3169, 3180, 3181, 3197, 3414, 4049, 4058
< 5 {10}: 3039, 3064, 3088, 3159, 3169, 3181, 3220, 3414, 4014, 4049, 4058
< 4 {9}: 3039, 3064, 3088, 3181, 3414, 4014, 4058
< 3 {8}: 3039, 3073, 3414, 3502, 2001
< 2 {7}: 3039, 3073, 3414
< 1 { }: 3039

Chapter 32: SECTION UAZONE95 by P.O. Baumgartner *et al.*

SECTION UAZONE95: bottom 1-top 22

< {UAZ95} 22: 3255, 3263, 3285, 3287, 3295, 3947, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5069, 5073, 5090, 5166, 5183, 5186, 5204, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5296, 5334, 5359, 5362, 5369, 5422, 5462, 5469, 5511, 5521, 5524, 5532, 5544, 5550, 5553, 5575, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5674, 5693, 5711, 5712, 5744, 5771, 5773, 5902, 5903, 5927, 5973, 6121, 6123
< {UAZ95} 21: 3227, 3228, 3255, 3263, 3266, 3285, 3287, 3293, 3295, 3947, 4037, 4073, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5357, 5359, 5362, 5369, 5422, 5426, 5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5550, 5553, 5572, 5575, 5576, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5642, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5744, 5761, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123
< {UAZ95} 20: 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5090, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5357, 5359, 5362, 5369, 5371, 5397, 5416, 5422, 5426, 5427, 5453,

5462, 5469, 5481, 5511, 5521, 5522, 5524, 5526, 5532, 5544, 5553, 5572, 5575, 5576, 5578, 5580, 5582, 5595, 5607, 5620, 5625, 5636, 5641, 5647, 5668, 5672, 5673, 5674, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5904, 5913, 5927, 6121, 6123

< {UAZ95} 19: 3162, 3185, 3202, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5262, 5266, 5267, 5274, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5511, 5521, 5524, 5526, 5532, 5544, 5553, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5625, 5628, 5636, 5647, 5668, 5672, 5693, 5711, 5712, 5716, 5721, 5725, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5903, 5913, 5927, 6121, 6123, 6129

< {UAZ95} 18: 3162, 3171, 3185, 3202, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3291, 3293, 3295, 3947, 4026, 4037, 4073, 5003, 5011, 5012, 5032, 5033, 5041, 5042, 5044, 5046, 5049, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5229, 5243, 5253, 5261, 5266, 5287, 5290, 5296, 5314, 5332, 5334, 5359, 5369, 5371, 5397, 5407, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5511, 5521, 5524, 5532, 5544, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5625, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5712, 5716, 5721, 5744, 5761, 5766, 5771, 5773, 5901, 5902, 5913, 5927, 6121, 6123, 6129

< {UAZ95} 17: 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3266, 3281, 3282, 3284, 3285, 3286, 3287, 3288, 3289, 3291, 3293, 3295, 3919, 3947, 4026, 4037, 4073, 5003, 5011, 5032, 5033, 5041, 5042, 5044, 5046, 5055, 5065, 5068, 5069, 5073, 5132, 5143, 5163, 5166, 5183, 5186, 5193, 5194, 5196, 5199, 5204, 5209, 5229, 5243, 5253, 5261, 5287, 5290, 5314, 5332, 5334, 5371, 5407, 5408, 5409, 5416, 5422, 5426, 5436, 5453, 5462, 5464, 5481, 5532, 5544, 5565, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5628, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5744, 5766, 5901, 5902, 5913, 5927, 6101, 6121, 6123, 6129

< {UAZ95} 16: 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3227, 3228, 3255, 3263, 3264, 3266, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3289, 3291, 3293, 3294, 3295, 3717, 3911, 3912, 3919, 3947, 3955, 4037, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5204, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5334, 5359, 5369, 5371, 5409, 5410, 5416, 5417, 5426, 5436, 5453, 5462, 5464, 5481, 5510, 5544, 5565, 5568, 5572, 5575, 5576, 5578, 5580, 5595, 5607, 5620, 5636, 5647, 5668, 5672, 5673, 5674, 5703, 5712, 5716, 5721, 5771, 5785, 5901, 5913, 6101, 6121, 6123, 6129

< {UAZ95} 15: 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3227, 3228, 3245, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3289, 3291, 3293, 3294, 3295, 3591, 3717, 3911, 3912, 3919, 3947, 3955, 4037, 4073, 5003, 5041, 5042, 5044, 5046, 5055, 5065, 5073, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5287, 5290, 5314, 5332, 5359, 5369, 5371, 5396, 5408, 5409, 5410, 5416, 5417, 5426, 5436, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5572, 5575, 5577, 5578, 5580, 5595, 5607, 5636, 5668, 5672, 5674, 5712, 5716, 5721, 5771, 5785, 5796, 5824, 6101, 6121, 6129

< {UAZ95} 14: 3112, 3113, 3161, 3162, 3165, 3171, 3185, 3202, 3203, 3213, 3225, 3226, 3227, 3228, 3245, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3288, 3289, 3290, 3291, 3293, 3294, 3295, 3591, 3717, 3911, 3912, 3918, 3919, 3924, 3947, 3955, 4037, 4073, 5003, 5041, 5042, 5044, 5055, 5065, 5132, 5163, 5166, 5183, 5186, 5193, 5194, 5199, 5209, 5243, 5253, 5314, 5332, 5409, 5410, 5416, 5417, 5426, 5433, 5436, 5453, 5462, 5464, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5595, 5607, 5636, 5674, 5716, 5721, 5771, 5785, 5796, 5824, 6101, 6121, 6129

< {UAZ95} 13: 3092, 3094, 3096, 3097, 3111, 3112, 3113, 3118, 3121, 3161, 3162, 3165, 3167, 3171, 3182, 3185, 3199, 3202, 3203, 3213, 3215, 3225, 3226, 3227, 3228, 3230, 3245, 3255, 3263, 3264, 3266, 3280, 3281, 3282, 3283, 3284, 3285, 3286, 3287, 3289, 3290, 3291, 3293, 3294, 3295, 3591, 3717, 3911, 3912, 3918, 3919, 3924, 3947, 3955, 4037, 4073, 5003, 5042, 5044, 5055, 5065, 5132, 5163, 5183, 5194, 5209, 5243, 5253, 5332, 5396, 5408, 5409, 5410, 5416, 5433, 5436, 5453, 5462, 5481, 5506, 5510, 5544, 5565, 5568, 5577, 5578, 5580, 5607, 5636, 5674, 5721, 5771, 5785, 5796, 5824, 6101, 6121, 6129

< {UAZ95} 12: 3090, 3092, 3094, 3096, 3097, 3111, 3112, 3113, 3115, 3118, 3121, 3161, 3162, 3164, 3165, 3167, 3170, 3171, 3182, 3185, 3189, 3199, 3202, 3203, 3213, 3215, 3225, 3226, 3227, 3228, 3230, 3241, 3245, 3263, 3266, 3274, 3281, 3286, 3287, 3289, 3290, 3292, 3293, 3294, 3295, 3305, 3911, 4037, 4073, 5003, 5209, 5416, 5426, 5462, 5544, 5607, 5674, 5771, 6101

< {UAZ95} 11: 3063, 3064, 3065, 3066, 3069, 3070, 3078, 3081, 3083, 3085, 3087, 3088, 3090, 3091, 3092, 3094, 3095, 3096, 3097, 3100, 3103, 3111, 3112, 3113, 3115, 3118, 3119, 3121, 3122, 3123, 3131, 3138, 3145, 3160, 3161, 3162, 3164, 3167, 3168, 3170, 3171, 3177, 3179, 3181, 3182, 3185, 3188, 3189, 3193, 3197, 3199, 3202, 3203, 3213, 3215, 3216, 3217, 3218, 3224, 3225, 3226, 3227, 3228, 3230, 3240, 3241, 3243, 3245, 3258, 3259, 3263, 3265, 3266, 3267, 3287, 3289, 3290, 3292, 3293, 3294, 3295, 3305, 3406, 4015, 4018, 4037, 4055, 4068, 4069, 4070, 4072, 4073, 4079, 5003, 5416, 5426, 5462, 5544, 5607, 5674, 5771

< {UAZ95} 10: 3055, 3062, 3063, 3064, 3065, 3066, 3069, 3070, 3078, 3081, 3082, 3083, 3085, 3087, 3088, 3090, 3091, 3092, 3094, 3095, 3096, 3097, 3100, 3103, 3104, 3105, 3106, 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3122, 3123, 3124, 3126, 3129, 3131, 3135, 3137, 3138, 3139, 3140, 3144, 3145, 3147, 3160, 3161, 3162, 3164, 3166, 3167, 3168, 3169, 3170, 3171, 3176, 3177, 3179, 3180, 3181, 3182, 3185, 3187, 3189, 3193, 3197, 3199, 3203, 3210, 3213, 3215, 3216, 3217, 3218,

3220, 3223, 3224, 3225, 3226, 3230, 3240, 3241, 3243, 3245, 3254, 3258, 3259, 3263, 3265, 3266, 3267, 3273, 3274, 3286, 3289, 3290, 3292, 3295, 4015, 4037, 4055, 4068, 4069, 4070, 4072, 4073, 4079, 5003, 5544, 5771

< {UAZ95} 9: 3034, 3035, 3036, 3055, 3062, 3063, 3064, 3065, 3066, 3069, 3070, 3078, 3081, 3082, 3083, 3085, 3088, 3090, 3091, 3094, 3095, 3096, 3097, 3100, 3103, 3104, 3105, 3106, 3108, 3111, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3122, 3123, 3124, 3126, 3127, 3129, 3131, 3133, 3135, 3137, 3139, 3140, 3144, 3145, 3147, 3160, 3161, 3162, 3163, 3164, 3166, 3167, 3168, 3169, 3170, 3171, 3176, 3177, 3179, 3180, 3181, 3185, 3187, 3189, 3193, 3197, 3199, 3204, 3205, 3206, 3210, 3212, 3213, 3215, 3216, 3217, 3218, 3220, 3223, 3224, 3225, 3226, 3230, 3240, 3241, 3243, 3245, 3254, 3258, 3259, 3261, 3263, 3265, 3266, 3267, 3273, 3289, 3290, 3292, 3305, 3406, 3412, 4004, 4006, 4010, 4015, 4037, 4055, 4068, 4069, 4072, 4073, 4079, 5544

< {UAZ95} 8: 3020, 3021, 3022, 3024, 3033, 3034, 3035, 3036, 3049, 3051, 3052, 3055, 3059, 3061, 3062, 3063, 3064, 3065, 3066, 3069, 3070, 3076, 3078, 3081, 3082, 3083, 3085, 3088, 3090, 3091, 3095, 3096, 3097, 3100, 3103, 3104, 3105, 3108, 3109, 3110, 3112, 3113, 3115, 3116, 3117, 3118, 3119, 3121, 3122, 3123, 3124, 3126, 3127, 3129, 3131, 3133, 3135, 3137, 3139, 3140, 3144, 3147, 3148, 3152, 3159, 3160, 3161, 3162, 3163, 3164, 3166, 3167, 3169, 3174, 3179, 3180, 3181, 3187, 3189, 3193, 3197, 3199, 3204, 3205, 3206, 3210, 3212, 3213, 3215, 3216, 3217, 3218, 3220, 3221, 3223, 3224, 3225, 3226, 3230, 3240, 3241, 3243, 3244, 3245, 3254, 3259, 3261, 3263, 3265, 3266, 3267, 3273, 3274, 3277, 3279, 3290, 3292, 3412, 4004, 4006, 4010, 4037, 4055, 4060, 4063, 4068, 4069, 4071, 4072, 4073, 5544

< {UAZ95} 7: 3007, 3008, 3009, 3012, 3013, 3014, 3015, 3016, 3017, 3020, 3021, 3023, 3024, 3028, 3031, 3032, 3033, 3034, 3035, 3043, 3044, 3045, 3046, 3047, 3049, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3063, 3064, 3065, 3066, 3069, 3117, 3118, 3119, 3121, 3122, 3123, 3124, 3125, 3126, 3129, 3131, 3133, 3135, 3137, 3139, 3140, 3144, 3147, 3148, 3149, 3150, 3152, 3159, 3160, 3161, 3162, 3163, 3164, 3167, 3169, 3174, 3176, 3179, 3180, 3181, 3187, 3189, 3217, 3218, 3220, 3221, 3222, 3223, 3225, 3235, 3236, 3237, 3238, 3239, 3240, 3241, 3243, 3244, 3254, 3261, 3265, 3266, 3267, 3268, 3269, 3270, 3271, 3273, 3274, 3276, 3277, 3278, 3279, 3290, 3292, 3297, 3298, 3412, 3413, 4006, 4010, 4014, 4023, 4034, 4037, 4044, 4046, 4048, 4055, 4060, 4063, 4066, 4068, 4069, 4071, 4072, 5544

< {UAZ95} 6: 3005, 3006, 3007, 3008, 3012, 3013, 3014, 3015, 3016, 3017, 3020, 3024, 3028, 3031, 3032, 3033, 3044, 3045, 3046, 3047, 3049, 3051, 3052, 3054, 3055, 3059, 3061, 3062, 3064, 3065, 3066, 3070, 3074, 3076, 3081, 3082, 3085, 3089, 3090, 3095, 3096, 3097, 3100, 3103, 3104, 3109, 3110, 3113, 3116, 3117, 3118, 3119, 3121, 3123, 3124, 3125, 3129, 3135, 3137, 3139, 3140, 3144, 3147, 3148, 3149, 3150, 3152, 3159, 3160, 3162, 3163, 3164, 3167, 3169, 3231, 3235, 3237, 3238, 3243, 3244, 3254, 3266, 3267, 3269, 3270, 3271, 3273, 3276, 3277, 3278, 3290, 3297, 3298, 3301, 3303, 3309, 3412, 3413, 3414, 3543, 3813, 4005, 4010, 4013, 4014, 4023, 4032, 4034, 4044, 4045, 4046, 4050, 4060, 4061, 4063, 4064, 4066, 4069, 4071, 4072

< {UAZ95} 5: 3007, 3008, 3012, 3013, 3014, 3016, 3017, 3020, 3024, 3028, 3031, 3032, 3033, 3039, 3049, 3051, 3052, 3054, 3055, 3061, 3062, 3064, 3066, 3070, 3072, 3074, 3076, 3081, 3085, 3088, 3089, 3090, 3095, 3096, 3100, 3103, 3104, 3109, 3110, 3113, 3116, 3117, 3118, 3119, 3121, 3123, 3124, 3125, 3129, 3135, 3137, 3140, 3144, 3147, 3148, 3149, 3150, 3152, 3159, 3160, 3163, 3164, 3167, 3169, 3174, 3181, 3187, 3192, 3194, 3195, 3197, 3204, 3210, 3213, 3215, 3216, 3218, 3220, 3221, 3222, 3223, 3231, 3237, 3238, 3243, 3244, 3247, 3254, 3266, 3269, 3270, 3271, 3273, 3277, 3278, 3290, 3297, 3298, 3301, 3302, 3303, 3309, 3412, 3413, 3414, 3543, 3813, 4005, 4010, 4014, 4032, 4034, 4042, 4044, 4045, 4047, 4048, 4049, 4050, 4052, 4053, 4054, 4056, 4057, 4058, 4060, 4061, 4063, 4064, 4066, 4069, 4071, 4072

< {UAZ95} 4: 3002, 3004, 3005, 3006, 3007, 3011, 3012, 3014, 3020, 3024, 3026, 3028, 3031, 3032, 3033, 3039, 3040, 3041, 3042, 3048, 3049, 3050, 3051, 3052, 3054, 3055, 3062, 3064, 3066, 3070, 3071, 3072, 3074, 3076, 3081, 3085, 3088, 3089, 3090, 3095, 3096, 3103, 3104, 3109, 3110, 3113, 3116, 3117, 3118, 3119, 3121, 3123, 3124, 3125, 3129, 3135, 3137, 3140, 3144, 3147, 3148, 3149, 3150, 3158, 3159, 3180, 3181, 3187, 3192, 3194, 3195, 3197, 3204, 3210, 3213, 3215, 3216, 3218, 3220, 3222, 3223, 3231, 3237, 3243, 3244, 3247, 3253, 3254, 3269, 3270, 3271, 3273, 3278, 3297, 3301, 3302, 3303, 3307, 3309, 3409, 3410, 3413, 3813, 4005, 4007, 4009, 4010, 4011, 4014, 4027, 4028, 4032, 4034, 4044, 4049, 4050, 4052, 4053, 4057, 4058, 4059, 4060, 4061, 4063, 4064, 4066, 4069, 4071, 4072, 4077, 4078

< {UAZ95} 3: 2019, 2021, 2022, 2023, 2026, 3001, 3002, 3004, 3005, 3006, 3007, 3010, 3011, 3012, 3014, 3026, 3027, 3028, 3030, 3032, 3033, 3039, 3040, 3041, 3042, 3048, 3049, 3050, 3051, 3052, 3054, 3055, 3064, 3070, 3071, 3072, 3073, 3076, 3081, 3085, 3088, 3089, 3096, 3109, 3116, 3118, 3124, 3125, 3135, 3140, 3144, 3147, 3148, 3149, 3150, 3151, 3158, 3159, 3167, 3169, 3180, 3181, 3184, 3187, 3192, 3194, 3195, 3197, 3204, 3210, 3213, 3216, 3222, 3223, 4010, 4011, 4014, 4027, 4028, 4031, 4044, 4049, 4058, 4059, 4061, 4063, 4064, 4066, 4071, 4072, 4077

< {UAZ95} 2: 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2022, 3001, 3006, 3010, 3011, 3033, 3039, 3040, 3042, 3048, 3055, 3071, 3072, 3073, 3074, 3089, 3096, 3125, 3148, 3149, 3151, 3158, 3194, 3195, 3222, 3231, 3247, 3253, 3271, 3278, 3302, 3303, 3310, 3407, 3408, 3409, 3410, 3411, 3414, 3502, 4008, 4009, 4010, 4011, 4027, 4028, 4031, 4058, 4061, 4063, 4064, 4066, 4077

< {UAZ95} 1: 2012, 2013, 2014, 2015, 2018, 2019, 3001, 3006, 3010, 3039, 3040, 3048, 3055, 3073, 3089, 3125, 3148, 3149, 3195, 3231, 3247, 3253, 3278, 3301, 3302, 3303, 3310, 3407, 3408, 3409, 3410, 3411, 3414, 3502, 4008, 4009, 4010, 4011, 4027, 4028, 4031, 4061, 4063, 4066, 4077

38. Complete List of Zonal Assignment and Calibration of all samples

EXPLANATORY NOTES

The sections listed in the following appear in the same order and have the same synthax as in the datafile (Chapter 37). This order follows the order of the biostratigraphic chapters (Chapters 5-31) in this book. A star "✳" in front of the names of sections indicates that the section was not used for the construction of UAZones, but was compared to them by running the section together with the numerical range chart (UAZ95.TGI, see Chapter 32 for procedure).

The sequential sample number "< **1**" is followed by the original sample number in { }, followed by the range expressed as UAZones and as age range.

The age range is stated as follows: The hyphen "**-**" marks the age range of each UAZone, the "**to**" links the age ranges of the early and the late UAZone. By definition, the total possible age range of a combination of taxa that defines the range of a sample, goes from the beginning of the earliest to the end of the latest UAZone. The actual range of a sample, however, can be anywhere from within the range of the ealiest to within the range of the latest UAZone.

The abbreviations used are as follows: **Aal.** = Aalenian, **Baj.** = Bajocian, **Bath.** = Bathonian, **Call.** = Callovian, **Oxf.** = Oxfordian. **Kimm.** = Kimmeridgian, **Tith.** = Tithonian, **Berr.** = Berriasian, **Val.** = Valanginian, **Haut.** = Hauterivian, **Barr.** = Barremian, **Apt.** = Aptian.

Calibration by other fossils, magneto- and isotope stratigraphy:
For each sample that can be related to an age-diagnostic fossil, to magneto- or to isotope stratigraphy, observed in the same section, the UAZ, - range is followed by a sign for the relationship, the abbreviated name of the fossil group/stratigraphy and by the age given by it. The signs used mean:

<< radiolarian sample is well above (may be much younger than) age diagnostic fossil/stratigraphy (e.g. separated by disconformity, hardground, several metres of pelagic sediments, etc.)
< radiolarian sample is above (may be slightly younger than) age diagnostic fossil/stratigraphy
≤ radiolarian sample is immediately above (about the same age as) age diagnostic fossil/stratigraphy
= radiolarian sample is in the same bed as (strictly the same age as) age diagnostic fossil/stratigraphy
≥ radiolarian sample is immediately below (about the same age as) age diagnostic fossil/stratigraphy
> radiolarian sample is below (may be slightly older than) age diagnostic fossil/stratigraphy
>> radiolarian sample is well below (may be much older than) age diagnostic fossil/stratigraphy

Abbreviations for fossil groups/stratigraphy: **Amm.** = Ammonites, **Ap.** = Aptichi, **Bent.** = Bentonites, **Ca.** = Calpionellids, **Nann.** = Nannofossils, **Dino.** = Dinofalgellates, **Pmag.** = Paleomagnetic stratigraphy, $\delta^{13}C$ = Carbon isotope stratigraphy.

This information is summarized from the biostratigraphic chapters. Detailed correlation of the Lower Cretaceous radiolarian samples in the sections studied by Dumitrica-Jud to the magnetostratigraphy and nannofossil events is fopund in *Chapter* 12. Details on all calibrations are given in the respective chapters *(Chapters* 5-31).

Chapter 5: Towards a Mesozoic radiolarian database by P.O. Baumgartner

SECTION POB39_DSDP_LEG_1_SITE_5
1 {5A-7-1-top}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.

SECTION *POB29_DSDP_LEG_41_SITE_367
< 7 {32-4-009}: UAZ. 10-13 late Oxf.-early Kimm. to latest Tith.-earliest Berr.
< 6 {34-4-104}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith. ≥Ap: latest Kimm.-earliest Tith.
< 5 {35-2-028}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 4 {35-2-042}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm. ≤Ap: Oxf.-Kimm.
< 3 {36-3-049}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 2 {37-1-007}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1 {37-1-147}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

{MOROCCO EL KADIRI}
SECTION *KS302_412
< 2 {ks302}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 1 {ks412}: UAZ. 2-3 late Aal. to early-middle Baj. **«Amm: late Toarc.**

SECTION *POB38_VEVEYSE_DE_CH_ST_DE
< 1 {bed 67-4}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut. **= Amm: terminal Val.**

SECTION *POB17_BESOZZO_II
< 3 {RK101, 3020cm}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {RK92, 2045cm}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {RK95, 605cm}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.

SECTION *POB18_MONTE_GENEROSO
< 3 {A-19}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2 {A-2}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {BB1}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION *POB20_VALMAGGIORE
< 4 {RK1085}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 3 {RK1086}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2 {RK1088}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 1 {RK1095}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION *POB21_BESOZZO_I
< 5 {RK115}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {RK111}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 3 {RK110}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {RK109}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 1 {RK106}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION POB22_23_RJ9_SANGIANO_RUSCONI
< 18 {RU166.00 RJ AU26-27}: UAZ. 19-19 early Haut. to early Haut.
< 17 {RU 146.50 RJ AU26}: UAZ. 19-19 early Haut. to early Haut.
< 16 {RU135.50 RJ AU25}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< 15 {RU128.80 RJ AU25}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< 14 {RU107.90 RJ AU11-24}: UAZ. 15-18 late Berr.-earliest Val. to latest Val.-earliest Haut.
< 13 {RU 91.50 RJ AU19}: UAZ. 15-17 late Berr.-earliest Val. to late Val.
< 12 {RU50.80 RJ AU10}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 11 {RU38.60 RJ AU 10}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 10 {RU10.60 RJ AU10}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 9 {POB1205 POB7.05.RJ3.50 AU7}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. **= Ca: earliest Berr.**
< 8 {RU0.50 RJ AU5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. **= Ca: latest Tith.**
< 7 {RK9}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 6 {RK48}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 5 {RK11}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {RK24}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 3 {RK30}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 2 {RK36}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 1 {RK37}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION POB24_RJ10_BREGGIA_JUR_CRET
< 36 {BR12.40 RJ UA30-31}: UAZ. 21-21 early Barr. to early Barr.
< 35 {BR23.00 RJ29-31}: UAZ. 19-20 early Haut. to late Haut.

< 34 {BR74.80 RJ UA23}: UAZ. 19-20 early Haut. to late Haut.
< 33 {BR68.40 RJ UA21-22}: UAZ. 17-17 late Val. to late Val.
< 32 {BR62.80 RJ UA21}: UAZ. 17-17 late Val. to late Val.
< 31 {BR54.70 RJ UA15}: UAZ. 17-17 late Val. to late Val.
< 30 {BR49.05 RJ UA15}: UAZ. 16-16 early Val. to early Val.
< 29 {BR39.05 RJ UA15}: UAZ. 16-16 early Val. to early Val.
< 28 {BR34.05 RJ UA15}: UAZ. 16-16 early Val. to early Val.
< 27 {BR28.85 RJ UA15}: UAZ. 16-16 early Val. to early Val.
< 26 {POB141.55=BR9.10 RJ UA34}: UAZ. 16-16 early Val. to early Val.
< 25 {POB1330=BR10.50 POB UA11 RJ UA7}: UAZ. 14-14 early-early late Berr. to early-early late Berr. = **PMag: early Berr.**
< 24 {BR0.03 RJ UA5-6}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Pmag: earliest Berr.**
< 23 {RK B48 2.33 POB UA9-10}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 22 {RK B45 5.45 POB UA9-10}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 21 {RK B85 14.90 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 20 {RK 430 17.50m POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 19 {RK B30 20.75m POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 18 {RK 433 24.10m POB UA7-8}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 17 {RK B27 26.40m POB UA7-8}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 16 {RK B 22 30.05m POB UA7-8}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 15 {RK B21 32.40m POB UA7}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 14 {RK B19 35.70M POB UA6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 13 {RK B90 40.10m POB UA6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 12 {RK B12 42.15m POB UA6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 11 {RK B11 42.25m POB UA6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 10 {RK B9=B10 IN BG84 POB UA6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 9 {RK B2 POB UA5}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 8 {RK B6=B8 IN BG84 POB AU5}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 7 {RK B3 46.05m POB AU4}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 6 {RK B4 POB AU3-4?}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 5 {RK B69 POB AU3}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 4 {RK B57 POB AU3}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 3 {RK B72 POB AU3}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 2 {RK B100=B10 IN BG84 POB AU1}: UAZ. 6-6 middle Bath. to middle Bath.
< 1 {RK B61 POB AU1}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION POB25_SALTRIO
< 12 {S51}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 11 {S50}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 10 {S48}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 9 {S47}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 8 {S46}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 7 {S45}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 6 {S43}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 5 {S41}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 4 {S40}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 3 {S39}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 2 {S36}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 1 {S29}: UAZ. 6-6 middle Bath. to middle Bath.

SECTION *POB36_GLASENBACH
< 2 {123}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {122}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

SECTION *POB43_TRATTBERG
< 2: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 1: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.

SECTION *POB27_MONTE_CETONA
< 9 {RK1051}: UAZ. 5-9 latest Baj.-early Bath. to middle-late Oxf.
< 8 {RK1049}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 7 {RK1048}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 6 {RK1047}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 5 {RK1046}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 4 {RK1045}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 3 {RK1043}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

< 2 {RK1039}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 1 {RK1038}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION *POB46_MONTE_CAMPANELLO_ELBA
< 2 {POB1630}: UAZ. 7-11 late Bath.-early Call. to late Kimm.-early Tith.
< 1 {POB1628}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

SECTION *POB47_S_FELO_NAMIA_ELBA
< 1 {POB1615}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION *POB48_ROCCHETTE_DI_VARA
< 2 {POB1662}: UAZ. 4-11 late Baj. to late Kimm.-early Tith.
< 1 {POB1661}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION 26RJ_1_BOSSO_JUR_CRET
< 81 {BO 1mab.sellibase RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 80 {BO2 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 79 {BO619.90 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 78 {BO619.05 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 77 {BO617.00 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 76 {BO615.20 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 75 {BO606.80 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 74 {BO588.20 RJ UA31-33}: UAZ. 20-21 late Haut. to early Barr.
< 73 {BO582.80 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 72 {BO581.65 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 71 {BO581.60 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 70 {BO580.40 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 69 {BO580.10 RJ UA32}: UAZ. 20-20 late Haut. to late Haut.
< 68 {BO575.05 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 67 {BO574.40 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 66 {BO573.00 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 65 {BO569.60 RJ UA31}: UAZ. 20-20 late Haut. to late Haut.
< 64 {BO566.50 RJ UA31}: UAZ. 20-20 late Haut. to late Haut.
< 63 {BO563.60 RJ UA30-31}: UAZ. 20-20 late Haut. to late Haut.
< 62 {BO561.80 RJ UA30-31}: UAZ. 19-20 early Haut. to late Haut.
< 61 {BO556.40 RJ UA30}: UAZ. 19-20 early Haut. to late Haut.
< 60 {BO552.10 RJ UA30}: UAZ. 19-20 early Haut. to late Haut.
< 59 {BO551.05 RJ UA27-30}: UAZ. 19-20 early Haut. to late Haut.
< 58 {BO547.50 RJ UA27}: UAZ. 19-19 early Haut. to early Haut.
< 57 {BO540.50 RJ UA27}: UAZ. 19-19 early Haut. to early Haut.
< 56 {BO537.90 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 55 {BO534.30 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 54 {BO533.30 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 53 {BO529.20 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 52 {BO525.30 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 51 {BO523.70 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 50 {BO520.10 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 49 {BO515.05 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 48 {BO490.60 RJ UA26-27}: UAZ. 17-19 late Val. to early Haut.
< 47 {BO488.80 RJ UA26-27}: UAZ. 17-19 late Val. to early Haut.
< 46 {BO486.50 RJ UA26-27}: UAZ. 17-19 late Val. to early Haut.
< 45 {BO482.50 RJ UA22}: UAZ. 17-19 late Val. to early Haut.
< 44 {BO482.20 RJ UA22}: UAZ. 17-17 late Val. to late Val.
< 43 {BO481.45 RJ UA22}: UAZ. 17-17 late Val. to late Val.
< 42 {BO479.50 RJ UA22}: UAZ. 17-17 late Val. to late Val.
< 41 {BO449.50 RJ UA20}: UAZ. 17-17 late Val. to late Val.
< 40 {BO447.50 RJ UA18}: UAZ. 17-17 late Val. to late Val.
< 39 {BO427.20 RJ UA12-18}: UAZ. 15-17 late Berr.-earliest Val. to late Val.
< 38 {BO409.00 RJ UA12}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 37 {BO391.20 RJ UA10-12}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 36 {BO382.00 RJ UA10-12}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 35 {BO370.10 RJ UA10}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 34 {BO 361.80 RJ UA10}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val. **= Ca: late Berr.**
< 33 {BO351.50 RJ UA6-10}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.

< 32 {BO336.20 RJ UA6-10}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 31 {BO332.70 RJ UA 6-8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 30 {BO323.20 RJ UA6}: UAZ. 14-14 early-early late Berr. to early-early late Berr. = **Ca: early Berr.**
< 29 {BO315.50 RJ UA6}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Ca: earliest Berr.**
< 28 {BO312.90 RJ UA6}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Ca: earliest Berr.**
< 27 {BO312.00 RJ UA6}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Ca: earliest Berr.**
< 26 {BO311.20 RJ UA6-7}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Ca: latest Tith.**
< 25 {RK 1083 309.50m POB UA11}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr. = **Ca: latest Tith.**
< 24 {RK 1082 308.00m POB UA11}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 23 {BO306.20 RJ UA3}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 22 {BO305.00 RJ UA3}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 21 {BO304.00 POB UA11 RJ UA3}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 20 {RK 1079 POB UA10}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 19 {RK 1078 POB UA10}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 18 {RK 1076 POB UA10}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 17 {BO294.60 POB UA10 RJ UA2}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 16 {BO292.20 POB UA10 RJ UA1}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 15 {BO289.80 POB UA9 RJ UA1}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 14 {RK 1072 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 13 {BO279.30 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 12 {RK 1071 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 11 {W79-223 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 10 {RK 1070 POB UA5-6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 9 {BO 268.00 POB UA5-6}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 8 {RK1065 POB UA5-6}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 7 {RK 1064 POB UA4-6}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 6 {RK 1062 POB UA3-6}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 5 {RK 1059 POB UA3-4}.: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 4 {BO254.50 POB UA3-4}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 3 {W79-227 POB UA1}: UAZ. 4-6 late Baj. to middle Bath.
< 2 {BO234.30 POB UA1}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 1 {BO230.80 POB UA0 ok19/12/91pob}: UAZ. 3-3 early middle Baj. = **Amm.: middle Bajocian.**

SECTION POB56_RJ7_VALDORBIA_JUR_CRET
< 25 {V-10.00 RJ UA7}: UAZ. 14-14 early-early late Berr. = **Ca: earliest Berr.**
< 24 {V-6.50 RJ UA6-7}: UAZ. 13-13 latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 23 {V-6.20 RJ UA6-7}: UAZ. 13-13 latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 22 {V-6.00 POB UA11 RJ UA6}: UAZ. 13-13 latest Tith.-earliest Berr. = **Ca: latest Tith.**
< 21 {V0.40 RJ UA6}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 20 {V2.00 RJ UA6}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 19 {V5.00 RJ UA6}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 18 {V23.70 POB UA11}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 17 {V33.00 POB UA11}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 16 {V41.65 POB UA11 RJ UA4-7}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 15 {V46.10 POB UA11}: UAZ. 13-16 latest Tith.-earliest Berr. to early Val.
< 14 {V47.60 RJ UA4}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 13 {V51.25 POB UA10}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 12 {V60.70 POB UA10}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 11 {V65.90 POB UA10 RJ UA1}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 10 {V71.00 POB UA7-8 RJ UA1}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 9 {V74.00 POB UA7-8}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 8 {V98.00 POB UA4-7}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 7 {V102.80 POB UA3-5}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 6 {V112.60 POB UA3}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 5 {V118.50 POB UA3}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 4 {V130.30 POB UA0}: UAZ. 3-4 early-middle Baj. to late Baj.
< 3 {V132.70 POB UA0}: UAZ. 3-4 early-middle Baj. to late Baj.
< 2 {V133.60 POB UA0}: UAZ. 3-4 early-middle Baj. to late Baj.
< 1 {V135.50 POB UA0}: UAZ. 2-4 late Aal. to late Baj. =

Nann: early Baj.

SECTION 57_RJ5_RANCHI_SUP
< 10 {MN47.70 RJ UA32}: UAZ. 20-20 late Haut. to late Haut.
< 9 {MN45.50 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 8 {MN39-40 RJ UA26-27}: UAZ. 19-19 early Haut. to early Haut.
< 7 {MN37.05 RJ UA24}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< 6 {MN30.20 RJ UA18-24}: UAZ. 17-18 late Val. to latest Val.-earliest Haut.
< 5 {MN24.50 RJ UA17}: UAZ. 16-16 early Val. to early Val.
< 4 {MN18.70 RJ UA5-15}: UAZ. 13-16 latest Tith.-earliest Berr. to early Val.
< 3 {MN7.30 POB UA8-9}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith. > **Amm: latest Kimm.**
< 2 {MN6.60 POB UA8}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 1 {MN3.00 POB UA2-3}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call. **< Amm: middle Baj.**

SECTION POBRJ6_CAMPO_AL_BELLO
< 4 {POB1592 RJ UA31-33}: UAZ. 20-21 late Haut. to early Barr.
< 3 {POB1590 RJ UA29-33}: UAZ. 20-21 late Haut. to early Barr.
< 2 {POB1589 RJ UA29-33}: UAZ. 20-21 late Haut. to early Barr.
< 1 {POB1584 sample ch.29/11/91pob}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm. = **Amm: early Kimm.**

SECTION *POB28_SANTA_ANNA
< 4 {S4}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf. > **Amm: Kimm.**
< 3 {S3}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 2 {S2}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {S1}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION *POB10_PINDOS
< 3 {B78-139}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 2 {B78-76}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {B78-54}: UAZ. 5-10 latest Baj.-early Bath. to late Oxf.-early Kimm.

SECTION *POB11_MARATHOS
< 6 {LN80/76}: UAZ. 12-22 early-early late Tith. to late Barr.-early Apt.
< 5 {LN78/76}: UAZ. 12-20 early-early late Tith. to late Haut.
< 4 {LN58/77}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3{LN54}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2{LN51/76}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1{LN50a/76}: UAZ. 4-10 late Baj. to late Oxf.-early Kimm.

SECTION *POB49_C_31_SIMANTOV
< 1 {C31}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.

SECTION *POB51_ACHLADI_GREECE
< 1 {DB45-75}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION COMPOSITE_ARGOLIS_PENINSU
< 13 {POB668.2-8.ok18/12/91pob}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 12 {POB1061.2-7.ok18/12/91pob}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 11 {POB154.2-6.ok18/12/91pob}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 10 {POB770. 4-3}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 9 {POB774. 4-2}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 8 {POB783. 4-1}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 7 {POB137.2-5ok18/12/91pob}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 6 {ABV124.1-3}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 5 {ABV123.1-2}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 4 {POB899.2-4. ok18/12/91pob}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 3 {POB144.2-3ok18/12/91pob}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 2 {POB28.2-2ok18/12/91pob}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {POB22.2-1ok18/12/91pob}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

SECTION POB7_8_THEOKAFTA_KOLIAKI_COM
< 5 {POB986. 8.1}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 4 {POB1261}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 3 {POB325}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 2 {POB1262}: UAZ. 4-4 late Baj. to late Baj.
< 1 {POB1263}: UAZ. 3-4 early-middle Baj. to late Baj.

SECTION *POB1_DHIMAINA
< 9 {ABV 134}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 8 {ABV 133}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 7 {ABV 132}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 6 {ABV 131}: UAZ. 8-11 middle Call.-early Oxf. to late

Kimm.-early Tith.
< 5 {ABV 129}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 4 {ABV 127}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 3 {ABV 124}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {ABV 123}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1 {ABV 122}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION *POB3_PROSIMNI
< 3 {ABV 272}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2 {ABV 267}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1 {ABV 266}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION *POB5_KANDHIA
< 2 {POB284.5}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 1 {POB1050}: UAZ. 10- 11 late Oxf.-early Kimm. to late Kimm.-early Tith.

SECTION *POB9_RHADON
< 1 {POB926}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

SECTION *POB13_LACU_ROSU
< 1 {LEAN ROSU, HAGHIMAS MOUNTAINS, ROMANIA, 1}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.

SECTION *POB14_PIATRA_SOIMULUI
{also in Chapter 24: by P. Dumitrica}
< 1 {R 102}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION POB15_GOMIELOR_VALLEY
< 1 {KO 1981}: UAZ. 4-10 late Baj. to late Oxf.-early Kimm.

SECTION *POB50_JEBEL_AL_HASI_OMAN
< 1 {DB6214}: UAZ. 6-7 middle Bath. to late Bath.-early Call.

SECTION *POB42_SUR_OMAN
< 2 {OM191}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 1 {OM200}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.

SECTION *POB31_DSDP_LEG_17
< 6 {167-69-3-36}
< 5 {167-74-2-65}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 4 {167-76-2-65}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 3 {167-88-CC}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 2 {167-93-2-22}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 1 {167-94-2-40}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

SECTION *POB32_DSDP_LEG_32_SITE_306
< 7 {306-14-CC}: UAZ. 11-14 late Kimm.-early Tith. to early-early late Berr.
< 6 {306-16-CC}: UAZ. 11-14 late Kimm.-early Tith. to early-early late Berr.
< 5 {306-21-CC}: UAZ. 11-14 late Kimm.-early Tith. to early-early late Berr.
< 4 {306-40-1-119}: UAZ. 12-14 early-early late Tith. to early-early late Berr.
< 3 {306-41-CC}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 2 {306-42-1-103}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 1 {306-42-1-116}: UAZ. 12-14 early-early late Tith. to early-early late Berr.

SECTION *POB33_DSDP_LEG_32_SITE_307
< 6 {307-6-CC}: UAZ. 12-17 early-early late Tith. to late Val.
< 5 {307-7-1-75}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 4 {307-8-CC}: UAZ. 12-17 early-early late Tith. to late Val.
< 3 {307-9-1-80}: UAZ. 12-17 early-early late Tith. to late Val.
< 2 {307-10-1-119}: UAZ. 12-17 early-early late Tith. to late Val.
< 1 {307-12-1-120}: UAZ. 12-17 early-early late Tith. to late Val.

SECTION *POB34_DSDP_LEG_20_SITE_195
< 4 {195-3-CC}: UAZ. 12-14 early-early late Tith. to early-early late Berr.
< 3 {195-4-CC}: UAZ. 13-20 latest Tith.-earliest Berr. to late Haut.
< 2 {195-B1-CC}: UAZ. 12-20 early-early late Tith. to late Haut.
< 1 {195-B2-CC}: UAZ. 12-20 early-early late Tith. to late Haut.

SECTION *POB35_DSDP_LEG_20_SITE_196
< 3 {196-3-1}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 2 {196-4-1-P3}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 1 {196-5-CC}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.

SECTION *POB37_POINT_SAL
< 3 {NFS 909}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {NFS 908}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {NFS 907}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION ∗POB41_GUATEMALA_NICOYA
< 1 {2-18-1-79}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.

Chapter 6: Jurassic Radiolarians from the Lesser Caucasus (Koshuni River Basin) by V.S. Vishneskaya

SECTION ∗VV1_Zod_Pass: bottom 1-top 1
< 1 {Sample 0}: UAZ. 1-1 early-middle Aal. to early-middle Aal.

SECTION ∗VV2_Mt_Karawul: bottom 1-top 7
< 7 {Sample 011-4}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 6 {Sample 011-3}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.
< 5 {Sample 011-2}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 4 {Sample 139-37}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3 {Sample 07}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2 {Sample 05}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 1 {Sample 146}: UAZ. 3-9 early-middle Baj. to middle-late Oxf.

SECTION ∗VV3_Site_22: bottom 1-top 7
< 7 {Sample 3419}: UAZ. 5-11 latest Baj.-early Bath. to late Kimm.-early Tith.
< 6 {Sample 3421}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 5 {Sample 3428}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 4 {Sample 3429 T}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 3 {Sample 3429}: UAZ. 3-4 early-middle Baj. to late Baj.
< 2 {Sample 3430 T}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {Sample 3430}: UAZ. 1-1 early-middle Aal. to early-middle Aal.

Chapter 7: DSDP Site 535, Blake Bahama Basin, Central Northern Atlantic by P.O. Baumgartner

SECTION POBMA30_DSDP_LEG_76_S_534
{sample 12 did not exist in BG84 > only 27 samples}
< 28: {081-2-003}: UAZ. 13-15 latest Tith.-earliest Berr. to late Berr.-earliest Val. ≥ **Dino: earliest Val.**
< 27: {081-2-064}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val. ≥ **Dino: earliest Val.**
< 26: {089-2-047}: UAZ. 14-14 early-early late Berr. to early-early late Berr. ≤ **Ca: earliest Berr.**
< 25: {106-1-029}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith. ≥ **Dino: latest Kimm.**
< 24: {111-1-012}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 23: {115-1-070}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 22: {117-1-032}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 21: {120-1-052}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 20: {121-1-025}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 19: {121-1-052}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 18: {122-1-042}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 17: {122-1-131}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 16: {123-2-037}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 15: {124-2-097}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 14: {124-1-041}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 13: {124-1-052}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 12: {125-2-035}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 11: {125-2-115}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 10: {125-4-001}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 9: {125-5-072}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 8: {125-5-111}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 7: {125-6-013}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 6: {125-6-063}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 5: {126-2-045}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 4: {126-2-065}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 3: {126-2-125}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 2: {126-4-140}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 1: {76-534A-127-1-13-15}: UAZ. 6-6 middle Bath. to middle Bath.

Chapter 8: Jurassic radiolarian from the Subbetic Realm (Southern Spain) by L. O'Dogherty et al.

SECTION LO_CASA_BLANCA

< 1 {89cb7}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath. = **Amm: early Bath.**

SECTION 59_LO_S_HARANA_JA4_2

< 1 {JA4.2}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf. **= Amm: late middle -early late Oxf.**

SECTION 60_LO_ELVIRA

< 4 {90-AA-11}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 3 {90-AA-8}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 2 {90-AA-7}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 1 {90A-C-1a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.

SECTION LO_60A_CERRO_LA_MARTINA

< 1 {89L-M-6}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 2 {89N-M-16. 0.5m below 16}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call. = **Amm: late Bath.**

SECTION 58_LO__CB_7

1: {CB-7}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.= **Amm: early Bath.**

SECTION 45_POBLO_SIERRA_DE_RICOTE

< 30 {RI H 2.70}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith. **>Amm: late early Tith.**

< 29 {POB1768}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 28 {POB1766}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 27 {POB1760}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 26 {POB1757}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 25 {POB1755}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith. = **Amm: early Kimm.**

< 24 {POB1779}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith. = **Amm: early Kimm.**

< 23 {POB1778}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 22 {POB1754}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 21 {POB1777}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.

< 20 {POB1776}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

< 19 {POB1753}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 18 {POB1750}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 17 {POB1746}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 16 {POB1770}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 15 {POB1771}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 14 {POB1772}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 13 {POB1773}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 12 {POB1732}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 11 {POB1731}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 10 {POB1730}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.

< 9 {POB1775}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf. **< Amm: early Call.**

< 8 {POB1797}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf. **> Amm: early Bath**

< 7 {POB1796}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath. **= Amm: latest Baj.**

< 6 {POB1792}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.

< 5 {POB1789}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.

< 4 {POB1788}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.

< 3 {POB1786}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

< 2 {POB1785}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

< 1 {POB1784}: UAZ. 4-4 late Baj. to late Baj. <Amm: early late Baj. ≤ **Amm: late Baj.**

SECTION *52_LO_BERMEJA

< 35 {LOB87-35}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

< 34 {LOB87-34}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 33 {LOB87-33}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 32 {LOB87-32}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 31 {LOB87-31}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 30 {LOB87-30}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 29 {LOB87-29}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 28 {LOB87-28}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 27 {LOB87-27}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 26 {LOB87-26}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

< 25 {LOB87-25}: UAZ. 8-8 middle Call.-early Oxf. to

middle Call.-early Oxf.
< 24 {LOB87-24}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 23 {LOB87-23}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 22 {LOB87-22}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 21 {LOB87-21}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 20 {LOB87-20}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 19 {LOB87-19}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 18 {LOB87-18}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 17 {LOB87-17}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 16 {LOB87-16}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 15 {LOB87-15}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 14 {LOB87-14}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 13 {LOB87-13}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 12 {LOB87-12}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 11 {LOB87-11}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 10 {LOB87-10}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 9 {LOB87-9}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 8 {LOB87-8}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 7 {LOB87-7}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 6 {LOB87-6}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 5 {LOB87-5}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 4 {LOB87-4}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 3 {LOB87-3}: UAZ. 5-10 latest Baj.-early Bath. to late Oxf.-early Kimm.
< 2 {LOB87-2}: UAZ. 4-10 late Baj. to late Oxf.-early Kimm.
< 1 {LOB87-1}: UAZ. 4-10 late Baj. to late Oxf.-early Kimm.

SECTION *53_LO_MARTINA
< 14 {LOM87-14}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 13 {LOM87-13}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 12 {LOM87-12}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 11 {LOM87-11}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 10 {LOM87-10}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 9 {LOM87-9}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 8 {LOM87-8}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 7 {LOM87-7}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 6 {LOM87-6}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 5 {LOM87-5}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 4 {LOM87-4}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 3 {LOM87-3}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 2 {LOM87-2}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {LOM87-1}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

SECTION *54_LO_JARROPA
< 32 {LOJ87-32}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 31 {LOJ87-31}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 30 {LOJ87-30}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 29 {LOJ87-29}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 28 {LOJ87-28}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 27 {LOJ87-27}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 26 {LOJ87-26}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 25 {LOJ87-25}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 24 {LOJ87-24}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 23 {LOJ87-23}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 22 {LOJ87-22}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 21 {LOJ87-21}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 20 {LOJ87-20}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 19 {LOJ87-19}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 18 {LOJ87-18}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 17 {LOJ87-17}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 16 {LOJ87-16}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 15 {LOJ87-15}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 14 {LOJ87-14}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 13 {LOJ87-13}: UAZ. 7-8 late Bath.-early Call. to middle

Call.-early Oxf.
< 12 {LOJ87-12}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 11 {LOJ87-11}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 10 {LOJ87-10}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 9 {LOJ87-9}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 8 {LOJ87-8}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 7 {LOJ87-7}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 6 {LOJ87-6}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 5 {LOJ87-5}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 4 {LOJ87-4}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 3 {LOJ87-3}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 2 {LOJ87-2}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.
< 1 {LOJ87-1}: UAZ. 6-10 middle Bath. to late Oxf.-early Kimm.

SECTION *55_LO_PELADA
< 8 {LOP87-8}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 7 {LOP87-7}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 6 {LOP87-6}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 5 {LOP87-5}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 4 {LOP87-4}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 3 {LOP87-3}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 2 {LOP87-2}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {LOP87-1}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

Chapter 9: Radiolarians from the Schistes Lustrés Formation in the Alps (France and Italy) by P. De Wever and P.O. Baumgartner

SECTION DW2_ALPES_QUEYRAS_DW81
< 1 {DW2_ALPES_QUEYRAS_DW81}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.

SECTION DW3_ALPES_ITALIE_TRAVERSIERA_DWPOB
< 1 {DW3_ALPES_ITALIE_TRAVERSI}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

Chapter 10: Postophiolite Radiolarites from Alpine Corsica (France) by P. De Wever and T. Danelian

SECTION DW4_CORSE_KM59
< 4 {85c35}: UAZ. 5-10 latest Baj.-early Bath. to late Oxf.-early Kimm.
< 3 {85c36}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 2 {85c37}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 1 {85c40}: UAZ. 5-9 latest Baj.-early Bath. to middle-late Oxf.

SECTION DW5_CORSE_SAN_COLOMBANO_IIB_LATER
< 2 {85c48-50}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 1 {85c47-49}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

SECTION DW6_CORSE_SAN_COLOMBANO_IIA
< 6 {85-5-56}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 5 {85-5-57}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 4 {85-5-58}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 3 {85-5-59}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 2 {85-5-60}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1 {85-5-64}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

Chapter 11: Jurassic radiolarian from Southern Alps (Northern Italy) by P.O. Baumgartner et al.

SECTION POB19_TORRE_DE_BUSI
< 9 {RK 187}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 8 {RK 332}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 7 {RK 199}: UAZ. 9-10 middle-late Oxf. to late Oxf.-

early Kimm.
< 6 {RK 206}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 5 {RK 403}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 4 {RK 207}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 3 {RK 208}: UAZ. 5-8 latest Baj.-early Bath. to middle Call.-early Oxf.
< 2 {RK 414}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 1 {POB1341}: UAZ. 3-3 early-middle Baj. to early-middle Baj. = **Nann: early Baj.**

SECTION 6_SERRADA
< 1 {POB1403: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

SECTION 44_CENIGA
< 4 {POB1704sample ch. 29/12/91pob}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3 {POB1703sample ch. 29/12/91pob}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 2 {POB1701 sample ch.29/12/91pob}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.**< Bent: middle middle Oxf.**
< 1 {POB1695 sample ch. 29/12/91pob}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf. **> Bent: middle middle Oxf.**

SECTION 44A_MADONNA_DELLA_CORONA_A
< 3 {MCB0.35}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf. ≤ **Bent: middle Oxf.**
< 2 {MCB0.90}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith. = **Bent: middle Oxf.**
< 1 {MCA0.35}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm. **> Bent: middle Oxf.**

SECTION 44B_KABERLABA
< 2 {K13.40 det 1/1/92pob :rads F sponges A ca. 90%}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf. = **Bent: middle Oxf.**
< 1 {K12.00 det 1/1/92pob :rads only a few specs. sponge spics and raxes >99%}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.- early Oxf. **> Bent: middle Oxf.**

SECTION 44C_MAZZE
< 3 {M21.75}: UAZ.10-11 late Oxf.-early Kimm. to late Kimm.-early Tith. **< Bent: middle Oxf.**
< 2 {M20.60}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm. **< Bent: middle Oxf.**
< 1 {M18.20}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm. **> Bent: middle Oxf.**

SECTION VAJONT_DAM
< 2 {VAJ-FON3}: UAZ. 7 -7 late Bath.-early Call. to late Bath.-early Call.
< 1 {VAJ-FON 0}: UAZ. 7 -7 late Bath.-early Call. to late Bath.-early Call.

SECTION ∗VAL_ARDO
< 2 {VA C3.90}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {VA A10.60}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.

SECTION ∗PONTE_SERRA
< 2 {PS C15.00}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 1 {PS B14.60}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

Chapter 12: Early Cretaceous radiolarian biostratigraphy (Italy, Switzerland and Oman) by R. Dumitrica-Jud

Cretacous samples of Ruth Jud in the composite sections POB22_23_RJ9_SANGIANO_RUSCONI, POB24_RJ10_BREGGIA_JUR_CRET, POB26_RJ1_BOSSO_JUR_CRET, POB56_RJ7_VALDORBIA, POB57RJ5_RANCHI_SUP, and POBRJ_CAMPO_AL_BELLO are listed under Chapter 5, where the Jurassic part of these sections is discussed.

SECTION RJ2_PIEIA
< 42 {PI97.35 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 41 {PI95.50 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 40 {PI94.30 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 39 {PI91.45 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 38 {PI89.40 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 37 {PI86.60 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 36 {PI84.75 RJ UA13-17}: UAZ. 16-16 early Val. to early Val.
< 35 {PI82.75 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 34 {PI81.60 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 33 {PI81.00 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 32 {PI78.50 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 31 {PI77.20 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 30 {PI75.60 RJ UA13}: UAZ. 16-16 early Val. to early Val.
< 29 {PI74.90 RJ UA9-13}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 28 {PI74.60 RJ UA9-13}: UAZ. 15-16 late Berr.-earliest

Val. to early Val.
< 27 {PI71.50 RJ UA9-13}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 26 {PI69.10 RJ UA9-13}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 25 {PI67.70 RJ UA9}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 24 {PI66.60 RJ UA9}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 23 {PI64.70 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 22 {PI63.00 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 21 {PI62.20 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 20 {PI61.10 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 19 {PI59.35 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 18 {PI59.00 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 17 {PI58.10 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 16 {PI57.50 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 15 {56.00 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 14 {PI40.20 RJ UA8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 13 {PI37.60 RJ UA6-8}: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< 12 {PIBiB2 RJ UA6-8}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 11 {PI16.20 RJ UA6-8}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 10 {PI13.25 RJ UA6-8}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.
< 9 {PI4mSL RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 8 {PI18.70 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 7 {PI17.90 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 6 {PI17.50 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 5 {PI17.40 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 4 {PI17.15 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 3 {PI16.80 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 2 {PI16.04 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 1 {PI10.00 coll. pob83 RJ UA5}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.

SECTION RJ3_GORGO_A_CERBARA
< 25 {GC911.35 RJ UA33-35}: UAZ. 21-22 early Barr. to late Barr.-early Apt.
< 24 {GC911.10 RJ UA33-35}: UAZ. 21-22 early Barr. to late Barr.-early Apt.
< 23 {GC902.40 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 22 {GC901.30 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 21 {GC893.30 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 20 {GC 889.30 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 19 {GC887.00 RJ UA35}: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< 18 {GC882.40 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 17 {GC874.65 RJ UA 33}: UAZ. 21-21 early Barr. to early Barr.
< 16 {GC869.80 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 15 {GC867.20 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 14 {GC859.75 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 13 {GC846.35 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 12 {GC840.30 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 11 {GC837.15 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 10 {GC832.10 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.
< 9 {GC821.45 RJ UA32}: UAZ. 20-20 late Haut. to late Haut.
< 8 {GC819.75 RJ UA31}: UAZ. 20-20 late Haut. to late Haut.
< 7 {GC817.90 RJ UA31}: UAZ. 20-20 late Haut. to late Haut.
< 6 {GC814.80 RJ UA30-31}: UAZ. 20-20 late Haut. to late Haut.
< 5 {812.25 RJ UA30}: UAZ. 20-20 late Haut. to late Haut.
< 4 {GC801.20 RJ UA30}: UAZ. 20-20 late Haut. to late Haut.
< 3 {GC799.00 RJ UA30}: UAZ. 20-20 late Haut. to late Haut.
< 2 {GC791.70 RJ UA30}: UAZ. 20-20 late Haut. to late Haut.
< 1 {GC786.70 RJ UA28}: UAZ. 19-19 early Haut. to early Haut.

SECTION RJ4_PRESALE
< 10 {PR238.80 RJ UA33-34}: UAZ. 21-21 early Barr. to early Barr.
< 9 {PR225.30 RJ UA34}: UAZ. 21-21 early Barr. to early Barr.
< 8 {PR221.05 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 7 {PR220.75 RJ UA33}: UAZ. 21-21 early Barr. to early Barr.
< 6 {PR211.35 RJ UA31}: UAZ. 20-20 late Haut. to late Haut.
< 5 {PR204.30 RJ UA29}: UAZ. 20-20 late Haut. to late Haut.
< 4 {PR197.30 RJ UA29-31}: UAZ. 20-20 late Haut. to late Haut.
< 3 {PR187.15 RJ UA22-31}: UAZ. 17-20 late Val. to late Haut.
< 2 {PR180.10 RJ UA17-27}: UAZ. 16-19 early Val. to early Haut.
< 1 {PR174.80 RJ UA17}: UAZ. 16-16 early Val. to early Val.

SECTION RJ8_BOTTACIONE
< 1 {POB1602 RJ UA31-32}: UAZ. 20-20 late Haut. to late Haut.

SECTION RJ11_CAPRIOLO
< 27 {CA10.60 RJ UA28-34}: UAZ. 19-21 early Haut. to early Barr.
< 26 {CA15.40 RJ UA28-34}: UAZ. 19-21 early Haut. to early Barr.
< 25 {CA18.40 RJ UA29-31}: UAZ. 20-20 late Haut. to late Haut.
< 24 {CA28.80 RJ UA30-31}: UAZ. 20-20 late Haut. to late Haut.
< 23 {CA37.50 RJ UA28}: UAZ. 19-19 early Haut. to early Haut.
< 22 {CA44.35 RJ UA28-31}: UAZ. 19-20 early Haut. to late Haut.
< 21 {CA46.60 RJ UA28-31}: UAZ. 19-20 early Haut. to late Haut.
< 20 {CA57.85 RJ UA28-31}: UAZ. 19-20 early Haut. to late Haut.
< 19 {CA64.30 RJ UA20-25}: UAZ. 17-18 late Val. to latest Val.-earliest Haut.
< 18 {CA84.90 RJ UA20-25}: UAZ. 17-18 late Val. to latest Val.-earliest Haut.
< 17 {CA99.75 RJ UA22}: UAZ. 17-17 late Val. to late Val.
< 16 {CA100.00 RJ UA20}: UAZ. 17-17 late Val. to late Val.
< 15 {CA109.60 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 14 {CA114.30 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 13 {CA118.40 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 12 {CA120.10 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 11 {CA129.80 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 10 {CA137.60 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 9 {CA139.80 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 8 {CA144.60 RJ UA16}: UAZ. 16-16 early Val. to early Val.
< 7 {CA145.60 RJ UA11-15}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 6 {CA146.20 RJ UA11}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 5 {CA146.50 RJ UA11}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 4 {CA146.60 RJ UA11}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 3 {CA154.00 RJ UA9-11}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 2 {CA162.80 RJ UA7-10}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 1 {CA163.00 RJ UA7-10}: UAZ. 13-15 latest Tith.-earliest Berr. to late Berr.-earliest Val.

SECTION RJ12_PFAFFENGRAT
< 13 {PF67.50 RJ UA7-17}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 12 {PF64.40 RJ UA7-17}: UAZ. 14-17 early-early late Berr. to late Val.
< 11 {PF61.00 RJ UA7-17}: UAZ. 14-17 early-early late Berr. to late Val.
< 10 {PF54.00 RJ UA7-17}: UAZ. 14-17 early-early late Berr. to late Val.
< 9 {PF49.50 RJ UA7-17}: UAZ. 14-17 early-early late Berr. to late Val.
< 8 {PF49.40 RJ UA7-17}: UAZ. 14-17 early-early late Berr. to late Val.
< 7 {PF45.20 RJ UA7-15}: UAZ. 14-16 early-early late Berr. to early Val.
< 6 {PF41.75 RJ UA7-13}: UAZ. 14-16 early-early late Berr. to early Val.
< 5 {PF35.00 RJ UA7-10}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 4 {PF33.00 RJ UA8-12}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 3 {PF30.50 RJ UA8-15}: UAZ. 14-16 early-early late Berr. to early Val.
< 2 {PF28.80 RJ UA7-15}: UAZ. 14-16 early-early late Berr. to early Val.
< 1 {PF20.00 RJ UA7-15}: UAZ. 14-16 early-early late Berr. to early Val.

SECTION RJ13_WAHRAH_FM__AL_HAMMAH_RANGE
< 19 {OM20 RJ UA31-34}: UAZ. 20-21 late Haut. to early Barr.
< 18 {OM19 RJ UA25-34}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.
< 17 {OM18 RJ UA28-34}: UAZ. 19-21 early Haut. to early Barr.
< 16 {OM17 RJ UA24-34}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.
< 15 {OM16 RJ UA25-31}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 14 {OM15 RJ UA30-31}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 13 {OM14 RJ UA30-31}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 12 {OM13 RJ UA30-31}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 11 {OM12 RJ UA30-31}: UAZ. 18-20 latest Val.-earliest Haut. to late Haut.
< 10 {OM11 RJ UA11-25}: UAZ. 15-18 late Berr.-earliest Val. to latest Val.-earliest Haut.
< 9 {OM10 RJ UA11-25}: UAZ. 15-18 late Berr.-earliest Val. to latest Val.-earliest Haut.
< 8 {OM3 RJ UA11-14}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 7 {OM2 RJ UA11-15}: UAZ. 15-16 late Berr.-earliest Val. to early Val.
< 6 {OM1 RJ UA14-15}: UAZ. 16-16 early Val. to early Val.
< 5 {OM9 RJ UA11-15}: UAZ. 15-16 late Berr.-earliest Val. to early Val.

< 4 {OM7 RJ UA10-12}: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< 3 {OM6 RJ UA8-12}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 2 {OM5 RJ UA8-12}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.
< 1 {OM4 RJ UA8-31}: UAZ. 14-20 early-early late Berr. to late Haut.

SECTION UARJRUN93
< {RJ UA} 35: UAZ. 22-22 late Barr.-early Apt. to late Barr.-early Apt.
< {RJ UA} 34: UAZ. 21-21 early Barr. to early Barr.
< {RJ UA} 33: UAZ. 21-21 early Barr. to early Barr.
< {RJ UA} 32: UAZ. 20-20 late Haut. to late Haut.
< {RJ UA} 31: UAZ. 20-20 late Haut. to late Haut.
< {RJ UA} 30: UAZ. 20-20 late Haut. to late Haut.
< {RJ UA} 29: UAZ. 20-20 late Haut. to late Haut.
< {RJ UA} 28: UAZ. 19-19 early Haut. to early Haut.
< {RJ UA} 27: UAZ. 19-19 early Haut. to early Haut.
< {RJ UA} 26: UAZ. 19-19 early Haut. to early Haut.
< {RJ UA} 25: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< {RJ UA} 24: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< {RJ UA} 23: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 22: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 21: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 20: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 19: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 18: UAZ. 17-17 late Val. to late Val.
< {RJ UA} 17: UAZ. 16-16 early Val. to early Val.
< {RJ UA} 16: UAZ. 16-16 early Val. to early Val.
< {RJ UA} 15: UAZ. 16-16 early Val. to early Val.
< {RJ UA} 14: UAZ. 16-16 early Val. to early Val.
< {RJ UA} 13: UAZ. 16-16 early Val. to early Val.
< {RJ UA} 12: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< {RJ UA} 11: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< {RJ UA} 10: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< {RJ UA} 9: UAZ. 15-15 late Berr.-earliest Val. to late Berr.-earliest Val.
< {RJ UA} 8: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< {RJ UA} 7: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< {RJ UA} 6: UAZ. 14-14 early-early late Berr. to early-early late Berr.
< {RJ UA} 5: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< {RJ UA} 4: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< {RJ UA} 3: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< {RJ UA} 2: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< {RJ UA} 1: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

Chapter 13: Radiolarian biostratigraphy of cherts of the Apenninic ophiolites (Italy) by M. Marcucci and M. Conti

SECTION *MM_Monte_Vitalba: bottom 1-top 1
< 1 {0.35 m above the base}: UAZ. 7-11 late Bath.-early Call. to late Kimm.-early Tith.

SECTION *MM_Riparbella: bottom 1-top 3
< 3 {3 metres above the preceding sample}: UAZ. 10-12 late Oxf.-early Kimm. to early-early late Tith.
< 2 {upper level}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 1 {lower chert level at Il Terriccio}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION *MM_Quercianella: bottom 1-top 2
< 2 {1.6 metres below the top}: UAZ. 10-12 late Oxf.-early Kimm. to early-early late Tith.
< 1 {Near the base}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.

SECTION *MM_MONTEROSSOLA: bottom 1-top 1 UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {Sample RS3}:

SECTION *MM_IL_CONVENTINO: bottom 1-top 7
< 7 {CC 1}: UAZ. 10-12 late Oxf.-early Kimm. to early-early late Tith.
< 6 {CC 4}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.
< 5 {CC 10}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 4 {CC 12}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3 {CC 28}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 2 {CC 26}: UAZ. 7-11 late Bath.-early Call. to late Kimm.-early Tith.
< 1 {CC 23}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

SECTION *CT01_02_MONTE_CETONA
< 6 {CT14}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 5 {CT15}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 4 {CT16}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.

< 3 {CT17-CET107}: UAZ. 7- 9 late Bath.-early Call. to middle-late Oxf.
< 2 {CET110}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 1 {CT18}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.

SECTION ∗MCCT_01_COSTA_SCANDELLA
< 1 {AI3+AI4}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.

SECTION ∗MC_01_CAPANNELLE
< 1 {C1}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

SECTION ∗MCCT_01_MONTE_VOLTERRAIO
{MC= Marcucci Marta. CT= Conti Maurizio}
< 1 {VOL1}: UAZ. 5-9 latest Baj.-early Bath. to middle-late Oxf.

SECTION ∗MCCT_01_MURLO
< 2 {B4}: UAZ. 3-11 early-middle Baj. to late Kimm.-early Tith.
{Podobursa sp. 1 not codified}
< 1 {B1+B2}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

SECTION ∗MCCT_01_ROCCHETTA_DI_VARA
< 1 {RV11}: UAZ. 7-11 late Bath.-early Call. to late Kimm.-early Tith.

SECTION ∗MCCT_01_TIMPA_DELLE_MURGE
< 1 {LC18}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

SECTION ∗MCCT_01_VAL_GRAVEGLIA
< 1 {GR6}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

SECTION ∗MC_01_ROMITO
< 1 {SO3+SO5}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION ∗MC_01_SOVANA_ELMO
< 2 {SOV6}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm.
< 1 {SOV3}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

Chapter 14: Radiolarian of the Tuscan Cherts from Val di Lima, Tuscany, Apennines (Italy) by G. Cortese

SECTION ∗CS01_VAL_DI_LIMA
{CS= Cortese Giuseppe}
< 5 {P6}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.
< 4 {P5}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3 {P4}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 2 {P3}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 1 {P2}: UAZ. 6-7 middle Bath. to late Bath.-early Call.

Chapter 15: Jurassic radiolarian biostratigraphy (Appennines, Central Italy) by A. Bartolini *et al.*

SECTION TERMINILLETTO
< 37 {TM 207.34}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 36 {TM 206.75}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 35 {TM 197.30}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 34 {TM 197.03}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 33 {TM 193.40}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 32 {TM 192.44}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 31 {TM 188.50}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 30 {TM 188.45}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 29 {TM 188.18}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 28 {TM 187.44}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 27 {TM 187.30}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 26 {TM 179.20}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 25 {TM 174.98}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 24 {TM 174.88}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 23 {TM 174.86}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 22 {TM 168.15}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 21 {TM 166.70}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 20 {TM 165.80}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 19 {TM 164.66}: UAZ. 7-7 late Bath.-early Call. to late

Bath.-early Call.
< 18 {TM 164.06}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 17 {TM 163.05}: UAZ. 6-6 middle Bath. to middle Bath.
< 16 {TM 109.25}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 15 {TM 105.50 = To 170}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 14 {TM 90.32}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 13 {RTT 140}: UAZ. 2-3 late Aal. to early-middle Baj.
< 12 {TM 64.74 = To 130}: UAZ. 2-2 late Aal. to late Aal.
< 11 {RTT 116}: UAZ. 2-2 late Aal. to late Aal.
< 10 {TM 51.44}: UAZ. 2-2 late Aal. to late Aal.
< 9 {T 115}: UAZ. 2-2 late Aal. to late Aal.
< 8 {T 113}: UAZ. 2-2 late Aal. to late Aal.
< 7 {TM 48.35 = To 112}: UAZ. 2-2 late Aal. to late Aal.
< 6 {T 106}: UAZ. 1-2 early-middle Aal. to late Aal.
< 5 {TM 40.15 = To 104}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 4 {T 96}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 3 {TM 29.52}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 2 {TM 25.15}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {RTT 74.5}: UAZ. 1-1 early-middle Aal. to early-middle Aal.

SECTION COLLE_BERTONE
< 1 {CB2 45.0}: UAZ. 3-3 early-middle Baj. to early-middle Baj. **≤ Amm, Nann. early Baj. = δ^{13}C: early Baj.**

Chapter 16: Jurassic radiolarians from the Campofiorito and Peloritan zones, Sicily (Italy) by N. Kito and P. De Wever

SECTION KI1_GALATI
< 9 {S58}: UAZ. 4-6 late Baj. to middle Bath.
< 8 {S57}: UAZ. 6-8 middle Bath. to middle Call.-early Oxf.
< 7 {S59}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 6 {S63}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 5 {S64}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 4 {S66}: UAZ. 4-4 late Baj. to late Baj.
< 3 {S68}: UAZ. 4-4 late Baj. to late Baj.
< 2 {S69}: UAZ. 4-4 late Baj. to late Baj.
< 1 {S70}: UAZ. 4-4 late Baj. to late Baj.

SECTION KI2_CONTRADA_LA_FERTA
< 9 {S34}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 8 {S33}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 7 {S32}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.
< 6 {S31}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 5 {S30}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 4 {S29}: UAZ. 4-4 late Baj. to late Baj.
< 3 {S28}: UAZ. 4-4 late Baj. to late Baj.
< 2 {S27}: UAZ. 4-4 late Baj. to late Baj.
< 1 {S25}: UAZ. 4-4 late Baj. to late Baj.

Chapter17: Radiolarians from the Sciacca Zone, Santa Anna, Sicily (Italy) by P. De Wever

SECTION DW1_SANTA_ANNA_SICILY
< 10 {sa94}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 9 {sa96}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 8 {sa104}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 7 {sa105}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 6 {sa106}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 5 {sa107}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {sa108}: UAZ. 10-10 late Oxf.-early Kimm. to late Oxf.-early Kimm.
< 3 {sa109}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 2 {sa110}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 1 {sa111}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.

Chapter 18: Middle Jurassic-Early Cretaceous radiolarians biochronology of the Budva Zone by S. Gorican

SECTION 2_VERIGE
< 5 {Ve 10}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 4 {Ve 9}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 3 {Ve 8}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 2 {Ve 7}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 1 {Ve 6}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION 3_1_BIJELA_I
< 7 {Bj 15}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 6 {Bj 14}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 5 {Bj 13}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 4 {Bj 12}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 3 {Bj 11}: UAZ. 3-5 early-middle Baj. to latest Baj.-early Bath.
< 2 {Bj 10}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 1 {Bj 9}: UAZ. 2-3 late Aal. to early-middle Baj.

SECTION 3_2_BIJELA_II
< 2 {Bj 15/2}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 1 {Bj 15/1}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

SECTION 3_3_BIJELA_III_IV
< 3 {Bj 17}: UAZ. 17-17 late Val. to late Val.
< 2 {BjIII 3.00}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 1 {BjIII 0.40}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

SECTION 4_GORNJA_LASTVA
< 20 {GL 214}: UAZ. 17-17 late Val. to late Val.
< 19 {GL 142}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 18 {GL 139}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.
< 17 {GL 138}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 16 {GL 137}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 15 {GL 210}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 14 {GL 209+6.60}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 13 {GL 209}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 12 {GL 208+1.00}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 11 {GL 208}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 10 {GL 207}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 9 {GL 135}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 8 {GL 134}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 7 {GL 6}: UAZ. 4-4 late Baj. to late Baj.
< 6 {GL 132}: UAZ. 4-4 late Baj. to late Baj.
< 5 {ZB 28}: UAZ. 4-4 late Baj. to late Baj.
< 4 {GL 128}: UAZ. 3-4 early-middle Baj. to late Baj.
< 3 {GL 127}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 2 {GL 125}: UAZ. 2-3 late Aal. to early-middle Baj.
< 1 {GL 123}: UAZ. 2-2 late Aal. to late Aal. ≤ **Gutnicella Aal. early Baj**.

SECTION 6_PETROVAC
< 3 {PK 7}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 2 {PK 9}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {PK 12}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

SECTION 7_CANJ
< 18 {UPC 30}: UAZ. 17-17 late Val. to late Val.
< 17 {UPC 29}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 16 {UPC 28}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 15 {UPC 27}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 14 {UPC 26}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 13 {UPC 25}: UAZ. 12-12 early-early late Tith. to early-early late Tith.
< 12 {UPC 262.70}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 11 {UPC 257.10}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 10 {UPC 251.50}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.
< 9 {UPC 23}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 8 {UPC 22}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 7 {UPC 21}: UAZ. 8-8 middle Call.-early Oxf. to middle Call.-early Oxf.
< 6 {UPC 20}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 5 {UPC 18}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 4 {UPC 16}: UAZ. 3-4 early-middle Baj. to late Baj.
< 3 {UPC 15}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 2 {UPC 14}: UAZ. 2-3 late Aal. to early-middle Baj.
< 1 {UPC 13}: UAZ. 2-3 late Aal. to early-middle Baj.

SECTION 8_DIN_VRH

< 8 {DIN 31.50}: UAZ. 17-17 late Val. to late Val.

< 7 {DIN 29.30}: UAZ. 13-13 latest Tith.-earliest Berr. to latest Tith.-earliest Berr.

< 6 {DIN 24.30}: UAZ. 12-12 early-early late Tith. to early-early late Tith.

< 5 {DIN 11.55}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.

< 4 {DIN 7.00}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 3 {DIN 4.50}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

< 2 {DIN 2.35}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.

< 1 {DIN 1.50}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm.

SECTION 10_BAR

< 9 {BM 478.60}: UAZ. 17-17 late Val. to late Val.

< 8 {BM 469.00}: UAZ. 17-17 late Val. to late Val.

< 7 {BM 466.40}: UAZ. 17-17 late Val. to late Val.

< 6 {BM 8}: UAZ. 12-12 early-early late Tith. to early-early late Tith.

< 5 {BM 7}: UAZ. 12-12 early-early late Tith. to early-early late Tith.

< 4 {BM 6}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 3 {BM 5}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.

< 2 {BM 106}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 1 {BM 102}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

Chapter 19: Middle to Upper Jurassic Radiolarian Ionian & Maliac Zones (Greece) by T. Danelian

SECTION *TD1_ANO_KOUKLESSI

< 2 {587}: UAZ. 13-20 latest Tith.-earliest Berr. to late Haut.

< 1 {ASAX-4}: UAZ. 3-7 early-middle Baj. to late Bath.-early Call.

SECTION *TD2_KATO_KOUKLESSI

< 5 {ASB1-7}: UAZ. 13-14 latest Tith.-earliest Berr. to early-early late Berr.

< 4 {ASB1-6}: UAZ. 10-17 late Oxf.-early Kimm. to late Val.

< 3 {ASB1-4}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

< 2 {ASB1-3}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

< 1 {ASB1-1}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

SECTION *TD3_VATHY

< 1 {3A}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

SECTION *TD4_KHIONISTRA

< 1 {BSA4-1}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.

SECTION *TD5_PALIAMBELA

< 5 {BSB-15}: UAZ. 9- 18 middle-late Oxf. to latest Val.-earliest Haut.

< 4 {BSB-11}: UAZ. 4-12 late Baj. to early-early late Tith.

< 3 {BSB-10}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

< 2 {BB9-7,7}: UAZ. 7- 12 late Bath.-early Call. to early-early late Tith.

< 1 {BB5-1,3}: UAZ. 9-8 middle-late Oxf. to middle Call.-early Oxf.

SECTION *TD7_SKANDHALON

< 15 {CSA10-1}: UAZ. 10-15 late Oxf.-early Kimm. to late Berr.-earliest Val.

< 14 {CSA9-6}: UAZ. 10-15 late Oxf.-early Kimm. to late Berr.-earliest Val.

< 13 {CSA9-4}: UAZ. 9-12 middle-late Oxf. to early-early late Tith.

< 12 {CSA9-3}: UAZ. 9-12 middle-late Oxf. to early-early late Tith.

< 11 {CSA9-2}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.

< 10 {CSA9-1}: UAZ. 10-12 late Oxf.-early Kimm. to early-early late Tith.

< 9 {CSA8-1}: UAZ. 9-12 middle-late Oxf. to early-early late Tith.

< 8 {CSA7-1}: UAZ. 9-12 middle-late Oxf. to early-early late Tith.

< 7 {CSA6-2}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.

< 6 {CSA6-1}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

< 5 {CSA4-2}: UAZ. 4-12 late Baj. to early-early late Tith.

< 4 {CSA4-1}: UAZ. 4-10 late Baj. to late Oxf.-early Kimm.

< 3 {CSA3-5}: UAZ. 4-9 late Baj. to middle-late Oxf.

< 2 {CSA3-2}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.

< 1 {CSA3-1}: UAZ. 5- 5 latest Baj.-early Bath. to latest Baj.-early Bath.

SECTION *TD8_TSIBOURIKI

< 10 {TD 84-91}: UAZ. 5-11 latest Baj.-early Bath. to late Kimm.-early Tith.

< 9 {TD 84-90}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 8 {TD 84-88}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.

< 7 {TD 84-87}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

< 6 {TD 84-86}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.

< 5 {TD 84-83}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 4 {TD 84-81}: UAZ. 4-6 late Baj. to middle Bath.
< 3 {TD 84-79}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 2 {TD 84-78}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 1 {TD 84-73}: UAZ. 2-8 late Aal. to middle Call.-early Oxf.

SECTION *MIGDALIA
< 6 {TD93-21}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 5 {TD93-19}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 4 {TD93-16}: UAZ. 5- 7 latest Baj.-early Bath. to late Bath.-early Call.
< 3 {TD92-14}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 2 {TD93-13}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.
< 1 {TD93-12}: UAZ. 6-7 middle Bath. to late Bath.-early Call.

Chapter 20: Radiolarians overlying ophiolites of the Almopias domain (Macedonia, Greece) by P. De Wever

SECTION *DW7_GRECE_ALMOPIAS_UNIVRI
< 1 {ALM1}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

SECTION *DW8_GRECE_ALMOPIAS_UNIVRI
< 1 {ALM2}: UAZ. 6-12 middle Bath. to early-early late Tith.

Chapter 21: Radiolarians from the Pindos Olonos Zone (Greece): Bajocian (?) to Tithonian by P. De Wever and F. Cordey

SECTION *DW9_GRECE_PINDE_OLONOS_CO
< 4 {fc19}: UAZ. 4-8 late Baj. to middle Call.-early Oxf.
< 3 {fc10}: UAZ. 3-7 early-middle Baj. to late Bath.-early Call.
< 2 {fc5}: UAZ. 3-4 early-middle Baj. to late Baj.
< 1 {fc3}: UAZ. 1-7 early-middle Aal. to late Bath.-early Call.

SECTION *DW1O_GRECE_PINDE_OLONOS_COUPE_B
< 2 {fc47}: UAZ. 4-11 late Baj. to late Kimm.-early Tith.
< 1 {fc35}: UAZ. 3-7 early-middle Baj. to late Bath.-early Call.

SECTION *DW14_GRECE_PINDE_OLONOS_COUPE_C1
< 5 {fc144}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {id93}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 3 {fc133}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 2 {fc127}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 1 {fc121}: UAZ. 6-7 middle Bath. to late Bath.-early Call.

SECTION *DW13_GRECE_PINDE_OLONOS_COUPE_C2
< 3 {id99}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.
< 2 {id98}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 1 {id96}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.

SECTION *DW11_GRECE_PINDE_OLONOS_COUPE_D
< 1 {id214}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

SECTION *DW12_GRECE_PINDE_OLONOS_COUPE_E
< 2 {id192}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 1 {id200}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

Chapter 22: Upper Jurassic radiolarites in the Pieniny Klippen Belt, Carpathians by K. Birkenmayer and D. Widz

SECTION *WI1_CZ_SKALA
< 4 {2/15}: UAZ. 8-9 middle Call.-early Oxf. to middle-late Oxf.
< 3 {2/11}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {2/9-10}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 1 {2/2}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

SECTION *WI2_PODMAJ
< 5 {1/34}: UAZ. 8-11 middle Call.-early Oxf. to late

Kimm.-early Tith.
< 4 {1/37}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 3 {1/39-40}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 2 {1/45}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 1 {1/57}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.

SECTION *WI3_SZAFL
< 21 {4/79}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 20 {4/74}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 19 {4/71}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.
< 18 {4/69}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 17 {4/64}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 16 {4/62}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 15 {4/60}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 14 {4/54}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 13 {4/53}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 12 {4/52}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 11 {4/49-50}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 10 {4/44}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 9 {4/39}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 8 {4/37}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 7 {4/35}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 6 {4/34}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 5 {4/33}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {4/26}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 3 {4/16}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 2 {4/3}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 1 {4/1}: UAZ. 9-9 middle-late Oxf. to middle-late Oxf.

SECTION *WI4_SZCZWYZ
< 13 {3/11-13}: UAZ. 9-11-13 middle-late Oxf. to late Kimm.-early Tith.
< 12 {3/21-23}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 11 {3/27}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 10 {3/29-31}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 9 {3/33}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 8 {3/34}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 7 {3/36}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 6 {3/39}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 5 {3/40}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 4 {3/41}: UAZ. 9-10 middle-late Oxf. to late Oxf.-early Kimm.
< 3 {3/43}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 2 {3/44}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.
< 1 {3/47}: UAZ. 8-10 middle Call.-early Oxf. to late Oxf.-early Kimm.

Chapter 23: Upper Jurassic and Lower Cretaceous radiolarians at Svinita, Romania by P. Dumitrica

SECTION *DU1_SVINITA
< 28 {Mo.54}: UAZ. 18- 19 latest Val.-earliest Haut. to early Haut.
< 27 {Mo.52}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 26 {Mo.146}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 25 {Mo.45}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 24 {Mo.44}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 23 {Mo.43}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 22 {Mo.42}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 21 {Mo.41}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 20 {Mo.39}: UAZ. 17- 18 late Val. to latest Val.-earliest Haut.
< 19 {Mo.38}: UAZ. 16- 18 early Val. to latest Val.-earliest Haut.
< 18 {Mo.37}: UAZ. 16- 18 early Val. to latest Val.-earliest Haut.
< 17 {Mo.36}: UAZ. 16- 18 early Val. to latest Val.-earliest Haut.
< 16 {Mo.35.5}: UAZ. 16- 17 early Val. to late Val.
< 15 {Mo.34}: UAZ. 16- 17 early Val. to late Val.
< 14 {Mo.33}: UAZ. 16- 17 early Val. to late Val.
< 13 {Mo.29}: UAZ. 16- 17 early Val. to late Val.
< 12 {Mo.27}: UAZ. 16- 17 early Val. to late Val.

< 11 {Mo.26}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 10 {Mo.25}: UAZ. 13- 14 latest Tith.-earliest Berr. to early-early late Berr.
< 9 {Mo.24}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 8 {Mo.23}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 7 {Mo.22}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 6 {Mo.21}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 5 {Mo.20}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 4 {Mo.19}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 3 {Mo.18}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 2 {Mo.17}: UAZ. 13- 15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 1 {Mo.16.5}: UAZ. 13- 16 latest Tith.-earliest Berr. to early Val.

Chapter 24: Biostratigraphy of the Radiolarites at Pojorita (Rarau Syncline, East Carpathians) by P. Dumitrica

SECTION *DU2_POJORITA
< 20 {PJ25}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm. **> Amm. early Kimm.**
< 19 {PJ24}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 18 {PJ23}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 17 {PJ22}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 16 {PJ21}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 15 {PJ20}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 14 {PJl9}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 13 {PJ18}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 12 {PJ17}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 11 {PJ16}: UAZ. 9- 10 middle-late Oxf. to late Oxf.-early Kimm.
< 10 {PJ15}: UAZ. 8- 9 middle Call.-early Oxf. to middle-late Oxf.
< 9 {PJ14}: UAZ. 7- 8 late Bath.-early Call. to middle Call.-early Oxf.
< 8 {PJ13}: UAZ. 7- 8 late Bath.-early Call. to middle Call.-early Oxf.
< 7 {PJ12}: UAZ. 7- 8 late Bath.-early Call. to middle Call.-early Oxf.
< 6 {PJll}: UAZ. 7- 8 late Bath.-early Call. to middle Call.-early Oxf.
< 5 {PJ10}: UAZ. 7- 7 late Bath.-early Call. to late Bath.-early Call.
< 4 {PJ 9}: UAZ. 7- 7 late Bath.-early Call. to late Bath.-early Call.
< 3 {PJ. 8}: UAZ. 7- 7 late Bath.-early Call. to late Bath.-early Call.
< 2 {PJ. 7}: UAZ. 7- 7 late Bath.-early Call. to late Bath.-early Call.
< 1 {PJ. 6}: UAZ. 7- 7 late Bath.-early Call. to late Bath.-early Call. **< Amm ?. late Bath.-early Call.**

Chapter 26: Upper Jurassic to Lower Cretaceous stratigraphy of Hokkaido, Japan by N. Kito

SECTION *KI3_20_RINPAN
< 7 {82090101}: UAZ. 12-22 early-early late Tith. to late Barr.-early Apt.
< 6 {82090112}: UAZ. 11-22 late Kimm.-early Tith. to late Barr.-early Apt.
< 5 {82090111}: UAZ. 11-22 late Kimm.-early Tith. to late Barr.-early Apt.
< 4 {82090110}: UAZ. 11-13 late Kimm.-early Tith. to latest Tith.-earliest Berr.
< 3 {82090109}: UAZ. 11-15 late Kimm.-early Tith. to late Berr.-earliest Val.
< 2 {82090108}: UAZ. 11-22 late Kimm.-early Tith. to late Barr.-early Apt.
< 1 {82090104}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.

SECTION *KI4_SOASHIBETSUKITA
< 7 {90090405}: UAZ. 13-22 latest Tith.-earliest Berr. to late Barr.-early Apt.
< 6 {90090407}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 5 {90090409}: UAZ. 13-21 latest Tith.-earliest Berr. to early Barr.
< 4 {90090410}: UAZ. 13-22 latest Tith.-earliest Berr. to late Barr.-early Apt.
< 3 {90090411}: UAZ. 16-18 early Val. to latest Val.-earliest Haut.
< 2 {90090412}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 1 {90090413}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.

SECTION ∗KI5_ASHIBETSU
< 13 {90090701}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 12 {90090703}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 11 {90090704}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 10 {90090705}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 9 {90090706}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 8 {90090707}: UAZ. 16-18 early Val. to latest Val.-earliest Haut.
< 7 {90090708}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 6 {90090709}: UAZ. 16-17 early Val. to late Val.
< 5 {90090710}: UAZ. 16-17 early Val. to late Val.
< 4 {90090711}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.
< 3 {90090712}: UAZ. 13-15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 2 {90090716}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 1 {90090717}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.

SECTION ∗KI6_SOASGIBETSU
< 9 {89081002}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 8 {90090505}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 7 {89081006}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.
< 6 {89081007}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 5 {89081010}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 4 {89081009}: UAZ. 13-18 latest Tith.-earliest Berr. to latest Val.-earliest Haut.
< 3 {89081008}: UAZ. 12-21 early-early late Tith. to early Barr.
< 2 {90090510}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 1 {90090509}: UAZ. 13-17 latest Tith.-earliest Berr. to late Val.

SECTION ∗KI7_SHUPARO
< 28 {82073022}: UAZ. 12-17 early-early late Tith. to late Val.
< 27 {82073019}: UAZ. 12-17 early-early late Tith. to late Val.
< 26 {82073016}: UAZ. 12-17 early-early late Tith. to late Val.
< 25 {82073015}: UAZ. 12-17 early-early late Tith. to late Val.
< 24 {82073013}: UAZ. 14-17 early-early late Berr. to late Val.
< 23 {82073011}: UAZ. 12-17 early-early late Tith. to late Val.
< 22 {82073010}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 21 {82072803}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 20 {82072804}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 19 {82072805}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 18 {82072807}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 17 {82072808}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 16 {82072809}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 15 {82072810}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 14 {82072814}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 13 {82072816}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 12 {82072817}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 11 {82072818}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 10 {82072819}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 9 {82072820}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 8 {82072821}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 7 {82072822}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 6 {82072823}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 5 {82072824}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 4 {82072825}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 3 {82072826}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 2 {LJ37}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 1 {82072838}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.

SECTION ∗KI8_YUFURE
< 5 {82090403}: UAZ. 12-17 early-early late Tith. to late Val.
< 4 {82090404}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 3 {82090405}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 2 {82090406}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.
< 1 {82090407}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.

SECTION ∗KI9_FUKINOSAWA
< 3 {82090312}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 2 {82090316}: UAZ. 13-14 latest Tith.-earliest Berr. to

early-early late Berr.
< 1 {82090315}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.

SECTION ∗KI10_NIJUGOSEN
< 6 {82090920}: UAZ. 13-21 latest Tith.-earliest Berr. to early Barr.
< 5 {82090318}: UAZ. 13-21 latest Tith.-earliest Berr. to early Barr.
< 4 {82090317}: UAZ. 13-21 latest Tith.-earliest Berr. to early Barr.
< 3 {81062901}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 2 {81062902}: UAZ. 12-14 early-early late Tith. to early-early late Berr.
< 1 {82052601}: UAZ. 12-21 early-early late Tith. to early Barr.

SECTION ∗KI11_SHUPARO1
< 1 {82073012}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.

SECTION ∗KI12_NUNOBE
< 1 {81062827}: UAZ. 14-15 early-early late Berr. to late Berr.-earliest Val.

SECTION ∗KI13_NAE
< 4 {81071309}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 3 {81071310}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 2 {81071317}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 1 {81072501}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.

SECTION ∗KI14_SATOZAWA
< 9 {81071802}: UAZ. 11-22 late Kimm.-early Tith. to late Barr.-early Apt.
< 8 {81071803}: UAZ. 12-17 early-early late Tith. to late Val.
< 7 {81071806}: UAZ. 12-17 early-early late Tith. to late Val.
< 6 {81071807}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 5 {81071811}: UAZ. 12-17 early-early late Tith. to late Val.
< 4 {81071812}: UAZ. 12-17 early-early late Tith. to late Val.
< 3 {81071813}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.
< 2 {81071824}: UAZ. 11-18 late Kimm.-early Tith. to latest Val.-earliest Haut.
< 1 {81071836}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.

SECTION ∗KI15_PENKE
< 8 {81072408}: UAZ. 12-22 early-early late Tith. to late Barr.-early Apt.
< 7 {81072410}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 6 {81072412}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 5 {81072413}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 4 {81072417}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 3 {81072420}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 2 {81072423}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 1 {81072425}: UAZ. 12-13 early-early late Tith. to latest Tith.-earliest Berr.

SECTION ∗KI16_PANKE1
< 5 {81082801}: UAZ. 12-17 early-early late Tith. to late Val.
< 4 {81082802}: UAZ. 12-17 early-early late Tith. to late Val.
< 3 {81082805}: UAZ. 12-17 early-early late Tith. to late Val.
< 2 {81082806}: UAZ. 12-17 early-early late Tith. to late Val.
< 1 {81082812}: UAZ. 12-17 early-early late Tith. to late Val.

SECTION ∗KI17_PANKE2
< 2 {81083103}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 1 {81083104}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.

SECTION ∗KI18_HORIMOTO
< 5 {81090701}: UAZ. 11-17 late Kimm.-early Tith. to late Val.
< 4 {81090702}: UAZ. 11-20 late Kimm.-early Tith. to late Haut.
< 3 {81090704}: UAZ. 11-22 late Kimm.-early Tith. to late Barr.-early Apt.
< 2 {81082904}: UAZ. 12-18 early-early late Tith. to latest Val.-earliest Haut.
< 1 {81082906}: UAZ. 11-13 late Kimm.-early Tith. to latest Tith.-earliest Berr.

SECTION ∗KI19_SAKUGAWA
< 8 {82092805}: UAZ. 12-22 early-early late Tith. to late Barr.-early Apt.
< 7 {82092808}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 6 {82092806}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 5 {82092811}: UAZ. 13-15 latest Tith.-earliest Berr. to late Berr.-earliest Val.
< 4 {82092813}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 3 {82092816}: UAZ. 12-15 early-early late Tith. to late Berr.-earliest Val.
< 2 {82092817}: UAZ. 11-15 late Kimm.-early Tith. to late Berr.-earliest Val.
< 1 {82092819}: UAZ. 3-18 early-middle Baj. to latest Val.-earliest Haut.

Chapter 27: Middle Jurassic to Early Cretaceous radiolarian (Japan -Western Pacific) by A. Matsuoka

SECTION MA1_LEG129_SITE_800A

< 18 {51R-1-30-31}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.

< 17 {51R-CC}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.

< 16 {52R-1- 57-59}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.

< 15 {52R-2- 49-51}: UAZ. 18-21 latest Val.-earliest Haut. to early Barr.

< 14 {52R-CC}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.

< 13 {53R-1- 53-55}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.

< 12 {53R-2- 17-19}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.

< 11 {53R-CC}: UAZ. 18-18 latest Val.-earliest Haut. to latest Val.-earliest Haut.

< 10 {54R-1- 54-56}: UAZ. 17-18 late Val. to latest Val.-earliest Haut.

< 9 {54R-1- 140-142}: UAZ. 17-17 late Val. to late Val.

< 8 {54R-2- 50-52}: UAZ. 17-17 late Val. to late Val.

< 7 {54R-2- 98-100}: UAZ. 17-17 late Val. to late Val.

< 6 {54R-CC}: UAZ. 17-17 late Val. to late Val.

< 5 {55R-1- 70-72}: UAZ. 17-17 late Val. to late Val.

< 4 {55R-1- 137-139}: UAZ. 17-17 late Val. to late Val.

< 3 {55R-2- 44-46}: UAZ. 17-17 late Val. to late Val.

< 2 {55R-2- 133-135}: UAZ. 17-18 late Val. to latest Val.-earliest Haut.

< 1 {55R-CC}: UAZ. 17-20 late Val. to late Haut.

SECTION MA2_LEG129_SITE_801B

< 59 {14R-CC}: UAZ. 17-21 late Val. to early Barr.

< 58 {15R-1- 23-25}: UAZ. 17-21 late Val. to early Barr.

< 57 {16R-1- 9-11}: UAZ. 17-21 late Val. to early Barr.

< 56 {16R-1- 32-34}: UAZ. 17-21 late Val. to early Barr.

< 55 {16R-1- 37-39}: UAZ. 17-21 late Val. to early Barr.

< 54 {16R-CC}: UAZ. 17-21 late Val. to early Barr.

< 53 {17R-1- 22-25}: UAZ. 17-20 late Val. to late Haut.

< 52 {17R-CC}: UAZ. 17-21 late Val. to early Barr.

< 51 {18R-1- 7-9}: UAZ. 17-20 late Val. to late Haut.

< 50 {18R-1- 34-36}: UAZ. 17-20 late Val. to late Haut.

< 49 {18R-CC}: UAZ. 17-17 late Val. to late Val.

< 48 {19R-CC}: UAZ. 11-20 late Kimm.-early Tith. to late Haut.

< 47 {20R-1- 7-9}: UAZ. 11-12 late Kimm.-early Tith. to early-early late Tith.

< 46 {20R-1- 16-18}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.

< 45 {20R-CC}: UAZ. 11-11 late Kimm.-early Tith. to late Kimm.-early Tith.

< 44 {21R-1- 1-3}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 43 {21R-1- 13-15}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 42 {21R-CC}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 41 {22R-CC- 0-2}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 40 {22R-CC}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 39 {23R-CC- 7-9}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 38 {23R-CC- 14-16}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 37 {23R-CC}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 36 {24R-1- 22-23}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 35 {24R-1- 66-68}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 34 {24R-CC}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 33 {25R-1- 10-12}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 32 {25R-1- 32-35}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 31 {25R-1- 65-68}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 30 {25R-CC}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.

< 29 {26R-CC- 11-13}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

< 28 {26R-CC}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

< 27 {27R-1- 99-101}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

< 26 {27R-CC}: UAZ. 8-11 middle Call.-early Oxf. to late Kimm.-early Tith.

< 25 {28R-1- 6-7}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm.

< 24 {28R-CC}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 23 {29R-1- 16-17}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 22 {29R-CC}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 21 {30R-1- 1-2}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 20 {30R-1- 12-14}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 19 {30R-CC}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 18 {31R-1- 1-3}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.

< 17 {31R-1- 21-22}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 16 {31R-CC}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 15 {32R-CC}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

< 14 {33R-1- 8-10}: UAZ. 5-7 latest Baj.-early Bath. to late Bath.-early Call.

< 13 {33R-1- 131-133}: UAZ. 6-7 middle Bath. to late Bath.-early Call.

< 12 {33R-2- 14-17}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 11 {33R-CC}: UAZ. 6-6 middle Bath. to middle Bath.
< 10 {34R-1- 15-17}: UAZ. 6-6 middle Bath. to middle Bath.
< 9 {34R-CC}: UAZ. 6-6 middle Bath. to middle Bath.
< 8 {35R-1- 43-45}: UAZ. 6-6 middle Bath. to middle Bath.
< 7 {35R-1- 76-80}: UAZ. 6-6 middle Bath. to middle Bath.
< 6 {35R-2- 95-98}: UAZ. 6-6 middle Bath. to middle Bath.
< 5 {35R-2- 138-140}: UAZ. 6-6 middle Bath. to middle Bath.
< 4 {35R-3- 24-26}: UAZ. 6-6 middle Bath. to middle Bath.
< 3 {35R-CC}: UAZ. 6-6 middle Bath. to middle Bath.
< 2 {36R-CC}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 1 {37R-1- 16-20}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.

SECTION MA3_OYASHIKI_1
< 13 {M-64}: UAZ. 6-6 middle Bath. to middle Bath.
< 12 {M-63}: UAZ. 6-6 middle Bath. to middle Bath.
< 11 {M-61}: UAZ. 4-6 late Baj. to middle Bath.
< 10 {M-60}: UAZ. 4-6 late Baj. to middle Bath.
< 9 {M-57}: UAZ. 4-6 late Baj. to middle Bath.
< 8 {M-55}: UAZ. 4-6 late Baj. to middle Bath.
< 7 {M-54.5}: UAZ. 4-6 late Baj. to middle Bath.
< 6 {M-54}: UAZ. 4-6 late Baj. to middle Bath.
< 5 {M-53.5}: UAZ. 4-6 late Baj. to middle Bath.
< 4 {M-53}: UAZ. 4-6 late Baj. to middle Bath.
< 3 {M-52.5}: UAZ. 4-6 late Baj. to middle Bath.
< 2 {M-52}: UAZ. 4-4 late Baj. to late Baj.
< 1 {M-50}: UAZ. 3-4 early-middle Baj. to late Baj.

SECTION MA4_SHIRAISHIGAWA_1
< 25 {S-25}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 24 {S-24}: UAZ. 6-6 middle Bath. to middle Bath.
< 23 {S-21}: UAZ. 6-6 middle Bath. to middle Bath.
< 22 {S-20}: UAZ. 6-6 middle Bath. to middle Bath.
< 21 {S-18}: UAZ. 6-6 middle Bath. to middle Bath.
< 20 {S-17}: UAZ. 6-6 middle Bath. to middle Bath.
< 19 {S-15}: UAZ. 6-6 middle Bath. to middle Bath.
< 18 {S-14.6}: UAZ. 6-6 middle Bath. to middle Bath.
< 17 {S-14}: UAZ. 6-6 middle Bath. to middle Bath.
< 16 {S-13.5}: UAZ. 6-6 middle Bath. to middle Bath.
< 15 {S-13}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 14 {S-12}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 13 {S-10}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 12 {S-8}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 11 {S-6}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 10 {S-3}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 9 {S-2}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 8 {S-1}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 7 {IX-1403}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 6 {T-15}: UAZ. 4-6 late Baj. to middle Bath.
< 5 {T-11}: UAZ. 4-6 late Baj. to middle Bath.
< 4 {T-8}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 3 {T-5}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 2 {XI-1404}: UAZ. 3-4 early-middle Baj. to late Baj.
< 1 {T-01}: UAZ. 3-4 early-middle Baj. to late Baj.

SECTION MA5_YANASEGAWA_1
< 8 {Z-40}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 7 {Z-36}: UAZ. 6-6 middle Bath. to middle Bath.
< 6 {Y-07}: UAZ. 6-6 middle Bath. to middle Bath.
< 5 {Z-32}: UAZ. 6-6 middle Bath. to middle Bath.
< 4 {Z-27.5}: UAZ. 6-6 middle Bath. to middle Bath.
< 3 {Z-22}: UAZ. 4-6 late Baj. to middle Bath.
< 2 {XI-1800}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 1 {Z-20.2}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

SECTION MA6_YANASEGAWA_2
< 16 {VII-3110}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 15 {VII-3109}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 14 {VII-2922}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 13 {VII-2921}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 12 {VII-3108}: UAZ. 6-6 middle Bath. to middle Bath.
< 11 {VII-2919}: UAZ. 6-6 middle Bath. to middle Bath.
< 10 {VII-3107}: UAZ. 6-6 middle Bath. to middle Bath.
< 9 {VII-2917}: UAZ. 6-6 middle Bath. to middle Bath.
< 8 {VII-1522}: UAZ. 6-6 middle Bath. to middle Bath.
< 7 {VII-2912}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 6 {VII-2911}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 5 {VII-3104}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 4 {VII-2910}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 3 {VII-2909}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 2 {VII-3103}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 1 {VII-3102}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.

SECTION MA7_YANASEGAWA_3
< 10 {P-3}: UAZ. 4-7 late Baj. to late Bath.-early Call.
< 9 {P-3.5}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 8 {P-5.5}: UAZ. 6-6 middle Bath. to middle Bath.
< 7 {P-6}: UAZ. 6-6 middle Bath. to middle Bath.
< 6 {P-7}: UAZ. 6-6 middle Bath. to middle Bath.
< 5 {P-11}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 4 {P-13}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 3 {P-16}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 2 {P-18}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 1 {P-21}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.

SECTION MA8_KAWANOUCHI_1

< 14 {12-0702}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm.
< 13 {12-0701}: UAZ. 7-10 late Bath.-early Call. to late Oxf.-early Kimm.
< 12 {17-0302}: UAZ. 7-8 late Bath.-early Call. to middle Call.-early Oxf.
< 11 {11-0909}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.
< 10 {17-0301}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 9 {11-0905}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 8 {11-0906}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 7 {11-0908}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 6 {17-0304}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 5 {17-0303}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 4 {18-2701}: UAZ. 6-7 middle Bath. to late Bath.-early Call.
< 3 {12-0704}: UAZ. 6-6 middle Bath. to middle Bath.
< 2 {12-0705}: UAZ. 6-6 middle Bath. to middle Bath.
< 1 {12-0706}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.

SECTION MA9_KASHIBARA

< 35 {MKS-27}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 34 {MKS-26}: UAZ. 6-6 middle Bath. to middle Bath.
< 33 {MKS-25}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 32 {MKS-23}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 31 {MKS-21}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 30 {MKS-19}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 29 {MKS-18}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 28 {MKS-17}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 27 {MKS-16}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 26 {MKS-15}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 25 {MKS-14}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 24 {MKS-13}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 23 {MKS-12}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 22 {MKS-11}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 21 {MKS-10.5}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 20 {MKS-10}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 19 {MKS-9.5b}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 18 {MKS-9b}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 17 {MKS-8b}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 16 {MKS-7b}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 15 {MKS-6b}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 14 {MKS-9.5a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 13 {MKS-8a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 12 {MKS-7.5a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 11 {MKS-7a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 10 {MKS-6a}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 9 {MKS-5}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 8 {MKS-4}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 7 {MKS-3}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 6 {MKS-2}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 5 {MKS-1}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 4 {MKS-0}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 3 {MKS-Z}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 2 {MKS-Y}: UAZ. 4-4 late Baj. to late Baj.
< 1 {MKS-X}: UAZ. 4-4 late Baj. to late Baj.

SECTION MA10_HISUIKYO

< 12 {MHS-}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 11 {MHS-C}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 10 {MHS-B}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 9 {MHS-A}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 8 {MHS-13.8}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 7 {MHS-12}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 6 {MHS-10}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 5 {MHS-08}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 4 {MHS-06}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 3 {MHS-04}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 2 {MHS-02}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 1 {MHS-00}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.

SECTION MA11_INUYAMA_CH1A

< 1 {MIN-1}: UAZ. 4-4 late Baj. to late Baj.

SECTION MA12_KOMAMI

< 1 {MKM-1, compl.POB7/95$}: UAZ. 3-3 early-middle Baj. to early-middle Baj.

Chapter 28: Middle Jurassic manganese nodules of the Inuyama area, Japan by A. Yao and P.O. Baumgartner

SECTION POB40_IN_UNUMA
< 2: UAZ. 4-4 late Baj. to late Baj.
< 1: UAZ. 3-3 early-middle Baj. to early-middle Baj.

SECTION HK_UNUMA
< 1: UAZ. 3-3 early-middle Baj. to early-middle Baj.

SECTION RH1_KS
< 15 {KS 20}: UAZ. 2-3 late Aal. to early-middle Baj.
< 14 {KS 19}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 13 {KS 18}: UAZ. 2-2 late Aal. to late Aal.
< 12 {KS 16}: UAZ. 2-2 late Aal. to late Aal.
< 11 {KS 15}: UAZ. 2-2 late Aal. to late Aal.
< 10 {KS 14}: UAZ. 2-2 late Aal. to late Aal.
< 9 {KS 13}: UAZ. 2-2 late Aal. to late Aal.
< 8 {KS 10}: UAZ. 1-2 early-middle Aal. to late Aal.
< 7 {KS 9}: UAZ. 1-4 early-middle Aal. to late Baj.
< 6 {KS 7}: UAZ. 1-4 early-middle Aal. to late Baj.
< 5 {KS 6}: UAZ. 1-4 early-middle Aal. to late Baj.
< 4 {KS 5}: UAZ. 1-4 early-middle Aal. to late Baj.
< 3 {KS 4}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 2 {KS 3}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {KS 2}: UAZ. 1-1 early-middle Aal. to early-middle Aal.

SECTION RH2_UF
< 4 {UF 22}: UAZ. 2-3 late Aal. to early-middle Baj.
< 3 {UF 21}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 2 {UF 20}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {UF 19}: UAZ. 1-4 early-middle Aal. to late Baj.

SECTION RH3_IY
< 14 {IY 24}: UAZ. 2-2 late Aal. to late Aal.
< 13 {IY 23}: UAZ. 1-2 early-middle Aal. to late Aal.
< 12 {IY 22}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 11 {IY 21}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 10 {IY 20}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 9 {IY 19}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 8 {IY 18}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 7 {IY 17}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 6 {IY 16}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 5 {IY 15}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 4 {IY 14}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 3 {IY 13}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 2 {IY 12}: UAZ. 1-4 early-middle Aal. to late Baj.
< 1 {IY 11}: UAZ. 1-4 early-middle Aal. to late Baj.

SECTION RH4_PT
< 8 {PT 8}: UAZ. 2-3 late Aal. to early-middle Baj.
< 7 {PT 7}: UAZ. 1-2 early-middle Aal. to late Aal.
< 6 {PT 6}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 5 {PT 5}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 4 {PT 4}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 3 {PT 3}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 2 {PT 2}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 1 {PT 1}: UAZ. 1-3 early-middle Aal. to early-middle Baj.

SECTION RH5_UC
< 2 {UC 17}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {UC 15}: UAZ. 1-4 early-middle Aal. to late Baj.

SECTION RH6_NKS
< 2 {NK 4}: UAZ. 1-5 early-middle Aal. to latest Baj.-early Bath.
< 1 {NK 3}: UAZ. 1-3 early-middle Aal. to early-middle Baj.

SECTION RH7_KD
< 6 {KD 21}: UAZ. 2-7 late Aal. to late Bath.-early Call.
< 5 {KD 20}: UAZ. 2-3 late Aal. to early-middle Baj.
< 4 {KD 18}: UAZ. 2-3 late Aal. to early-middle Baj.
< 3 {KD 17}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 2 {KD 16}: UAZ. 1-1 early-middle Aal. to early-middle Aal.
< 1 {KD 15}: UAZ. 1-1 early-middle Aal. to early-middle Aal.

Chapter 29: Middle Jurassic (Aalenian-Early Bajocian) radiolarians, Queen Charlotte (Canada)by E.S. Carter

SECTION 12_ESC_COMPOSITE
{ESC_Graham_Island_Branch_Rd_57 lower Bajocian}
< 9 {GSC C-080595}: UAZ. 3-3 early-middle Baj. to early-middle Baj. = **Amm. early Baj.**
< 8 {GSC C-080594}: UAZ. 3-3 early-middle Baj. to early-middle Baj .= **Amm. early Baj.**
< 7 {GSC C-080592}: UAZ. 3-5 early-middle Baj. to latest Baj.-early Bath. = **Amm. early Baj.**
{CA2_ESC_Graham_Island_Yakoun_River_upper Aalenian}
< 6 {GSC C-176578}: UAZ. 1-2 early-middle Aal. to late Aal. = **Amm. late Aal.**
< 5 {GSC C-176580}: UAZ. 1-2 early-middle Aal. to late Aal. = **Amm. late Aal.**
< 4 {GSC C-176577}: UAZ. 2-2 late Aal. to late Aal. = **Amm. late Aal.**
< 3 {GSC C-156399}: UAZ. 2-2 late Aal. to late Aal. = **Amm. late Aal.**
< 2 {GSC C-176579}: UAZ. 2-2 late Aal. to late Aal. = **Amm. late Aal.**
{CA3_ESC_Graham_Island_Branch_Rd_59_lower Aalenian}: = **Amm. late Aal.**

Chapter 30: Stratigraphic Study of Stanley Mountain, California by D.M. Hull and E.A. Pessagno

SECTION *DH_STANLEY_MOUNTAIN_COMPO
< 15 {SM-51. 106.1 m above base. 4 alpha. SECTION 2}: UAZ. 10-17 late Oxf.-early Kimm. to late Val.
< 14 {SM-50. 105.0 m above base. 4 alpha. SECTION 2}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 13 {SM-29. 100.1 m above base. 4 beta. SECTION 2}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 12 {SA-43B. 99.1 m above base. 4 beta. SECTION 1}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 11 {SM-49. 98.9 m above base.4 beta. SECTION 2}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 10 {SM-75. 96.8 m above base. 4 beta. SECTION 3}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 9 {SM-48. 91.3 m above base. 4 beta. SECTION 2}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 8 {SM-69. 86.5 m above base. 4 beta. SECTION 3}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 7 {SM-68. 80.7 m above base. 4 beta SECTION 3}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 6 {SM-67. 80.0 m above base. 3 alpha. SECTION 3}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 5 {SA-35. 79.6 m above base. 3 alpha. SECTION 1}: UAZ. 10-11 late Oxf.-early Kimm. to late Kimm.-early Tith.
< 4 {SM-11. 75.5 m above base. 3 alpha. SECTION 2}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 3 {SA-34. 75.3 m above base. 3 alpha. SECTION 1}: UAZ. 9-11 middle-late Oxf. to late Kimm.-early Tith.
< 2 {NSF 973. 45.6 m above base. 2 beta. SECTION 1}: UAZ. 7-9 late Bath.-early Call. to middle-late Oxf.
< 1 {SM105}: UAZ. 7-7 late Bath.-early Call. to late Bath.-early Call.

Chapter 31: Middle Jurassic Radiolarians in the Franciscan Complex, California by B.L. Murchey and P.O. Baumgartner

SECTION BM_POB1_GEYSERS
< 15 {716}: UAZ. 6-6 middle Bath. to middle Bath.
< 14 {715}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 13 {714}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 12 {713}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 11 {712}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 10 {711}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 9 {710}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 8 {709}: UAZ. 5-5 latest Baj.-early Bath. to latest Baj.-early Bath.
< 7 {708}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 6 {707}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 5 {706}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 4 {705}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 3 {704}: UAZ. 3-4 early-middle Baj. to late Baj.
< 2 {703}: UAZ. 3-3 early-middle Baj. to early-middle Baj.
< 1 {702}: UAZ. 1-2 early-middle Aal. to late Aal.

SECTION BM_MARIN_HEADLANDS
< 12 {16}: UAZ. 5-6 latest Baj.-early Bath. to middle Bath.
< 11 {15}: UAZ. 3-6 early-middle Baj. to middle Bath.
< 10 {14}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 9 {13}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 8 {12B}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 7 {12A}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 6 {11}: UAZ. 3-5 early-middle Baj. to latest Baj.-early Bath.
< 5 {10}: UAZ. 4-5 late Baj. to latest Baj.-early Bath.
< 4 {9}: UAZ. 3-5 early-middle Baj. to latest Baj.-early Bath.
< 3 {8}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 2 {7}: UAZ. 1-3 early-middle Aal. to early-middle Baj.
< 1 { }: UAZ. 1-5 early-middle Aal. to latest Baj.-early Bath.

Chapter 32: SECTION UAZONE95 by P.O. Baumgartner *et al.*

< {UAZ95} 22: UAZ. 22 late Barr.-early Apt.
< {UAZ95} 21: UAZ. 21 early Barr.
< {UAZ95} 20: UAZ. 20 late Haut.
< {UAZ95} 19: UAZ. 19 early Haut.
< {UAZ95} 18: UAZ. 18 latest Val.-earliest Haut.
< {UAZ95} 17: UAZ. 17 late Val.
< {UAZ95} 16: UAZ. 16 early Val.
< {UAZ95} 15: UAZ. 15 late Berr.-earliest Val.
< {UAZ95} 14: UAZ. 14 early-early late Berr.
< {UAZ95} 13: UAZ. 13 latest Tith.-earliest Berr.
< {UAZ95} 12: UAZ. 12 early-early late Tith.
< {UAZ95} 11: UAZ. 11 late Kimm.-early Tith.
< {UAZ95} 10: UAZ. 10 late Oxf.-early Kimm.
< {UAZ95} 9: UAZ. 9 middle-late Oxf.
< {UAZ95} 8: UAZ. 8 middle Call.-early Oxf.
< {UAZ95} 7: UAZ. 7 late Bath.-early Call.
< {UAZ95} 6: UAZ. 6 middle Bath. to middle Bath.
< {UAZ95} 5: UAZ. 5 latest Baj.-early Bath.
< {UAZ95} 4: UAZ. 4 late Baj.
< {UAZ95} 3: UAZ. 3 early-middle Baj.
< {UAZ95} 2: UAZ. 2 late Aal.
< {UAZ95} 1: UAZ. 1 early-middle Aal.

Cover Illustrations

Front cover

The front cover illustrates six successive species of the genus *Mirifusus* treated in this volume:
- *M. proavus* (UAZones 2 - 4, late Aalenian to late Bajocian)
- *M. fragilis s.l.* (UAZones 3 - 8 , early-middle Bajocian to middle Callovian-early Oxfordian)
- *M. guadalupensis* (UAZones 5 - 11, latest Bajocian-early Bathonian to late Kimmeridgian-early Tithonian)
- *M. dianae dianae* (UAZones 7 - 12, late Bathonian-early Callovian to early-early late Tithonian)
- *M. dianae baileyi* (UAZones 9 - 11, middle-late Oxfordian to late Kimmeridgian-early Tithonian)
- *M. dianae minor* (UAZones 9 - 20, middle-late Oxfordian to late Hauterivian)

Although their ranges are largely overlapping, their successive first occurrence, and the presence of transitional forms suggests an evolutionary lineage that began in the late Aalenian and lasted to the late Hauterrivian. Typical forms of *Mirifusus* with 3 rows of pores existed since the early-middle Bajocian, whereas forms with two rows of pores came into existence since the late Bathonian.

Back cover

During the Middle and Late Jurassic radiolarians were rock-forming in many Tethyan pelagic basins.
The outcrop photo shows Late Jurassic ribbon bedded green and red radiolarites of the upper variegated member of the Schisti Silicei Formation in the Eastern Lagonegro Domain (Southern Italy).
(Photography and data by Filomena Amodeo).

Back

Eucyrtidiellum unumaense unumaense (UAZones 3 - 8 , early-middle Bajocian to middle Callovian-early Oxfordian) and
E. unumaense pustulatum (UAZones 5 - 8, latest Bajocian-early Bathonian to middle Callovian-early Oxfordian) form part another evolutionary lineage characteristic of the Middle-Late Jurassic.

Cover design by P. O. Baumgartner

Mémoires de Géologie (Lausanne)

No. 1 BAUD A. 1987. Stratigraphie et sédimentologie des calcaires de Saint-Triphon (Trias, Préalpes, Suisse et France). 202 pp., 53 text-figs., 29 pls.

No. 2 ESCHER A, MASSON H. and STECK A. 1988. Coupes géologiques des Alpes occidentales suisses. 11 pp., 1 text-figs., 1 map

No. 3 STUTZ E. 1988. Géologie de la chaîne Nyimaling aux confins du Ladakh et du Rupshu (NW-Himalaya, Inde). Evolution paléogéographique et tectonique d'un segment de la marge nord-indienne. 149 pp., 42 text-figs., 11 pls. 1 map.

No. 4 COLOMBI A. 1989. Métamorphisme et géochimie des roches mafiques des Alpes ouest-centrales (géoprofil Viège-Domodossola-Locarno). 216 pp., 147 text-figs., 2 pls.

No. 5 STECK A., EPARD J.-L., ESCHER A., MARCHANT R., MASSON H. and SPRING L. 1989 Coupe tectonique horizontale des Alpes centrales. 8 pp., 1 map.

No. 6 SARTORI M. 1990. L'unité du Barrhorn (Zone pennique, Valais, Suisse). 140 pp., 56 text-figs., 3 pls.

No. 7 BUSSY F. 1990. Pétrogenèse des enclaves microgrenues associées aux granitoïdes calco-alcalins: exemple des massifs varisque du Mont-Blanc (Alpes occidentales) et miocène du Monte Capanne (Ile d'Elbe, Italie). 309 pp., 177 text-figs.

No. 8 EPARD J.-L. 1990. La nappe de Morcles au sud-ouest du Mont-Blanc. 165 pp., 59 text-figs.

No. 9 PILLOUD C. 1991 Structures de déformation alpines dans le synclinal de Permo-Carbonifère de Salvan-Dorénaz (massif des Aiguilles Rouges, Valais). 98 pp., 59 text-figs.

No. 10 BAUD A., THELIN P. and STAMPFLI G. 1991. (Eds.) Paleozoic geodynamic domains and their alpidic evolution in the Tethys. IGCP Project No. 276. Newsletter No. 2. 155 pp.

No. 11 CARTER E.S. 1993 Biochronology and Paleontology of uppermost Triassic (Rhaetian) radiolarians, Queen Charlotte Islands, British Columbia, Canada. 132 pp., 15 text-figs., 21 pls.

No. 12 GOUFFON Y. 1993. Géologie de la "nappe" du Grand St-Bernard entre la Doire Baltée et la frontière suisse (Vallée d'Aoste -Italie). 147 pp., 71 text-figs., 2 pls.

No. 13 HUNZIKER J.C., DESMONS J., and HURFORD AJ. 1992. Thirty-two years of geochronological work in the Central and Western Alps: a review on seven maps. 59 pp., 18 text-figs., 7 maps.

No. 14 SPRING L. 1993. Structures gondwaniennes et himalayennes dans la zone tibétaine du Haut Lahul-Zanskar oriental (Himalaya indien). 148 pp., 66 text-figs, 1 map.

No. 15 MARCHANT R. 1993. The Underground of the Western Alps. 137 pp., 104 text-figs.

No. 16 VANNAY J.-C. 1993. Géologie des chaînes du Haut-Himalaya et du Pir Panjal au Haut-Lahul (NW-Himalaya, Inde). Paléogéographie et tectonique. 148 pp., 44 text-figs., 6 pls.

No. 17 PILLEVUIT A. 1993. Les blocs exotiques du Sultanat d'Oman. Evolution paleogeographique d'une marge passive flexurale. 249 pp., 138 text-figs., 7 pls.

No. 18 GORICAN S. 1994. Jurassic and Cretaceous radiolarian biostratigraphy and sedimentary evolution of the Budva Zone (Dinarides, Montenegro). 120 pp., 20 text-figs., 28 pls.

No. 19 JUD R. 1994. Biochronology and systematics of Early Cretaceous Radiolaria of the Western Tethys. 147 pp., 29 text-figs., 24 pls.

No. 20 DI MARCO G. 1994. Les terrains accrétés du sud du Costa Rica. Evolution tectonostratigraphique de la marge occidentale de la plaque Caraïbe. 166 pp., 89 text-figs., 6 pls.

No. 21 O'DOGHERTY L. 1994. Biochronology and paleontology of Mid-Cretaceous radiolarians from Northern Apennines (Italy) and Betic Cordillera (Spain). 415 pp., 35 text-figs., 73 pls.

No. 22 GUEX J. and BAUD A. (Eds.) 1994. Recent Developments on Triassic Stratigraphy. 184 pp.

No. 23 BAUMGARTNER P. O., O'DOGHERTY L., GORICAN S., URQUHART E., PILLEVUIT A. and DE WEVER P. (Eds.). 1995. Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronolgy. 1172 pp.

No. 24 REYMOND B. 1994. Three-dimensional sequence stratigraphy offshore Louisiana, Gulf of Mexico (West Cameron 3D seismic data). 215 pp., 169 text-figs., 49 pls.

To place an order, contact

Institut de Géologie et Paléontologie,

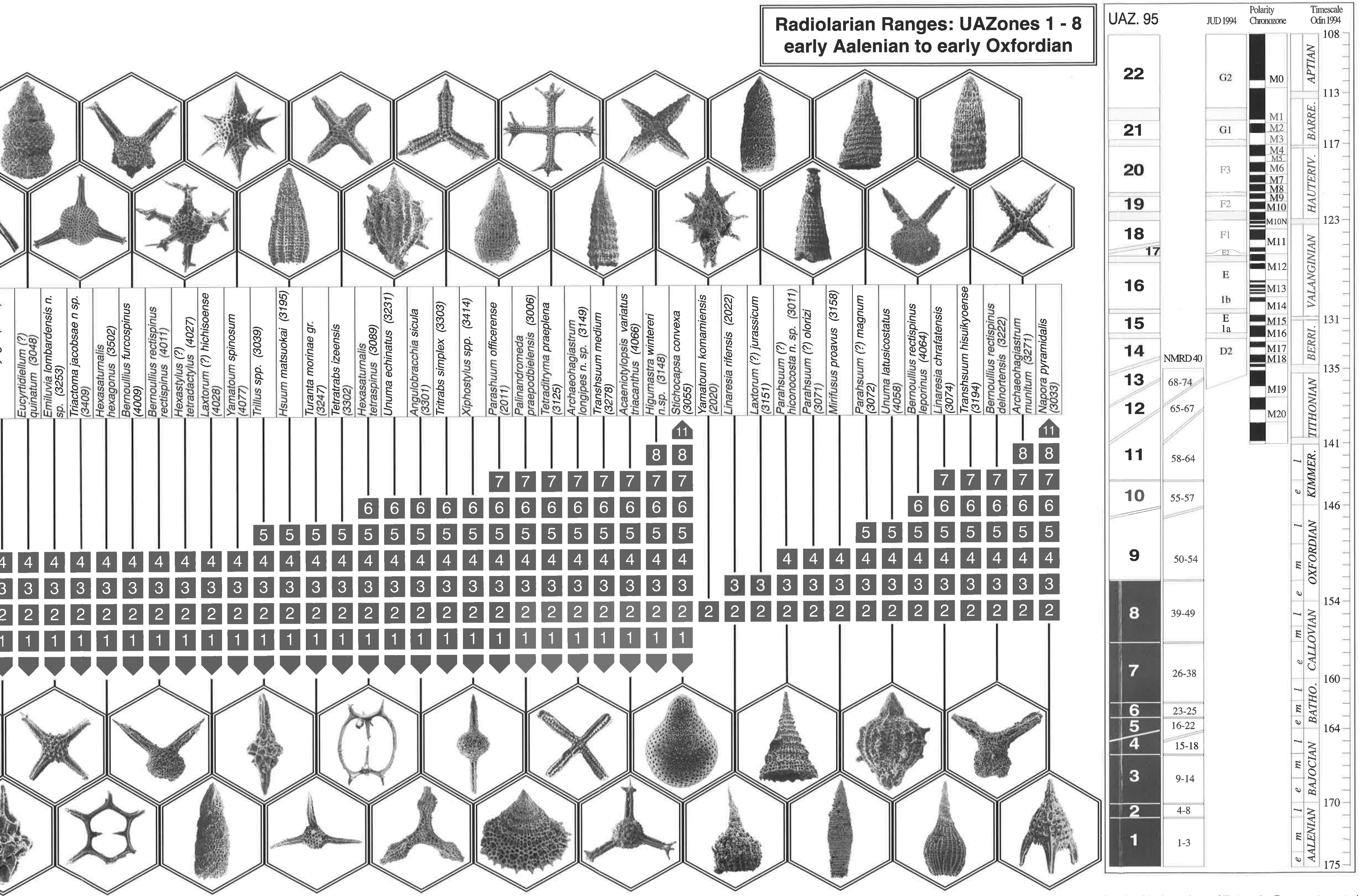
Université de Lausanne. BFSH-2. CH-1015, SWITZERLAND.

http://www-sst.unil.ch/publidep.htm

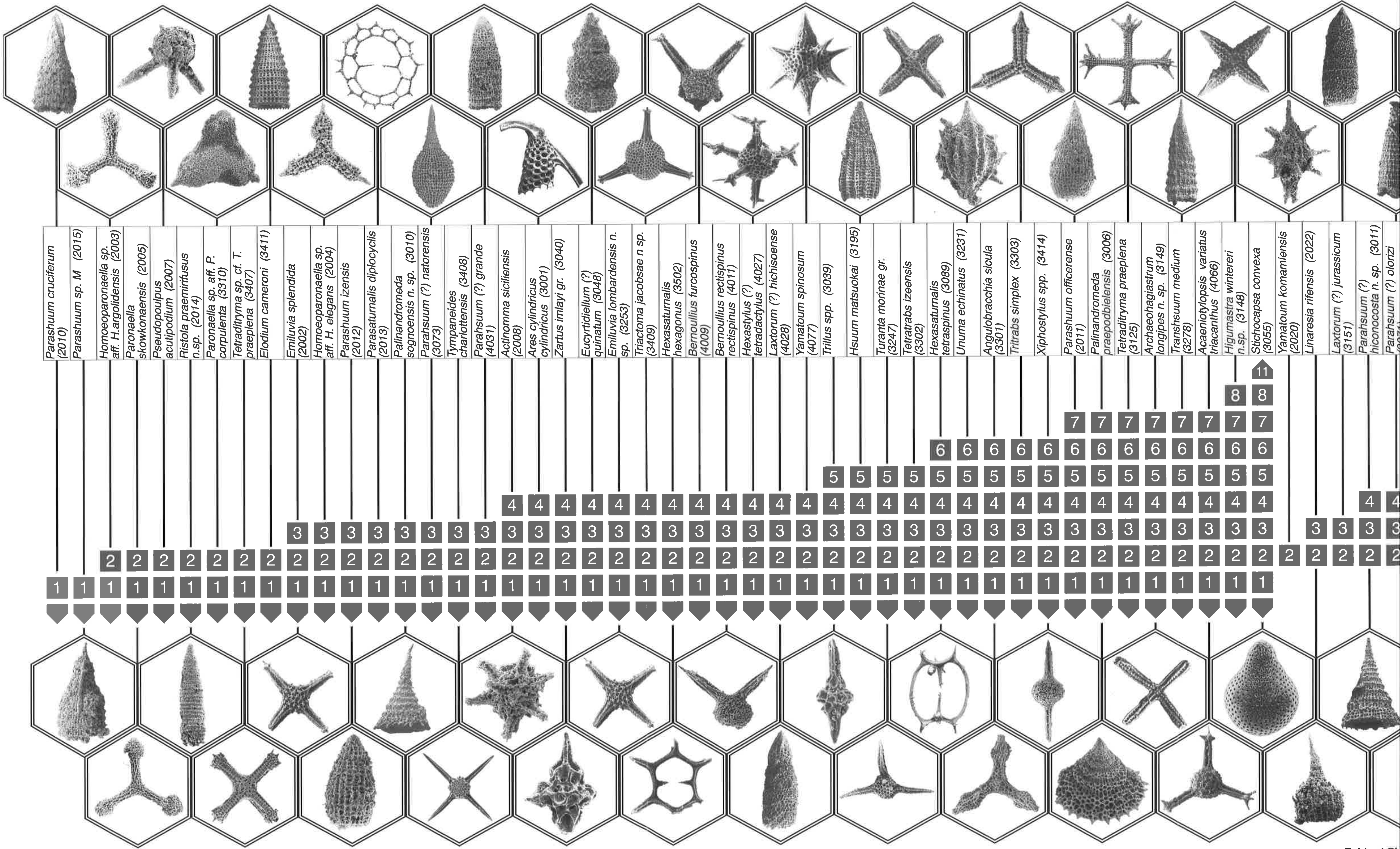
Fax: (41) 21 - 692.43.05

Price: CHF 30.- per volume, except volume 23 (CHF 100.-). This price does **not** include postage and handling.

Radiolarian Ranges: UAZones 1 - 8 early Aalenian to early Oxfordian

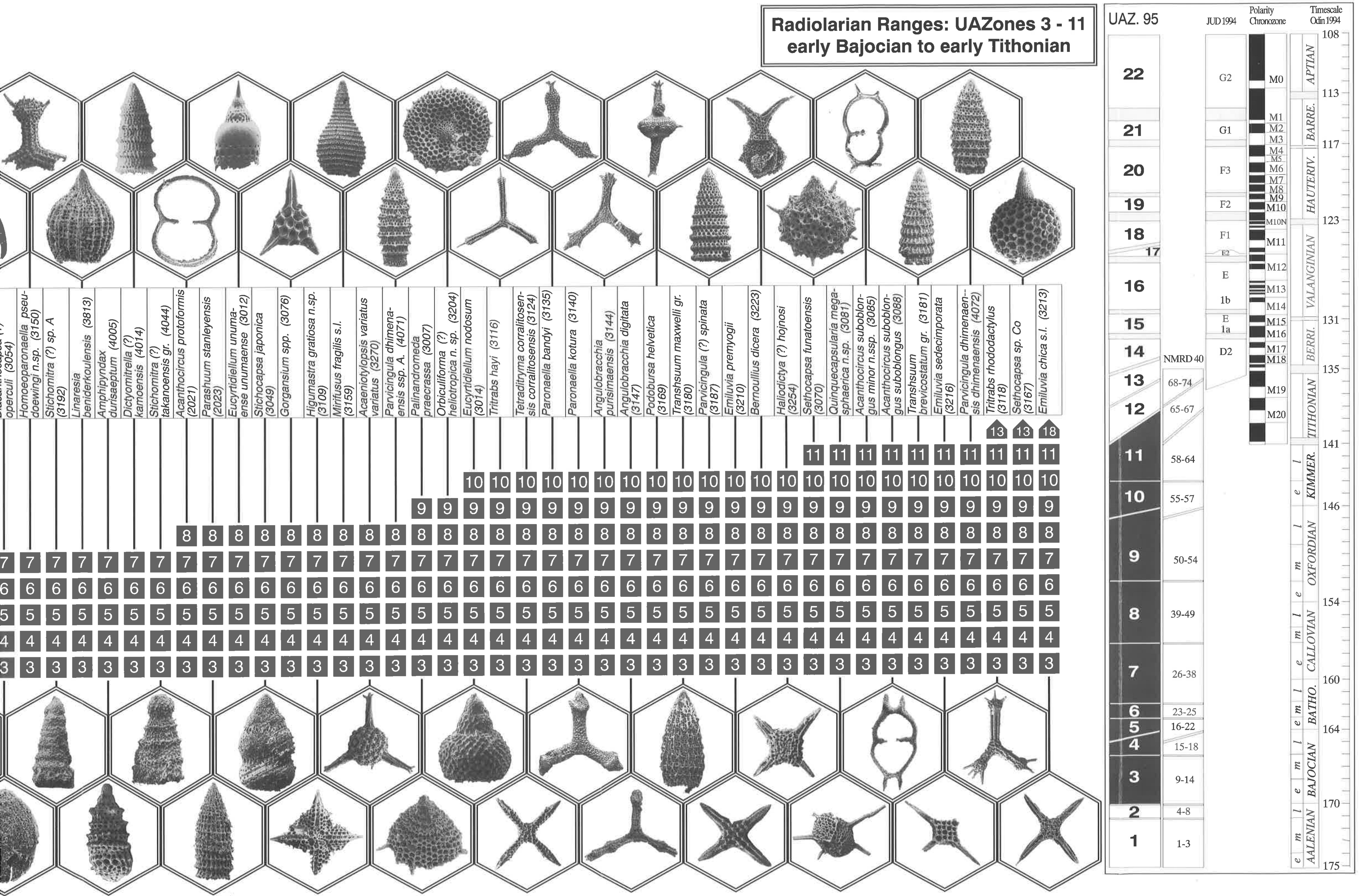


Foldout Plate 1. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.



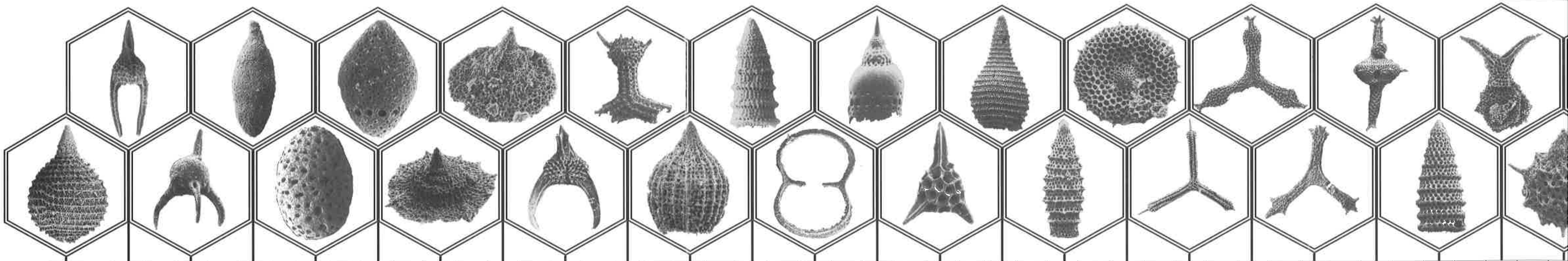
Radi
earl
Parashuum cruciferum (2010)
Parashuum sp. M (2015)
Homoeoparonaella sp. aff. H.argolidensis (2003)
Paronaella skowkonaensis (2005)
Pseudopoulpus acutipodium (2007)
Ristola praemirifusus n.sp. (2014)
Paronaella sp. aff. P. corpulenta (3310)
Tetraditryma sp. cf. T. praeplena (3407)
Elodium cameroni (3411)
Emiluvia splendida (2002)
Homoeoparonaella sp. aff. H. elegans (2004)
Parashuum izensis (2012)
Parasaturnalis diplocyclis (2013)
Palinandromeda sognoensis n. sp. (3010)
Parahsuum (?) natorensis (3073)
Tympaneides charlottensis (3408)
Parahsuum (?) grande (4031)
Actinomma siciliensis (2008)
Ares cylindricus cylindricus (3001)
Zartus imlayi gr. (3040)
Eucyrtidiellum (?) quinatum (3048)
Emiluvia lombardensis n. sp. (3253)
Triactoma jacobsae n sp. (3409)
Hexasaturnalis hexagonus (3502)
Bernoullius furcospinus (4009)
Bernoullius rectispinus rectispinus (4011)
Hexastylus (?) tetradactylus (4027)
Laxtorum (?) hichisoense (4028)
Yamatoum spinosum (4077)
Trillus spp. (3039)
Hsuum matsuokai (3195)
Turanta morinae gr. (3247)
Tetratrabs izeensis (3302)
Hexasaturnalis tetraspinus (3089)
Unuma echinatus (3231)
Angulobracchia sicula (3301)
Tritrabs simplex (3303)
Xiphostylus spp. (3414)
Parashuum officerense (2011)
Palinandromeda praepodbielensis (3006)
Tetraditryma praeplena (3125)
Archaeohagiastrum longipes n. sp. (3149)
Transhsuum medium (3278)
Acaeniotylopsis variatus triacanthus (4066)
Higumastra wintereri n.sp. (3148)
Stichocapsa convexa (3055)
Yamatoum komaniensis (2020)
Linaresia rifensis (2022)
Laxtorum (?) jurassicum (3151)
Parahsuum (?) hiconocosta n. sp. (3011)
Parahsuum (?) olorizi

Foldout Pla

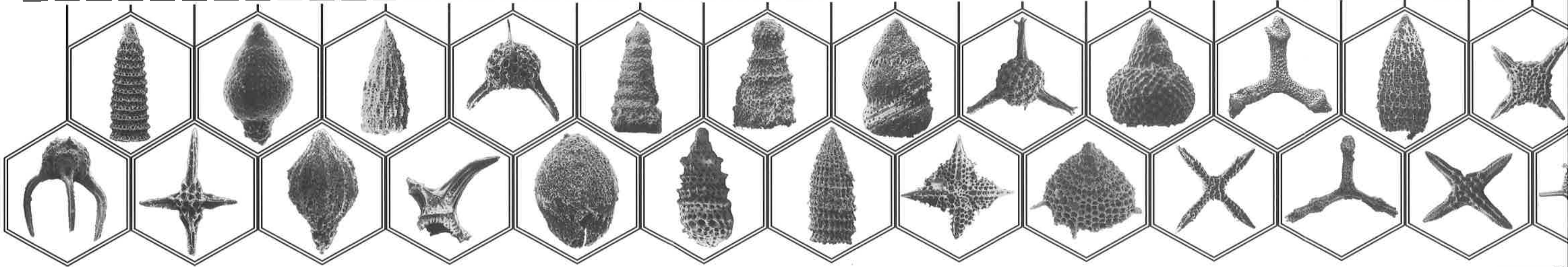


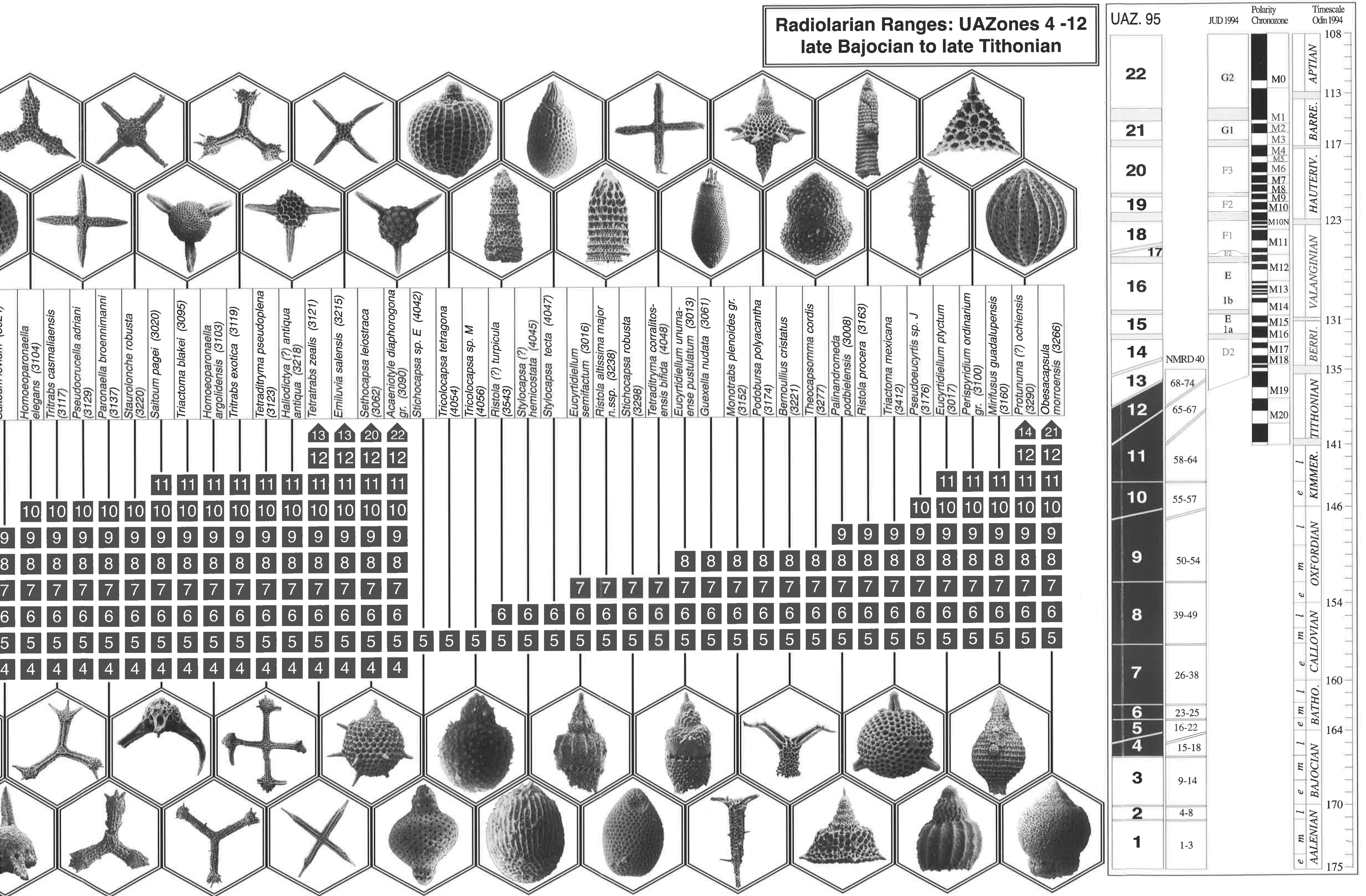
Foldout Plate 2. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.

Radic
earl



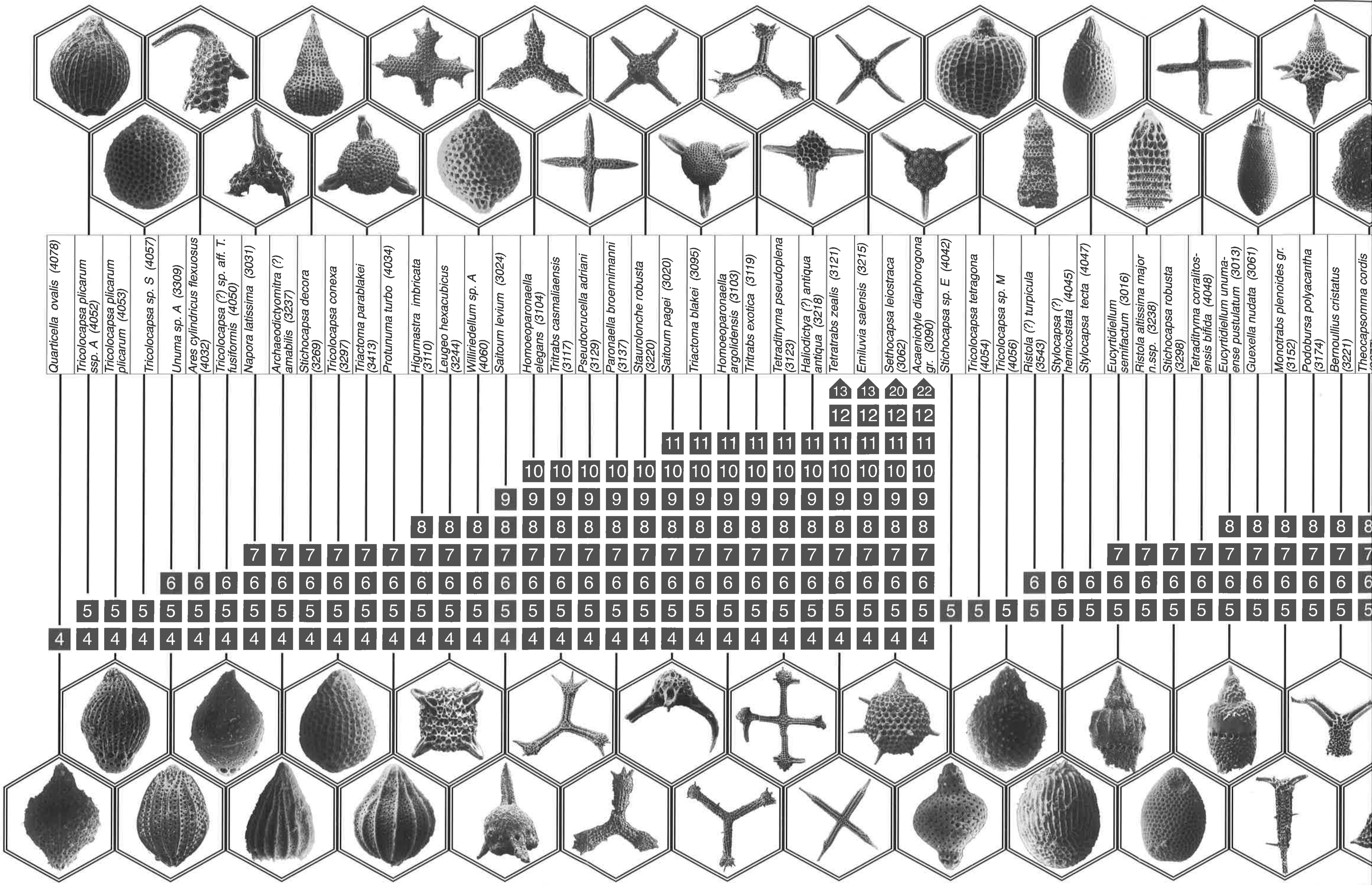
Mirifusus fragilis praeguadalupensis n.ssp. (2026)	3
Saitoum sp. aff. *S. pagei* (3027)	3
Napora sp. A (3030)	3
Parvicingula schoolhousensis gr. (3184)	3
Saitoum sp. aff. *S. levium* (3026)	3 4
Zartus dickinsoni gr. (3041)	3 4
Cyrtocapsa (?) kisoensis (3050)	3 4
Cyrtocapsa mastoidea (3307)	3 4
Archicapsa (?) pachyderma (4007)	3 4
Unuma typicus (4059)	3 4
Tricolocapsa (?) fusiformis (4049)	3 4 5
Hsuum sp. cf. *H. mirabundum* (2006)	3 4 5 6
Palinandromeda murcheyae n. sp. (3004)	3 4 5 6
Hilarisirex quadrangularis (3002)	3 4 5 6 7
Palinandromeda depressa (3005)	3 4 5 6 7
Poulpus sp. aff. *P. oculatus* (3028)	3 4 5 6 7
Napora saginata (3032)	3 4 5 6 7
Diacanthocapsa (?) operculi (3054)	3 4 5 6 7
Homoeoparonaella pseudoewingi n.sp. (3150)	3 4 5 6 7
Stichomitra (?) sp. A (3192)	3 4 5 6 7
Linaresia beniderkoulensis (3813)	3 4 5 6 7
Amphipyndax durisaeptum (4005)	3 4 5 6 7
Dictyomitrella (?) kamoensis (4014)	3 4 5 6 7
Stichomitra (?) takanoensis gr. (4044)	3 4 5 6 7
Acanthocircus protoformis (2021)	3 4 5 6 7 8
Parashuum stanleyensis (2023)	3 4 5 6 7 8
Eucyrtidiellum unumaense unumaense (3012)	3 4 5 6 7 8
Stichocapsa japonica (3049)	3 4 5 6 7 8
Gorgansium spp. (3076)	3 4 5 6 7 8
Higumastra gratiosa n.sp. (3109)	3 4 5 6 7 8
Mirifusus fragilis s.l. (3159)	3 4 5 6 7 8
Acaeniotylopsis variatus variatus (3270)	3 4 5 6 7 8
Parvicingula dhimenaensis ssp. A. (4071)	3 4 5 6 7 8
Palinandromeda praecrassa (3007)	3 4 5 6 7 8 9
Orbiculiforma (?) heliotropica n. sp. (3204)	3 4 5 6 7 8 9
Eucyrtidiellum nodosum (3014)	3 4 5 6 7 8 9 10
Tritrabs hayi (3116)	3 4 5 6 7 8 9 10
Tetraditryma corralitosensis corralitosensis (3124)	3 4 5 6 7 8 9 10
Paronaella bandyi (3135)	3 4 5 6 7 8 9 10
Paronaella kotura (3140)	3 4 5 6 7 8 9 10
Angulobracchia purisimaensis (3144)	3 4 5 6 7 8 9 10
Angulobracchia digitata (3147)	3 4 5 6 7 8 9 10
Podobursa helvetica (3169)	3 4 5 6 7 8 9 10
Transhsuum maxwelli gr. (3180)	3 4 5 6 7 8 9 10
Parvicingula (?) spinata (3187)	3 4 5 6 7 8 9 10
Emiluvia premyogii (3210)	3 4 5 6 7 8 9 10
Bernoullius dicera (3223)	3 4 5 6 7 8 9 10
Haliodictya (?) hojnosi (3254)	3 4 5 6 7 8 9 10
Sethocapsa funatoensis	3 4 5 6 7 8 9 10 11



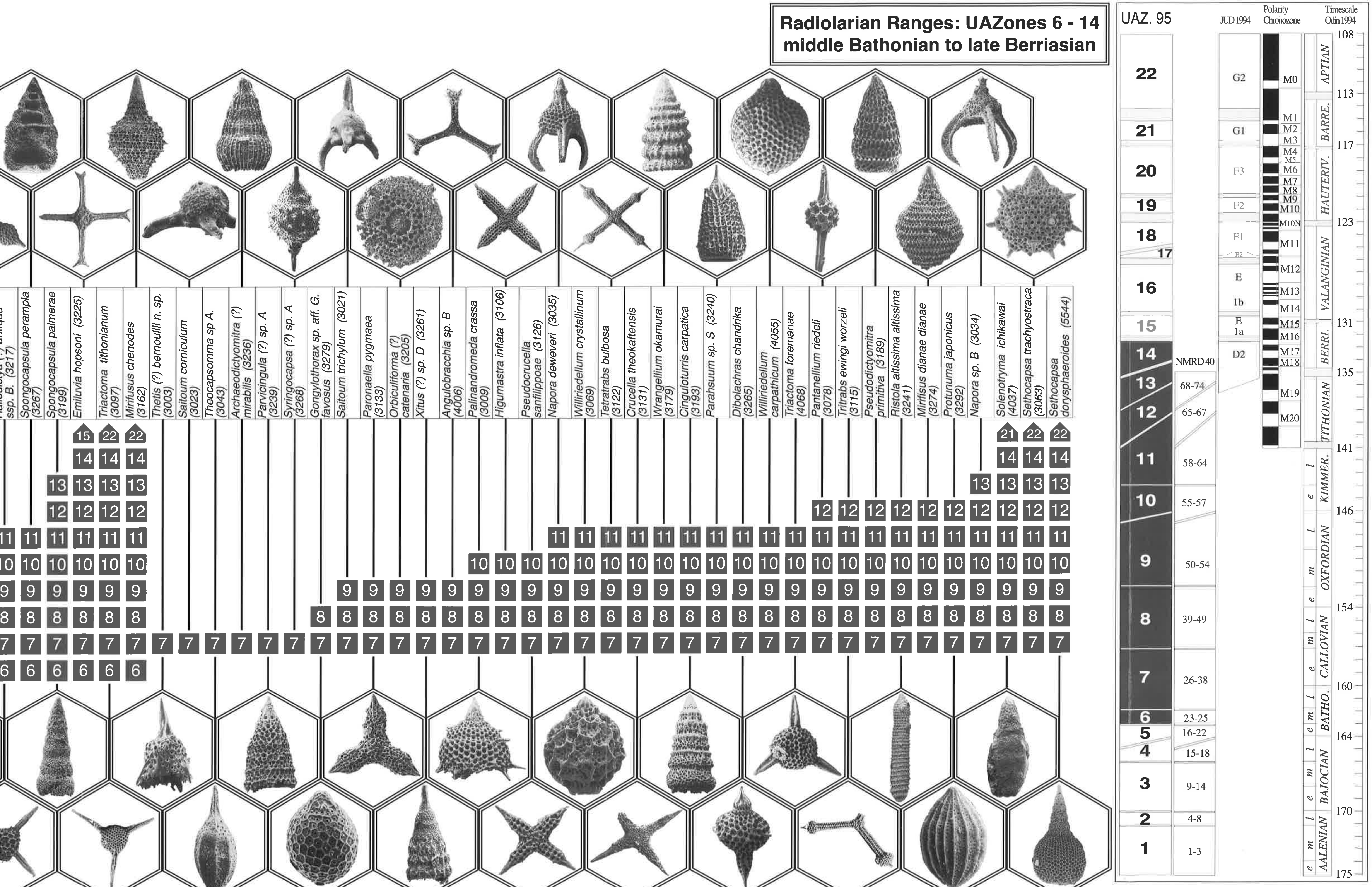


Foldout Plate 3. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.

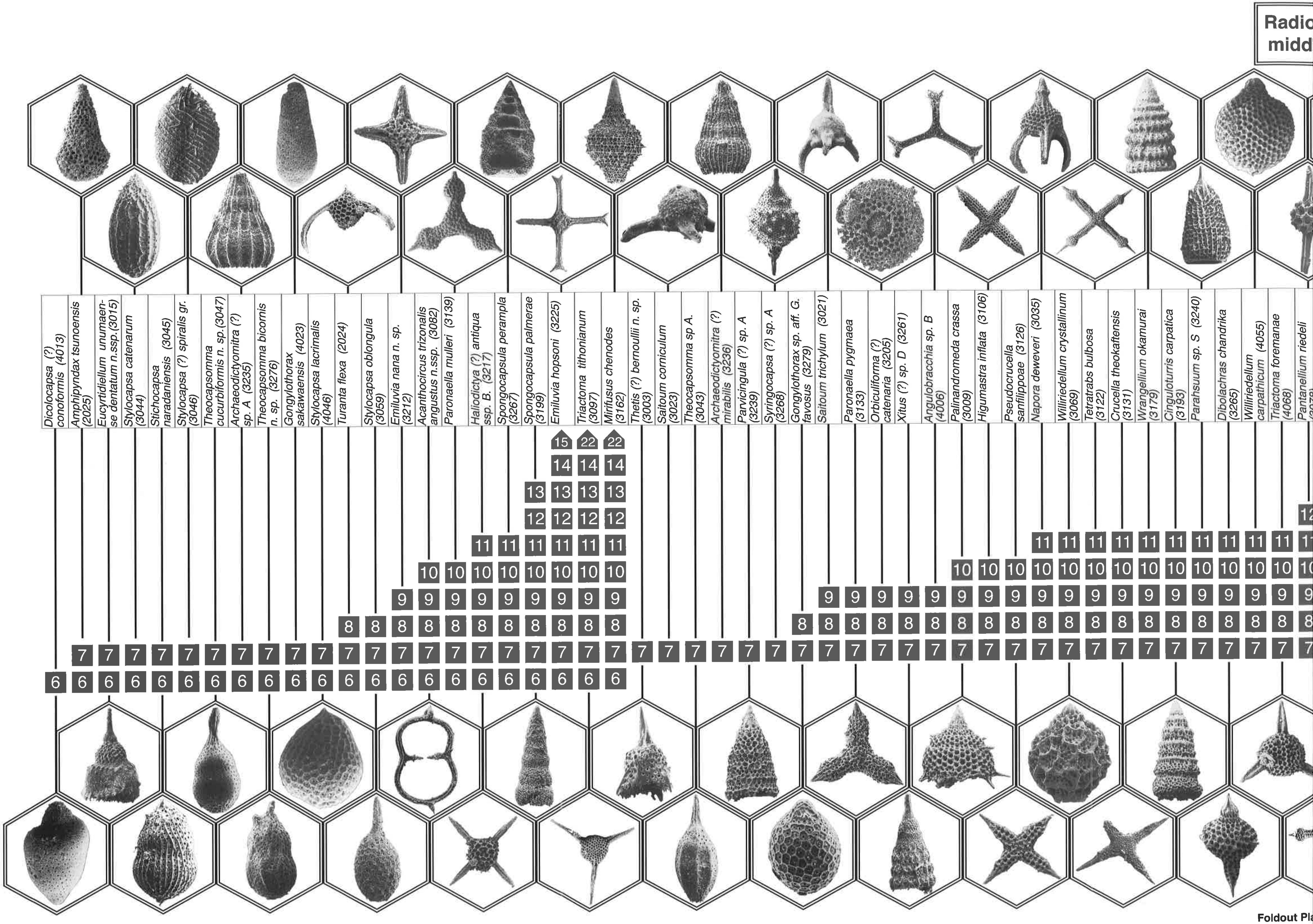
Radi
la



Foldout Pla

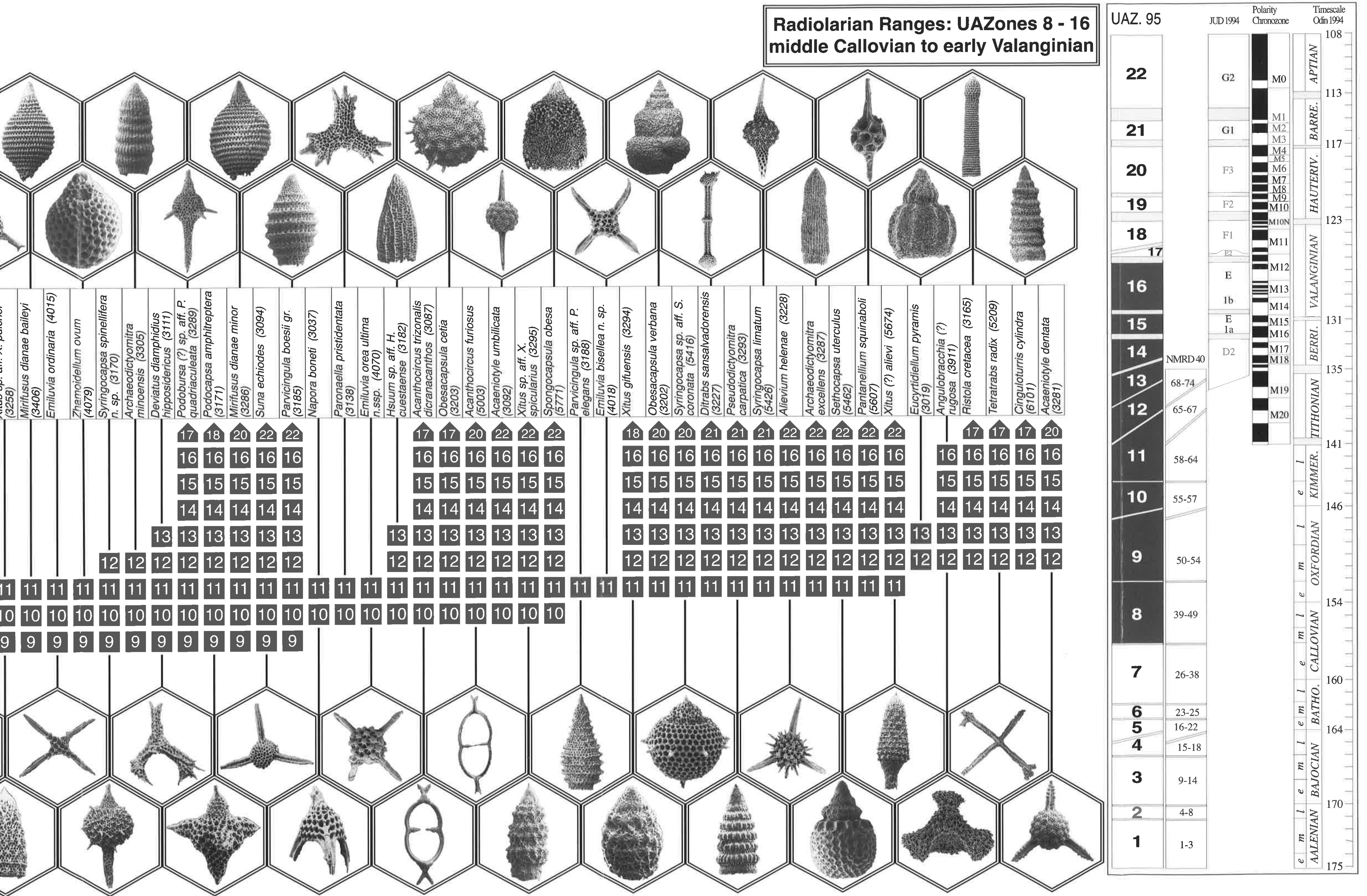


Foldout Plate 4. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.


Radio
midd
Dicolocapsa (?) conoformis (4013)
Amphipyndax tsunoensis (2025)
Eucyrtidiellum unumaense dentatum n.ssp.(3015)
Stylocapsa catenarum (3044)
Stichocapsa naradaniensis (3045)
Stylocapsa (?) spiralis gr. (3046)
Theocapsomma cucurbiformis n. sp.(3047)
Archaeodictyomitra (?) sp. A (3235)
Theocapsomma bicornis n. sp. (3276)
Gongylothorax sakawaensis (4023)
Stylocapsa lacrimalis (4046)
Turanta flexa (2024)
Stylocapsa oblongula (3059)
Emiluvia nana n. sp. (3212)
Acanthocircus trizonalis angustus n.ssp. (3082)
Paronaella mulleri (3139)
Haliodictya (?) antiqua ssp. B. (3217)
Spongocapsula perampla (3267)
Spongocapsula palmerae (3199)
Emiluvia hopsoni (3225)
Triactoma tithonianum (3097)
Mirifusus chenodes (3162)
Thetis (?) bernoullii n. sp. (3003)
Saitoum corniculum (3023)
Theocapsomma sp A. (3043)
Archaeodictyomitra (?) mirabilis (3236)
Parvicingula (?) sp. A (3239)
Syringocapsa (?) sp. A (3268)
Gongylothorax sp. aff. G. favosus (3279)
Saitoum trichylum (3021)
Paronaella pygmaea (3133)
Orbiculiforma (?) catenaria (3205)
Xitus (?) sp. D (3261)
Angulobracchia sp. B (4006)
Palinandromeda crassa (3009)
Higumastra inflata (3106)
Pseudocrucella sanfilippoae (3126)
Napora deweveri (3035)
Williriedellum crystallinum (3069)
Tetratrabs bulbosa (3122)
Crucella theokaftensis (3131)
Wrangellium okamurai (3179)
Cinguloturris carpatica (3193)
Parahsuum sp. S (3240)
Dibolachras chandrika (3265)
Williriedellum carpathicum (4055)
Triactoma foremanae (4068)
Pantanellium riedeli

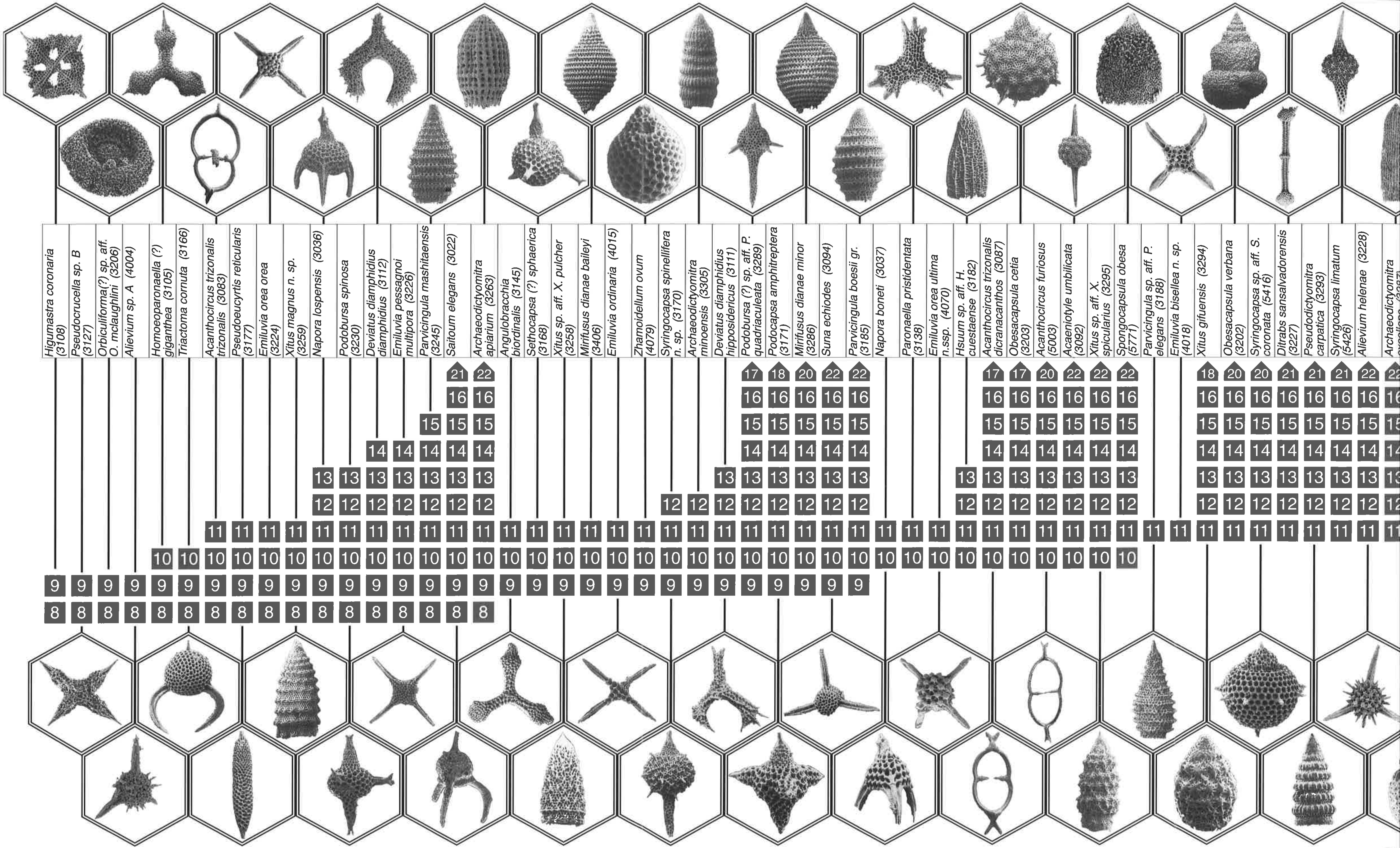
Foldout Pla

Radiolarian Ranges: UAZones 8 - 16 middle Callovian to early Valanginian

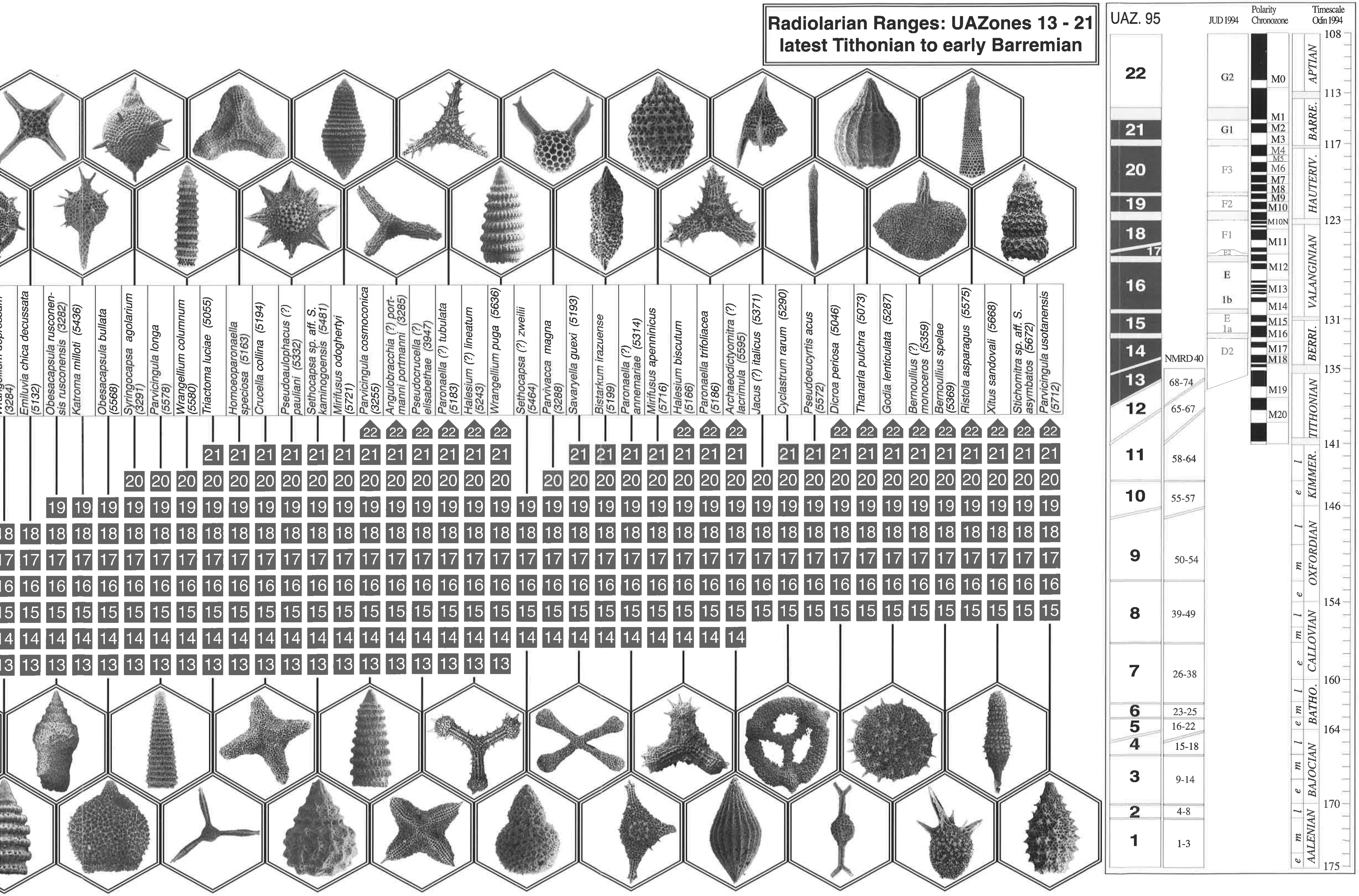


Foldout Plate 5. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.

Radic
middl

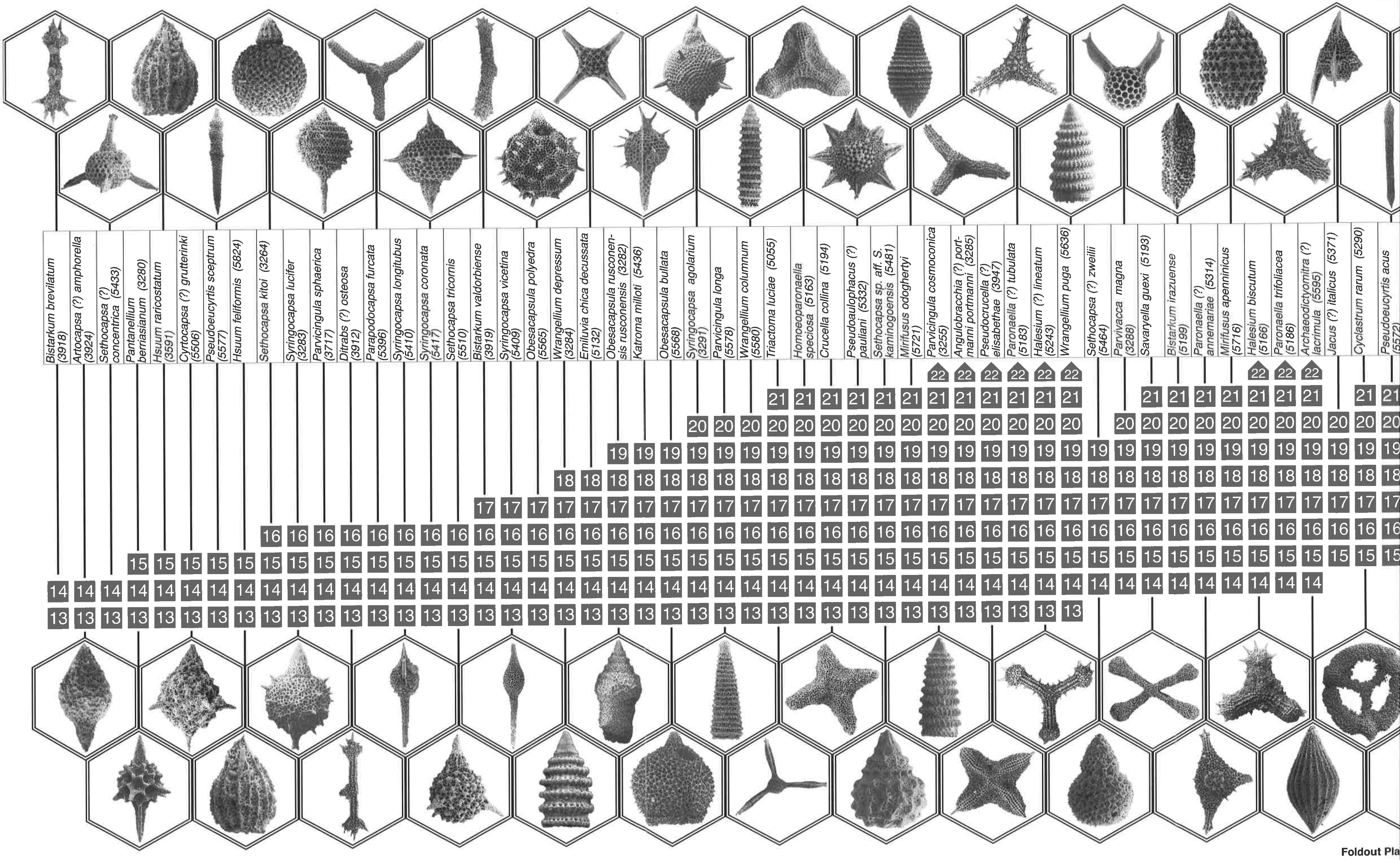


Foldout Pla

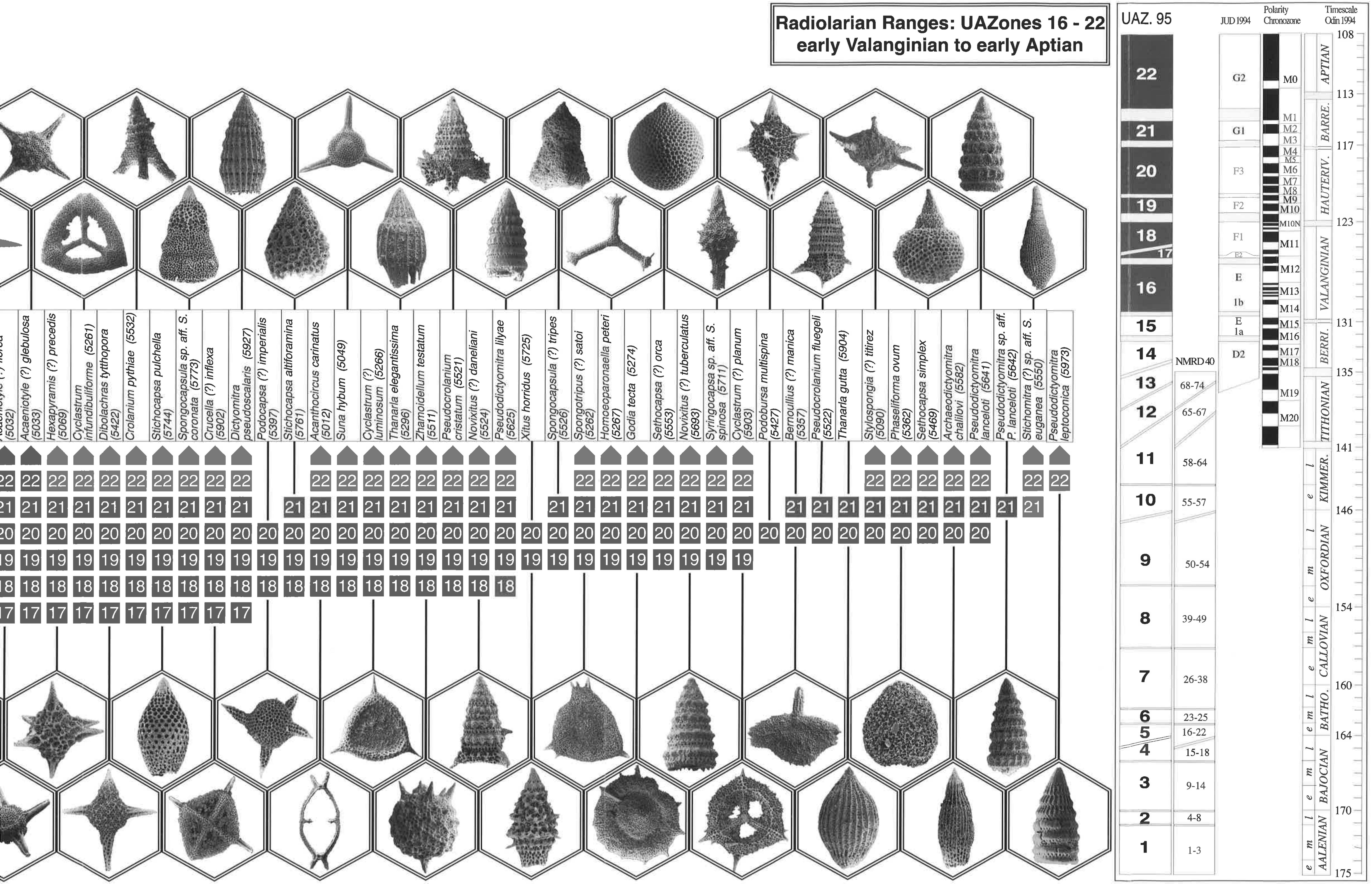


Foldout Plate 6. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.

Radiol... latest...

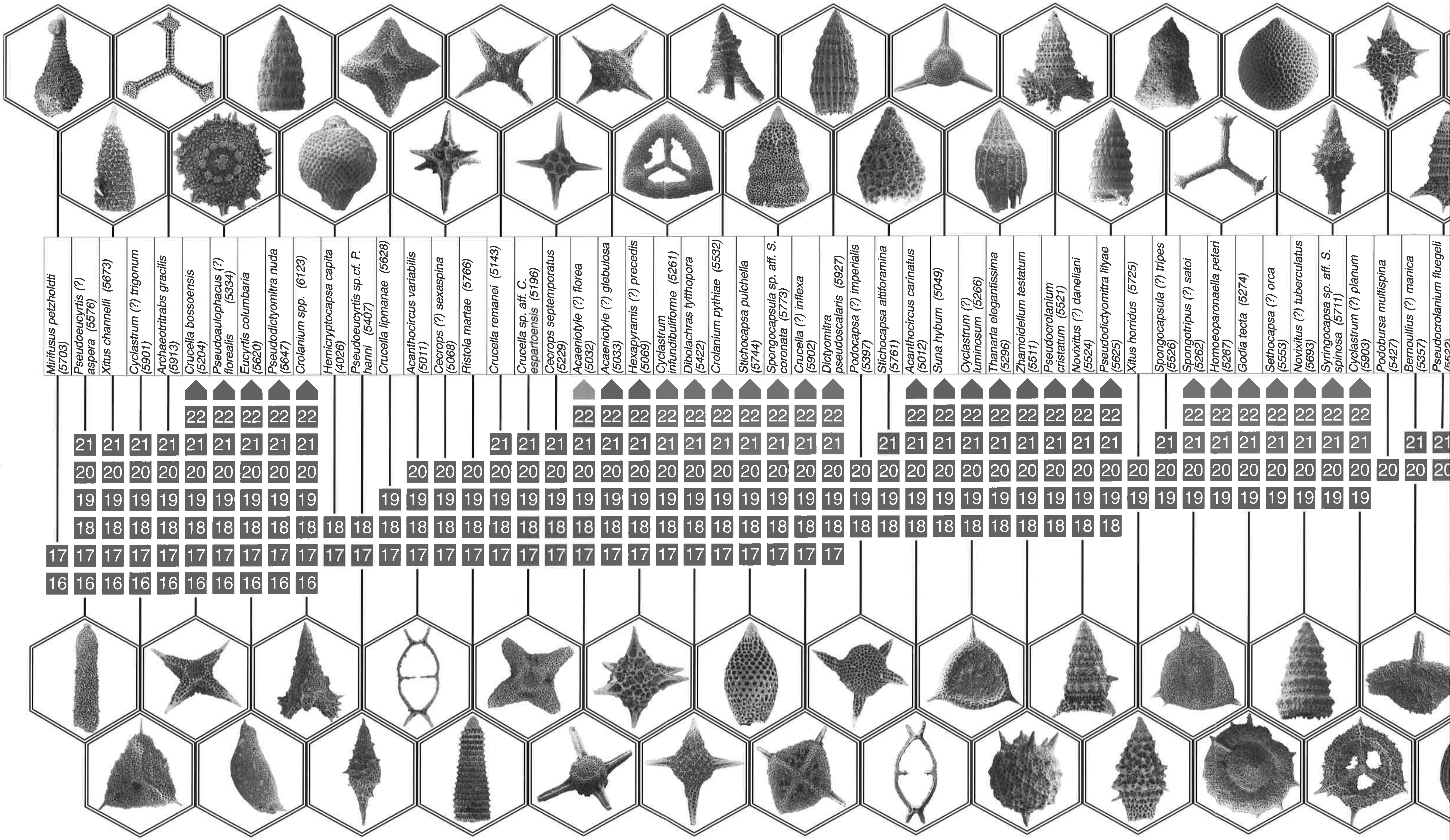


Foldout Pla...



Foldout Plate 7. to Chapter 32: Middle Jurassic to Early Cretaceous radiolarian biochronology of Tethys, by Baumgartner et al.

Radiol
earl



Foldout Pla

Radiolaria are a marine siliceous microplankton group that existed since the Cambrian to the Recent. Fossil Radiolaria were known since the middle of the last Century and intensely studied at the turn of this Century. Radiolaria regained the interest of scientists in the late Sixties, amongst others, through the work of W. R. Riedel to whom this volume is dedicated. Today, Radiolaria are an important microfossil group used worldwide to date Paleozoic, Mesozoic, and Cenozoic rocks.

This volume is the result of a collaborative effort of 32 contributors from 12 countries. It synthesises the systematics, occurrences, and biochronology of Middle Jurassic (Aalenian) to Lower Cretaceous (early Aptian) Radiolaria from the Tethys, an ancient low-latitude realm.

The systematics of 151 genera, 424 species, and 41 subspecies is treated in the alphabetical catalogue section of this volume; 19 species and 6 subspecies are newly described. Radiolarian occurrences are reported from a total of 1431 samples from 173 localities in the Central Atlantic, Europe, Russia, the Middle East, Japan, Northern and Central Pacific, and Western North and Central America. 451 species and subspecies from over 60 localities including 800 samples were used to construct a zonation by means of Unitary Associations. Each of the 22 new Unitary Association Zones are defined by characteristic taxa or pairs of taxa that co-occur in the zone. These zones are correlated to the standard stages by means of other fossils reported from the same sections, such as ammonites, nannofossils, calpionellids and dinoflagellates, as well as by means of paleomagnetic and stable isotope stratigraphy established in the same sections.

IMPRIMERIE CHABLOZ S.A., TOLOCHENAZ

ISSN 1015-3578