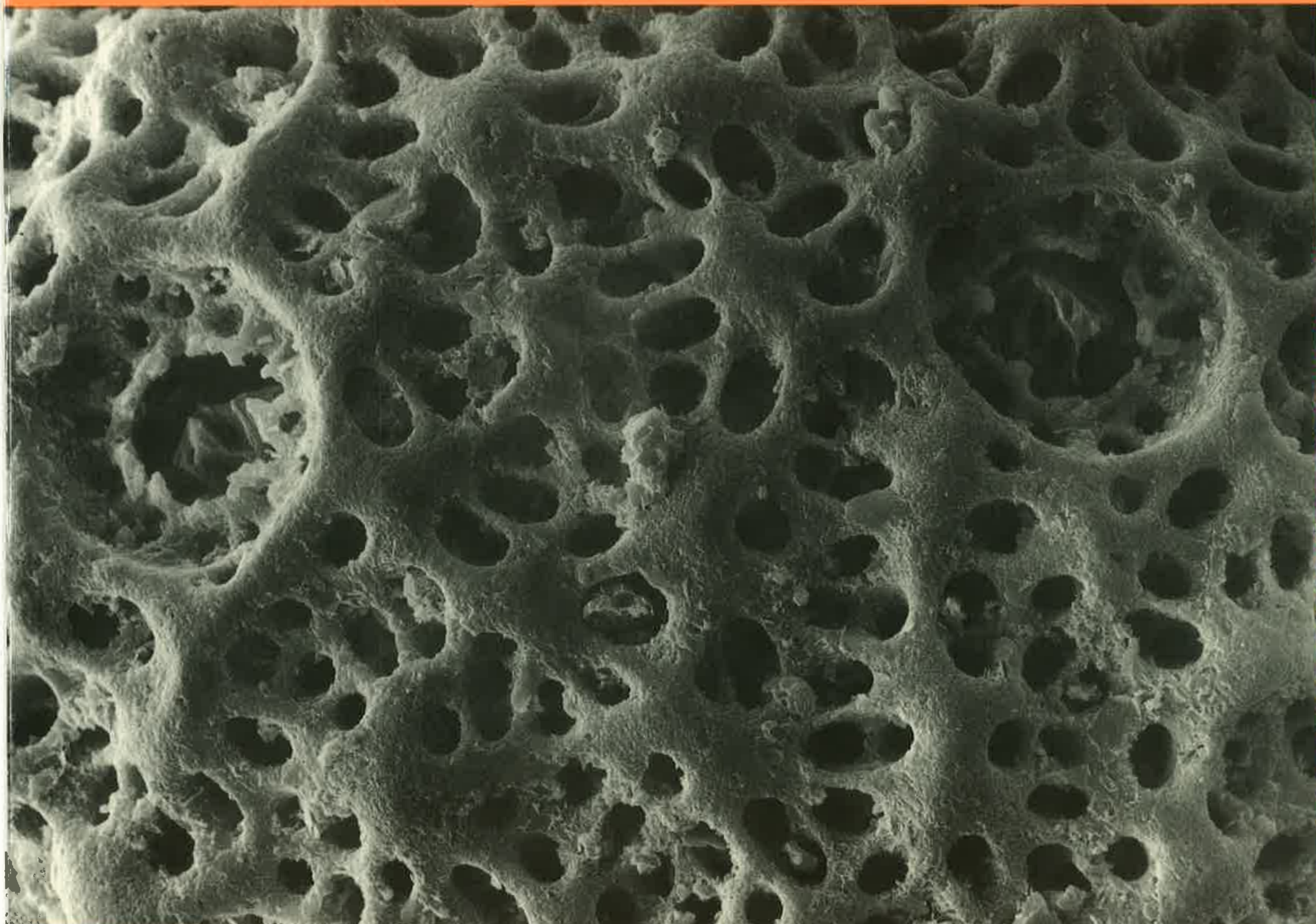
Mémoires de Géologie (Lausanne) No. 19, 1994

# Biochronology and Systematics of Early Cretaceous Radiolaria of the Western Tethys

by Ruth Jud



IMPRIMERIE CHABLOZ S.A., TOLOCHENAZ
ISSN 1015-3578

Université de Lausanne
Faculté des Sciences

Institut de Géologie
et de Paléontologie

# Biochronology and Systematics of Early Cretaceous Radiolaria of the Western Tethys

**Thèse de doctorat**
présentée à la Faculté des Sciences
de l'Université de Lausanne

par **Ruth Jud**

**Jury de thèse:**
Prof. Peter O. Baumgartner (Directeur)
Dr. Paulian Dumitrica (Bucarest)
Prof. Jean Guex (Lausanne)
Prof. Henri Masson (Lausanne)
Dr. Benita Murchey (U.S.A.)
Prof. Jürgen Remane (Neuchâtel)

Mémoires de Géologie (Lausanne) No. 19, 1994

Cover photo

Detail of the superficial ornamentation of a Lower Cretaceous nassellarian.

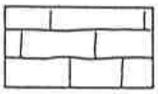
# TABLE OF CONTENTS



## LIST OF FIGURES

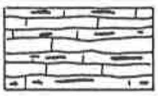
## Key to symbols on sections

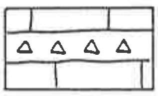
### Lithology

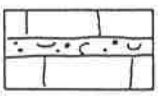

well-bedded mudstones


chert layers and chert nodules

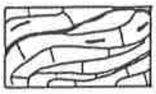

black shales and marls


inter-bedded siliceous limestones and chert

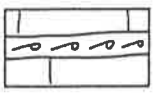

breccia layer


resedimented limestones

### Structures


slumps

### Fossils


aptychi

## ABSTRACT

About 500 samples of Uppermost Jurassic to Lowermost Aptian cherty limestones, most of them in the Maiolica facies, were studied for their contents in radiolarians in order to make a comprehensive inventory of radiolarian assemblages and to establish a radiolarian biochronology calibrated and correlated to the magnetostratigraphy established in the same sections and to biozonations of other fossil groups. 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 biozones whose terminology follows and continues that of Baumgartner (1984b). 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.

The 11 radiolarian zones (C1-G2) were correlated to magnetic polarity chrons, calpionellid zones and nannofossil events established by previous workers on the investigated sections. Diachrony in correlating the radiolarian zones is probably caused by several reasons among which lithostratigraphy, species definition and abundance, calibration with magnetic chrons and definition of these chrons are among the most important.

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 new radiolarian zonation, based on the co-existence of several species within one zone, to most of the previous radiolarian zonations is impossible or very difficult, because most of them were defined by first or last appearances of one or two "marker" species, which may greatly differ from section to section.

The time span covered by the new radiolarian biozones is variable. Zone E2 has a duration of less than 1 million years whereas zone E1b spans about 4 million years. Zone E2 is located in the Middle Valanginian at the base of the magnetic polarity zone M11 and corresponds, in the Southern Alps, to a time of elevated $^{13}C$ values (Weissert & Lini, 1991). During this characteristic period, explained by the authors as an episode of greenhouse climate, pelitic intervals, elevated bioturbation and cyclic sedimentation occurred. The same interval (Zones E2 and F1 corresponding to the Middle and the Upper Valanginian) is also characterized by the high abundance of some taxa in the samples of the Fiume Bosso section.

All the 175 taxa investigated, of which 1 new subspecies, 61 new species and 2 new genera, are described and illustrated in the systematic part of the thesis.

## RESUME

Au cours du présent travail, nous avons étudié environ 500 échantillons de calcaires siliceux du Jurassique supérieur au Crétacé inférieur, dont la plupart proviennent du faciès Maiolica. Ceci a été fait afin d'obtenir un inventaire détaillé des assemblages de radiolaires et d'établir une biochronologie des radiolaires calibrée et corrélée à la magnétostratigraphie établie dans les mêmes sections et aux biozonations des autres groupes fossiles. Les échantillons ont été récoltés dans 26 sections affleurant en Suisse, Italie et Oman. Cent soixante quinze taxa ont été selectionnés parmi plusieurs centaines de morphotypes provenant de 245 échantillons présentant une bonne préservation dans 13 des 26 sections examinées. Les Associations Unitaires (A.U.) ont été calculées à l'aide du programme "BioGraph" (Savary & Guex, 1990). Ceci a permis de définir 35 A.U. pouvant être regroupées en 11 biozones dont la définition suit celle de Baumgartner (1984b).

Les 11 zones de radiolaires (C1 - G2) ont été corrélées avec les zones de polarité magnétique, les zones à calpionelles et à nannofossiles établies au préalable par des auteurs ayant étudiés les mêmes sections. Le diachronisme visible lors de la calibration des zones de radiolaires a vraisemblablement plusieurs causes parmi lesquelles la lithostratigraphie, la définition des espèces et des abondances relatives, la calibration avec les zones magnétiques et la définition de celles-ci sont les plus importantes.

Les sections étudiées appartiennent à divers domaines paléogéographiques présentant des faciès de bassin et de hauts fonds: Nappes Préalpines (Téthys septentrionale), Alpes méridionales et Apennins (plaque apulienne, Téthys méridionale) et Complexe d'Hawasina (marge distale de l'Arabie). Cependant les Associations Unitaires à radiolaires fournissent une clé utile pour les corrélations entre ces différents domaines.

Une corrélation précise de la nouvelle zonation à radiolaires, basée sur la co-existence de plusieurs espèces dans une zone, avec la plupart des biozonations antérieures est impossible ou très difficile, car le plus souvent ces dernières sont définies par l'apparition ou la disparition d'une ou deux espèces caractéristiques, qui

peuvent varier de façon importante d'une section à l'autre.

Le laps de temps couvert par les nouvelles biozones à radiolaires est variable. La Zone E2 a une durée inférieure à 1 million d'années alors que la Zone E1b recouvre environ 4 millions d'années. La Zone E2 est située dans le Valanginien moyen à la base de la magnétozone M11 et correspond, dans les Alpes méridionales, à une période à valeur de 13C élevée (Weissert & Lini, 1991). Durant cette période caractéristique, interprétée par les auteurs comme un épisode climatique soumis à un effet de serre, on observe des intercalations pellitiques, une forte bioturbation et une sédimentation cyclique. Cette même période (Zones E2 et F1 datées du Valanginien moyen à supérieur) est aussi caractérisée par l'abondance de certaines espèces dans les échantillons de la section Fiume Bosso.

Tous les taxa étudiés, parmi lesquels une nouvelle sous-espèces, 61 nouvelles espèces et 2 nouveaux genres, sont décrits et illustrés dans la partie systématique de cette thèse.

## ACKNOWLEDGEMENTS

This thesis would not have been possible without the help and friendship of many people and J would like to thank everybody. Without the limitless support of my mother and my grandparents, I would have never reached the stage I am at now.

I am very much indebted to my principal supervisor, Prof. Peter O. Baumgartner. His knowledge, help, understanding and patience both in the field and in the laboratory, and the many useful discussions were of a great benefit.

Many thanks go to Jean Guex and Jean Savary and their help in processing and analysing my data.

I am very thankful to Prof. J. Remane (University of Neuchâtel) for the determination of calpionellids and to my husband Paulian Dumitrica for all his encouragements and his precious help in carefully looking through the systematic part.

The late Detlef Wurm spent many days with me in quarries and on road cuts for collecting samples and encouraged me during the preparation of the thesis.

I would like to thank Prof. E. Flügel (Institute of Paleontology at Erlangen, Germany) who allowed me access to their SEM, Christian Dullo for his help on the SEM and Christel Sporn, Beate Forrer and Mrs Neuffert for the photographic work.

Many thanks go to Werner Witte (technician for SEM) and Fred Zweili (technician for SEM, Universität Bern), to Edouard Sottas and R. Ansermoz at Université de Lausanne for their advices and help.

Further, I am very grateful to Walter Alvarez (University of Berkely), Rodolpho Coccioni (University of Urbino), Fabrizio Cecca and Stephano Cresta (Geological survey, Rome) for guiding me in the Umbrian area.

Many thanks go to Daniele Biaggi, Philipp Steinmann and Wolfgang Kickmaier (University of Berne) who provided me residues of about 100 samples from sections in Oman.

I am very thankful to Luis O'Dogherty, who shared during several years the working place with me, for his help, patience and encouragements. Many thanks go to Spela Gorican, Glynn Ellis, Pascale Mallan, Lucia Santini, Christel Daelman, Claudia Baumgartner and Johannes Hunziker for their help and encouragements.

I would like to thank also Bettina Ernst, Gianni di Marco, Alain Pillevuit for the preparation of many samples, to Rosemary Cosca and Glynn Ellis for the correction of the English text, to Anne-marie Magnenat and her cat Bazile for giving me a second home in Lausanne and helping me in so many ways.

This thesis would not have been possible without the founding of the Swiss National Foundation (project No. 2.332-0.86) and of the Société Académique Vaudoise.

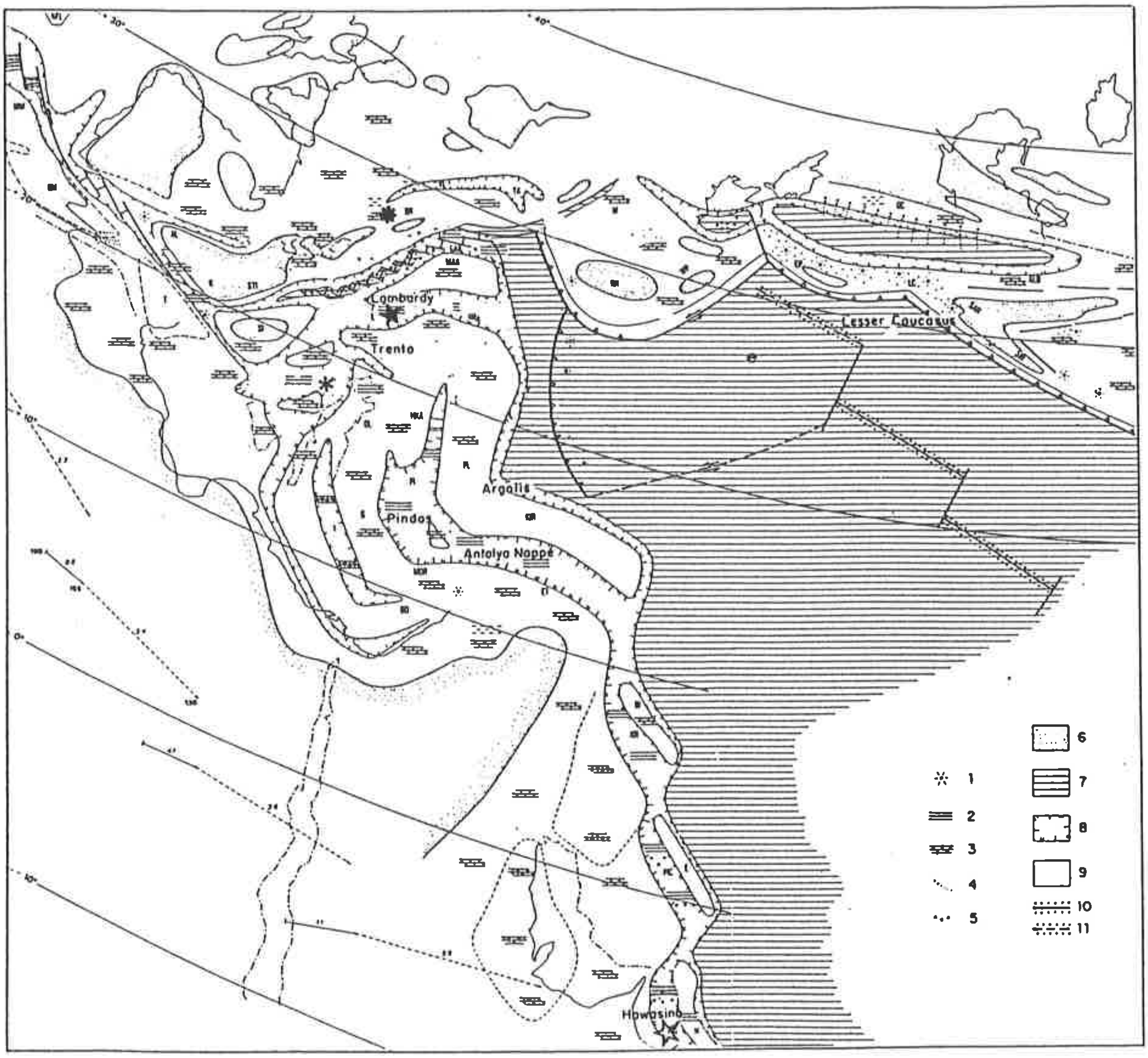
Publication would not have been possible without support of the Université de Lausanne (Réctorat) and the Fondation De Giacomi.

# 1. LITHO-, MAGNETO- AND BIOSTRATIGRAPHY

## 1.1. Introduction

During the Upper 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 limestone (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.

Radiolarians of the Maiolica Formation have been discovered and described about 100 years ago (Rüst 1885, 1888, 1898, Parona 1890, Vinassa de Regny 1898, 1899, Squinabol 1914). However this research was not renewed until the 1980's 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). Whereas a number of sections from the Southern Alps and of the Umbria Marche Apennines have been thoroughly studied for paleomagnetic




| | | | |
|---|---|---|---|
| ● Préalpes médianes | 1 Volcanism | | 7 oceanic crust |
| ★ Southern Alps | 2 Radiolarite | 3 limestone | 8 thin continental crust (basin) |
| ✱ Umbria (basins and seamounts) | 4 Flysch | | 9 thick continental crust (platform) |
| ☆ Oman (Hawasina basin) | 5 Breccia | | 10 active spreading ridge |
| | 6 emergent land (on any type of crust) | | 11 spreading ridge when dying out |

Fig. 1 Paleogeographic map of the Upper Jurassic with location of sampling areas (modified after Dercourt et al., 1985a).

events (e.g. Lowrie & Channell, 1983, Channell et al., 1984, Premoli-Silva et al., 1990), nannofossils (Monechi, 1981, Bralower, 1987, Bralower et al., 1989) and calpionellids (Remane, 1985), no comprehensive study was made on the radiolarian biostratigraphy of the Maiolica Formation. Radiolarians are the most frequent and diverse group of planktonic microfossils occurring at the level of this formation and their biostratigraphic value is not at all smaller than of the other microfossils.

It is the purpose of this thesis to prove this value and to establish a radiolarian biochronology of the Lower Cretaceous, based on the rich radiolarian faunas recovered from the Maiolica and adjacent formations, as well as from some sections of the Wahrah Formation (Hawasina Complex, Oman) that represents a mostly siliceous pelagic facies of similar age.

## 1.2. Purpose of the study

- To make a comprehensive inventory of the radiolarian assemblages occurring in the interval comprised between the Upper Tithonian and the lowermost Aptian corresponding to the Maiolica Formation.
- To make a systematic description of the taxa recorded, including new genera, species and subspecies.
- To establish a radiolarian biochronology with the Unitary Association method developed by Guex (1977-1987).
- To correlate and calibrate the constructed radiolarian zones with magnetostratigraphy established in the same sections and with biozonations of other fossil groups.

## 1.3. Methods

Twenty six sections were examined from which more than 500 samples were collected, most of them of radiolarian-bearing limestones, in order to analyse their radiolarian faunas. Radiolarians are generally calcified in the pure micrite beds. They are more or less well preserved inside of non completely silicified chert bands or nodules. Selection of radiolarian samples was based on preliminary acid preparations in the field as follows: samples were soaked in 10% HCl acid for 2-3 minutes, then washed, dried and examined under a binocular microscope. Only those samples showing well preserved siliceous radiolarians etched out of the lime matrix were collected for laboratory work.

In the laboratory the limestone samples were placed in dilute (5 to 10%) hydrochloric acid for 30 to 60 minutes (Fig. 3b). They were then washed through a 63 micrometer sieve. Radiolarians from siliceous rocks were extracted with a standard HF method, the samples being reacted in 5% diluted acid for one or two days, and the freed radiolarians collected after washing through a 63 μm nylon sieve.

Radiolarians were first examined under a binocular microscope. They were picked out from the residue and systematically grouped into Plummer-cells. The best preserved specimens were mounted on Scanning Electron Microscope (SEM) stubs for photography. More than 4000 SEM pictures were taken during the study. After a systematic search of all different morphotypes in 245 samples, the data of 175 selected taxa were collated in a data base and processed by BIOGRAPH (Savary & Guex 1990). We have obtained 35 Unitary Associations which were grouped to establish a radiolarian zonation for the Uppermost Oxfordian to Lowermost Aptian. This zonation was refined and correlated with callpionellid, nannofossil and paleomagnetic zonations.

## 1.4. Description of sections

### 1.4.1. Introduction

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 grey pelagic limestones with abundant black, grey or rose coloured chert layers and nodules and abundant slumps. Black shales are intercalated in the Valanginian (Weissert et al., 1987) and in the Barremian in the Southern Alps, and in the Barremian only in the 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, grey-green marls, shales and intervals of cyclic sedimentation. Limestones are rich in radiolarians but very rare ammonites were also found (Rieber, 1977; Cecca et al., in press).

The basinal correlative facies of the Maiolica are 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 developed in the eastern part of the Prealpine Nappes, in the "Klippendecke" (Schardt, 1898) or Nappes des Prealpes médianes plastiques internes (Lugeon & Gagnebin, 1941, Baud, 1972).

A series of samples at the level of the Maiolica Formation was also studied from several sections of the Wahrah-Formation belonging to the Hawasina Nappes (Oman, distal Arabian Margin) and consisting of nonmetamorphic mudstones, mud-siltstones, chert horizons, siliceous clay beds and intercalated manganese horizons (Kickmeier & Peters, 1990, Biaggi, Steinmann 1991).

## 1.4.2. Préalpes médianes plastiques: Pfaffengrat (Switzerland)

The "Klippendecke" or "Nappes des Préalpes médianes plastiques" which paleogeographically were part of the Northern Tethys in the Middle Penninic Zone, are characterized by a hemipelagic turbiditic sequence and by beige limestones rich in chert layers and chert nodules. The "Kummlischichten" (uppermost Tithonian) and the following Neocomian "Fleckenkalke" have not previously been studied for radiolarians, although the occurrence of radiolarians in thin sections has been mentioned by previous workers such as Umiker (1952), Boller (1963), Spicher (1965), Thury (1971), Andrey (1974), Isenschmid (1983), Jud (1983) and others.

### Pfaffengrat

*Study area*

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 part of an anticline named after the peak of the Stockhorn and is situated on the eastern flank of the Pfaffengrat (north-east of point 1957.30). The coordinates on the topographic map Thun (1:25'000) are the following: 605.410/170.910.

*Lithology*

The "Kummlischichten" (Upper Tithonian) and the Neocomian "Fleckenkalke" (Berriasian-Valanginian) consist mostly of thin-bedded limestones and thicker turbiditic coarse-grained beds in the lower part of the sequence (Fig. 3a, 4). The transition between the thick-bedded Upperjurassic "Massivkalk" ("Formation des calcaires massifs", Spicher, 1965) and the "Kummlischichten" is gradual; consequently the Jurassic-Cretaceous boundary is not marked by a distinct lithological change. Thick resedimented coarse-grained beds are dominant in the "Massivkalk" Formation, but become more and more rare in the "Kummlischichten" and in the "Fleckenkalke", towards the Lower Valanginian.

A base level for sampling (0.00 m) was chosen at the top of the last very thick, massive bed which is visible on the right part of the photography. Above it there are 61 m of thin-bedded limestones and some intercalated coarse-grained beds. Limestones contain abundant chert beds and nodules. No slumps were recognized, which contrasts to the sections in the Southern Alps and in the Umbria-Marche Apennines. A very thick turbiditic bed between 61.50 and 63.40 m (Fig. 3a, left arrow) represents a marker-bed, since it is continuous over several kilometers to the south-west (Boller, 1963). It is also visible on the eastern cliff of the Stockhorn peak, at a distance of about 1 km from the studied section Pfaffengrat. The thin-bedded Neocomian "Fleckenkalke" are characterized by an intensive bioturbation and by the absence of chert horizons and nodules at the upper part. Consequently this part could not be sampled.

The Cretaceous deposits are set in narrow anticlines and synclines. However the lower portion of the Lower Cretaceous is generally less disturbed because of its rather protected position above the mostly massive Jurassic beds, whereas the upper portion of the Lower Cretaceous and all younger sequences have undergone strong folding which hampers a proper sampling.

*Calpionellids*

Calpionellids of this section were first studied by Boller (1963). Unfortunately his data can only vaguely be correlated with our results because of the differences in the measurements of the sampled portion. A detailed study of the calpionellids and radiolarians recovered from the same levels is therefore required.

*Radiolarians*

This study represents the first radiolarian analysis of parts of the "Kummlischichten" and of the "Fleckenkalke". Radiolarians are rare to common but poorly to moderately preserved, most of them being replaced by calcite. Diversity is low, quite probably rather because of the diagenesis than of paleoecologic reasons. The best sample was collected at 35.00 m. It contains the U.A.7-10 and can be compared with the samples 1 and 2 at 163.00 m and 162.80 m respectively of the section Capriolo, in the Southern Alps. There we have a direct stratigraphic control by the correlation of calpionellids, nannofossils and paleomagnetics. The sample 5 at Pfaffengrat could therefore correspond to the calpionellid zone D1 identified at Capriolo in the interval between the FAD of the nannofossil *C. angustiforatus* and the LAD of *U. granulosa granulosa,* in the magnetic polarity chron M16 (Channell et al., 1987). It would prove an Upper Berriasian age.

## 1.4.3. Southern Alps: Breggia Gorge, Cava Rusconi, Capriolo

The 3 investigated sections, Breggia Gorge, Capriolo and Cava Rusconi (Fig. 5a, 5b) are paleogeographically situated in the Lombardian Basin which belonged to the Southern Tethyan margin and was part of the Apulian Plate (Bosellini & Winterer 1975, Weissert, 1979). The Lombardian Basin was at its turn divided into several smaller basins or troughs separated by small ridges. The Cava Rusconi section, in the west, is located in the Mt. Nudo Trough, the

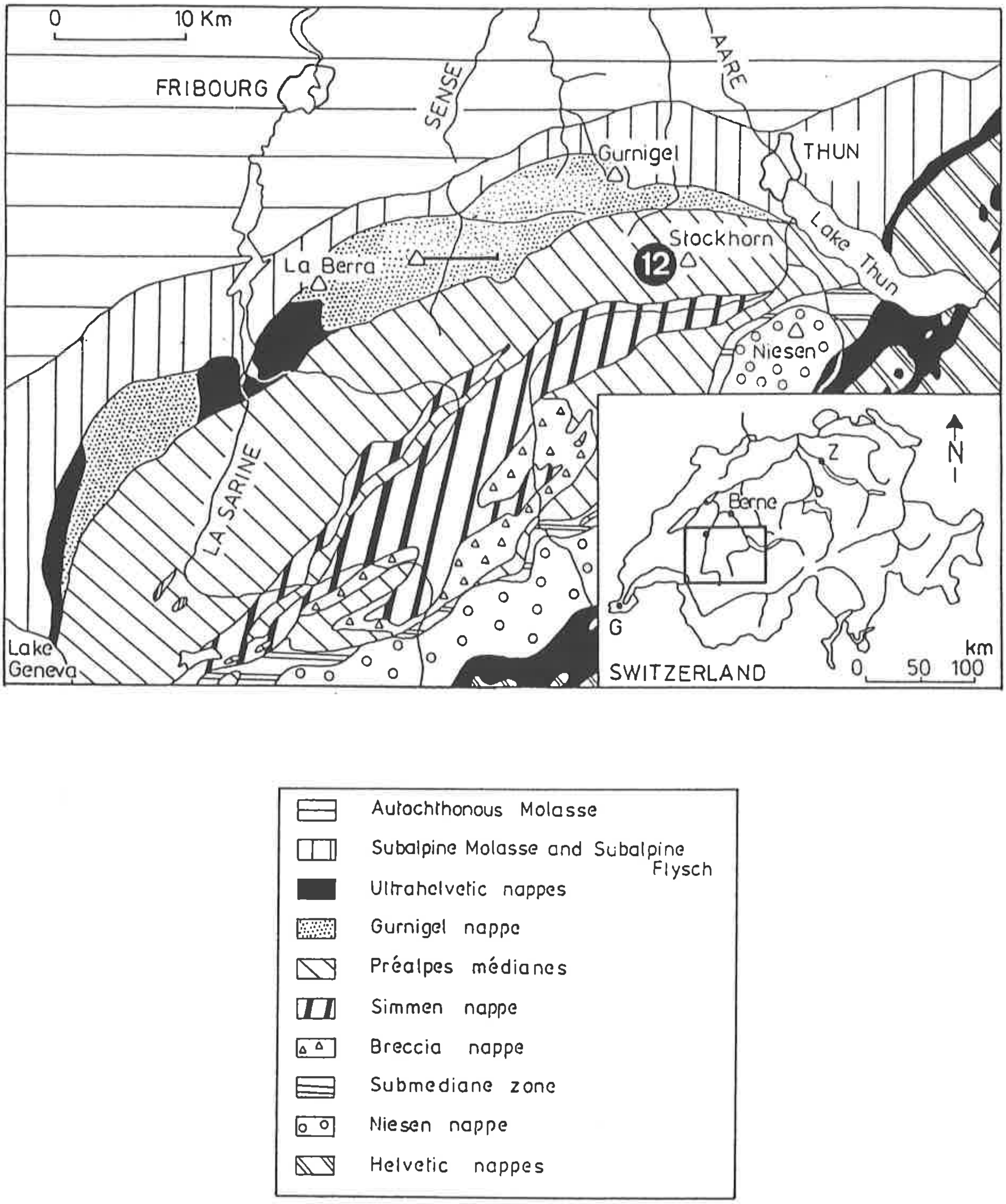



Fig. 2 Tectonic map with location of Pfaffengrat section in the Préalpes médianes (modified after De Kaenel et al., 1989).

Fig. 3a Pfaffengrat section: thin-bedded limestones with thick turbiditic reference bed (arrow A). Base of sampling is on the right (arrow B).

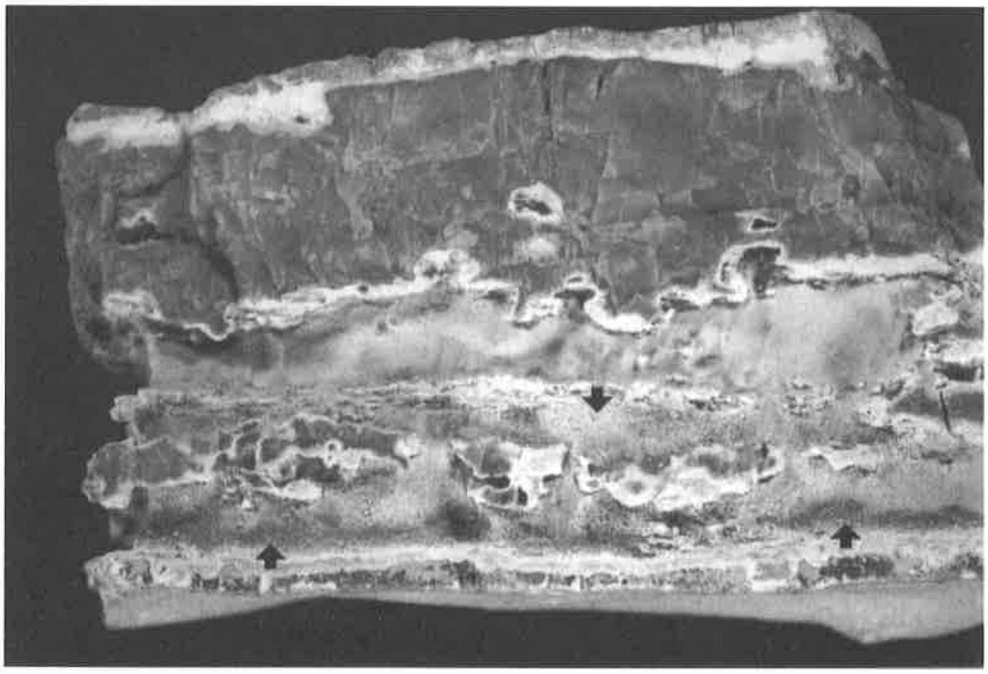


Fig. 3b Etched limestone sample with a thick dark-gray chert band and small chert nodules. Radiolarian-rich zones are marked by arrows.

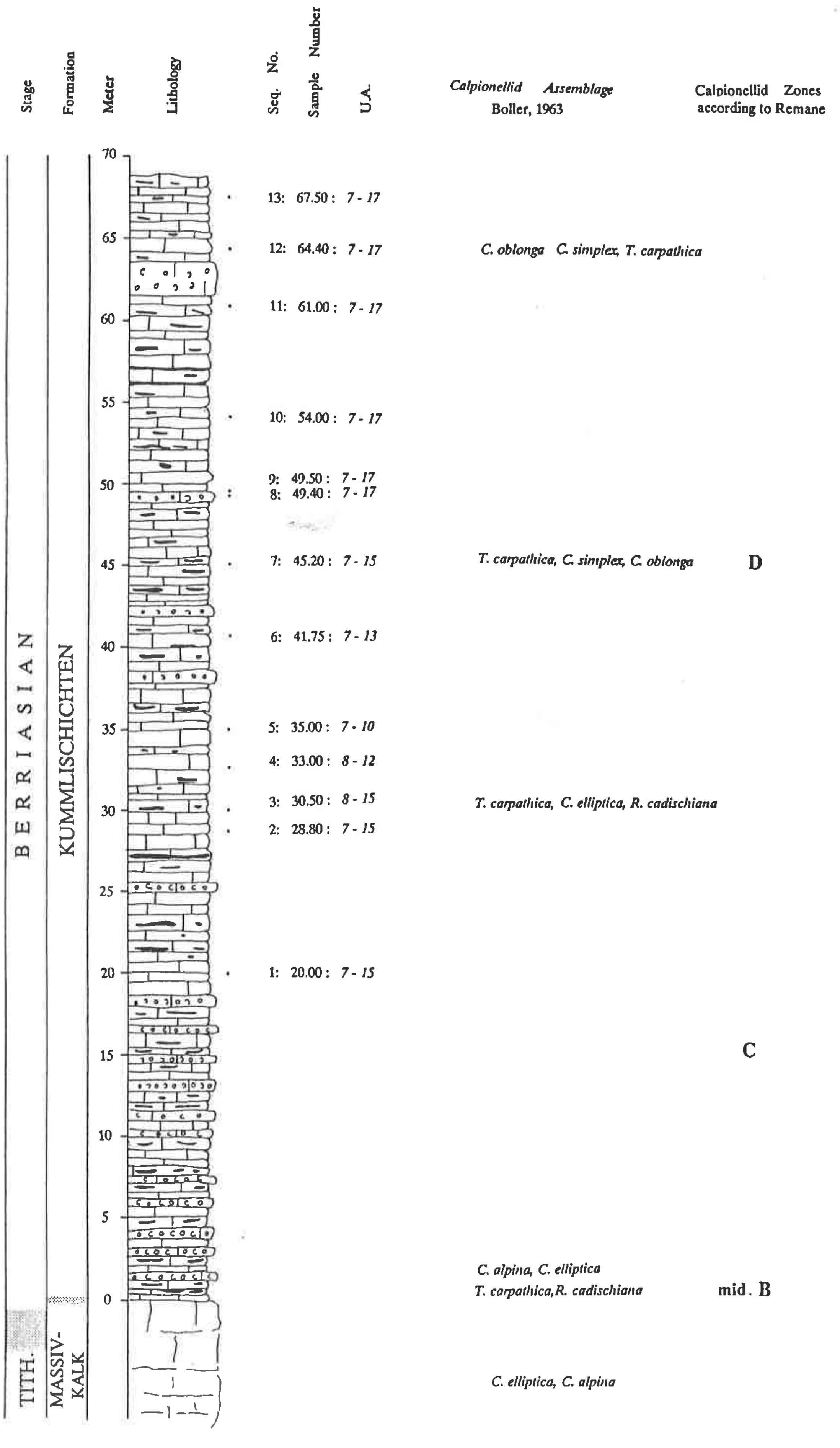



Fig. 4 Pfaffengrat section: correlation of Unitary Associations to calpionellid assemblages and to lithostratigraphy.

Breggia Gorge section in the Monte Generoso Trough and the Capriolo section in the eastern Lombardian Basin, west of the Trento Plateau.

Only the uppermost Tithonian to lowermost Aptian part of the sections, the Maiolica Formation respectively, was here investigated. The Maiolica Formation overlies the Jurassic Rosso ad Aptici Formation and is conformably overlain by Aptian to Cenomanian deep-water pelagic sediments known as Scaglia Variegata Formation. The Maiolica consists of white to gray colored, well-bedded limestones with chert layers and chert nodules and pelitic intervals. Synsedimentary processes such as slumps and breccia horizons are frequent as well as laminated bedding, cyclic bedding and intervals of pelitic sedimentation suggesting paleoclimatic changes.

Recent investigations of many sections in the Southern Alps by Channell et al. (1987) and Channell et al. (1993) have led to well established correlations of magneto-, nannofossil and calpionellid stratigraphy.

## Breggia Gorge

### *Study area*

The Breggia-Gorge is located in Southern Switzerland north of Chiasso (Fig. 5a), near the border to Italy (coordinates on the topographic map 722.300/79.530). The section is situated in an abandoned quarry on the western side of the Breggia River, which is reached on a small foot path which starts on the western side of the buildings of the former cement factory and follows the eastern border of the Breggia River.

### *Lithology*

The Maiolica Formation was sampled at the western side of the river. Two tunnel entrances disturb the sampling area and forced us to sample in two portions. The first one contains all samples upwards from the first white limestone beds overlying the Rosso ad Aptici Formation (Fig. 6a) and finishes at 74.80 m. The second portion was sampled downwards from the base of the Scaglia Variegata Formation (Fig. 6b) and terminates at 23.00 m. There was no possibility to sample between the two tunnel entrances and therefore our two measured and sampled parts were merged filling the missing portion by comparison with the total thickness of 130 m of the section as it had been measured by Weissert (1979).

The contact between the Maiolica Formation and the underlying siliceous Rosso ad Aptici Formation is abrupt and well exposed. The last steeply dipping red bed covered with trace fossils and aptychi was the base (0.00 m) of our measured section. The first sample was collected at 0.025 m, just within the first undisturbed, very thin, dark-grey bed. Above this sample there are two slump horizons totalizing a thickness of about 23 meters (Fig. 6a, the equivalent part of the slump deposits was photographed on the eastern side of the river). A breccia bed with chert-components is observed in the second slump. Just above the northern tunnel entrance, at about 33 m, pelitic intervals appear and increase in number and thickness up to about 60 m.

A zone of cyclic sedimentation was observed in the interval between 46 and 60 m. Slump horizons are located at several levels. Chert layers are very abundant in the lower portion of the section. Four remarkably thick chert bands are observed between 25 and 26 m and 38 and 39 m. In the lower part of the section the limestones become increasingly bioturbated, and above 28 m there is a distinct change in colour from white to gray. Above 73 m again the color changes into beige and white.

The southern portion was sampled stratigraphically downwards starting below the base of the Scaglia Variegata Formation. The boundary with this formation indicates an abrupt change in facies. Rieber (1977) and Weissert (1979) mentioned at this boundary a glauconitic hardground which might indicate an interruption in sedimentation. The interval between 0.00 and 22.00 m is marked by some very thick pelitic black-coloured layers. Chert bands and nodules are rather rare and increase in number only in the non accessible zone, above the southern tunnel entrance. Limestones are highly bioturbated and a zone with remarkably red-coloured beds was observed between 22 and 23 m.

### *Calpionellids*

Several samples were examined by Prof. J. Remane (pers. comm. 1991). But calpionellids were rare and preservation poor. By present we have no concrete results, consequently we had no possibility to correlate the radiolarian zones herein distinguished with calpionellid zones.

### *Nannofossils*

Aita & Okada (1986) examined 17 samples spanning the Upper Jurassic-Barremian interval. They indicated that preservation was poor and concluded that further investigations on nannofossils were required. The section is studied at present in detail for nannofossils, magnetostratigraphy and chemostratigraphy by Channell, Erba and Lini (pers. communications).

### *Aptychi*

Renz & Habicht (1985) sampled the Breggia section for aptychi and defined the stage boundaries by correlating their data to those of DSDP Leg 76, Hole

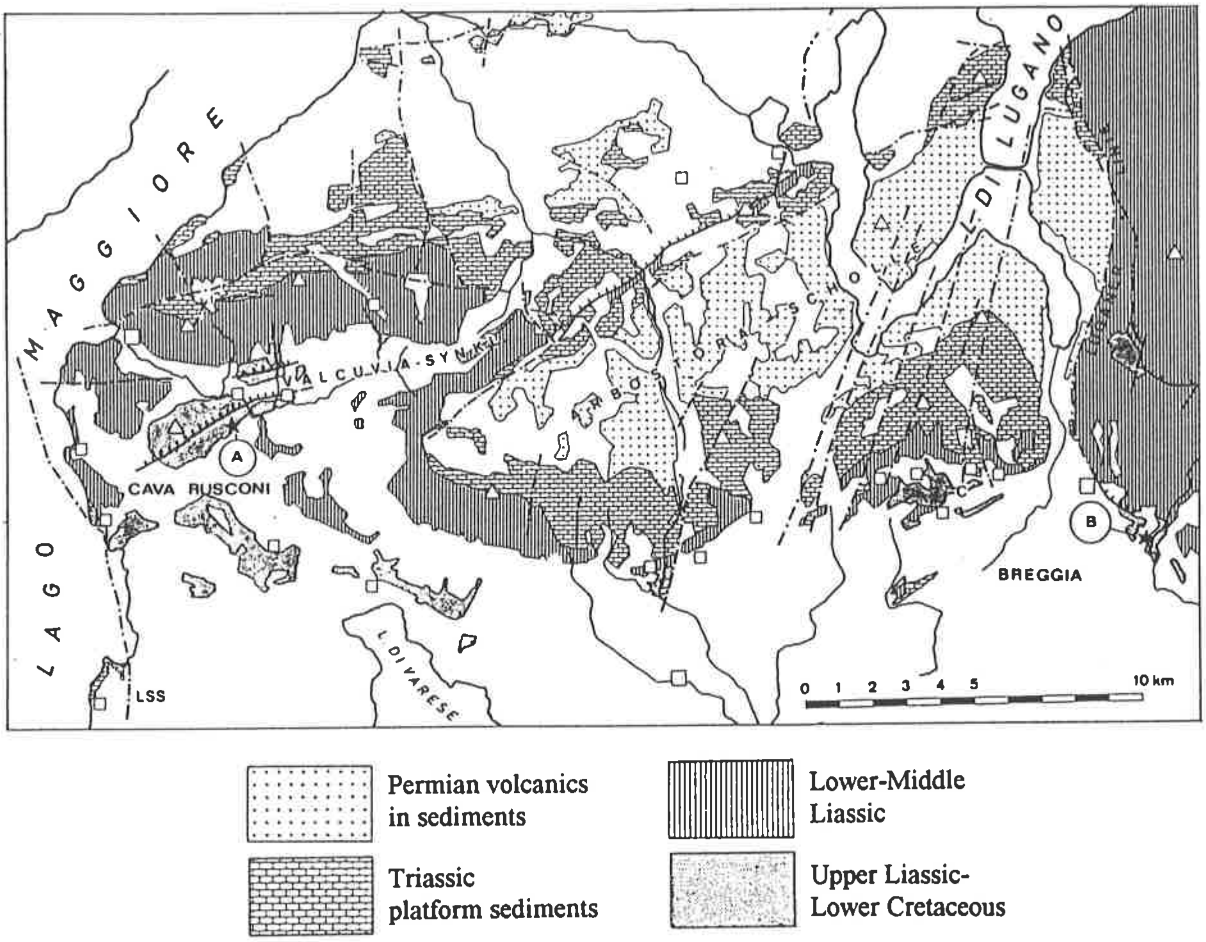



Fig. 5a Geological-tectonical map of the Western Southern Alps with location of Cava Rusconi section (A) and Breggia section (B) (modified after Kaelin et al., 1977).

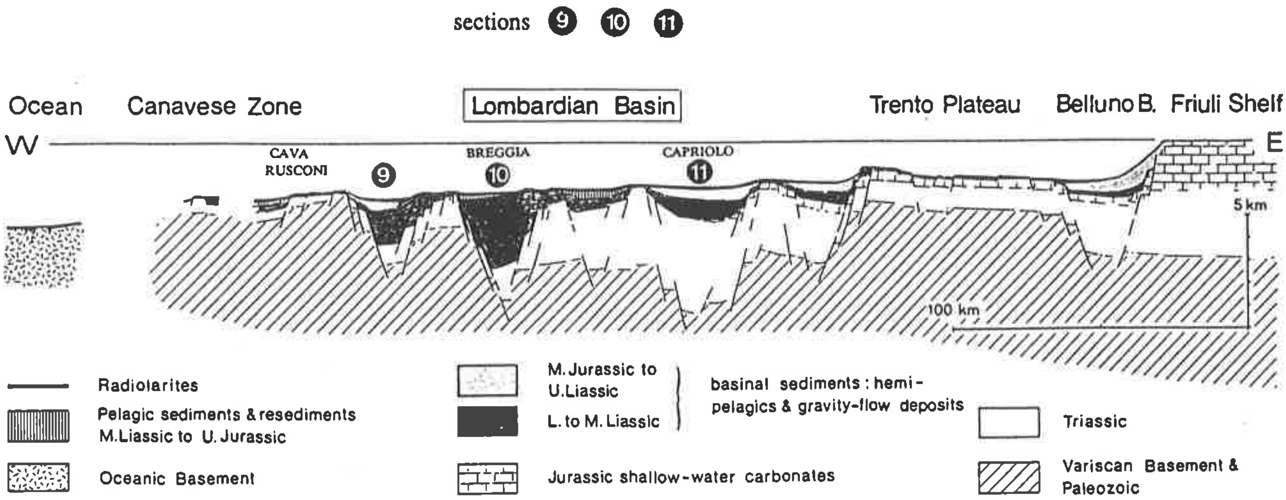



Fig. 5b Palinspastic cross-section through the Southern continental margin of the Tethys in the Late Jurassic with paleogeographic position of the Cava Rusconi section (9), the Breggia (10) and the Capriolo section (11) (modified after Bernoulli & Kälin).

Fig. 6a Breggia Gorge section (outcrop near Breggia river): base of section with thin-bedded Rosso ad Aptici on the left and white Maiolica limestones (slumped interval) on the right.

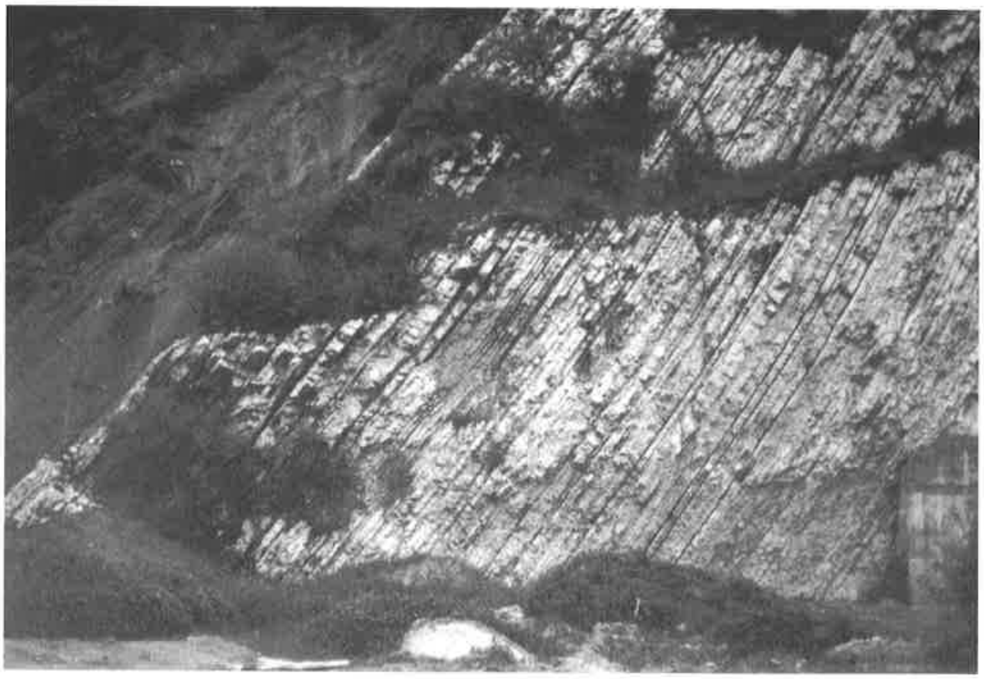


Fig. 6b Breggia Gorge section: top of section with Maiolica limestones, intercalated by black-shales and marls on the middle and right portion and Scaglia variegata on the upper left.

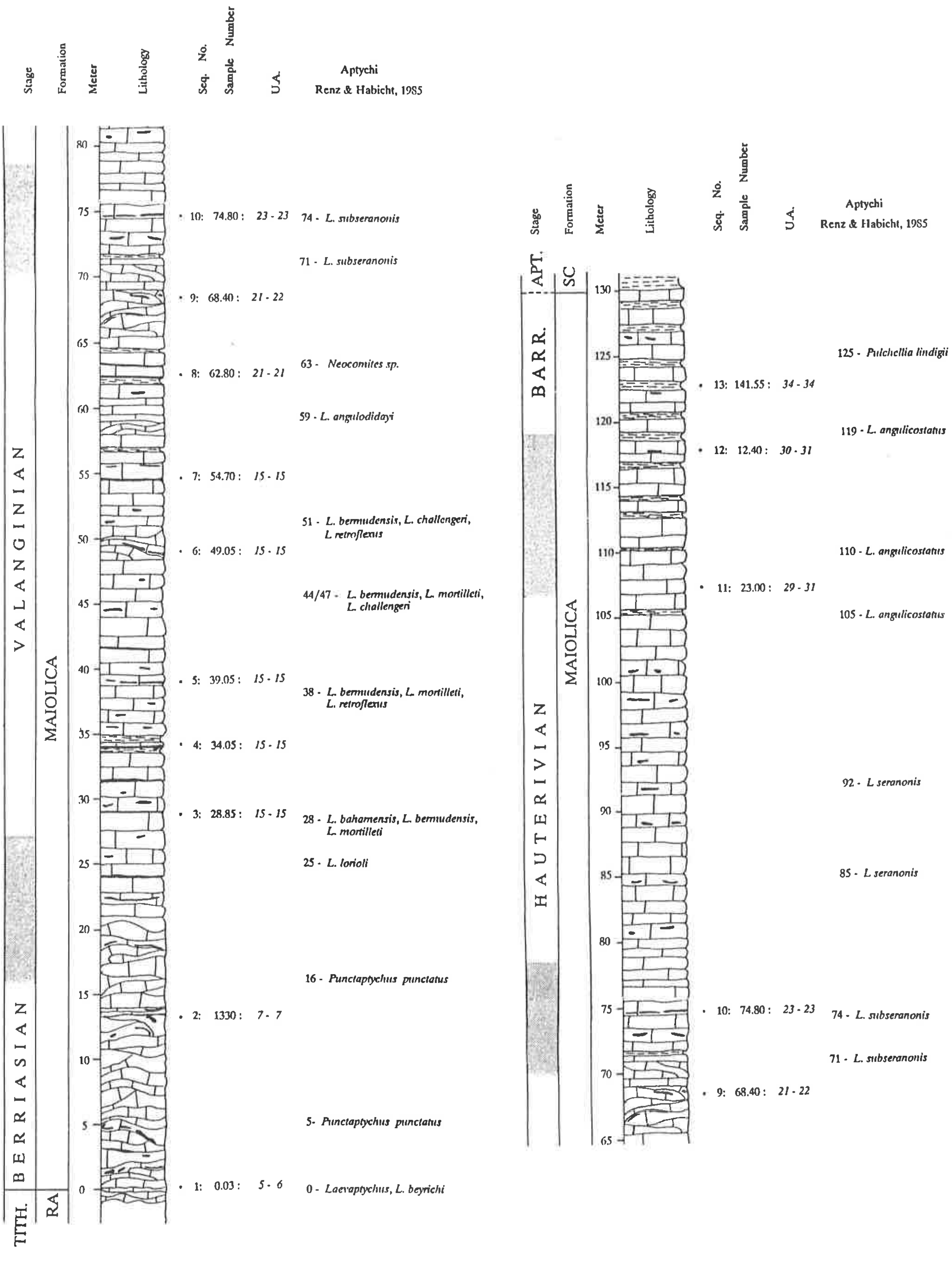



Fig. 7 Breggia Gorge section: correlation of Unitary Associations to Aptichi assemblages and to lithostratigraphy.

534A and Leg 44, Hole 391C. We tried to correlate their data to ours (see Fig. 7) precising their sample-levels on the lithologic column and comparing their stages boundaries with ours placed by the correlation of the radiolarian zones of this section to those of the Capriolo section.

### *Radiolarians*

The radiolarian fauna was very well preserved in most samples and is characterized by a high diversity. The very long interval comprised between 30 and 55 m (Fig. 7), corresponding to the Lower Valanginian, is characterized by only one Unitary Association whereas the interval between 60 and 75 m, corresponding to the Middle to Upper Valanginian, is defined by several rather short-ranged assemblages. These remarkable zones can be correlated to characteristic paleoclimatic changes. A discussion about this is found in chapter 4.

Baumgartner (1984) included the Breggia section in his Middle Jurassic-Early Cretaceous radiolarian zonation. His sample POB 1330 was collected 10.50 m above the last steeply dipping bed of the Rosso ad Aptici Formation and was identified as U.A.11, zone D, uppermost Tithonian to lowermost Berriasian in age. Included within our data set, the same sample is identified as U.A.7, which corresponds to our zone D2, having a lowermost Berriasian age.

Aita & Okada (1986) recognized two zones, of which one new, in the Breggia section and correlated them to sections in Japan. Only the FAD of *Sphaerostylus septemporatus* in the upper Valanginian, which defines the base of their *Sphaerostylus septemporatus* zone, is in agreement with our data.

In the Breggia section we established 6 radiolarian zones. The Tithonian/Berriasian boundary is included in our lowermost zone D2. The Berriasian/Valanginian boundary was placed between the samples POB1330 and 28.85 m. The Valanginian/Hauterivian boundary, placed by Renz & Habicht (1985) just above the level 63 m with *Neocomites sp.*, on the basis of a very conspicuous break in variability and abundance of aptychi, corresponds to our sample 62.80 m (U.A.21). This sample should however be placed in the Middle to Upper Valanginian if it is correlated with the data of the Capriolo section. The Hauterivian/Barremian boundary was placed by Renz & Habicht (l. cit.) at 102 m. This level falls into the interval where we could not collect radiolarian samples, just below the level 23.00 yielding the U.A.29-31. This indicates that the Hauterivian/Barremian boundary would lie in the interval between 23.00 and 74.80 m.

## Cava Rusconi

### *Study area*

The section is located in an active quarry, property of Cementi Rusconi, southwest of the small village Cittiglio at about 4 km southeast of the Lago Maggiore, in the province Varese, Italy. (Fig. 5a, b).

### *Lithology*

The succession of the section is much disturbed by tectonics, large chevron folds and numerous fractures (Fig. 8a). An intensive stylobedding is observable between 0 m and 50 m. Correlation of the beds within the folds was possible only by using as marker some very thick chert bands, or couplets or triplets of chert levels. The base of the section was defined at the top of the last bed of the Rosso ad Aptici Formation. The uppermost part of the Maiolica Formation does not outcrop (Fig. 10).

Like all other sections of the Southern Alps the Cava Rusconi section was also highly influenced by synsedimentary processes represented by slumps (Fig. 8b) and breccia horizons (Fig. 9a). Several breccia beds were observed between 10 m and 100 m and thick slump intervals in the upper part of the section. Thin dark-gray coarse-grained beds with aptychi occur at 89.90 m, 107.90 m and 177 m. Black, green, dark-gray to blue-gray pelitic intervals (Fig. 9b) and limestone beds containing dark-gray laminated levels (Fig. 9a) are abundant in the interval 76-135.00 m. At the basal part of the section limestones are white to beige and change at about 40 m to light-gray, showing more and more traces of bioturbation. A distinct change in colour from gray to green or red was observed at 53.30 m. The top of the examined section is characterized by thick beds of beige limestones with rounded yellow-greenish fragments up to 12 cm in size.

### *Calpionellids*

We had sampled the interval between 3.20 m and 97.40 m. The calpionellids of this interval were studied by Remane (pers. communication). But the micropaleontological content was very inconsistent, with intervals barren and intervals yielding only rare and mostly crushed specimens. Most samples seem to contain mixed faunas. Remane has already studied the calpionellids of this section in Lüthi (1973) but because of differences in the measured thicknesses of the section no correlation of our radiolarian zones to the calpionellid zones was possible.

### *Nannofossils and Magnetostratigraphy*

This section was never investigated neither for nannofossils nor for magnetostratigraphy, and the

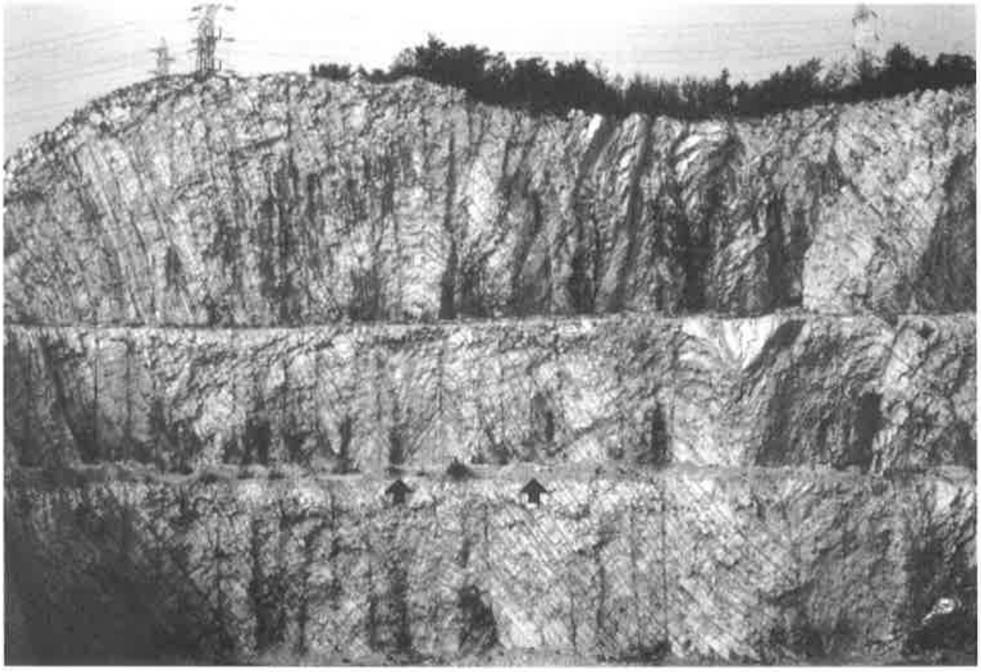


Fig. 8a Cava Rusconi section: samples were collected on the lowermost terrace.

Fig. 8b Cava Rusconi section: slumped interval of thin-bedded Maiolica limestones with contorted chert layer.

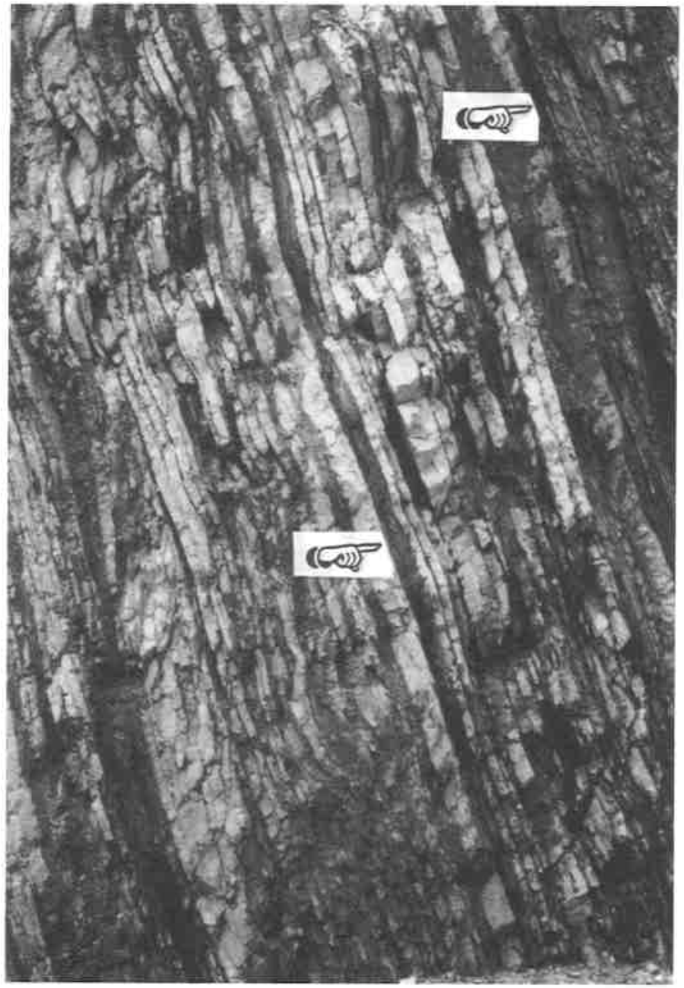


Fig. 9a Cava Rusconi: Maiolica limestones with chert bands, breccia layer and laminated portion at the base of the bed.

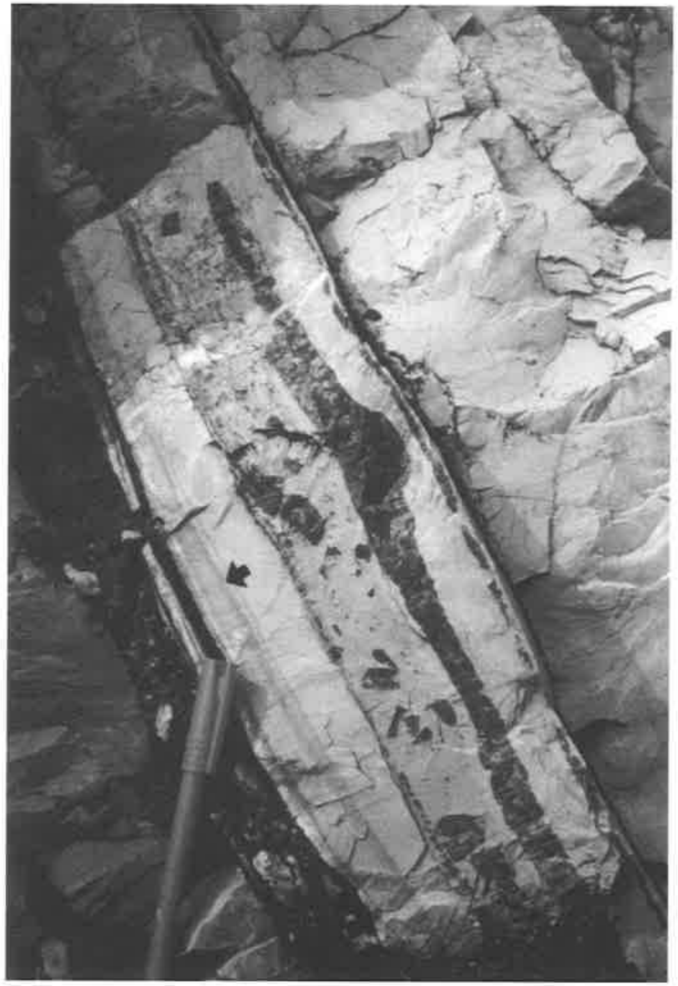


Fig. 9b Cava Rusconi: thin-bedded Maiolica limestones with intercalation of marls (finger-pointing).

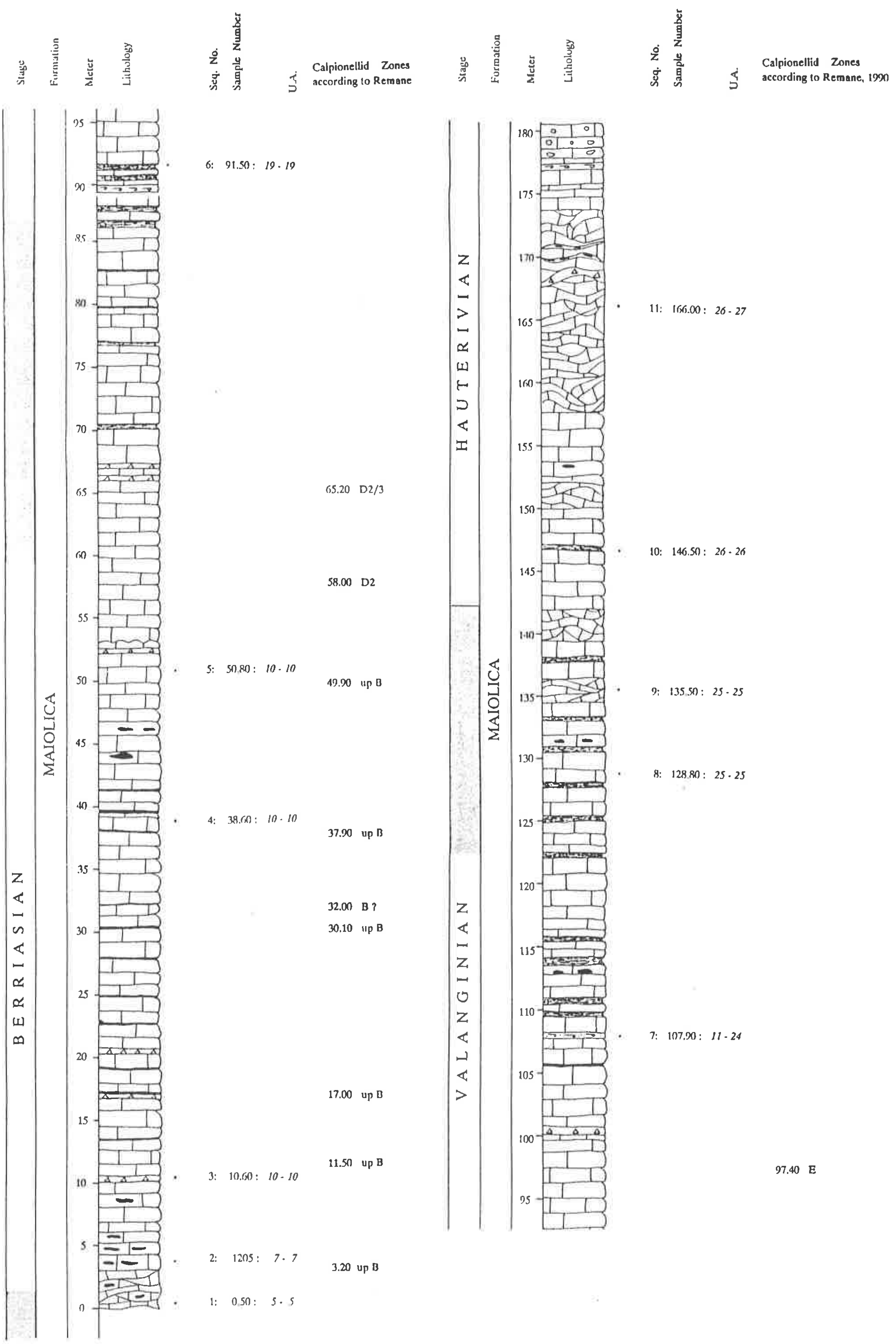



Fig. 10 Cava Rusconi section: correlation of Unitary Associations to calpionellid zones and lithostratigraphy.

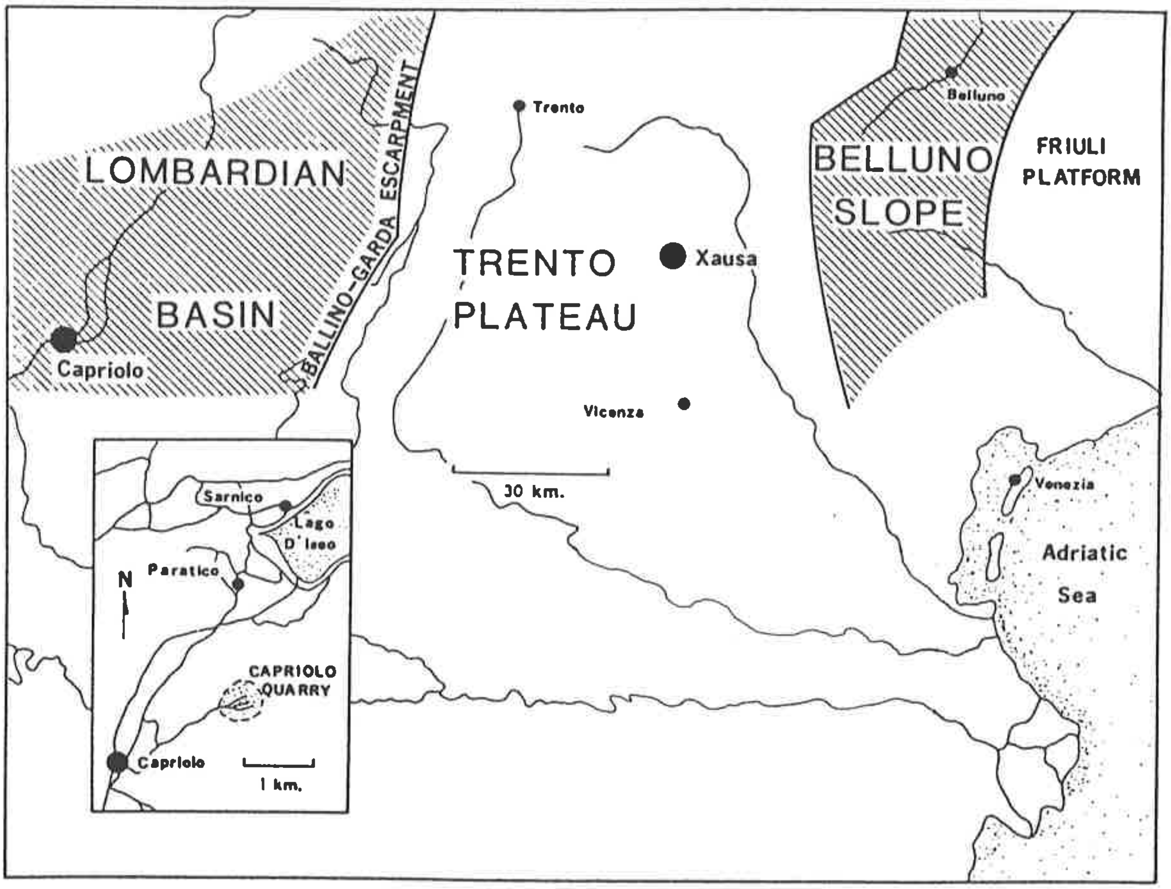



Fig. 11a Map of north-eastern Italy showing the sampling locality Capriolo. Inset shows the position of the Capriolo quarry north-east of the village (modified after Channell et al., 1987).

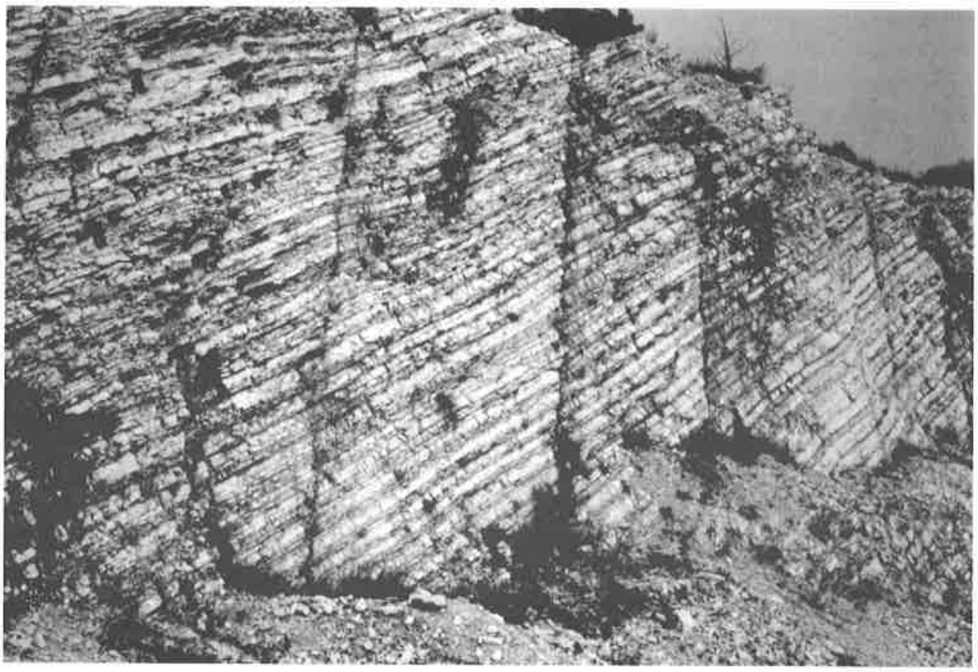


Fig. 11b Capriolo section: rhythmically bedded Maiolica limestones.

problems in correlating the beds in such a folded section is difficult and might be erroneous.

*Radiolarians*

Radiolarians are abundant, in some samples well preserved and highly diversified. Five radiolarian zones were identified (Fig. 10) of which the uppermost zone (F2) indicates a lowermost Hauterivian age for the slumped interval below the top of the outcropping sequence. The sample POB 1205 corresponds to Breccia POB 1330 (U.A. 7, Lowermost Berriasian).

## Capriolo

*Study area*

The section is situated in Italy, north of the village Capriolo and south of Lago d'Iseo (Fig. 11a). The outcrop is in an abandoned quarry which is divided into three terraces. The base of the section is situated in the northern lowermost part of the quarry and the top in the southern part of the uppermost terrace.

*Lithology*

The Maiolica Formation was sampled stratigraphically downwards, following the measurements of Channell et al. (1987), starting with 0.00 m just below the first shales of the Scaglia Variegata Formation and ending at 175.00 m which corresponds to the lowermost part of the outcrop (Fig. 12). The lowest portion of the section consists of light-gray limestones with several breccia beds of which one has a remarkably inconstant thickness from 7 cm to 26 cm. At the interval between 140 m and 102 m the limestones are light-gray to dark-gray, bioturbated and contain levels with lamination. Cyclic bedding was observed in the interval between 105 and 120 m (Fig. 11b) and gray-green pelitic intervals between 135 m and 65 m. Numerous slump levels are present of which the thickest is observable between 17 m and 29 m. At the top of the section a few black shale levels occur below the Maiolica/Scaglia Variegata boundary, which is marked by an abrupt lithologic change.

*Magnetostratigraphy*

The section was measured and studied for magnetostratigraphy by Channell et al. (1987). The magnetic correlation indicated, that lithology had been erroneously correlated by 1 meter between the second to the third terrace. Thus we have to add 1 meter in the interval between 84 and 175 m (also for all our sample levels, which were not corrected on the stratigraphic column). Capriolo was reinvestigated by Channell & Erba (1992) and the definition of the uppermost magnetic chrons was changed (see under *Nannofossils* in this chapter).

*Calpionellids*

Calpionellids were examined and correlated to magnetic polarity zones by Grandesso (in Channell et al., 1987). The Tithonian and Lower Berriasian are not exposed and the calpionellid stratigraphy begins at the top of the calpionellid zone C. Our calpionellid samples, collected from the interval between 130.30 m and 170.00 m were studied by Remane (pers. commun. 1991) but due to their small number, did not allow to precisely establish zonal boundaries. Therefore we had to correlate the radiolarian zones to the calpionellid zones defined by Channell et al. (1987).

*Nannofossils*

Bralower (in Channell et al. 1987) correlated the nannofossil events to magnetostratigraphy and to calpionellid zones. The nannofossils were reinvestigated by Erba (in Channell & Erba, 1992), and the FAD of *Ricinolithus irregularis* was recorded this time 7 m deeper in the section. Therefore the magnetic polarity zone M3 was redefined as ?M1-M3 and the zone M1 as M0. The only events which differ from those from the Umbria-Marche area are the FAD of *Percivalia fenestrata* and of *R. irregularis*. *Percivalia fenestrata* which occurs at Fiume Bosso in M16 normal (Bralower et al., 1989) and at Capriolo at Upper M15, and is thus time-transgressive by one polarity chron. The FAD of *R. irregularis* in M1 normal at Capriolo is correlative to Gorgo a Cerbara, but is a little time-transgressive at Presale where it is placed in M0.

*Radiolarians*

Preservation of the radiolarians at Capriolo is rather moderate and the faunal assemblages show peculiar characters as compared with other sections, suggesting probably a paleoenvironmental control. Spumellarians dominate over nassellarians throughout the section. Several long-ranged and in general common to abundant taxa such as *Thanarla pulchra*, *Archaeodictyomitra excellens*, *Archaeodictyomitra apiarium*, *Parvicingula cosmoconica*, *Pseudodictyomitra carpatica*, *Obesacapsula verbana*, *Sethocapsa doryspaeroides and Ristola cretacea*, are very rare and even absent on long stratigraphic intervals, whereas long ranged spumellarians are present in almost all samples. This spumellarian dominance gives to all residues a very "spiny" aspect.

Six radiolarian zones were identified and correlated to magnetic polarity zones, nannofossil events and calpionellid zones (Fig. 12a, b). The slumped interval between 12 m and 28 m, which magnetostratigraphically cannot be determined, corresponds to the radiolarian zone F3 (U.A. 30-31) which is well correlative with the section Presale in

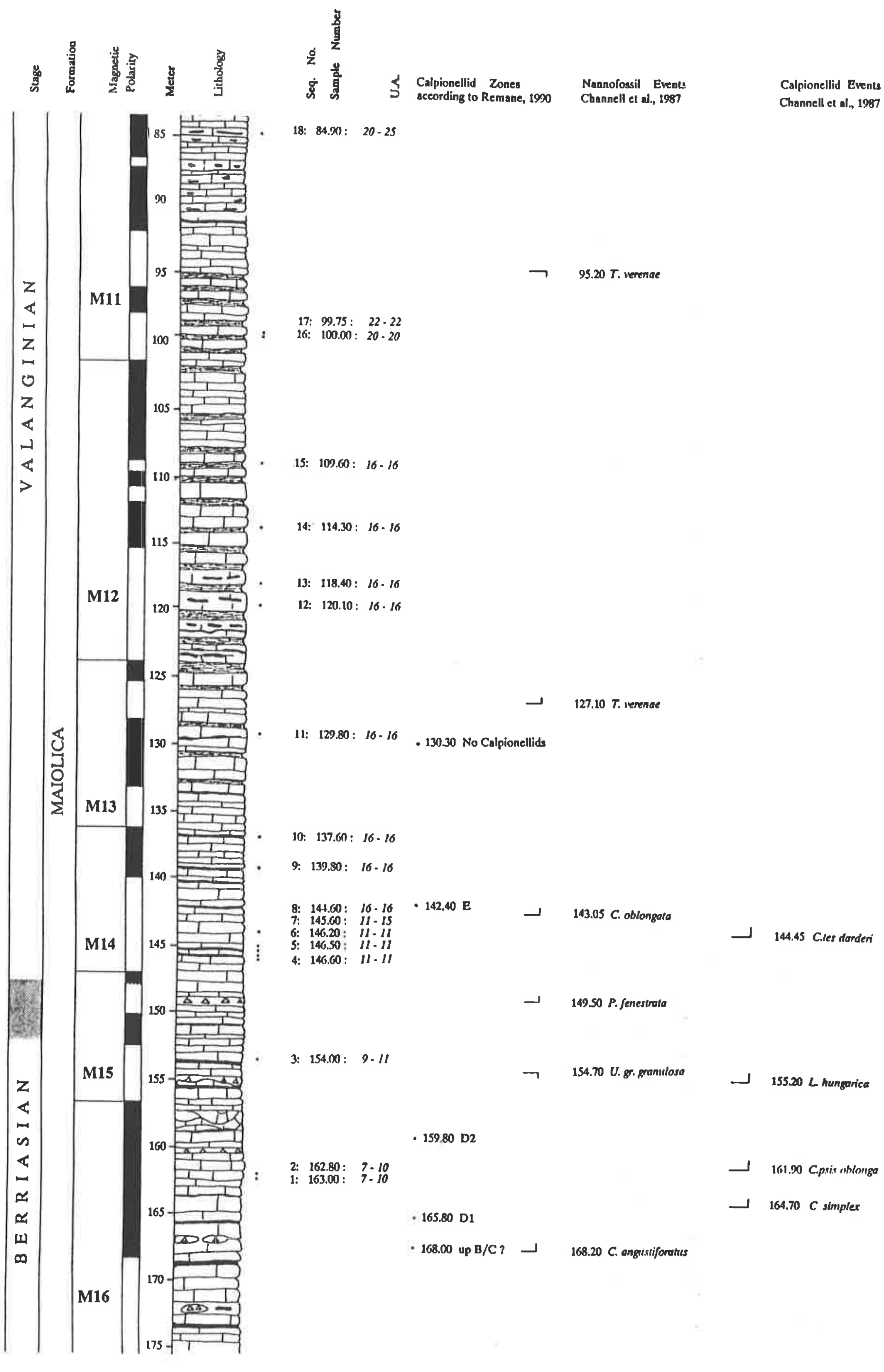



Fig. 12a Capriolo section: correlation of Unitary Associations to nannofossil events, calpionellid zones, magnetostratigraphy and to lithostratigraphy, part 1.

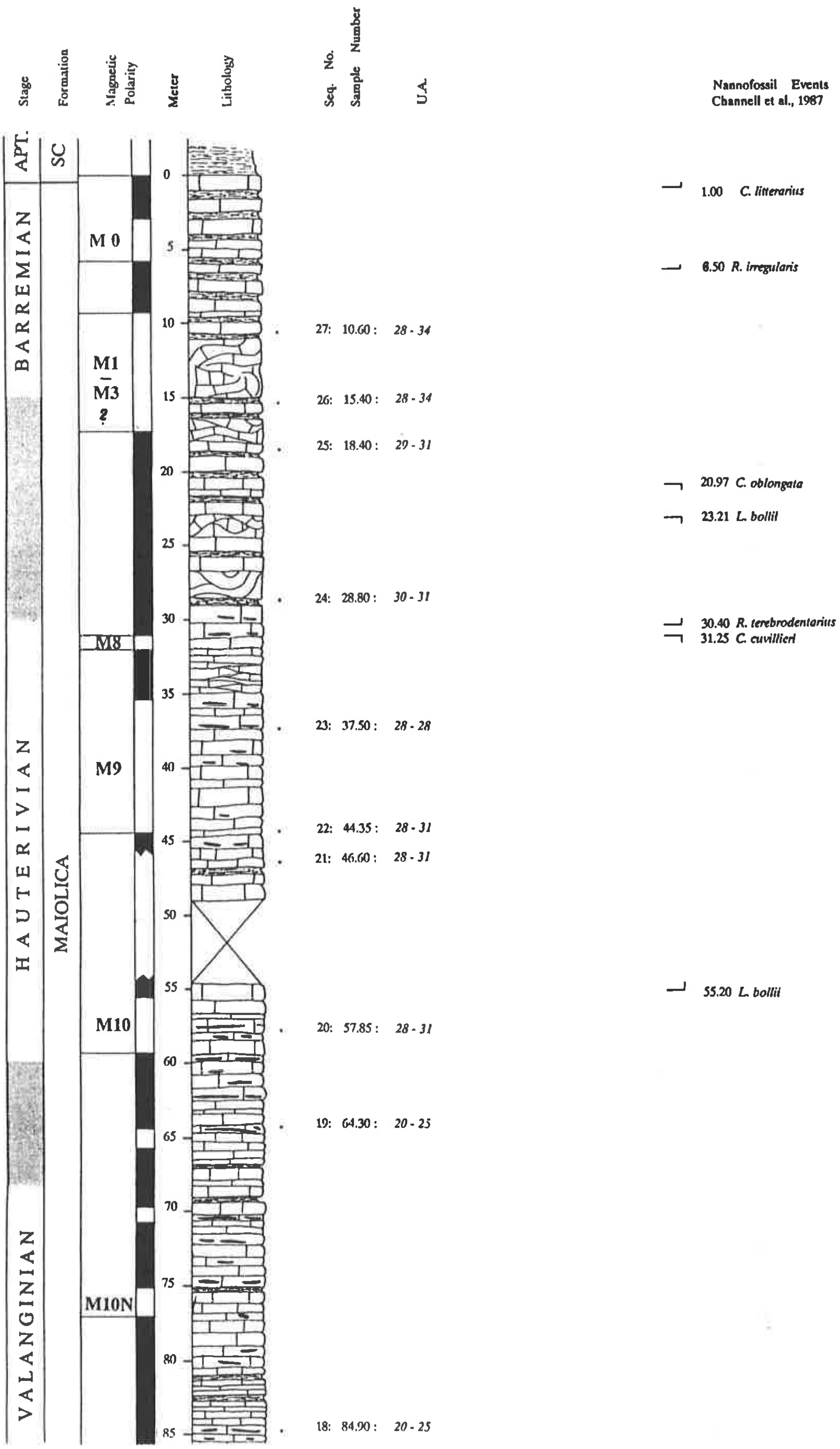



Fig. 12b Capriolo section: correlation of Unitary Associations to nannofossil events, calpionellid zones, magnetostratigraphy and to lithostratigraphy, part 2.

the Umbria-Marche, where zone F3 corresponds to the magnetic polarity zones M7-M4.

Channell et al. (1987) mentioned the presence of a hiatus in the uppermost beds of the Maiolica but due to the lack of well preserved radiolarian samples at the top of the section we cannot confirm it yet.

### 1.4.4. Umbria Marche Apennines: Fiume Bosso, Bottaccione, Valdorbia, Pieia, Gorgo a Cerbara, Presale, Ranchi superiore and Campo al Bello

The Maiolica Formation of the Umbria Marche Apennines is characterized by pelagic limestone sequences which were deposited on the passive continental margin of the Apulian Plate between the interval of the uppermost Tithonian and the lowermost Aptian (Fig. 13). The breakup of the Apulian Plate into a number of seamounts and basins occurred between the Jurassic and the Early Cretaceous (Alvarez, 1989). The Maiolica Formation is represented in both basinal as well as seamount sections. The Maiolica Formation in the basinal areas consists of about 300 meters of white to beige limestones with chert layers and nodules and pelitic intervals. It overlies the Calcari a Saccocoma e Aptici and is followed by the Marne a Fucoidi. The Maiolica Formation sedimented in the seamount facies is condensed and rarely exceeds 100 m in thickness. It overlies the Bugarone Formation and is followed by the Marne a Fucoidi. Slump horizons can be found in the basinal as well as in the seamount sequences.

The studied sections represent the following paleo-depositional environments:

<u>Basinal Facies:</u>

| | |
|---|---|
| Fiume Bosso: | about 330 m studied, 62 samples collected |
| Valdorbia: | about 80 m, 11 samples |
| Gorgo a Cerbara: | about 125 m, 25 samples |
| Bottaccione: | 1 sample |

<u>Seamount Margin:</u>

| | |
|---|---|
| Pieia: | about 120 m, 42 samples |

<u>Seamount Facies:</u>

| | |
|---|---|
| Presale: | about 60 m, 10 samples |
| Ranchi superiore: | about 30 m, 10 samples |
| Campo al Bello: | about 20 m above the top of the lower Bugarone, 3 samples |

#### Fiume Bosso

*Study area*

The Fiume Bosso section is located near the road Pianello-Cagli and follows the River Bosso.

*Lithology*

The Maiolica Formation exposed on Fiume Bosso (Fig. 14a-c) consists of about 300 meters of whitish limestones with chert-layers and nodules and with pelitic intervals at the top of the section. Beside of several relatively thin slump levels a long interval dominated mostly by thick slump deposits was observed between 400 m and 455 m. The sampling started within the last thin, cherty, red colored beds of the Jurassic Calcari a Saccocoma e Aptici, at 289.80 m, 10.20 m below the marked horizon 300.00 m (Lowrie & Channell, 1984). The uppermost samples of the section were collected in the Middle Cretaceous Selli Level which represents the base of the Marne a Fucoidi Formation and crops out just north of the very small bridge passing a rivulet. Coccioni et al. (1989) had sampled the Selli Level just below this bridge for their investigations on the Marne a Fucoidi.

*Magnetostratigraphy*

Lowrie & Channell (1984) investigated for magnetostratigraphy the lower part of the section, in the interval between 300.00 m and 386.50 m. The Jurassic/Cretaceous boundary was defined by Channell & Grandesso (1987) between the interval M19 normal and lowermost M17 reversed. Lowrie & Channell (1984) had placed the Berriasian/Valanginian boundary in the magnetic polarity zone M16 normal but Channell & Grandesso (1987).changed it to M14 reversed.

*Calpionellids*

The Calpionellids have been studied by Grandesso (in Channell et al. 1987) and by Remane (pers. communication 1991). The discrepancies between their zonal boundaries are negligible and are caused by the individual biostratigraphic method used in defining the first and last appearance datum of taxa. Remane found no signs of *Chitinoidella*, which contrasts to Grandesso who defined the *Chitinoidella* zone below 303.50 m. *Saccocoma* was recorded by Remane in the interval between 301.9 m and 305.5 m.

Lowrie & Channell (1984) placed the Jurassic/Cretaceous boundary close to the base of the magnetic polarity zone M17 reversed, which was later redefined by Channell & Grandesso (1987) between the interval M19 normal and lowermost M17 reversed. Based on the calpionellid data of Remane we place it at the lower part of M19 normal between 311 m and

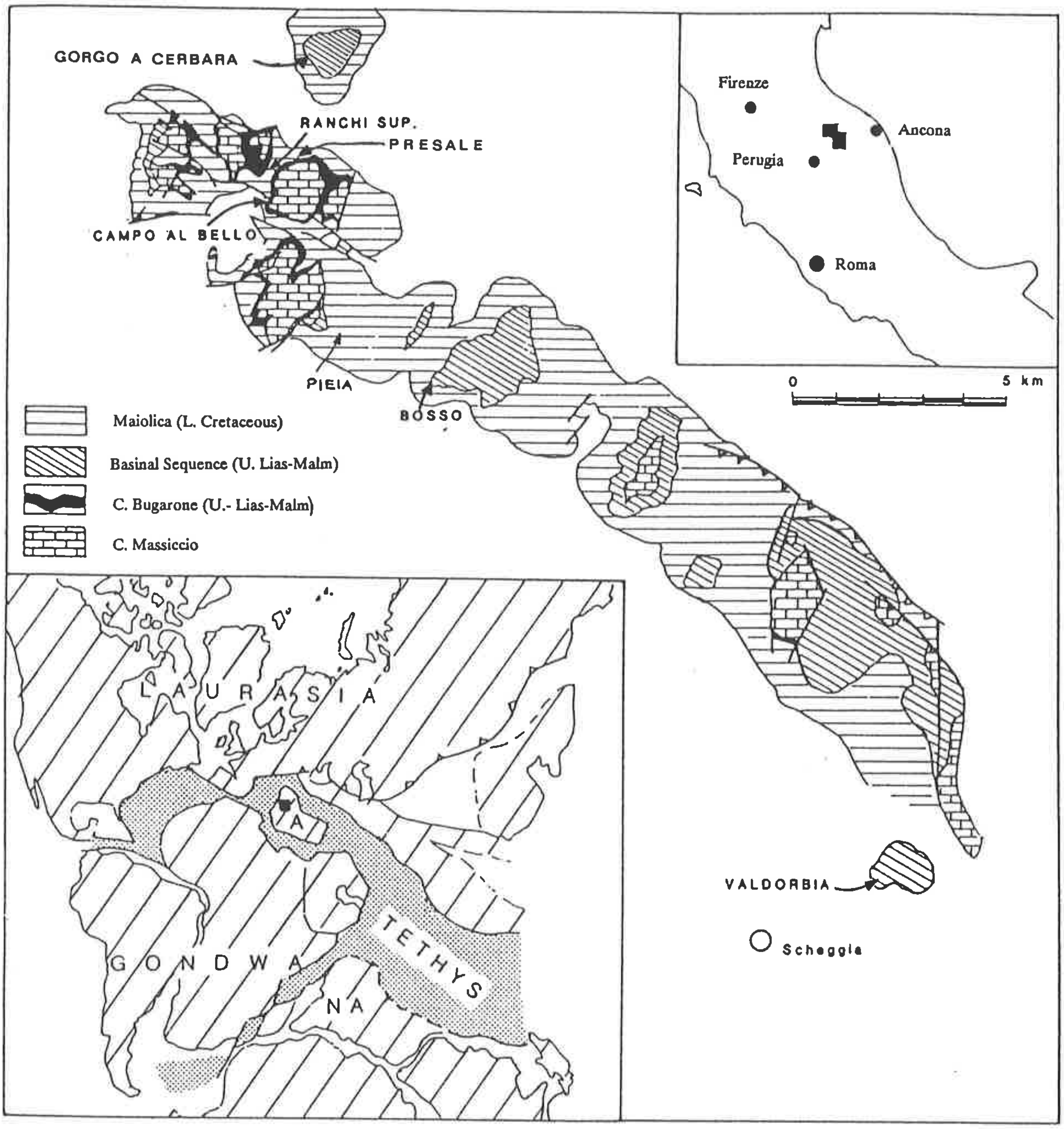



Fig. 13 Geological map showing sampling localities in Italy. Inset on the lower left shows the paleogeographical position of the Umbria Marche Appenines on the Apulian plate (modified after Baumgartner, 1987).

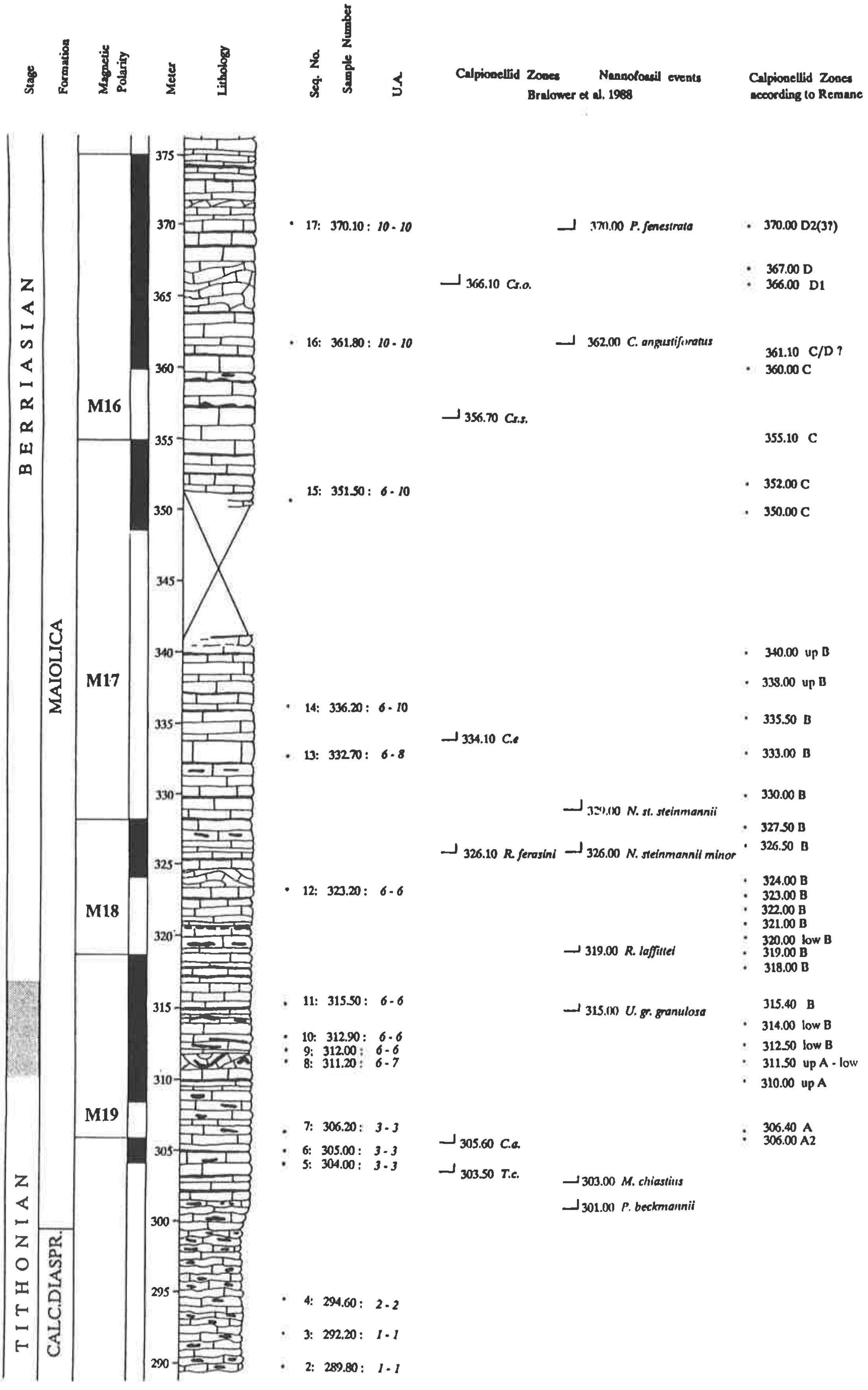



Fig. 14a Fiume Bosso section, part 1: correlation of Unitary Associations to nannofossil events and calpionellid zones, magnetostratigraphy and lithostratigraphy.

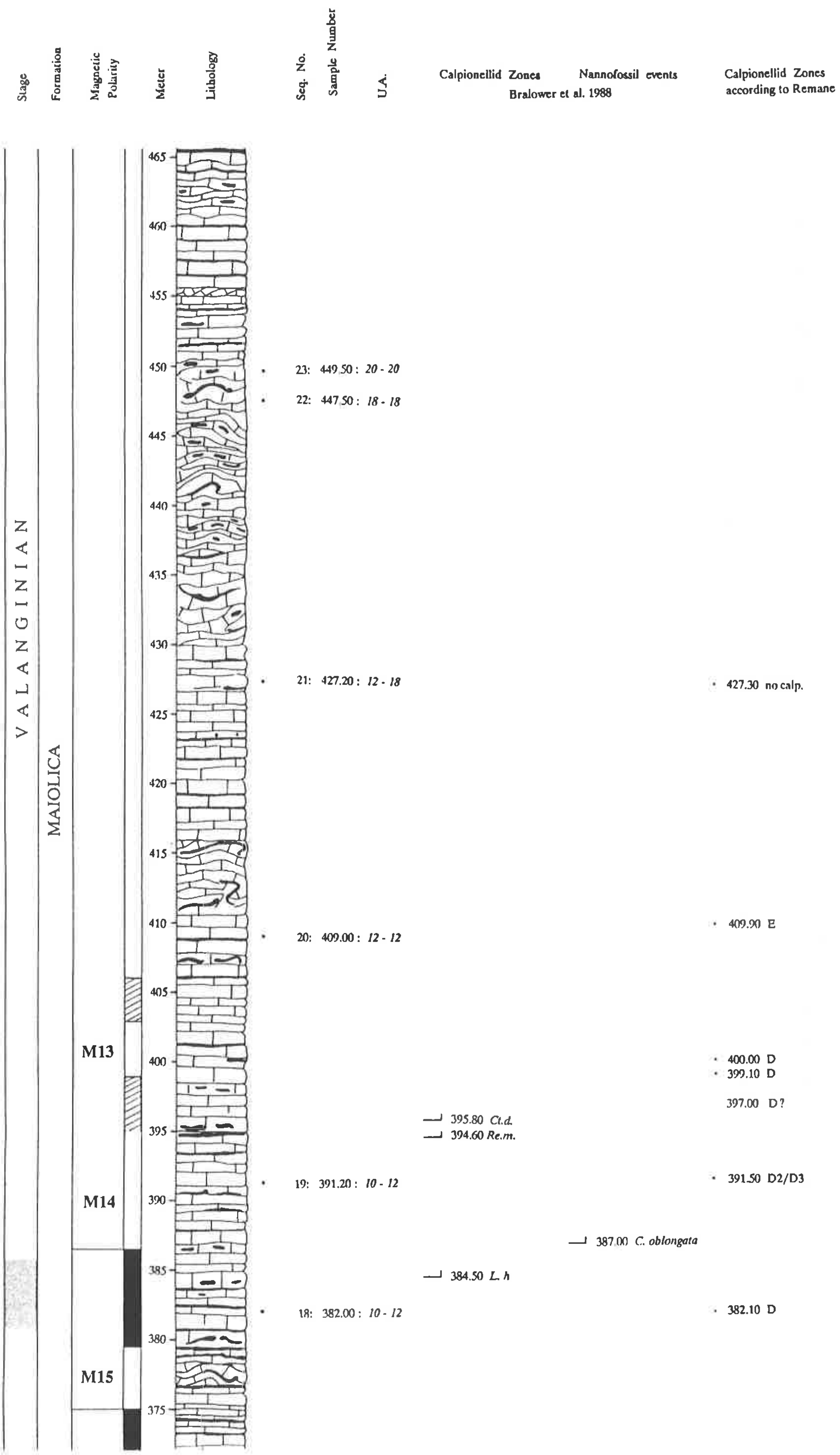



Fig. 14b Fiume Bosso section, part 2: correlation of Unitary Associations to nannofossil events and calpionellid zones, magnetostratigraphy and lithostratigraphy.

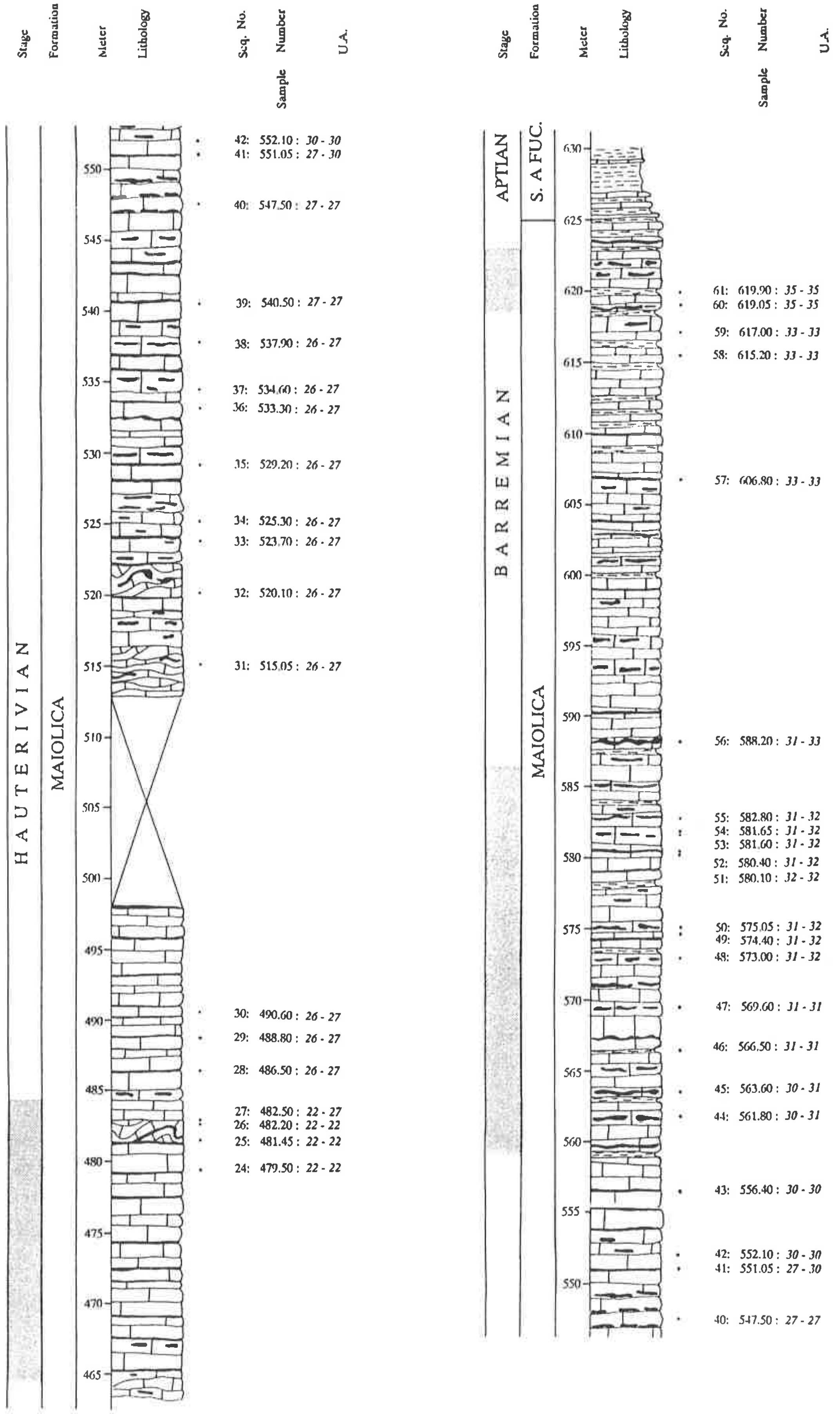



Fig. 14c Fiume Bosso section, part 3 and 4: correlation of Unitary Associations to lithostratigraphy.

312 m. It is of no relevance that the respective calpionellid sample was collected from an interval of slump since we have at this level the same radiolarian assemblage as in the following sample, at 312.90 m, where beds are undisturbed.

*Nannofossils*

The nannofossil events have been studied by Bralower et al.(1989) in the interval between 300.00 m and 407.00 m, and 8 zones were correlated to magnetic polarity zones. A remarkable difference in correlation exists for the FAD of *Percivalia fenestrata* which was found at Fiume Bosso in M16 normal and at Capriolo in upper M15. We suspect that this difference is due either to incomplete observation and/or to improper preservation at Capriolo.

*Radiolarians*

Radiolarians are generally very well preserved and highly diversified. Between 289.80 m and 1 m above the base of the Selli Level 10 radiolarian zones were identified of which 4 zones were correlated to magnetic polarity zones in the lower part of the section. The length of the zone E1a arose problems at Fiume Bosse when compared with Capriolo (Fig. 12). Zone E1a terminates in the calpionellid zone D in the magnetic chron M14 at Capriolo but continues at Fiume Bosso into the calpionellid zone E and even higher. As the chrons M12 and M13 had not been absolutely defined because of poor magnetic data we have no possibility for any precise correlation of the radiolarian zones to magnetic chrones. As regards Capriolo we think that the radiolarian zone E1a terminates in the chron M14. This suggests that a probable repetition of parts of the section at Fiume Bosso might have caused the apparent prolongation of the zone E1a.

## Valdorbia

*Study area*

The Valdorbia section is located along the road Nr. 360 Scheggia-Sasso Ferrato, between Valdorbia and Ponte Calcara.

*Lithology*

The Calcari a Saccocoma e Aptici Formation and the lowermost part of the Maiolica sequence had already been sampled for radiolarians and calpionellids by Baumgartner (1984, 1990). Some of his samples were used by us for our database (Fig. 15). Initially Baumgartner had measured and sampled starting from the top of the Calcari a Saccocoma e Aptici Formation. For all older samples he used positive meter-levels and for the younger ones negative metter-levels (0.00 m to -10.00 m). In 1987 he changed the meter-levels of his samples, adding 20 m to the base of 0.00 m and consequently to each sample number. The interval between 0.00 and -10.0 m (20.00 m to -30.00 m), which is part of the Maiolica Formation, was re-sampled by us for radiolarians and calpionellids.

*Calpionellids*

Samples for calpionellids were studied by Remane for Baumgartner (1987) and the A/B zonal boundary was placed at about 9.30 m. In our samples collected from the interval between 0.00 and 10.00 m this boundary could not be defined precisely by Remane (pers. commun., 1991) as the samples contained mostly saccocoma or Radiolaria only or calpionellid taxa which were not useful for precise biostratigraphic interpretations. Remane found no chitinoidellas. The Jurassic/Cretaceous boundary at POB 9.30 m corresponds to our Radiolarian U.A. 6 or 7.

*Radiolarians*

Radiolarians are generally well preserved. Three radiolarian zones were identified, correlated and calibrated with the calpionellid zones and with the radiolarian zones of Baumgartner (1984, 1987). The Tithonian/Berriasian boundary corresponds to our Radiolarian U.A.6 or 7.

## Gorgo a Cerbara

*Study area*

The section is located in the river bed of the Candigliano a few kilometers east of Piobbico near the road Nr. 257 to Aqualagna.

*Lithology*

The section is well exposed and was sampled on the southern border the uppermost part of the Maiolica Formation between 786.70 m and 893.30 m and the lowermost part of the Middle Cretaceous Marne a Fucoidi Formation between 901.30 m and 911.35 m (Fig. 16 and 17a, b). The section is disturbed by a few fractures, mentioned also by Bralower (1987). Slump intervals were recorded between 808 m and 817 m, 841 m and 844 m, 861 m and 862 m. The first pelitic intervals appear around 880 m. The base of the Selli Level is at 896 m. This lowermost member of the Marne a Fucoidi is almost completely covered by vegetation, but it is well marked by a depression of about 2 m width between rather thick limestone beds. The Marne a Fucoidi consist of thick red pelitic levels with short intervals of whitish siliceous limestone beds and radiolarian sands.

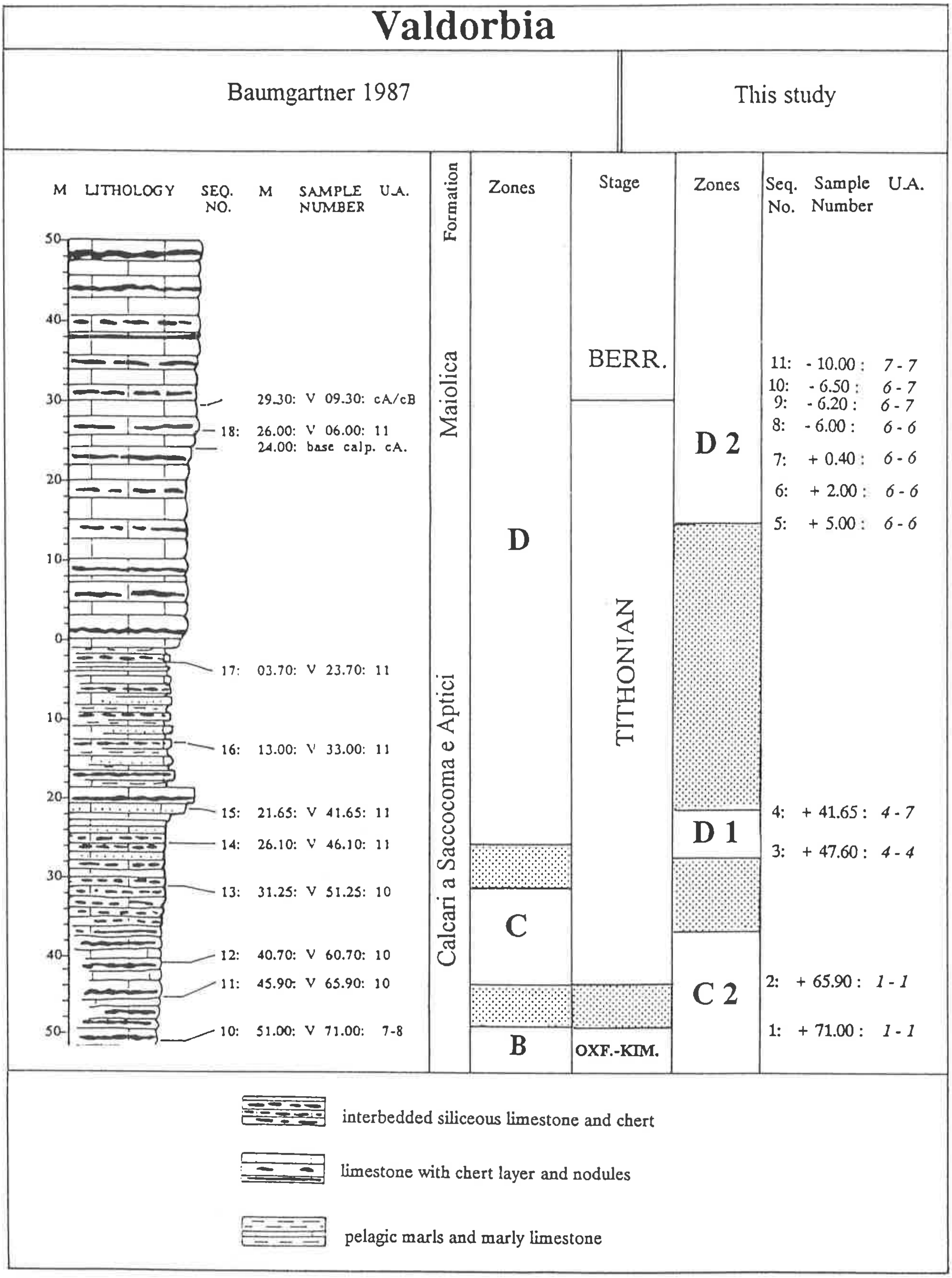



Fig. 15 Valdorbia section: correlation of Unitary Associations to lithostratigraphy and calpionellid zones from Baumgartner (1987).

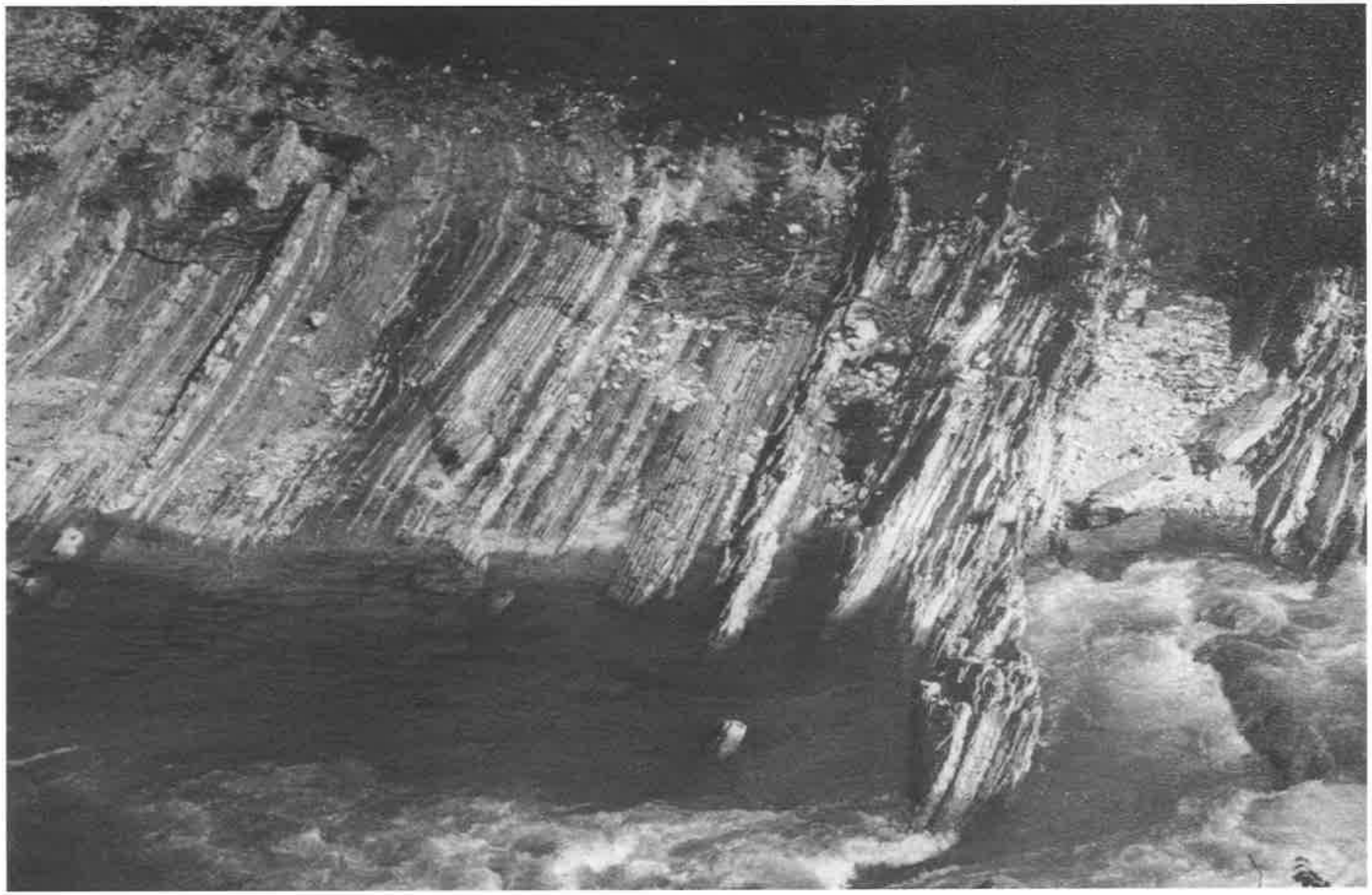


Fig. 16 Gorgo a Cerbara section: Maiolica limestones on the right and Scisti a Fucoidi with intercalated beds of radiolarian sands on the left portion of photography.

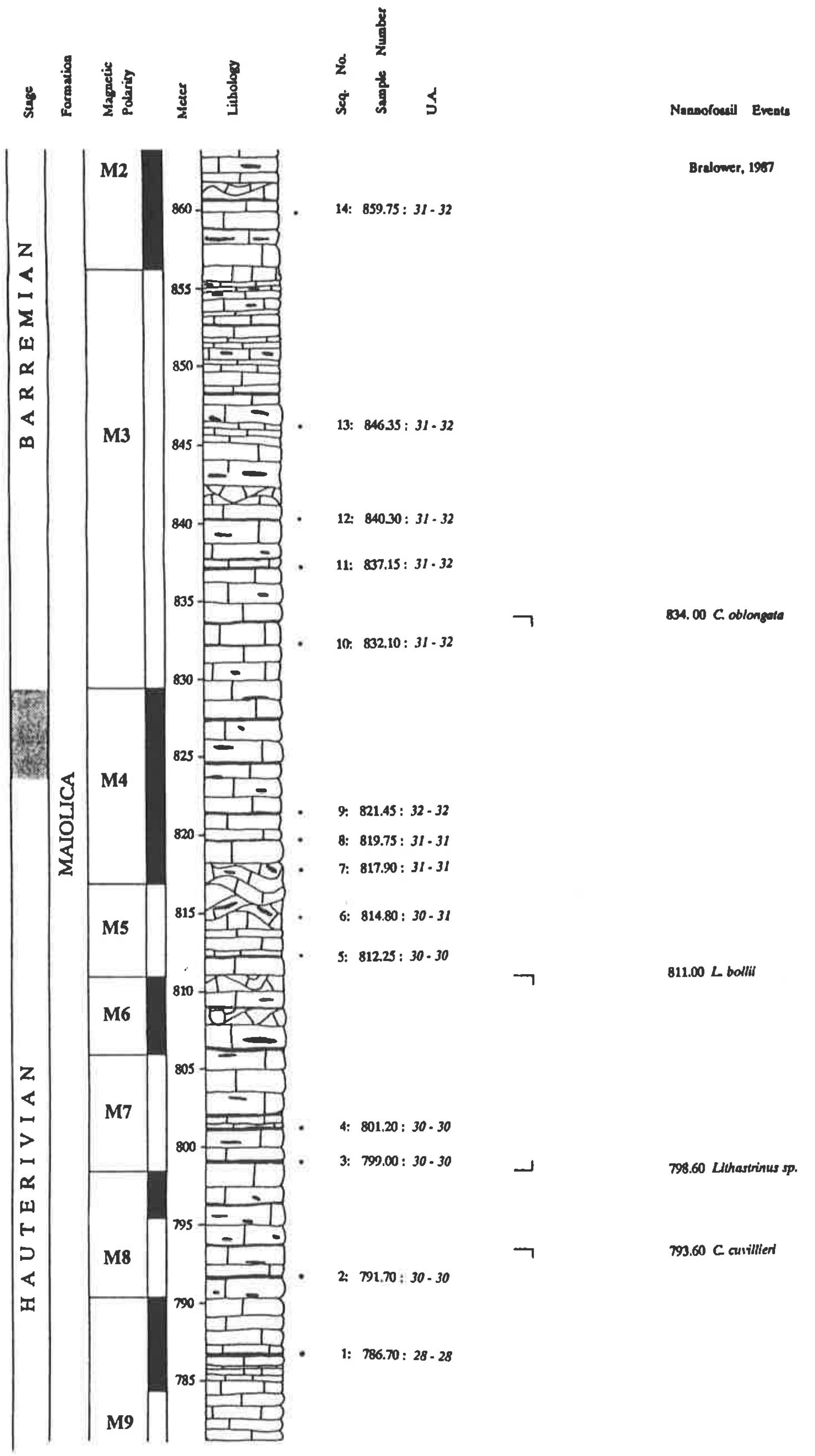



Fig. 17a Gorgo a Cerbara section: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and lithostratigraphy, part 1.

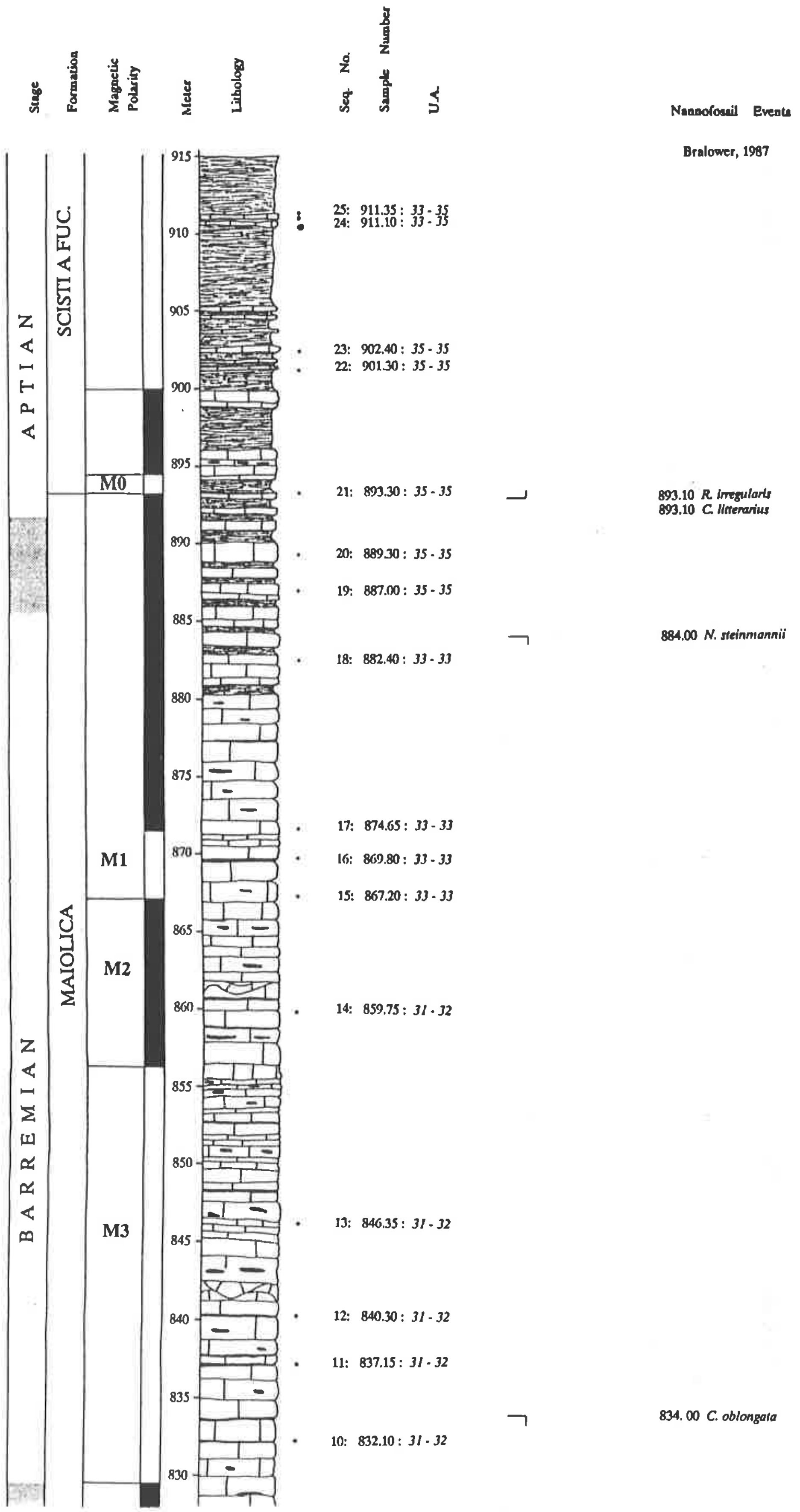



Fig. 17b Gorgo a Cerbara section: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and lithostratigraphy, part 2.

*Magnetostratigraphy*

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 which were correlated to magnetostratigraphy and nannofossil events. There were some problems in correlating the upper part of Gorgo a Cerbara and Presale. The top of radiolarian zone F3 is found at Gorgo a Cerbara in the magnetic polarity zone M2 whereas at Presale in the lower part of M3 (Fig. 20). The FAD of *Calcicalathina oblongata* however is time-consistent, occurring at the base of M3 reversed at both sections. It is to mention that Bralower (1987) correlated the data of the Gorgo a Cerbara section with those of Presale and two other sections, and the magnetic zones as well as the nannofossil events fitted rather well. A possibility to explain the mentioned discrepancy is to suggest that parts of the section have undergone synsedimentary processes (reworking or sliding) of one or several mudstone beds.

*Ammonites*

Recently the first ammonites were discovered by Cecca et al. (in press) when the section was reinvestigated for planktonic foraminifera and nannofossils. The correlation of all data to magnetic chrons resulted in establishing the Hauterivian/Barremian boundary in the upper M5.

## Pieia

*Study area*

The studied section is located north of Pianello along a small road leading up to the little village Pieia, south of the Monte Nerone.

*Lithology*

The section (Fig. 18) is characterized by its special position on the seamount margin. The Maiolica Formation was affected by synsedimentary sliding of the soft limestones (Alvarez, 1989). We sampled the outcrop situated on the eastern border of the small road, south-east of the bridge and south of the quarry. The section has been marked by many persons with several type of numbers and meter-levels. The lowermost sample POB 10.00 (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 meter-level started with 0.00 m above this zone. The colour of the chert bands and nodules is generally blue-gray. Some rare chert bands have a rose colour in the interval between 35 and 70 m. The last sample, situated just above a slump zone mostly covered by vegetation, was taken et 97.35 m.

*Magnetostratigraphy*

The section was not studied for magnetostratigraphy, probably because of the many disturbed levels in the lower part of the Maiolica Formation.

*Calpionellids*

We collected 20 calpionellid samples which were studied by Remane (pers. communic.). Most of the calpionellids were badly preserved, many crushed, and for most samples strict determinations were impossible.

*Radiolarians*

Radiolarians were generally abundant and moderately to well preserved. Three zones were recognized and correlated. U.A. 5 corresponds to the calpionellid zone lower B, suggesting that U.A. 6, which at Fiume Bosso (Fig. 14) corresponds also to the lower B, 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 well correlate with Fiume Bosso and also with Capriolo (if we suppose that the two lowermost samples are still included in E1a, Fig. 12a). The radiolarian zonal boundary E1/E1b is probably in the upper calpionellid subzone D2 or lower D3. This correlates rather well with Capriolo where the boundary is placed in the calpionellid subzone D3 but not with Fiume Bosso, as discussed under the latter.

## Presale

*Study area*

The Presale section crops out along a path which deviates from the road Piobbico-Secchiano east of the Monte Nerone at point S. Lorenzo (Fig. 19), near a small cemetery, (topographic elevation of 545 m). The path leads to the Fosso di Presale on the north-eastern flank of the Monte Nerone.

*Lithology*

The section (Fig. 20) represents, as well as Ranchi superiore and Campo al Bello (Fig. 21 and 22), a condensed limestone sequence deposited on seamounts. The Maiolica Formation overlies the Jurassic Bugarone-5-Limestones which have a Kimmeridgian-Tithonian age. The Maiolica contains abundant slumps at several levels (204-208, 216-224 and 240-260 m).

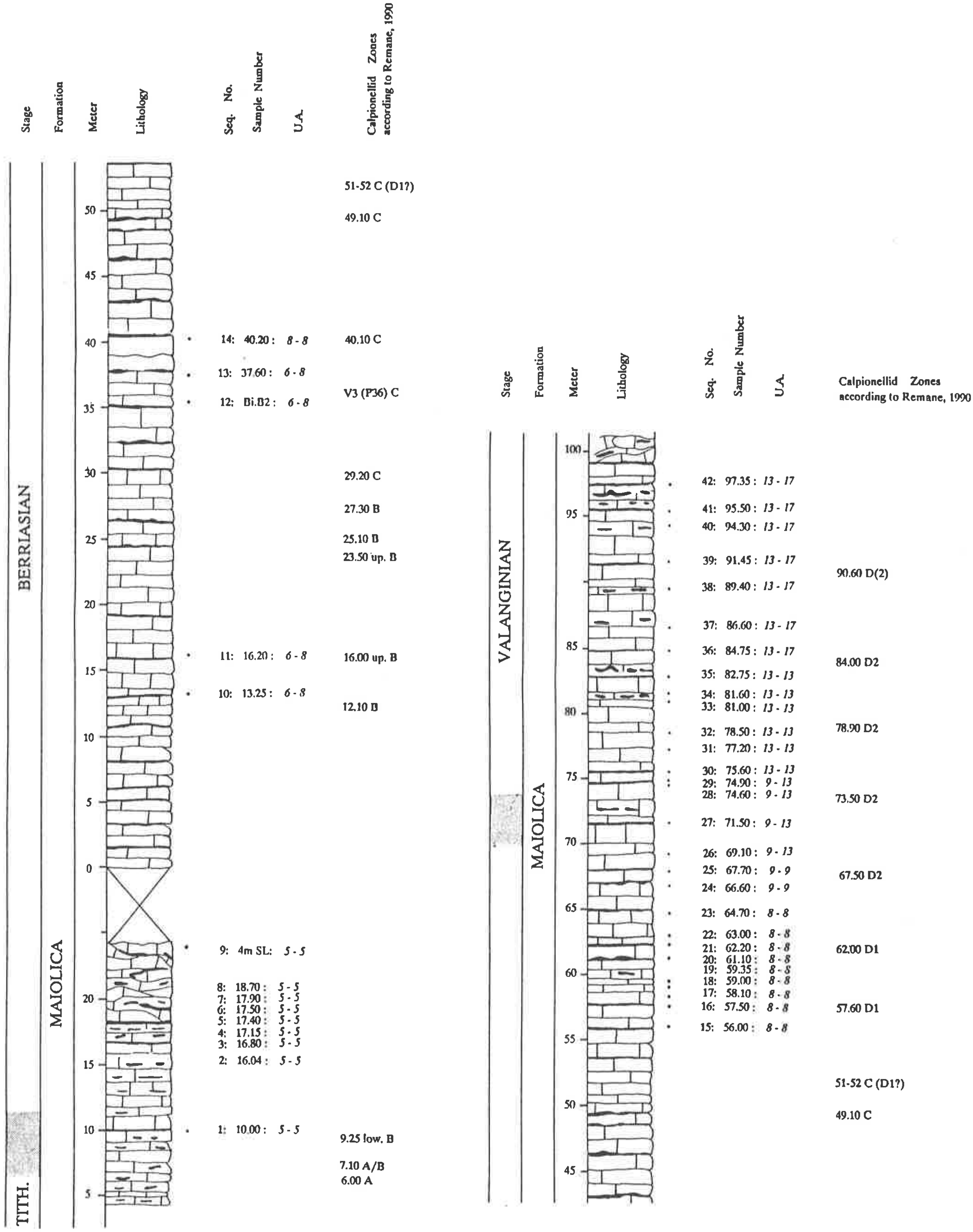



Fig. 18 Pieia section: correlation of Unitary Associations to calpionellid zones and lithostratigraphy.

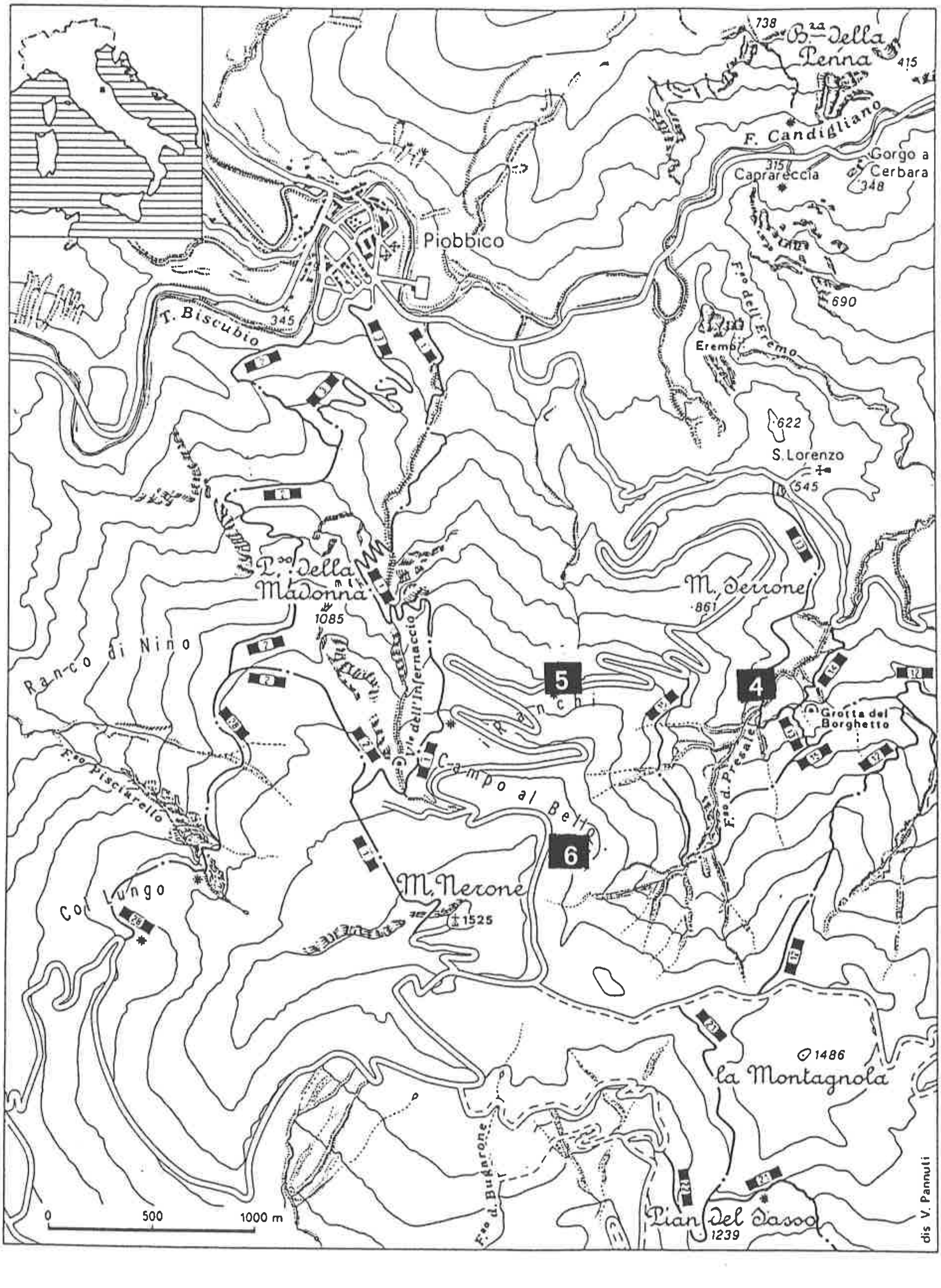



Fig. 19 Map showing Monte Nerone and sampling localities Presale (4), Ranchi superiore (5) and Campo al Bello (6)

The first pellitic intervals have been recognized at 260 m but might also occur below this level as many intervals of the section are covered by vegetation which made sampling very difficult.

*Magnetostratigraphy*

The magnetostratigraphy has been studied by Channell et al. (1979) and Lowrie & Alvarez (1984).

*Nannofossils*

The nannofossils were studied and correlated to the magnetic polarity zones by Bralower (1987). The Presale and the Gorgo a Cerbara sections can be well correlated with the exception of the FAD of *Ricinolithus irregularis*. This event normally coincides with the Barremian/Aptian boundary and is placed at Presale in M0 whereas at Gorgo a Cerbara in the uppermost M1 normal.

*Calpionellids*

The section was not sampled for calpionellids.

*Radiolarians*

Radiolarians are abundant and well preserved in the samples of the upper part of the section. We correlated 3 radiolarian zones to nannofossil events and magnetic polarity zones. The oldest sample belongs to the zone E1b and, by comparison with Capriolo, indicates for the lowermost part of the sampled section a Lower to Middle Valanginian age. Alvarez (1987) had mentioned a hiatus for the Berriasian and the Valanginian. By this sample, however, and by others from the section Ranchi Superiore one can prove that the Valanginian is present. The uppermost portion of the section is dominated by slump deposits and was not sampled. The last sample was collected just above the first appearance of the pellitic horizons, but contained only badly preserved radiolarians. Difficulties in correlating the zones F3 and G1 were discussed under Gorgo a Cerbara.

## Ranchi superiore

*Study area*

This section is situated near the small road leading from Piobbico upwards to the Monte Nerone, at about 1000 m topographic elevation (Fig. 19)

*Lithology*

The lower part of this section (Fig. 21) has been discussed by Baumgartner (1987). Sampling was started above a major unconformity which was observed about 16-17 m above the base of the Lower Bugarone Formation, in the calpionellid zone E. The section was very difficult to sample as it is covered by wire-fence. In the interval of 17 m between the base of the Lower Bugarone and the unconformity are enclosed the condensed Lower Bugarone (3-4 m), the Calcari Diasprigni (4-5 m) and the Upper Bugarone (5 m). The Upper Bugarone is a dolomitized wacke- to packstone and is overlain, with a sharp contact, by the Maiolica Formation. Several slump zones were observed in the interval between the unconformity and about 45 m. Sampling was successful in the lower part of the section whereas the upper portion did not contain any good radiolarian sample. The pelitic intervals of the uppermost Maiolica sequence do not outcrop.

*Calpionellids*

Calpionellid samples were taken below and above the unconformity, in the more or less dolomitized Maiolica which is overlaying the Upper Bugarone Formation. The determinations of the calpionellids by Remane (pers. communication, 1991 and in Baumgartner 1990) show a very condensed Berriasian and Valanginian. The calpionellid zone A is missing and zone D could not be identified probably due to inadequate sample density.

*Radiolarians*

The 4 identified radiolarian zones could not be correlated to magnetic polarity zones or to nannofossil events. The lowest sample at 18.70 m, just above the sample 17.10 m which indicates the calpionellid zone E, could not be precisely identified. At 24.50 m the same faunal assemblage (U.A. 17) as at Presale was identified indicating a Lower to Middle Valanginian age. The Valanginian/Hauterivian boundary is placed between 15 m and 20 m above the unconformity. The uppermost identified samples represent parts of the radiolarian zone F3 and are of Upper Hauterivian age.

## Campo al Bello

*Study area*

The Campo al Bello section is situated on the eastern flank of the Monte Nerone (Fig. 19, 22a, b) approximately 700 m northeast of the Monte Nerone peak, 250 m east of the road Piobbico-Monte Nerone and at an altitude of about 1350 m.

*Lithology*

Campo al Bello is one of the sections with the most condensed Formations deposited on a seamount. The 0.00 m level was placed by Baumgartner at the top of the Lower Bugarone. It is followed by only 1 m

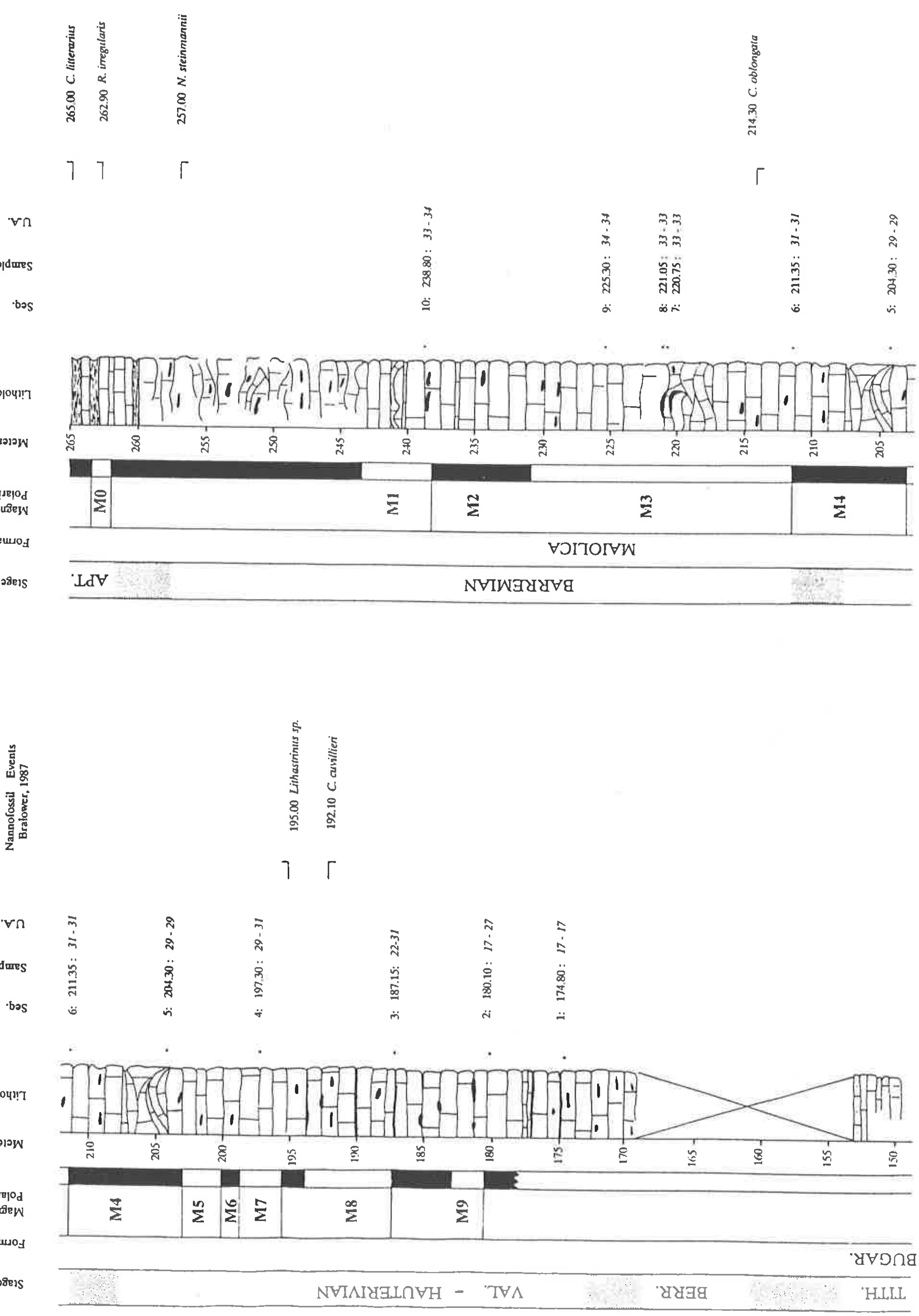



Fig. 20 Presale section: correlation of Unitary Associations to nannofossil events, magnetostratigraphy and lithostratigraphy.

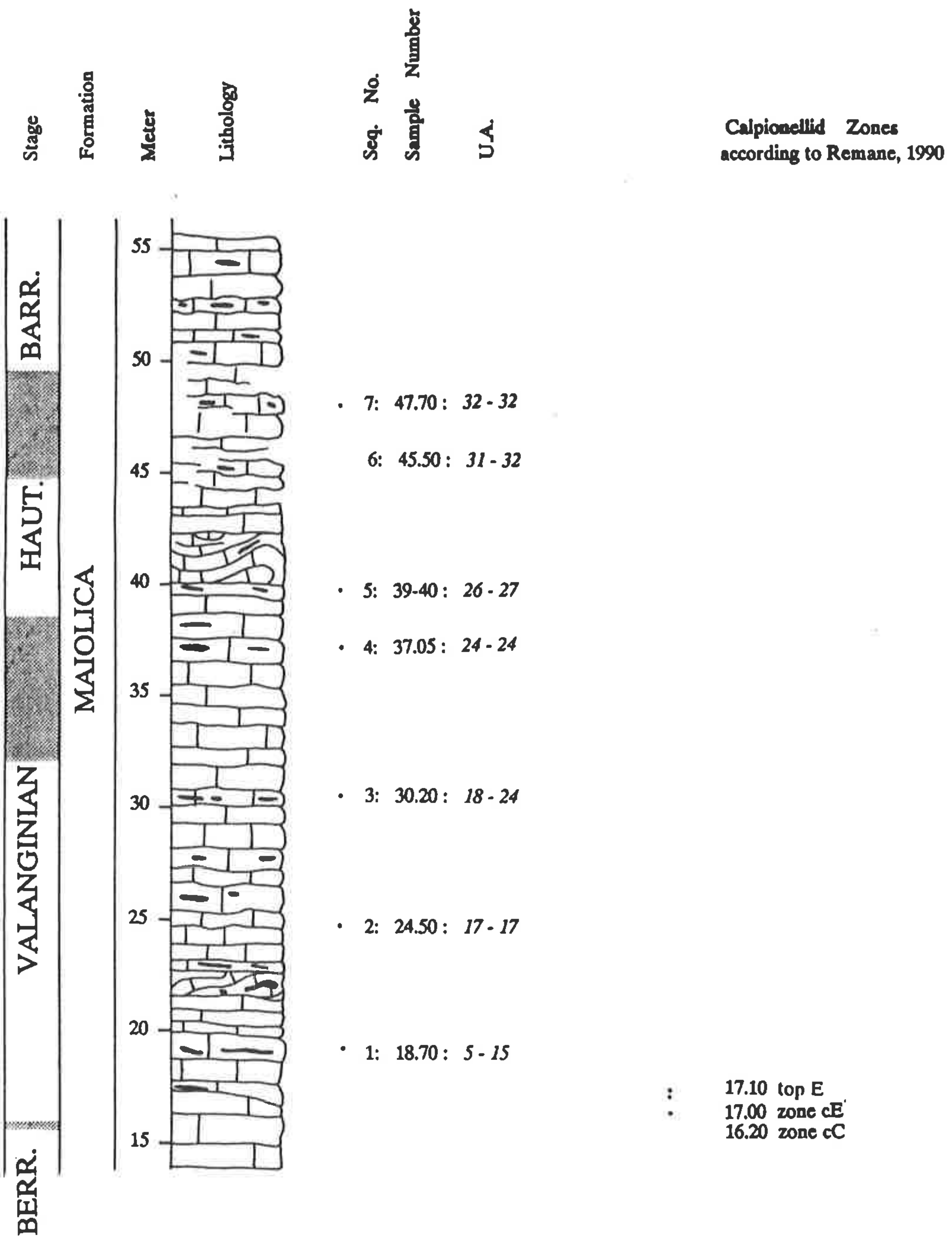



Fig. 21 Ranchi superiore section: correlation of U.A. to lithostratigraphy

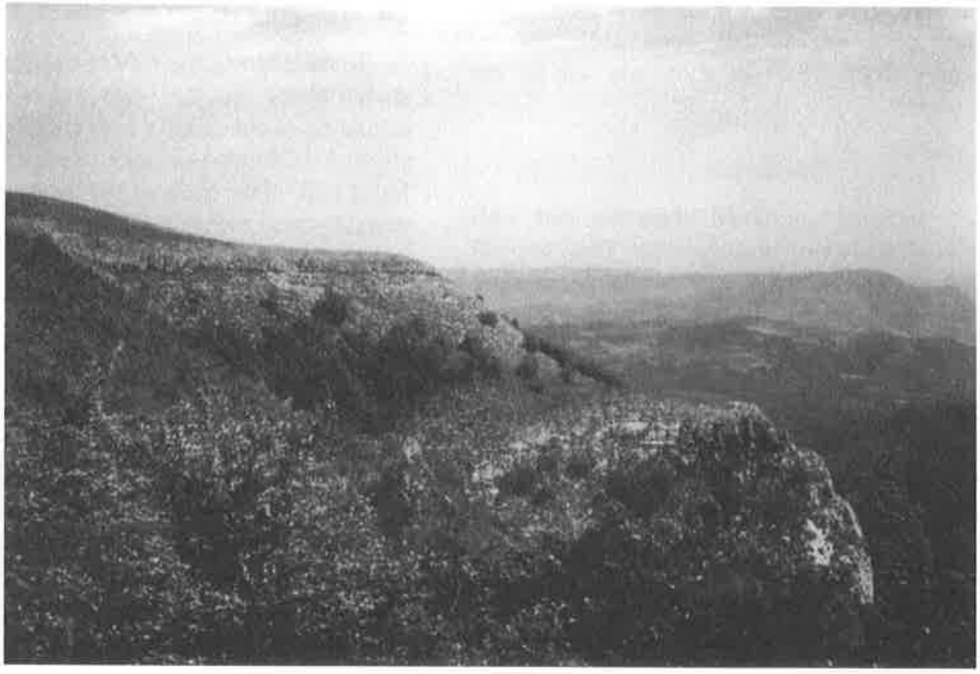


Fig. 22a Campo al Bello section on Monte Nerone.

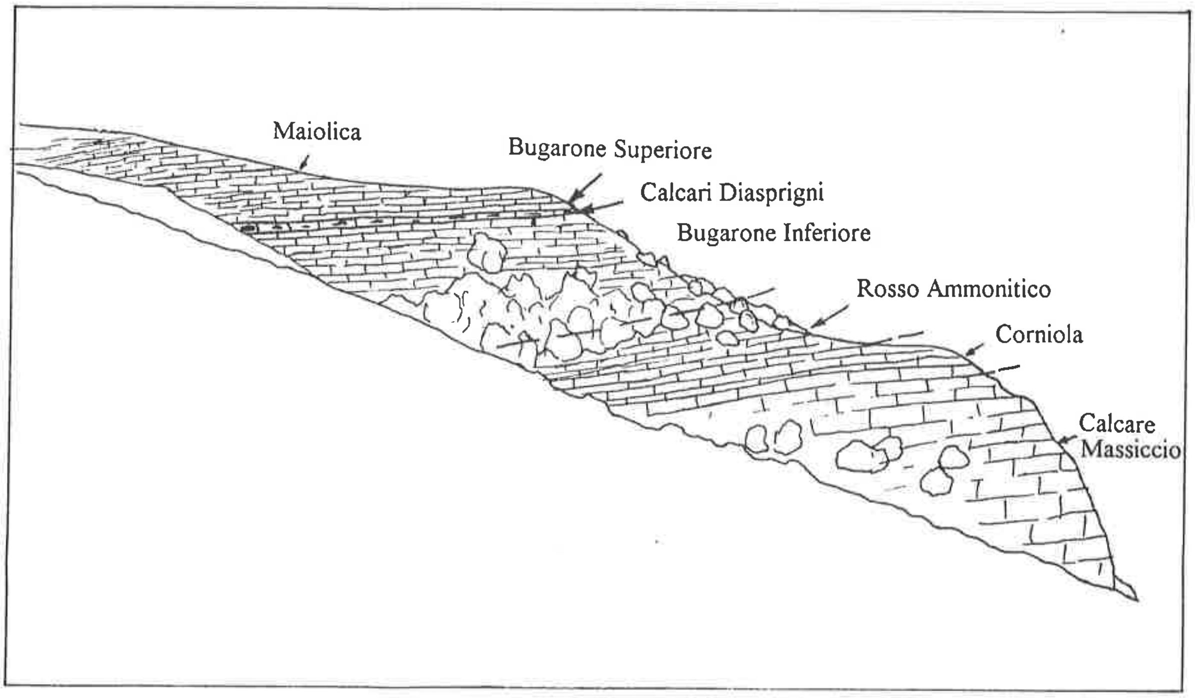



Fig. 22b Stratigraphic sketch of Campo al Bello (after Baumgartner, 1987).

of Calcari Diasprigni and about 4 m of Upper Bugarone. We have studied 3 samples: POB 1589, 1590 and 1592 which had been collected by Baumgartner about 19-21 m above the top of the Lower Bugarone.

*Radiolarians*

The 3 samples contained abundant and well preserved Radiolaria with high diversity. They were all identified as U.A. 31-32 indicating an Upper Hauterivian age.

#### 1.4.5. Hawasina Nappes: 1 section - Wahrah-Formation (Al Hammah Range, Oman)

*Study area*

The section (Fig. 23a, b) is situated in the Al Hammah Range which represents a segment of the Hawasina Complex and is situated about 125 km south of the town Muscat.

*Lithology*

The Wahrah-Formation was studied and sampled by D. Biaggi, W. Kickmeier and P. Steinmann (unpublished diploma, 1991) and by Kickmaier & Peters (1990). The Formation (Fig. 24) contains fine-grained turbiditic limestones, colored siltstones and cherts and lime-free chert. The top of the sequence is characterized 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 was moderate to low with the exception of those of the manganese horizons. Faunal assemblages are similar to those of all Italian and Swiss sections investigated, although the paleogeographical area and sedimentological features are different. We recognized 3 radiolarian zones. The lower manganese horizon has an assemblage of the U.A. 14-15 and is of Lower Valanginian age, the upper horizon is represented by the U.A. 30-34 (see sample 15) which indicates an age between the interval of the Upper Hauterivian and the Lower Barremian. The red radiolarian cherts below the first manganese horizon are of Berriasian to Lower Valanginian age, those between the two horizons of Hauterivian age and the uppermost levels of Lower Barremian age.

## 2. BIOCHRONOLOGY

### 2.1. Introduction

Knowledge of the Lower Cretaceous radiolarians started about 100 years ago and continued up to the beginning of our century with studies of samples from sections in Italy, Germany, Switzerland, Austria or 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 (1899), Hinde (1900), 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 their research. Although biostratigraphic 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 complete cores. During the 1970's the first attempts of radiolarian zonations for the Early Cretaceous were made by Moore (1973), Renz (1973), Riedel & Sanfilippo (1974), Foreman (1975), Schaaf (1981, 1984) etc. At the same time land sections more or less dated with other fossil groups have been increasingly studied and correlated with DSDP data (Pessagno, 1977; Baumgartner et al., 1980; Kocher, 1981; Baumgartner, 1984; Tumanda, 1989, etc.).

The radiolarian zonation of the Lower Cretaceous based on various sections in Italy (Umbria and Southern Alps) and in Switzerland (Southern Alps and Ultrahelvetics) was initially developed by Baumgartner (1984) together with the zonation of the Upper Jurassic. Some of these sections and several new ones were thoroughly sampled by us in order to detail and continue Baumgartner's zonation up to the base of the Aptian. For this purpose a number of 245 samples from 13 sections were selected out of about 500 samples. An artificial sample was added at the base of the Fiume Bosso section comprising species which due probably to diagenesis did not occur in the section but which should have occurred at this level. This was necessary to refine the base of our range chart and to illustrate the major faunal change that occurred in the Middle to Upper Tithonian

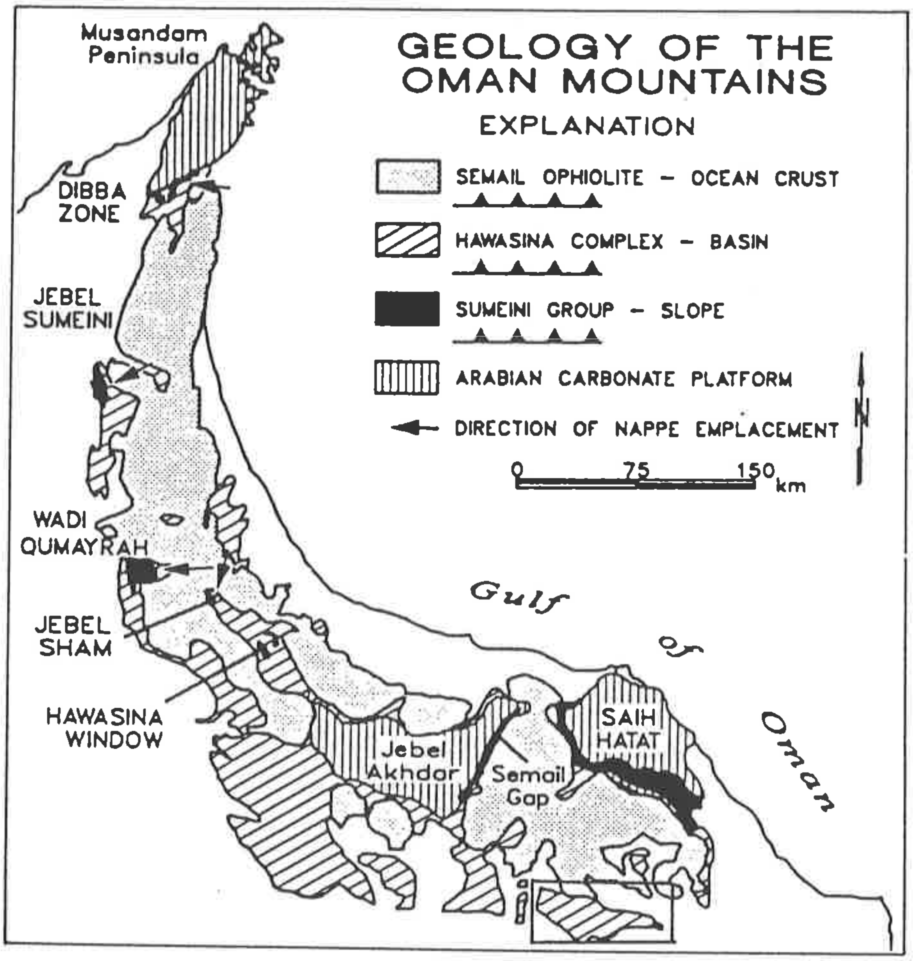



Fig. 23a Geologic map of Oman with location of Hawasina complex and Wahrah Formation (Watts, 1990).

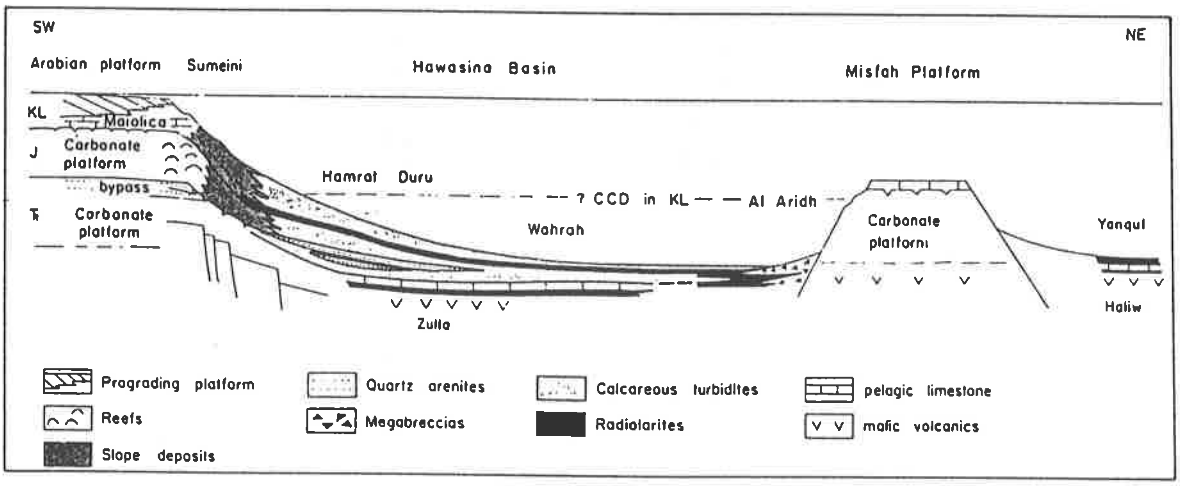



Fig. 23b Palinspastic cross section of the Hawasina Basin showing position of the Wahrah Formation in the basin between the Arabian and the Misfah Platform (Bernoulli et al., 1990).

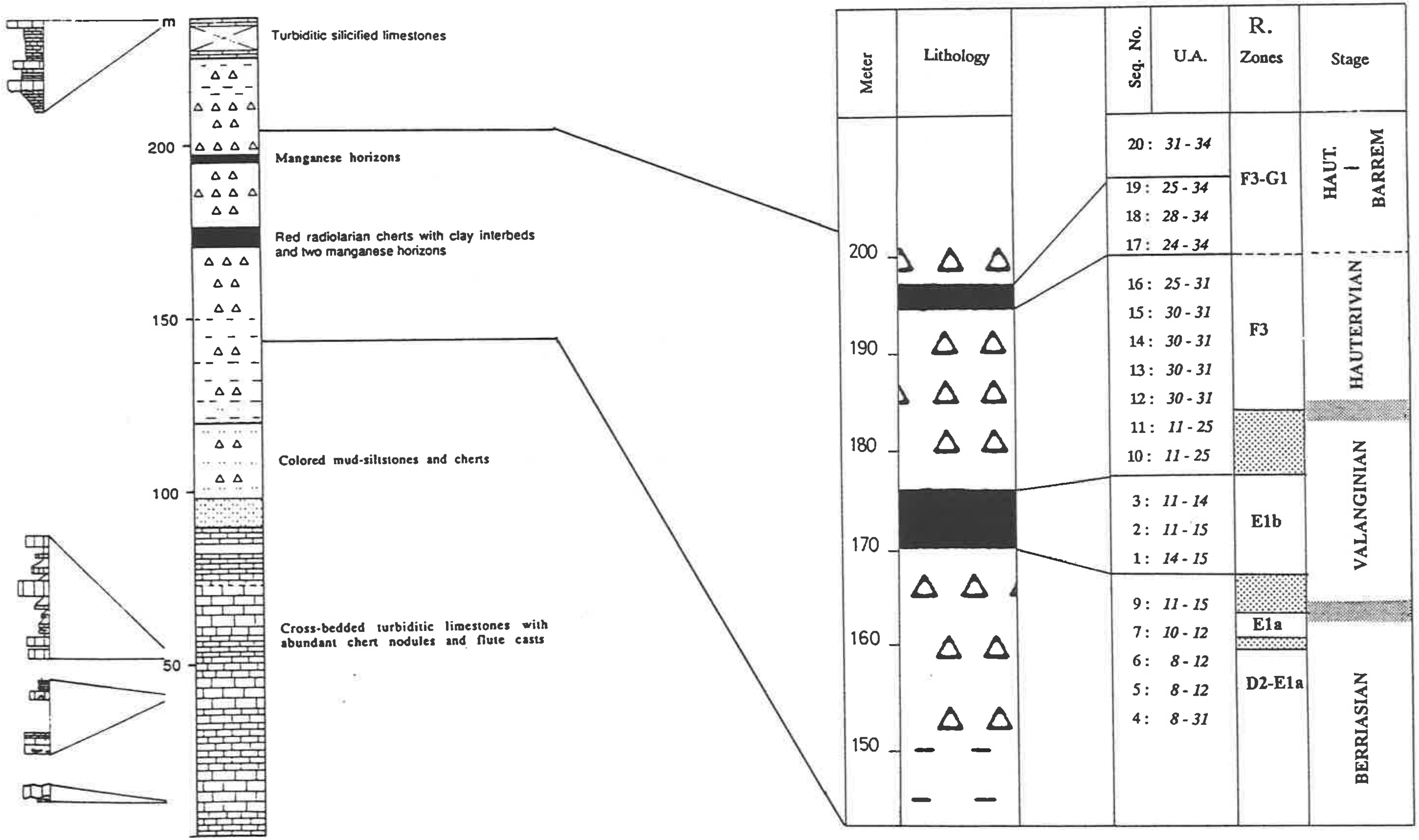



Fig. 24 Section 13: correlation of Unitary Associations and zones to lithostratigraphy of a section representing the Wahrah Formation in the Al Hammah Range (modified after Kickmaier & Peters, 1990).

## 2.2. Unitary Associations and zones

It is known at present (Baumgartner, 1984a, b) that radiolarian abundance and preservation, especially in land sections, which underwent deep burial diagenesis, is largely dissolution-controlled. That is why the absence of a species from a certain interval of a section does not necessarily have a chronologic significance. From the same reason the first and last occurrences of a taxon may essentially differ from a section to another, making these events, usually used in biostratigraphic zonations, worthless as regards many Mesozoic radiolarians from hard rocks.

In order to know whether the absence from a certain interval is consistent or not it is necessary to systematically analyse the occurrences of a species in all available sections and establish which species are mutually exclusive and represent consistent absences from certain stratigraphic intervals, and which species really co-occur. The stratigraphically successive sets of maximum number of co-occurring or potentially co-occurring species represent what Guex (1977) named Unitary Associations (U.A.). He elaborated later the logics and mathematics which made it possible to compute the U.A. with a program (Guex 1978, 1979, 1980, 1987; Guex & Davaud 1982, 1984). This program was previously successfully applied for radiolarians by Baumgartner et al. (1980), Kocher (1981) and Baumgartner (1984b, 1987), but a last, more efficient version ("BIOGRAPH") was later elaborated by Savary & Guex (1991). It is this program that we used in the computer treatment of our biostratigraphic data.

In order to define the Unitary Associations the occurrence data of 175 selected taxa from the sections studied have been processed. The code number of these taxa (see range chart, Fig. 26) were those used for the "Catalogue of Jurassic and Cretaceous Radiolaria" which is in preparation under the leadership of P. O. Baumgartner. The computer calculated 35 successive Unitary Associations. The identified U.A. and their reproducibility on the 13 sections are shown on Figure 25. The letter "n" in the left column indicates the number of identified Unitary Associations on each section. Each black rectangle represents a strictly identified U.A., as for example U.A. 28 or U.A. 35. The smaller rectangles represent not precisely identified U.A. (see correlation table of the database) as for example U.A. 26-27 at Ranchi superiore or U.A. 7-10 at Capriolo.

The 35 Unitary Associations have been grouped into 11 radiolarian zones spanning the interval between the Uppermost Oxfordian and Early Aptian (Fig. 25, 26). The boundaries of the biochronozones have been established by carefully studying the identified U.A., their superposition in sections and coincidence with lithologic boundaries or boundaries between biostratigraphic units of other fossils such as nannofossils and calpionellids. Finally the biochronozones were calibrated by means of magnetic polarity zones and nannofossil and calpionellid events and zones.

## 2.3. Definition of zones and U.A.

In agreement with Guex (1977, 1987) each Unitary Association is defined by one or several species pairs (Fig. 26). The radiolarian zone is defined by one or several species-pairs of the Unitary Associations included within this zone and by all other species passing the entire zone. Co-existing taxa in a zone are not automatically co-occurrent in the Unitary Associations included in that zone. In the following chapter we will try to define the Unitary Associations distinguished by some of the most important co-occurring species. It must be mentioned that several U.A. may be co-occurrent within a zone, as for example U.A. 15 and 16 which all represent the Lower Valanginian in the Southern Alps sections. Correlations should therefore be done strictly on the zonal level.

***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 pass 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 arabica*, *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.

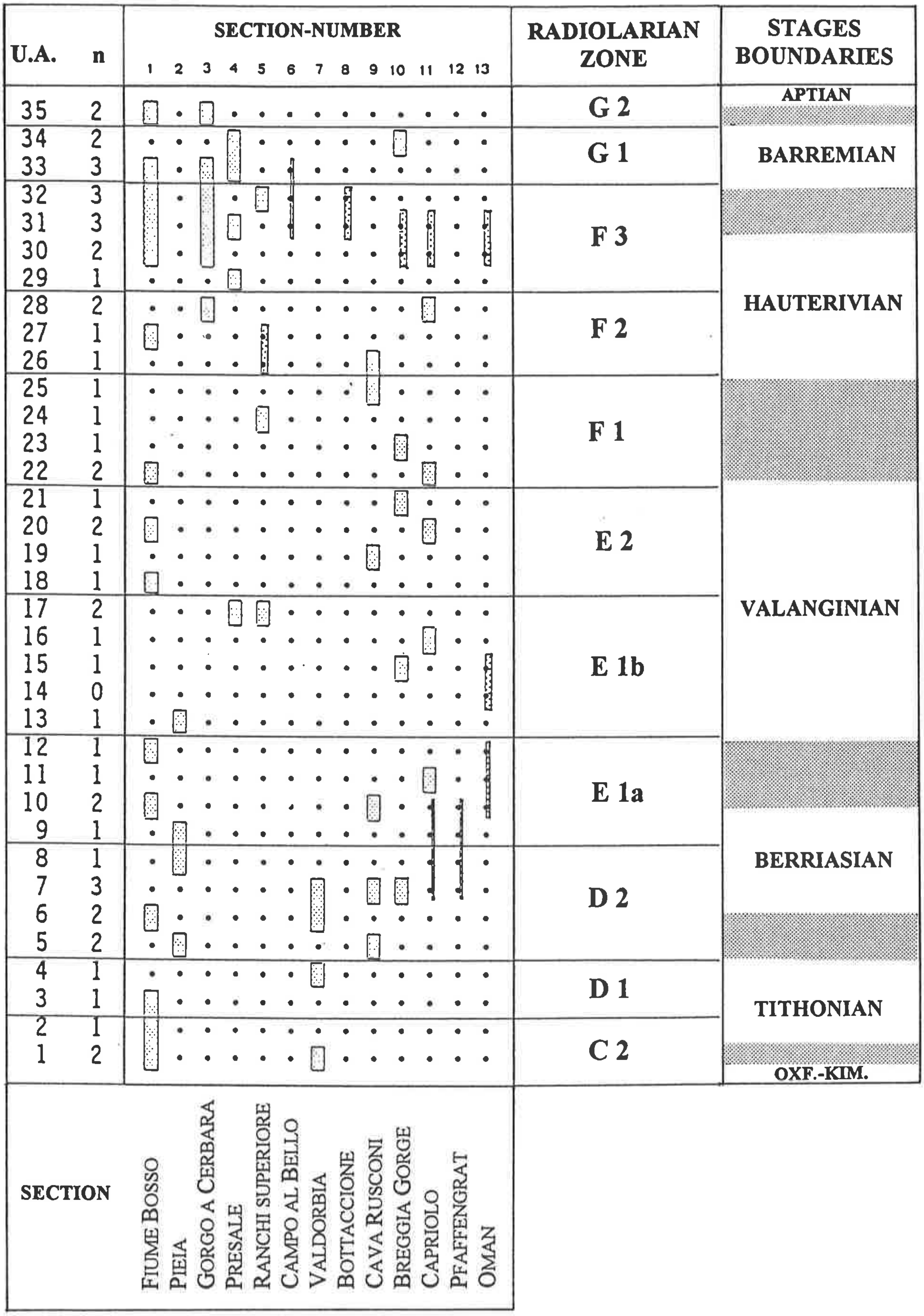



Fig. 25 Reproducibility table of 35 Unitary Assosiations (U.A.) on 13 sections.

U.A.7: Co-occurrence of *Artocapsa* (?) *amphorella* with *Savaryella guexi*, *Pseudoaulophacus* (?) *pauliani*, *Sethocapsa trachyostraca*, *Wrangellium puga* and others.

U.A.8: Co-occurrence of *Sethocapsa* (?) *concentric*a 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 flügeli*, *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 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 flügeli 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 euganea* and others with *Pseudodictyomitra leptoconica.*

## 2.4. Distribution, chronostratigraphic and biostratigraphic calibration of zones

### 2.4.1. Introduction

The radiolarian zones were calibrated by magnetic polarity zones, nannofossil and calpionellid events and zones. The magnetic polarity chrons have been previously established in 4 of our investigated sections (Fig. 27). The chrons are marked by a lower reversed white zone and an upper normal black zone. Haq et al. (1987) defined the chrons by placing the normal zone on the base and the reversed zone on the top of the chron which contrasts to the terms used by Cox in Harland et al. (1982) and many others. We followed the latter authors, placing the reversed zone at the bottom and the normal zone at the top of each chron. For calpionellids the Rome Standard Zonation (Allemann et al., 1970) was used, but we added a "c" in front of the letters naming the zones or subzones (cA, cB, cD1 etc.) in order to avoid confusion with the terms used for our radiolarian zones. 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 of these sections have been correlated to the magnetic polarity zones, nannofossil and calpionellid events and zones (Fig. 27).

For the following discussion about the distribution and the correlation of the radiolarian zones the reader is referred to the Correlation Table in the database, to the reproducibility table of the Unitary Associations on each section (Fig. 25), to the integrated correlation table (Fig. 27) and to the detailed stratigraphical columns of each section.

### 2.4.2. Distribution of zones on sections

*Zone C2 (U.A.1 - U.A.2)*

***Fiume Bosso***: Because of the bad preservation of the samples below 290.00 m many of the very important radiolarian taxa are lacking. Their absence would have influenced the calculations of the Unitary Associations in such a way that the virtual associations could not be clearly defined. Therefore an artificial sample, considered to be the lowermost of all, was added at the base of the section. Magnetic polarity zones had been established between 300.00 and 410.00 m. The radiolarian zone C2 (U.A.1, identified in the interval 289.80-292.20 m and U.A.2 at 294.60 m) corresponds to the magnetic chrons M20 and M21.

***Valdorbia***: Zone C2 (U.A.1, identified in the interval +71.00 to -65.90 m) corresponds to Baumgartner's (1984, 1987) zones B (U.A.7-8 at 71.00 m) and C2 (U.A. 10 at 65.90 m). The U.A.2, that is present at Fiume Bosso, is missing here probably because of the inadequate sample density.

*Zone D1 (U.A.3 - U.A.4)*

***Fiume Bosso***: Zone D1 (U.A.3, identified in the interval 304.00-306.20 m) corresponds to the magnetic polarity zones upper M20 normal and M19 reversed and is correlated to the calpionellid zone cA. The U.A.4 (identified at Valdorbia at +47.60 m) is missing probably due to an inadequate sample density (6 m without radiolarian samples), but it should be very short-ranged, including the lower part of the chron M19. Zone D1 corresponds to Baumgartner's Zone uppermost C2 (U.A.10) and/or lowermost D (U.A.11).

***Valdorbia***: Zone D1 (U.A.4) was identified at +47.60 m, which corresponds to Baumgartner's (1984, 1987) uppermost C2 (U.A.10) or to the radiolarian zonal boundary C2/D and/or to the base of the zone D (U.A.11).

*Zone D2 (U.A. 5 - U.A. 8)*

***Fiume Bosso***: Zone D2 (U.A.6 at 311.20-323.20 m and U.A. 6-8 at 332.70 m) includes the interval of the magnetic polarity zones M19 normal to lower M17 reversed and the calpionellid zones upper cA and cB. This zone may probably reach up to M16 reversed, if the 2 samples at 336.20 m and at 351.50 m, identified as U.A. 6-10, would also belong to D2. In this case the zone would also include the base of the calpionellid subzone cD1 as is the case in the Pieia section. The Tithonian/Berriasian boundary is in M19 normal and the FADs of the nannofossils *Umbria granulosa granulosa*, *Rotelapillus laffitei*, *Nannoconus steinmannii minor* and *Nannoconus steinmannii steinmannii* are included in zone D2

***Pieia***: No magnetostratigraphy was available for correlations. Zone D2 (U.A. 5 in 10.00 to "4 m above slump", U.A. 6-8 in 13.25-37.60 m and U.A. 8 in 40.20-64.70 m) corresponds to the calpionellid zone cB, cC and to the lowermost part of the subzone cD1, which correlates rather well with Fiume Bosso, provided that the samples 336.20 m and 351.10 m from that section be included in the radiolarian zone D2.

***Valdorbia***: Zone D2 (U.A.6 in +5.00 to -6.00 m, U.A.6-7 in -6.20 to -6.50 m, U.A.7 in -10.00 m) corresponds to Baumgartner's (1984, 1987) zone D and includes the base of the calpionellid zone cA and the cA/cB zonal boundary which at its turn approximates the Jurassic-Cretaceous boundary (see discussion in chapter 2.6).

***Cava Rusconi***: The section was not yet investigated for nannofossils and magnetic polarity zones. As already mentioned (Chapter 14.3. under Cava Rusconi), Remane (in Lüthi, 1973) determined the calpionellids from this section but the correlation with his data was impossible because of a difference of 30 m in our measurements of lithologic column due probably to the fact that the formation is intensely folded and recognition of the continuation of the beds is difficult to follow over several folds. Because also the samples collected by us and studied by Remane were not conclusive we could not correlate the radiolarian zones from this section with the other zones.

***Breggia Gorge***: Zone D2 (U.A.5-6 in 0.03 m and U.A.7 in 1330) contains the aptychus assemblage of *Laevaptychus*, *Lamellaptychus beyrichi* and *Punctaptychus punctatus* (Renz & Habicht, 1985) considered to be lowest Berriasian in age. It corresponds more precisely, if compared with Fiume Bosso, to the interval between uppermost Tithonian and lowermost Berriasian

***Capriolo***: Zone D2 was not precisely identified, meaning that the U.A.7-10 may fall either into the zone D2 (U.A.5-8) or E1a (U.A.9-12). With regards to Fiume Bosso we think that the samples 163.00 m and 162.80 m (+ 1 meter) may already belong to E1a.

### *Zone E1a (U.A.9 - U.A.12)*

***Fiume Bosso***: Zone E1a (U.A.10 in 361.80-370.10 m, U.A.10-12 in 382.00-391.20 m and U.A.12 in 409.00 m) corresponds to the magnetic polarity zones base M16 normal to M13. The sample 409.00 m is above the studied interval for magnetic polarity zones. The chrons M14 and M13 were only questionably identified because of their weak remanent magnetization properties (Lowrie & Channell, 1983, Channell & Grandesso, 1988). We think that the zone E1a terminates not higher that the lower M14, if compared with Capriolo, which means that there is a questionable interval between 391.20 m and 409.99 m which is not correlative at all. Consequently E1a would correlate to the calpionellid subzones cD1, cD2, cD2 and partly cD3. Zone E1a includes the FADs of the nannofossils *Cretarhabdus angustiforatus*, *Percivalia fenestrata* and *Calcicalathina oblongata*.

***Pieia***: Zone E1a (U.A.9 in 66.60-67.70 m) includes parts of the calpionellid subzone cD2, which corresponds to Fiume Bosso. The following samples were not precisely identified.

***Capriolo***: Zone E1a (U.A.9-11 in 154.00+1 m and U.A.11 in 146.60-146.20+1 m) corresponds to the magnetic polarity zones M15 reversed to base M14 reversed. Zone E1a includes partly the calpionellid subzone cD3 and the FADs of the nannofossils *Umbria granulosa granulosa* and *Percivalia fenestrata*. As the samples 1 and 2 (U.A.7-10) are placed at the base of M16 normal the zone E1a may include also, by comparison with Fiume Bosso, the calpionellid subzones cD2 and cD1. The nannofossil events of *Percivalia fenestrata* (included at Fiume Bosso in E1a and in M16) corresponds to cD1 and is time transgressiv to Capriolo, where it is also placed in E1a, but in the chron M15.

***Oman***: Zone E1a was identified in sample 7 (U.A.10-12) but could not be correlative to any other fossil group or to magnetic polarity zones. If compared to the section Fiume Bosso the sample 7 may correspond approximately to the Berriasian/Valanginian boundary.

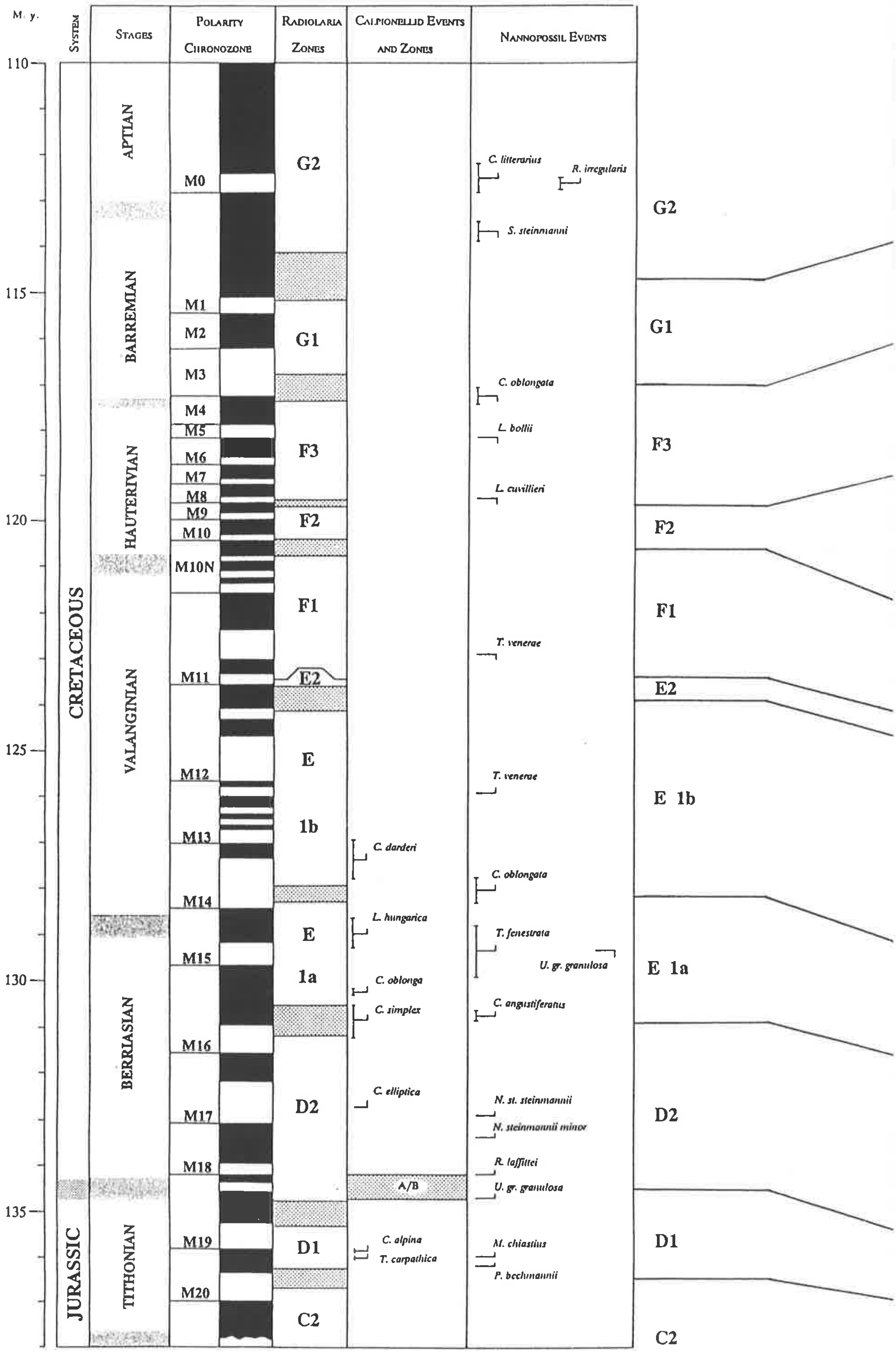
### *Zone E1b (U.A.13 - U.A.17)*

***Pieia***: Zone E1b (U.A.13 in 75.60-82.75 m and U.A.13-17 in 84.75-97.35 m) corresponds to the calpionellid subzones cD2 or cD3. Generally the calpionellids are not well preserved and determinations were difficult. The species *Calpionellopsis oblonga* is present, all the others however were rare and crushed. Zone E1a at Pieia is correlative with Capriolo where the base of the zone E1b includes the top of the calpionellid subzone cD3.

***Presale***: Magnetostratigraphic data of this section are available from 180.60 m upwards. Zone E1b (U.A.17 in 174.80 m) is placed just below the first identified chron M9.

***Ranchi superiore***: Zone E1b (U.A.17 in 24.50 m) was identified in the litholocical interval without calpionellids and in the Presale and Capriolo sections corresponds to the Lower Valanginian.

***Breggia Gorge***: Zone E1b (U.A.15 in 28.85-54.70 m) includes the aptychus assemblage of *Lamellaptychus bermudensis*, *Lamellaptychus mortilleti*, *Lamellaptychus retroflexus*, *Lamellaptychus bahamensis* and is attributed by Renz & Habicht (1985) to the Valanginian, which corresponds well if compared with Capriolo.



M. y.
System
Stages
Polarity Chronozone
Radiolaria Zones
Calpionellid Events and Zones
Nannofossil Events
110
115
120
125
130
135
CRETACEOUS
JURASSIC
APTIAN
BARREMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
TITHONIAN
M0
M1
M2
M3
M4
M5
M6
M7
M8
M9
M10
M10N
M11
M12
M13
M14
M15
M16
M17
M18
M19
M20
G2
G1
F3
F2
F1
E2
E
1b
E
1a
D2
D1
C2
C. darderi
L. hungarica
C. oblonga
C. simplex
C. elliptica
A/B
C. alpina
T. carpathica
C. litterarius
R. irregularis
S. steinmanni
C. oblongata
L. bollii
L. cuvillieri
T. venerae
T. venerae
C. oblongata
T. fenestrata
U. gr. granulosa
C. angustiferatus
N. st. steinmannii
N. steinmannii minor
R. laffittei
U. gr. granulosa
M. chiastius
P. beckmannii
G2
G1
F3
F2
F1
E2
E 1b
E 1a
D2
D1
C2

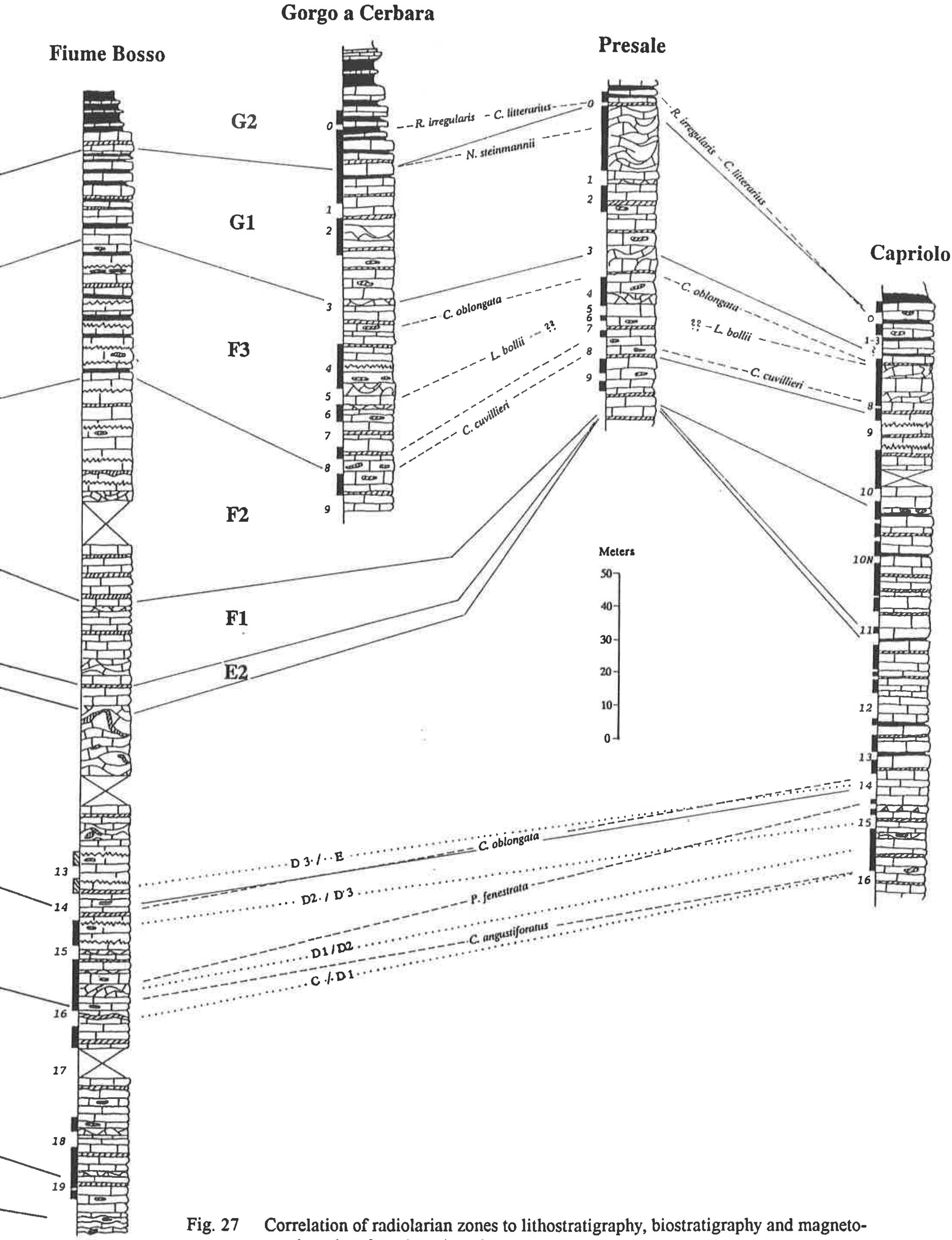



Fig. 27 Correlation of radiolarian zones to lithostratigraphy, biostratigraphy and magnetostratigraphy of 4 selected sections.

***Capriolo***: Zone E1b (U.A.16 in 144.60-109.60 m, +1 m) corresponds to the interval of the magnetic polarity zones M14 normal to base M12 normal. It correlates to the calpionellid zone cE and to the higher lithologic levels without calpionellids. E1b includes at its base the FAD of *Calcicalathina oblongata* and on a higher level the FAD of *Tubodiscus verenae* which contrasts to Fiume Bosso where the FAD of *Calcicalathina oblongata* is placed in the upper part of the zone E1a.

***Oman***: Zone E1b (U.A.14-15 in samples 1-3) was identified in the lower manganese horizon and can be dated, by comparison with the sections Capriolo and Presale, as Lower Valanginian.

### *Zone E2 (U.A.18 - U.A.21)*

***Fiume Bosso***: Zone E2 (U.A.18 in 447.50 m and U.A.20 in 449.50 m) can be dated by comparison with the section Capriolo.

***Cava Rusconi***: Zone E2 (U.A.19 in 91.50 m) can be dated by correlation with Capriolo.

***Breggia Gorge***: Zone E2 (U.A.21 in 62.80 m) is placed probably in the vicinity of the sample 63 of Renz & Habicht (1985) which contained *Neocomites sp.* and was placed by the authors just below the Valanginian-Hauterivian boundary. This boundary is at present placed in M10N at Capriolo (Channell et al. 1987) and compared with Capriolo the zone E2 has a Middle to lower Upper Valanginian age.

***Capriolo***: Zone E2 (U.A.20 in 100.00=101.00 m) corresponds to the lowermost base of the magnetic polarity zone M11 reversed and is located about 6.20 m below the LAD of the nannofossil *Tubodiscus verenae*. Zone E2 is very short-ranged, corresponding to approximatively only one magnetic polarity zone.

### *Zone F1 (U.A.22 - U.A.25)*

***Fiume Bosso***: Zone F1 (U.A.22 in 479.50-482.20 m) has to be dated by comparison with Capriolo.

***Ranchi superiore***: Zone F1 (U.A.24 in 37.05 m) can only be calibrated by correlation with Capriolo.

***Cava Rusconi***: Zone F1 (U.A.25 in 128.80-135.50 m) can be dated by comparison with Capriolo.

***Breggia Gorge***: Zone F1 (U.A.23 in 74.80 m), situated 11.80 meters above *Neocomites sp.* and containing the aptychus *L. subseranonis,* was dated by Renz & Habicht (1985) as Lower Hauterivian, which compared with Capriolo falls into the interval Upper Valanginian to lowermost Hauterivian.

***Capriolo***: Zone F1 (U.A.22 in 99.75 m and U.A.20-25 in 84.90-64.30 m, +1 m except for 64.90 m) corresponds to the interval of the magnetic polarity zones base M11 reversed to upper M10N normal. Zone F1 includes at its base the LAD of the nannofossils *Tubodiscus verenae* and has its top just below the FAD of *Lithraphidites bollii.*

### *Zone F2 (U.A.26 - U.A.28)*

***Fiume Bosso***: Zone F2 (U.A.26-27 in 486.50-537.90 m, U.A.27 in 540.50-547.50 m) must be dated by comparison with Gorgo a Cerbara or Capriolo.

***Gorgo a Cerbara***: Zone F2 (U.A.28 in 786.70 m) corresponds to the magnetic polarity zone M9 normal and is placed 6.90 m below the LAD of the nannofossil *Cruciellipsis cuvilleri.*

***Ranchi superiore***: Zone F2 (U.A.26-27 in 39-40 m) can be dated by comparison with Capriolo.

***Cava Rusconi***: Zone F2 (U.A.26 in 146.50 m and U.A.26-27 in 166.00 m) must be correlated with Capriolo.

***Capriolo***: Zone F2 (U.A.28 in 57.85-37.50 m) corresponds to the chrons M10 and M9. It includes the FAD of the nannofossil *Lithraphidites bollii* and is placed below the LAD of *Cruciellipsis cuvillieri.*

### *Zone F3 (U.A.29 - U.A.32)*

***Fiume Bosso***: Zone F3 (U.A.30 in 552.10-556.40 m, U.A.30-31 in 561.80-563.60 m, U.A.31 in 566.50-569.60 m, U.A.31-32 in 573.00-575.05 m and U.A.32 in 580.10-582.80 m) can be dated by comparison with Presale.

***Gorgo a Cerbara***: Zone F3 (U.A.30 in 791.70-812.25 m, U.A.30-31 in 814.80 m, U.A.31, 817.90-819.75 m and U.A.32 in 821.45-859.75 m) includes the interval of the chrons upper M8 to lower M2, including the FAD of the nannofossil *Lithastrinus sp.*, the LAD of *Cruciellipsis cuvillieri* at its base, and those of *Lithraphidites bollii* and *Calcicalathina oblongata* in its middle portion. These data contrast with Presale and also with Capriolo. We can only explain this by suggesting that some intervals in the lower part of the magnetic polarity zone M2 normal and in the upper part of M3 reversed underwent synsedimentary sliding and reworking that could not be detected in the field.

***Presale***: Zone F3 (U.A.29 in 197.30-204.30 m and U.A.31 in 211.35 m) corresponds to the interval of the magnetic polarity zones M7 to M4 reversed. It is situated between the FAD of the nannofossil *Lithastrinus sp.* and the LAD of *Calcicalathina oblongata*. By comparison with Gorgo a Gerbara the sample 187.15 m (U.A.22-31) could be included in Zone F3, this zone thus extending down to the base of the chron M8, in which case it would also include the LAD of the nannofossils *Cruciellipsis cuvillieri* and the FAD of *Lithraphidites bollii*. So the lower portions of Presale and Gorgo a Cerbara would be correlative but the upper interval contrasts in reaching at Presale only the top of M4 or probably the base of M3, whereas at Gorgo a Cerbara zone F3 reaches up to the chron M2. A possible explanation for this problem is given in the discussion of the latter section.

***Ranchi superiore***: Zone F3 (U.A.31-32 in 45.50 m and U.A.32 in 47.70 m) can be correlated to zone F3 at Presale, both section corresponding paleogeographically to the seamount facies.

***Bottaccione***: The single sample studied (POB 1206, U.A.31-32) is situated in the upper undisturbed part of the section and can be dated, by comparison with Presale, as Upper Hauterivian.

***Breggia Gorge***: Zone F3 (U.A.29-31 in 23.00 m and U.A.30-31 in 12.40 m) is correlated to the occurrence interval of the aptychus *L. angulocostatus*. Zone F3 can be dated by comparison with Presale.

***Capriolo***: F3 (U.A.30-31 in 28.80-18.40 m) is correlated to an interval without a possible precise definition of the magnetic polarity zones. In the interval 10-30 m the section contains several large scale slumps. Zone F3 includes at its base the FAD of the nannofossil *Rucinolithus terebrodentarius*, and at its upper part the LADs of *Lithraphidites bollii* and *Calcicalathina oblongata*.

***Oman***: Zone F3 (U.A.30-31, sample 12-16) was identified below the second manganese horizon and can be dated, by comparison with Presale, as Upper Hauterivian.

*Zone G1 (U.A.33 - U.A.34)*

***Fiume Bosso***: Zone G1 (U.A.33 in 606.80-617.00 m) can be dated by comparison with Presale.

***Gorgo a Cerbara***: Zone G1 (U.A.33 in 867.20-882.40 m) corresponds to the magnetic polarity zone M1 reversed and lower M1 normal. The top of this zone is placed 1.60 m below the LAD of the nannofossil *Nannoconus steinmannii*, and G1.

***Presale***: Zone G1 (U.A.33 in 220.75-221.05 m and U.A.34 in 225.30-238.80 m) includes the interval of the magnetic polarity zones middle M3 reversed to base M1 reversed and has its base about 6 m above the LAD of the nannofossil *Calcicalathina oblongata* and its top below the LAD of *Nannoconus steinmannii*. The top of Zone G1 cannot be dated more precisely since the interval 240-260 m is dominated by slumps and samples are lacking from this part of the section. The base of the zone G1 reaches the magnetic polarity zone M3 reversed which contrasts to Gorgo a Cerbara. A possible explanation for this discrepancy is given in the discussions under the zone F3.

***Breggia***: Zone G1 (U.A34 in 141.55 m, 9.10 m below the top of the Maiolica) was identified just below the ammonite level with *Pulchellia lindigii* (Rieber, 1977) and above the uppermost specimen of *L. angulocostatus*, dated by Renz & Habicht (1985) as Barremian and by Cecca et al. (in press) as the youngest early Barremian Caillaudi Zone, which correlates well with Gorgo a Cerbara (Bralower, 1987).

***Capriolo***: The uppermost samples, at 15.40 m and 10.60 m could not be precisely identified (U.A. 28-34). The chrons on top of the section were renamed after a reinvestigation by Channell & Erba (1992). The old M3 corresponds now to ?M1-M3, the former M1 to M0, whereas the FADs of the nannofossil *Rucinolithus irregularis* and of the foraminifer *Hedbergella similis* were identified in the former M2.

*Zone G2 (U.A.35)*

***Fiume Bosso***: Zone G2 (U.A.35 in 619.05 m - 1 m above the base of the Selli Level) has to be correlated with Gorgo a Cerbara.

***Gorgo a Cerbara***: Zone G2 (U.A.35 in 887.00-911.35 m) includes the magnetic polarity zones upper M1 normal and the base of the Middle Cretaceous quiet zone. It includes the FADs of *Chiastozygus litterarius* and *Rucinolithus irregularis*.

## 2.5. Integrated biostratigraphy and chronostratigraphy of 4 selected sections

### 2.5.1. Introduction

Until present only rare ammonites were found in the Maiolica Formation and biochronostratigraphy is mainly based on data of 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 do not raise problems. Correlation between the radiolarian zones to the three types of zones is sometimes difficult. Diachronism remarked are probably caused by the different concepts used for biostratigraphic data acquisition and different methods of 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 calibration of the chrons depends therefore on nannofossil and calpionellid occurrence data which at their 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 the recent reinvestigation of the nannofossils of the section Capriolo by Erba (Channell & Erba, 1992) where the interpretation of the magnetic polarity chrons in the uppermost portion had to be changed to adapt it to the new biostratigraphic data.

The radiolarian zones however are not defined only by a single first or last appearance datum (LAD) of one species but by the co-existence of several species within one zone. Therefore influences of sample density and preservation on the occurrence data are minimalized. Diachronism in correlating zones might also be caused by synsedimentary processes as slumping or sliding. Therefore, diachronism in correlation various fossil groups is to be expected as long as different biostratigraphic concepts are in use.

### 2.5.2. Correlation and calibration of zones and zonal boundaries

The correlations of the radiolarian zones to the magnetic polarity zones, nannofossil events and calpionellid zones on 4 selected sections will be discussed, taking into account data of some of the other investigated sections. For certain intervals correlations were impossible due to the lack of data (see table of correlation, Fig. 27 and all lithostratigrafic columns of the sections).

#### *Zone C2 (U.A.1 and U.A.2)*

Zone C2 was the lowermost zone identified at Fiume Bosso 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 in 289.80 m and U.A.10 in 292.20 m) and Valdorbia (U.A.7-8, U.A.10), there attributed an Upper Oxfordian (U.A.7-8), Kimmeridgian (U.A.9) and a Tithonian (U.A.10 and U.A.11) age. The calpionellid events and zones have been determined by Remane (personal communications, 1987-1991) and by Grandesso (Channel & Grandesso, 1988) and have led to different definitions and positions of the zonal boundaries which vary on the section between 3 and 6 meters. Grandesso defined the *Chitinoidella* zone at Fiume Bosso between 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 thought of a possible hiatus indicated by the lacking *Chitinoidella* zone and calpionellid subzone A1. At present we have no samples with better preserved radiolarians of the respective intervall. With regards to the presence of the FAD's of the nannofossils *Polycostella beckmannii* (301.00 m) and *Microstaurus chiastius* (303.00 m) which are correlated to the Chitinoidella zone by Bralower et al. (1989), we are not able to give at present any further interpretations for this questionable interval.

#### *Zone D1 (U.A.3 and U.A.4)*

Zone D1 corresponds to the magnetic polarity zones uppermost M20 to M19 reversed, includes the calpionellid zone cA and is defined only above the FADs of the nannofossils *Polycostella beckmannii* and *Microstaurus chiastius*. Zone D1 could not be correlated to any of the 3 other sections. It corresponds to Baumgartners (1984, 1987) uppermost zone C2 and/or lowermost zone D identified at Fiume Bosso and Valdorbia and must be dated as Upper Tithonian.

#### *Zone D2 (U.A.5-8)*

Zone D2 corresponds to the magnetic polarity zones M19 normal to lower M16 reversed. It includes in M19 normal the Jurassic/Cretaceous boundary and the calpionellid cA/cB zonal boundary, the calpionellid zone cB in chron M18 and M17, the calpionellid zone cC im 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 3 sections, but includes with regards to Valdorbia 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.

#### *Zone E1a (U.A.9-12)*

Zone E1a includes the polarity zones lower M16 normal to M14 reversed. 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 *Umbria granulosa granulosa*. Zone E1a includes the Upper Berriasian and the Berriasian/Valanginian stage 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 magnetic polarity zones M14 reversed to lower M12 normal and includes at its base the FAD of the nannofossil *Calcicalathina oblongata* and in the medium 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 the chron M11 reversed 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 magnetic polarity zones M11 reversed to 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 stage boundary.

#### *Zone F2 (U.A.26-28)*

Zone F2 corresponds to the magnetic polarity zones M10 and M9 and includes in its lower part in chron M10 normal the FAD of *Lithraphidites bollii* and in the upper zonal boundary in chron M8 the LAD of *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius.*and spans the Lower Hauterivian.

#### *Zone F3 (U.A.29-32)*

Zone F3 corresponds to the magnetic polarity zones M8 reversed to M3 reversed, including in its lower boundary the LAD of *Cruciellipsis cuvilleri* and the FAD of *Rhucinolithus terebrodentarius,* in the middle of the zone the LAD of *Lithraphidites bollii* and in its upper boundary the FAD of *Calcicalathina oblongata*. The zonal boundary F3/G1 corresponds roughly to the Hauterivian/Barremian stages boundary. Zone F3 includes the Middle and Upper Hauterivian.

#### *Zone G1 (U.A.33-34)*

Zone G1 corresponds to the magnetic polarity zones M3 reversed to lower M1 normal and is placed between the LADs of *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 magnetic polarity zones upper M1 normal, M0 and reaches into the Middle Cretaceous Quiet zone. This zone contains at its lower boundary the LAD of the nannofossil *Nannoconus steinmannii*, at the base of the zone the FADs of *Chiastozygus litterarius* and *Rucinolithus irregularis.* Zone G2 spans the Upper Barremian and the Lowermost Aptian.

### 2.6. Definition of stages boundaries

For the discussion of the stages boundaries see Fig. 27.

#### *Oxfordian/Kimmeridgian/Tithonian boundary*

The Oxfordian/Kimmeridgian and the Kimmeridgian/Tithonian boundary have been placed by correlating our Unitary Associations U.A.1-4 to those of Baumgartner (U.A.7-11) which have already been discussed by him in detail.

#### *Tithonian/Berriasian boundary*

In this study we adopt the recommendation made by the "Colloque international sur la limite Jurassique-Crétacé", Lyon-Neuchâtel (1975, p. 392) placing the Jurassic-Cretaceous boundary at the base of the combined *Berrriasella jacobi-Pseudosubplanites grandis* Ammonite zone. Ogg et al. (1991) correlated the boundary to the base of *Berriasella jacobi* at the base of M18 reversed respectively at the top of M19 normal which is situated in the zone of variability for the top of the calpionellid zone A and the base of B. Kent & Gradstein (1985) and Haq et al. (1987) also proposed the boundary at the base of *Pseudosubplanites grandis* however in M18 normal. Oloriz & Tavera (1989 and in another study in prep) placed the Jurassic/Cretaceous boundary at the base of the *Berriasella jacobi* Zone and correlated it to the upper part of the calpionellid *Crassicollaria* (A) Standard Zone. At Carcabuey Ogg et al. (1984) and Bralower et al. (1989) placed the boundary at the base of the *Berriasella jacobi* Zone. Thierstein et al. (1989) followed Ogg & Lowrie (1986) and proposed the Tithonian/Berriasian boundary at the base of M18 reversed in the upper half of the nannofossil Microstaurus chiastius zone. As zonal and subzonal boundaries of calpionellids are based on first (FAD) and last (LAD) appearances as well as on changes in relative abundances, the ranges of the zones vary between different authors. The calpionellid A/B zonal boundary varies at Fiume Bosso between 311.50 m (Remane 1991) and 315.20 m - 332.90 m (Channell & Grandesso, 1987) and correlates to the magnetic polarity chron M19 normal (in the case of Remane's data) or to the chrons M19 normal to M17 reversed respectively for Channell & Grandesso (1987). The U.A.6 is included in M19 normal at Fiume Bosso and corresponds to 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 to place the Berriasian/Valanginian at the base of the ammonite *Thurmanniceras otopeta* (Le Hegarat & Remane 1968, Le Hegarat 1973) which is correlated by Kent & Gradstein (1985) and by Haq et al. (1987) to middle M14 reversed and by Ogg et al. (1988 and 1991) in M15 normal based on data of Cehegin (Spain). The boundary cannot be defined neither with nannofossil nor with calpionellids and is at present placed between the FADs of the nannofossils *Percivalia fenestrata* and *Calcicalathina oblongata* (Bralower et al., 1988, Channel & Erba, 1992) and correlates to the upper part of the calpionellid subzone D2 at Fiume Bosso according to Bralower et al. (1988) and to the lower part of the calpionellid zone D3 at Capriolo according to Ogg et al. (1991). The Berriasian/Valanginian boundary is included in the radiolarian zone E1a.

#### *Valanginian/Hauterivian boundary*

The boundary was recommended at Copenhagen 1984 to be placed at the first occurrence of the ammonite genus *Acanthodiscus*. Thieuloy (1977) had proposed the base of *A. radiatus* as stratotype (La Chacre, Drome, France). Haq et al. (1987) placed the Valanginian/Hauterivian boundary below *A. radiatus* in the upper M10N. Ogg et al. (1991) placed it between upper M11 normal and upper M10N, Channel & Erba (1992) in upper M10N, between the FAD of the nannofossil *Lithraphidites bollii* and the LAD of *Tubodiscus verenae*. We followed Haq et al. (1987) and placed the boundary in upper M10N which is included in the uppermost portion of the radiolarian zone F1.

#### *Hauterivian/Barremian boundary*

This boundary was placed on three different levels: in the *Pseudothurmannia* beds, at the base of the *Pseudothurmannia* beds and at the top of the *Pseudothurmannia* beds. It was recommended in Copenhagen 1984 to choose either the base or the top of the *Pseudothurmannia* beds for the boundary. In Kent and Gradstein (1985) and in Haq et al. (1987) the Hauterivian/Barremian boundary is placed above *P. angulicostata* in the middle of the chron M3.

Channell et al. (1979 and 1987) had placed the boundary at the Cismon section in the Southern Alps between the chrons M6n and M7. Bralower (1987) proposed the boundary at Presale and Gorgo a Cerbara between the LADs of the nannofossils *Cruciellipsis cuvillieri* and *Lithraphidites bollii* between the magnetic polarity zones M6n and M7. In Ogg et al. (1991) the boundary is situated between the chrons M5r and M7r. Radiolarian occurrence data of samples of the section Murguceva (Romania) with Middle to Upper Hauterivian ammonite control (Dumitrica, personal communication) were calculated together with our database by "BIOGRAPH" and resulted in clearly showing 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. (1987).

Recently, in the Gorgo a Cerbara section ammonites of the Angulicostata Zone were found in the middle of M4, and of the Hugii-Nicklesi Zones (Lower Barremian) in the lower part of M3 by Cecca et al. (in press). They placed the boundary in the upper part of M4 in the interval between the FAD of *C. oblongata* (lowermost M3) and the FAD of *L. bollii*. We followed in the present paper their decision although the boundary could also be placed at the base of M3.

#### *Barremian/Aptian boundary*

The Barremian/Aptian boundary was recommended at Copenhagen 1984 to be placed at the first appearance of *Prodeshayesites* and was correlated by Kent & Gradstein (1985) and by Haq et al. (1987) to the uppermost part of the magnetic polarity zone M1 normal, a little below M0 reversed respectively. Bralower (1987) correlated the boundary at Gorgo a Cerbara and Presale to the FAD of *Rucinolithus irregularis* which was placed in M0. Cecca et al. (in press) 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 following Kent & Gradstein (1985) and Haq et al. (1987) in the uppermost part of M1 normal. The boundary is included in the lower part of zone G2.

## 2.7. Correlation to previous zonations

### 2.7.1 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, 1975, 1977; Pessagno, 1977; Baumgartner et al., 1980; Schaaf, 1981, 1984; Kocher, 1981; Nakaseko & Nishimura, 1981; Baumgartner, 1984; Sanfilippo & Riedel, 1985; Thurow, 1988, etc.). Most of these zonations (except Baumgartner 1981, 1984, Kocher, 1981) were based on first and final appearances of some selected taxa considered as "marker" species. The correlation between these zonations reveals important discrepancies in the time-equivalence of the zones. These discrepancies are partly due to the selection of different marker-species, to the biogeographic restriction of the taxa and to the distortion of assemblages by solution and diagenesis (Sanfilippo & Riedel, 1985).

The zonation presented herein uses the concept of Unitary Associations (U.A.), which is not based on the first and last occurrences of a species but tries to establish stratigraphically successive sets of the maximum number of co-occurring or potentially co-occurring species. Because of this its correlation to the previous zonations is very difficult or impossible. Therefore we only correlate our zonation with that of Baumgartner (1984).

### 2.7.2. Correlation with Baumgartner (1984)

In order to avoid difficulties in distinguishing the zones of P. O. Baumgartner POB) and Jud we mark them by POB U.A. and JUD U.A..

Radiolarians of 43 localities, most of them situated in the Atlantic and some in the Tethys area (some of them were reinvestigated by us) were studied by Baumgartner (1984) and the occurrence data of 109 radiolarian taxa calculated with a computer program for Unitary Associations after Guex & Davaux (1982, 1984). Baumgartner proposed 9 radiolarian zones based on 14 Unitary Associations spanning the Bathonian to Hauterivian. Two zones can be correlated.

POB Zone D (U.A.11 and 12) correlates to zone JUD D1 by the species pairs *Triactoma jonesi* and *Pantanellium* (?) *berriasianum* in the Upper Tithonian.

POB Zone E1 (U.A.13, Lower Valanginian) is defined by the co-existence of *Thanarla pulchra* and *Ristola cretacea* and cannot be correlated as *Thanarla pulchra* in our zonation appears already in the Upper Berriasian and *Ristola cretacea* has its last appearance datum in the Middle Valanginian.

*Cecrops septemporatus* appears first in POB Zone E2 (U.A.14, Valanginian and Hauterivian) in the middle Valanginian which correlates well to zone JUD E2.

It is worth noting that a major faunal change is observed in the Middle to Late Tithonian. A large number of the Jurassic rather long ranged taxa have their last appearance datum within zone C2 (both zonations) and an impressive number again of relatively long ranged Upper Jurassic to Lower Cretaceous taxa have their first appearance in the succeeding zone POB D or JUD D1. This faunal change coincides with the appearance of the calpionellids in the Western Tethys. Although it is not the subject of this thesis to detail the evolution of the Tethys, a major change in paleoceanography may be a possible cause with regards to Baumgartner (1987).

## 3. PALEOECOLOGY

Since Fiume Bosso was the only complete section from the Tithonian to the Aptian 19 samples (spanning the Berriasian-lowermost Aptian) were investigated for abundances of about 150 taxa. Of all those the data of 8 long-ranged taxa have been chosen and correlated to the radiolarian zones (Fig. 28). Minimum abundance values correspond generally to the zones E1a, E1b (Upper Berriasian, Lower Valanginian) and F2 (Lower Hauterivian), maximum values to the 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 13C excursion (Fig. 29) levels of rhythmically bedded, gray-colored, 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 paleo-ecological effects are highly influencing the faunal assemblages. High abundances of the taxa *Pantanellium squinaboli squinaboli* are observed in zone E2 and F1. The Pantanelliids were mentioned to be an indicator of upwelling conditions by Baumgartner (1987).

The rate of faunal change (see range chart, FADs x LADs per million years) was correlated to the composite carbonate isotope stratigraphy (Weissert & Lini, 1991) of the Southern Alps. The high rate of zone E2 coincides with the excursion of the 13C excursion (Fig. 29).

It is to be proved in a future study if the high abundances of taxa in zone E2 and F1 in the Umbria-Marche (Fiume Bosso section) can be correlated to the 13C excursion.

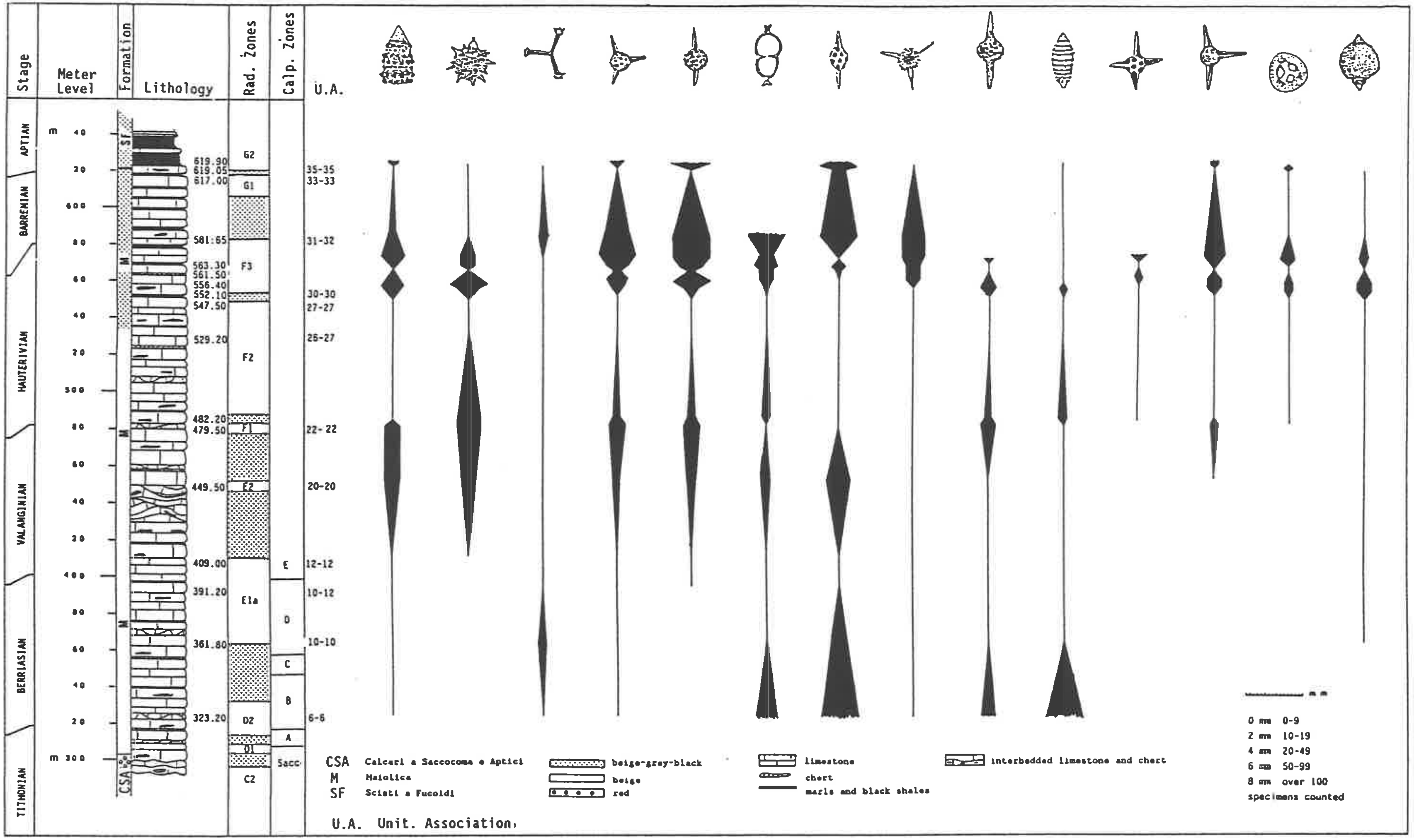



Fig. 28 Fiume Bosso section: Correlation of radiolarian zones and absolute abundances of 14 selected radiolarian taxa to lithostratigraphy and calpionellid zones.

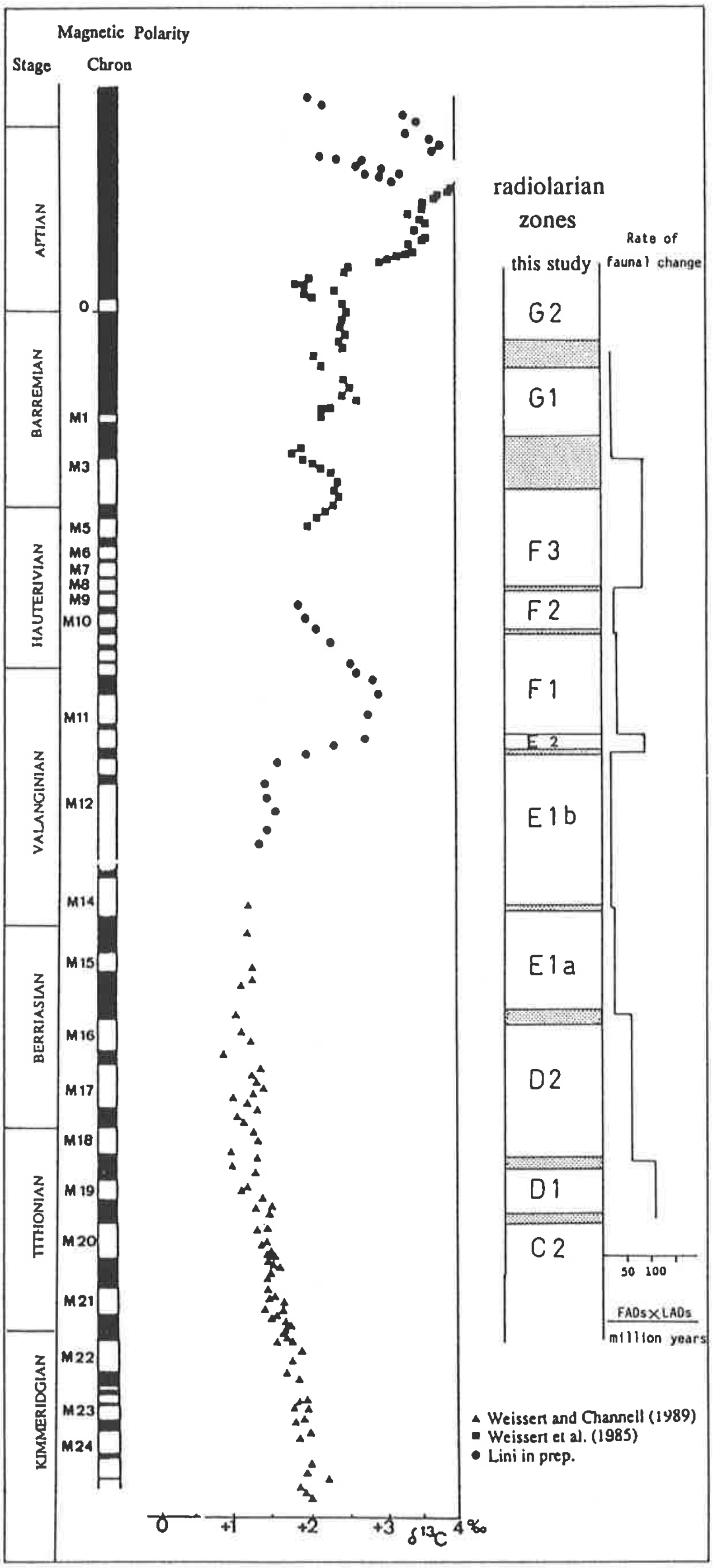



Fig. 29 Correlation of radiolarian zones and rate of faunal change to carbon isotope stratigraphy and magnetostratigraphy of the Southern Alps (modified after Weissert & Lini 1991).

## 4. CONCLUSIONS

It has been known since the end of the last century from the famous studies undertaken especially by PARONA (1890) and RÜST (1885, 1898) that the Maiolica Formation, an Upper Tithonian - lowermost Aptian pelagic formation of cherty limestones, contains rich and well preserved radiolarian faunas. Unfortunately these studies have been long time forgotten until the last decade when isolated samples or sections start being investigated for biostratigraphic purposes. In the same period the formation has been intensely investigated for magnetostratigraphy, nannofossils and calpionellids. A systematic and biostratigraphic study of the radiolarian faunas occurring in the same deposits was also necessary so much the more radiolarians represent the most frequent and diverse group of planktonic microfossils occurring in these deposits. Such a study, the results of which are presented in this paper, has been undertaken by us on more than 500 samples collected from 26 land sections in Southern Alps, in the Umbria-Marche region of the Apennines and in synchronous siliceous deposits from Oman.

The radiolarian fauna has proven to be very rich and diverse. It contains more than 200 species of which only 175 have been herein studied systematically and biostratigraphically. 61 species, 2 genera and one subspecies are newly described.

The objectives of the study were to make a comprehensive inventory and systematic study of the radiolarian faunas occurring in the Upper Tithonian - lowermost Aptian interval corresponding to the Maiolica Formation, to establish a radiolarian zonation defined by Unitary Associations, and to correlate and calibrate this zonation with the magnetic chrons and zonations of other fossil groups established in the same sections. These objectives have been more or less realized.

Although the radiolarian inventory is not yet complete it comprises the largest number of species known thus far at the level of the Maiolica Formation. More than a third of these species are new. Two new genera have been also described.

In order to establish a radiolarian biochronology of the Lower Cretaceous the occurrences of the taxa presented in this paper have been calculated with the computer program "BIOGRAPH" developed by Savary and Guex (1990). It permitted to recognize 35 Unitary Associations that could be grouped into 11 biozones whose terminology follows that previously used by BAUMGARTNER (1984b).

The radiolarian 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 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 radiolarian zones have been, when possible, correlated to the magnetic polarity chrons, calpionellid zones and nannofossil events. The diachronism sometimes remarked in correlating the 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 common Jurassic taxa to forms more typical of the Cretaceous coincides with the appearance of calpionellids, with the lithologic 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 paleoclimate seemed to have caused these changes (Baumgartner 1987).

The radiolarian biozones have a variable duration. Short duration corresponds to high rates of faunal change. Zone E2 which is very short, is located in the Upper Valanginian at the base of the magnetic polarity zone M11 and corresponds to a time of positive $^{13}C$ excursion (Weissert & Lini, 1991). A lithologic change from limestone to limestone-marl alternations, rhythmical and laminated bedding and bioturbation is observed in this interval. It is to prove if high abundances of *Pantanellium squinaboli squinaboli* (interpreted by Baumgartner 1987 as indicators of high fertility, upwelling conditions) in the Valanginian at Fiume Bosso in the Umbria-Marche can also be correlated to the $^{13}C$ excursion.

# 5. SYSTEMATIC PALEONTOLOGY

## 5.1. INTRODUCTION

The atlas is based on an alphabetical listing of the genera, species and subspecies studied. We chose this order instead of an arrangement in subfamilies, families or superfamilies because of the imperfection of these suprageneric systematic categories and of the impossibility of placing many of the taxa investigated in the suprageneric categories known at present. On the other way this arrangement is in agreement with the arrangement of the radiolarian taxa included in the "Catalogue of Middle Jurassic to Lower Cretaceous Radiolaria" prepared by an international group of radiolarists and edited at the University of Lausanne by Prof. P. O. Baumgartner.

The definition of the new genera, species and subspecies are based on the external diagnostic features of the skeleton recognized either under binocular (x 100 magnification) or with the scanning electron microscope, more than 4000 SEM photographs being extensively studied for this purpose. Infilling of radiolarian skeleton with silicified or recristallized sediment did not allow us to make also a study in transmitted light in order to know the possible internal skeletal structures.

For all new taxa measurements of different parameters have been made for holotype (HT) and paratypes (PT), and minimal (min.), maximal (max.) and average (av.) values have been calculated. Each specimen photographed and measured is identified by letters and numbers (e. g.: Bo. 449.50:1707), where the letters indicate the locality of provenance of the specimen (e. g. Bo. = Fiume Bosso section), first number (e. g. 449.50) indicates (in meters) the stratigraphic level of the specimen in the section, and the second number (e. g. 1707) the number of the negative. All taxa and genera are recorded with a MRD (Mesozoic Radioalarian Database) number.

## 5.2 SYSTEMATIC DESCRIPTIONS

### Genus: **Acaeniotyle** FOREMAN

*Acaeniotyle* FOREMAN
FOREMAN 1973b, p. 258

*Type Species*: *Xiphosphaera umbilicata* RÜST 1898

### **Acaeniotyle dentata** BAUMGARTNER

*Pl.1, Figs. 1, 2*

*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.

*Remarks*.- In our material this species shows a wide morphological variety expressed 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. *A. dentata* BAUMGARTNER was observed already in the Upper Tithonian (Breggia, sample POB 1330) but becomes frequent in the Berriasian and Valanginian.

*Range*.- U.A. 6-31

### **Acaeniotyle diaphorogona gr.** FOREMAN sensu BAUMGARTNER

*Pl. 1, Figs. 3, 4*

*Acaeniotyle diaphorogona* FOREMAN
FOREMAN 1973, p. 258, pl. 2, figs. 2-5.
FOREMAN 1975, pl. 2F, figs. 1-3, non 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, p. 134?, pl. 1, fig. 1-4.
TUMANDA 1989, p. 33, pl. 1, fig. 2, ?3
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 13, 16.
BAUMGARTNER 1992, p. 317, pl. 3, fig. 1.
*Acaeniotyle* sp. aff. *A. diaphorogona* FOREMAN
FOREMAN 1973, pl. 2, fig. 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* RUST
PESSAGNO 1977a, p. 80, pl. 7, figs. 8-9.
*Acaeniotyle diaphorogona* FOREMAN s. l.
BAUMGARTNER 1984, p. 753, pl. 1, figs. 1-2.

*Remarks*.- *Acaeniotyle diaphorogona* shows a wide variety 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°, and the third one, which is mostly shorter, makes with one of the curved spines a wide angle of about 140°-155°.
*Range*.- U.A. 1-35

## **Acaeniotyle (?) florea** OZVOLDOVA

*Pl. 1, Figs. 9-12*

?*Acaeniotyle florea* OZVOLDOVA
OZVOLDOVA & PETERCAKOVA 1992, p. 314, pl. 5, figs. 6-8

*Remarks*.- *Acaeniotyle* (?) *florea* differs from *Acaeniotyle* (?) *glebulosa* (FOREMAN) by the distinct cylindrical, drum-like shape of the 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 quincuncially arranged. Our specimens have the following measurements: (in μm, based on 10 specimens): diameter of central part av. 144, min. 110, max. 169; heigth of test av. 144, min. 124, max. 170; length of longest spine av. 141, min. 116, max. 155; length of shortest spine av. 98, min. 69, max. 115.
*Range*.- U.A. 20-35

## **Acaeniotyle (?) glebulosa** (FOREMAN)

*Pl. 1, Figs. 5-8*

*Staurosphaera glebulosa* FOREMAN
FOREMAN 1973, 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

*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.
*Range*.- U.A. 20-35

## **Acaeniotyle umbilicata** (RÜST)

*Pl. 1, Figs. 13-16*

*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 1973, p. 258, pl. 1, figs. 12-14, 16.
FOREMAN 1975, p. 607, pl. 2E, figs. 14-17; pl. 3, fig. 3.
MUZAVOR 1977, p. 26, 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, fig. 3a-b.
NAKASEKO & NISHIMURA 1981, p. 141, pl. 1, fig. 7; non 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, pl. 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.
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 & PETECAKOVA 1992, pl. 1, figs. 8, 10.
BAUMGARTNER 1992, p. 317, pl. 3, fig. 2.
*Acaeniotyle* sp.
OZVOLDOVA 1987, pl. 1, fig. 3
*Acaeniotyle tuberosa* STEIGER
STEIGER 1992, p. 27, pl. 1, figs. 18-20.

*Remarks*.- A wide variety of morphotypes exists in our material with regards 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 (pl. 1, fig. 15) with rather long and strong spines and with 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 the shell. More investigations will be necessary to be able to separate the various morphotypes from one another and to establish whether they have a biostratigraphic value. The total length of our specimens (measurements in µm, based on 10 specimens of 4 different sections) varies between 350-733, the width of the central shell between 132-210, the length of the longer spine between 114-312.

*Range*.- U.A. 1-35

## Genus: **Acanthocircus** SQUINABOL emend. DONOFRIO & MOSTLER

*Acanthocircus* SQUINABOL
SQUINABOL 1903, p. 124.
emend. DONOFRIO & MOSTLER 1978, p. 22.

*Type Species*: *Acanthocircus irregularis* SQUINABOL 1903 (subsequent designation by Campbell 1954).

### **Acanthocircus carinatus** FOREMAN

*Pl. 2, Figs. 1-3*

*Acanthocircus carinatus* FOREMAN
FOREMAN 1973 b, p. 260, pl. 5, fig. 2, not fig. 1
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
*Acanthocircus suboblongus* (YAO)
ORIGLIA-DEVOS 1983, p. 60, 61, pl. 4, fig. 5, not: 3

*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 morphologic and systematic study of this species is in preparation and will be published elsewhere.

*Range*.- U.A. 25-35

### **Acanthocircus furiosus n. sp.**

*Pl. 2, Figs. 4-7*

*Holotype*: Ru. 135.50: 2433

*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 rims 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.

*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 complete and 3 uncompl.specimens)

| | total length | length ring | width test | max. length spines |
|---|---|---|---|---|
| Br. 1330: 1590 | brok. | - | - | 105 |
| Br. 28.85: 555 | brok. | - | - | 117 |
| Br. 28.85: 2353 | 675 | 510 | 260 | 85 |
| Bo. 479.5: 1004 | 647 | 429 | 241 | 88 |
| V. -6.00: 62 | 650 | 500 | 325 | 85 |
| V. -6.50: 1263 | brok. | - | - | 101 |
| GC. 819.75: 1747 | 382 | 257 | 147 | 59brok. |
| Ru. 135.50: 2433 | 630 | 430 | 220 | 100 |
| Ru. 135.50: 2434 | 625 | 405 | 235 | 115 |
| Ca. 146.50: 2070 | 720 | 495 | 275 | 120 |

| | | | | |
|---|---|---|---|---|
| Total length test: | HT 630 | av. 618 | min. 382 | max. 720 |
| Length of ring: | HT 430 | av. 432 | min. 257 | max. 510 |
| Max. width test: | HT 220 | av. 243 | min. 147 | max. 325 |
| Max. length spine: | HT 100 | av. 102 | min. 85 | max. 120 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 3-32

### **Acanthocircus suboblongus** (YAO)

*Pl. 2, Figs. 8*

*Spongosaturnalis* (?) *suboblongus* YAO
YAO 1972, p. 29, pl. 3, figs. 1-6, pl. 10, fig. 3a-c.
WAKITA 1982, pl. 4, fig. 10.
*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.
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.
GORICAN 1987, p. 180, pl. 3, figs. 2-3.

OZVOLDOVA & PETERCAKOVA 1987, pl. 31, fig. 3.
*Acanthocircus carinatus* FOREMAN
DE WEVER & MICONNET 1985, pl. 2, figs. 7-8.

*Range*.- U.A. 1

## Acanthocircus trizonalis (RÜST)

*Pl. 2, Figs. 9-11*

*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.
*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.
MORE 1973, p. 824, pl. 3, figs. 1,3.
*Acanthocircus dizonius* (RÜST) (?)
FOREMAN 1973, p. 260, pl. 4, fig. 4,5.
*Acanthocircus trizonalis* (RÜST) (?)
FOREMAN 1973, 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.
DE WEVER & THIEBAULT 1981, p. 584, pl. 2, fig. 16.
SCHAAF 1981, p. 431, pl. 16, fig. 1.
ORIGLIA-DEVOS 1983, p. 61-63, 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.
*Spongosaturnalis amissus* (SQUINABOL)
MOORE 1974, p. 824, pl. 3, fig. 2.
*Acanthocircus dizonius* (RÜST)
RIEDEL & SANFILIPPO 1974, p. 775, pl. 2, figs. 4,5, non 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. 35.
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. 7-9.
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, pl. 1, fig. 3.
ORIGLIA-DEVOS 1983, p. 58, 59, pl. 4, figs. 2, 4
BAUMGARTNER 1984, p. 754, pl. 1, fig. 5.
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, pl. 5, 2a-e.
AITA & OKADA 1986, p. 108, pl. 1, fig. 5.
DE WEVER et al. 1986, pl. 6, figs. 3-4.
PAVSIC & GORICAN 1987, p. 22, pl. 2, fig. 2.
OZVOLDOVA & PETERCAKOVA 1987, pl. 31, fig. 3.
OZVOLDOVA 1988, pl. 3, fig. 7.
TUMANDA 1989, p. 34, pl. 2, fig. 12
STEIGER 1992, p. 34, pl. 5, figs. 3-6.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 1,2,11.
*Acanthocircus amissus* (SQUINABOL)
DONOFRIO & MOSTLER 1978, p. 23, pl. 1, figs. 1, 10, pl. 5, figs. ?1,3,4,?6,?9, non fig. 2.; pl. 6, figs. 4,?6,non figs. 8,11.
STEIGER 1992, p. 34, pl. 5, fig. 7.
*Acanthocircus variabilis* (SQUINABOL)
STEIGER 1992, p. 35, pl. 5, fig. 9.
*Acanthocircus* sp.
SCHAAF 1981, p. 431, pl. 7, fig. 7.
OZVOLDOVA 1987, pl. 1, fig. 12.
*Acanthocircus* sp. A
OZVOLDOVA & PETERCAKOVA 1992, p. 315, pl. 1, fig. 4.
*Acanthocircus* sp. B
OZVOLDOVA & PETERCAKOVA 1992, p. 315, pl. 1, fig. 3.

*Remarks*.- *Acanthocircus trizonalis* (RÜST) and *Acanthocircus dicranacanthos* (SQUINABOL) are herein synonymized, because together with the two morphotypes representing *A. trizonalis trizonalis* and *A. trizonalis dicranacanthos*, 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 large variety of other morphotypes differing from one another in the shape and the size of the distal spines and of the ring.

*Range*.- U.A. 1-35

## Acanthocircus variabilis (SQUINABOL)

*Pl. 2, Figs. 12-13*

*Saturnalis variabilis* SQUINABOL
SQUINABOL 1914, p. 291, pl. 22, fig. 8, not: 9
*Acanthocircus* sp. aff. *S. variabilis* SQUINABOL
FOREMAN 1973, 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* DONOFRIO & MOSTLER
DONOFRIO & MOSTLER 1978, p. 32, pl. 3, figs. 6, 10, pl. 6, figs. 5, 7
*Acanthocircus carinatus* FOREMAN
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 5.

*Remarks*.- In agreement with DONOFRIO &

MOSTLER (1978) we include in this species only forms with two spines at each end of the ring.

*Range*.- U.A. 24-32

## Genus: **Alievium** PESSAGNO, emend. FOREMAN

*Alievium* PESSAGNO
PESSAGNO 1972, p. 297.
FOREMAN 1973, p. 262.

*Type Species*: *Theodiscus superbus* SQUINABOL 1914

### **Alievium helenae** SCHAAF

*Pl. 3, Fig. 1*

*Alievium* sp.
FOREMAN 1973 b, p. 262, pl. 9, figs. 1-2.
MATSUYAMA et al. 1982, pl. 1, fig. 8.
OZVOLDOVA & SYKORA 1984, p. 261, 262, 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, figs7-8; pl. 5, fig. 14.
*Alievium* sp. A
PESSAGNO 1977, 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, fig. 2a-b.
AOKI 1982, pl. 2, fig. 3.
ORIGLIA-DEVOS 1983, p. pl. 13, figs. 6, 7, 10
BAUMGARTNER 1984, p. 755, pl. 1, figs. 8-10.
SCHAAF 1984, p. 112 - 113, fig. 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, textfig. 2, nr. 13
TUMANDA 1989, p. 34, pl. 1, fig. 9
OZVOLDOVA & PETERCAKOVA 1992, pl. 2, figs. 2, 7.

*Range*.- U.A. 3-35

## Genus: **Angulobracchia** BAUMGARTNER

*Angulobracchia* BAUMGARTNER 1980, p. 310.

*Type species*: *Paronaella (?) purisimaensis* PESSAGNO 1977a.

### **Angulobracchia portmanni gr.** BAUMGARTNER

*Pl. 3, Figs. 2-6*

*Angulobracchia* (?) *portmanni* BAUMGARTNER
BAUMGARTNER 1984, p. 757, pl. 2, fig. 3
*Angulobracchia* sp. C BAUMGARTNER
STEIGER 1992, p.50, pl. 13, fig. 1

*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 pore frames. 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 the 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 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 *A. 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.*

*Range*.- U.A. 5-35

### **Angulobracchia (?) portmanni portmanni** BAUMGARTNER

*Pl. 3, Fig. 7*

*Hagiastrid* gen et sp. indet.
FOREMAN pl. 7, figs. 1,2,5, non figs. 2, 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, fig. 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, fig. 16-17.

*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.

*Range*.- U.A. 5-35

### Angulobracchia (?) rugosa n. sp.

*Pl. 3, Figs. 8, 9*

*Hagiastridae*, gen. et sp. indet.
HOLZER 1980, pl. 2, figs. 15, 16
*Angulobracchia* (?) *portmanni* BAUMGARTNER
? STEIGER 1992, p. 50, pl. 12, fig. 8.

*Holotype*: V. -6.50: 1247

*Definition*.- Three-rayed test. Rays equal in length and regularly arranged at 120°. Central area inflated, slightly thinning distally. Middle portion of rays enlarged and prolonged into a short, small ray-tip. Upper and lower surfaces 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.

*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). This species could be also assigned to the genus *Paronaella* PESSAGNO if we take into account the resemblabce of the external structure on the upper and lower faces of test with *Paronaella mulleri* PESSAGNO. Most specimens found in our material have the distal parts of the beams broken off.

*Etymology*.- From the Latin *rugosus* = rough, coarse

*Measurements* (in µm).-

(based on max. 5 specimens; values between brackets are measurements for incomplete specimens, of which the rays were measured from the center of test to the distal rim of the enlarged portion of the rays)

| | length of rays | max. width of test | thickness of test |
|---|---|---|---|
| Br. 1330: 180 | - (176) | 131 | 162 |
| V. -6.0: 25 | 213 (160) | 80 | - |
| V. -6.0: 52 | - (187) | 120 | - |
| V. -6.0: 60 | 325 (162) | 124 | - |
| V. -6.5: 1247 | 273 (164) | 109 | - |

| | | | | |
|---|---|---|---|---|
| L. of rays: | HT 273 | av.(170) | min.(160) | max. (187) |
| Max. width: | HT 109 | av. 113 | min.80 | max.124 |
| Thick. test: | PT 162 | | | |

*Type Locality*.- Valdorbia, Umbria-Marche, Italy

*Range*.- U.A. 3-14

## Genus: **Archaeodictyomitra** PESSAGNO

*Archaeodictyomitra* PESSAGNO
PESSAGNO 1976, p. 49.
PESSAGNO 1977b, p. 41 (emend.)

*Type Species*: *Archaeodictyomitra squinaboli* PESSAGNO 1976

### Archaeodictyomitra apiarium (RÜST)

*Pl. 3, Figs. 10, 11*

*Lithocampe apiarium* RÜST
RÜST 1885, p. 314, pl. 39 (14), fig. 8.
*Dictyomitra apiarium* (RÜST)
RÜST 1898, p. 58.
non 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, fig. 6, 14.
DE WEVER & THIEBAULT 1981, p. 585.
non KANIE et al. 1981, pl. 1, fig. 8.
NAKASEKO & NISHIMURA 1981, p. 145, pl. 6, figs. 2-4; pl. *15*, figs. 2, 6, non fig. 1.
non SCHAAF 1981, p. 432, pl. 18, fig. 2a-b.
MATSUYAMA et al. 1982, pl. 1, fig. 1.
AOKI 1982, pl. 2, fig. 11, ?12
MATSUOKA & YAO 1985, pl. 2, fig. 4.
TANAKA et al. 1985, pl. 1, fig. 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.
TUMANDA 1989, p. 36, pl. 2, fig. 9.
STEIGER 1992, p. 88, pl. 25, figs. 8, 9.
*Dictyomitra apiarum* (RÜST)
NAKASEKO et al. 1979a, pl. 3, fig. 4, non fig. 3.
*Archaeodictyomitra apiarium* (RÜST)
KOCHER 1981, p. 56, pl. 12, fig. 13.
SCHAAF 1984, p. 92-93, figs. 1, 3a-b, 5a-b; non figs, 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.
PAVSIC & GORICAN 1987, p. 24, pl. 2, fig. 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.

non 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, no. 10, 11, ?12

*Range*.- U.A. 1-35

## **Archaeodictyomitra chalilovi** (ALIEV)

*Pl. 3, Figs. 12-14*

*Lithocampe chalilovi* ALIEV
ALIEV 1965, p. 67, pl. 12, figs. 10-13
*Dictyomitra* cf. *pseudoscalaris* TAN
DUMITRICA 1975, pl. 2, fig. 15
?*Mita magnifica* PESSAGNO
?SCHAAF 1981b, p. 435, pl. 24, figs. 13a, b, not pl. 6, fig. 10
*Mita gracilis* (SQUINABOL)
SCHAAF 1984, p. 110, 111, figs. 1-3, 4a, b, not 5a, b, c
GORICAN 1987, p. 184, pl. 3, figs. 22, 23

Remarks.- 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 have an average length of 410 in µm and a width of 156 in µm.

*Range*.- U.A. 31-35

## **Archaeodictyomitra excellens** (TAN)

*Pl. 3, Figs. 15, 16*

*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, non fig. 7; pl. 11, fig. 35.
*Dictyomitra apiarum* (RÜST)
NAKASEKO et al. 1979, pl. 3, fig. 3, non 4.
*Archaeodictyomitra apiara* (RÜST)
SCHAAF 1981, p. 432, pl. 18, fig. 2a-b.
NAKASEKO & NISHIMURA 1981, p. 145, pl. 6, fig. 1, non 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.
*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
STEIGER 1992, p. 88, pl. 25, figs. 10, 11.
*Archaeodictyomitra apiarium* (RÜST)
SCHAAF 1984, 92-93, figs. 2, 4a-b, non figs. 1, 3a-b, 5a-b.

*Range*.- U.A. 3-35

## **Archaeodictyomitra lacrimula** (FOREMAN)

*Pl. 3, Fig. 17*
*Pl. 4, Fig. 1*

*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. 5, figs. 5, 6, pl. 15, fig. 10
OKAMURA & UTO 1982, pl. 7, fig. 4
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. 1, pl. 2, fig. 6
*Thanarla* (?) *lacrimula* FOREMAN
VISHNEVSKAYA et al. 1982, pl. 2, fig. P
*Thanarla lacrimula* FOREMAN
VISHNEVSKAYA 1984b, pl. 12, figs. 1, 4, 8
*Thanarla* ex. gr. *lacrimula* FOREMAM
VISHNEVSKAYA et al 1985, pl. 2, fig. 5, 6

*Remarks*.- We included with the species *Archaeodictyomitra lacrimula* (FOREMAN) only specimens with a biconical, distally closed test.

*Range*.- U.A. 8-35

## Genus: **Archaeospongoprunum** PESSAGNO

*Archaeospongoprunum* PESSAGNO
PESSAGNO 1973, p. 57.

*Type Species*: *Archaeospongoprunum venadoensis* PESSAGNO 1973

## **Archaeospongoprunum patricki n. sp.**

*Pl. 4, Figs. 2-4*

*Archaeospongoprunum tehamaensis* PESSAGNO
SCHAAF 1981b, p. 432, pl. 7, figs. 3, 5, pl. 10, figs. 7a,b
ORIGLIA-DEVOS 1983, p. 126, 127, 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* cfr. *tehamaensis* PESSAGNO
IGO et al. 1987, textfig. 2, no. 5
THUROW 1988, p. 398, pl. 6, fig. 1

*Archaeospongoprunum cortinaensis* PESSAGNO
SCHMIDT-EFFING 1980a, p. 246, textfig. 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.
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. 2, fig.
STEIGER 1992, p. 29, 30, pl. 4, figs. 3, 4.

*Holotype*: Br. 28.85: 1

*Definition.*- Subglobular to ellipsoidal test, tapering and passing gently to the base of the two 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.

*Remarks.*- *Archaeospongoprunum patricki*, n. sp. differs from *A. tehamaensis*, *A. cortinaensis*, *A. salumis*, all these 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 in μm).-

(based on max. 7 specimens)

| | total length | length shell | width shell | max. length spine | min. length spine |
|---|---|---|---|---|---|
| Br. 1330: 133 | 349 | 121 | 100 | 121 | 107 |
| Br. 28.85:1 | 580 | 190 | 162 | 195 | 195 |
| Bo. 581.65: 49 | 417 | 142 | 100 | 142 | 133 |
| Bo. 581.65: 51 | 472 | 155 | 100 | 166 | 151 |
| Pr. 225.30: 134 | 379 | 142 | 105 | 126 | 111 |
| Pi. 94.30: 817 | 417 | 141 | 135 | 141 | 135 |
| Om. 1: 34 | 373 | 140 | 120 | broken | 133 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 580 | av. 426 | min. 349 | max. 580 |
| Length shell: | HT 190 | av. 147 | min. 121 | max. 190 |
| Width shell: | HT 162 | av. 117 | min. 100 | max. 162 |
| Max. l. spine: | HT 195 | av. 149 | min. 121 | max. 195 |
| Min. l. spine: | HT 195 | av. 138 | min. 111 | max. 195 |

*Type Locality.*- Breggia Gorge, near Chiasso, Ticino, Switzerland

*Range.*- U.A. 3-35

## Genus: **Archaeotritrabs** STEIGER emend. JUD

*Archaeotritrabs* STEIGER
STEIGER 1992, p. 40.

*Type Species*: *Archaeotritrabs gracilis* STEIGER 1992

*Emended definition.*- 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.

*Remarks.*- The genus was described as possessing 6 longitudinal beams on each ray (STEIGER, 1992). 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).

### **Archaeotritrabs gracilis** STEIGER

*Pl. 4, Figs. 5-8*

*Paronaella* (?) *ewingi* PESSAGNO
HOLZER 1980, p. 159, 160, pl. 1, figs. 16, 17, not 15
*Paronaella* (?) *worzeli* PESSAGNO
HOLZER 1980, p. 160, 161, 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, 79, only pl. 10, fig. 1
*Archaeotritrabs gracilis* STEIGER
STEIGER 1992, p. 40, pl. 8, figs. 6-8
*Homoeoparonaella tricuspidata* (RÜST)
STEIGER 1992, p. 41, pl. 9, figs. 1, 2.

*Remarks.*- 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.

*Range.*- U.A. 13-34

## Genus: **Artocapsa** HAECKEL

*Type species*: *Artocapsa fusiformis* HAECKEL 1887

### **Artocapsa (?) amphorella n. sp.**

*Pl. 4, Figs. 9, 10*

*Holotype*: V. -6.5: 1250

*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.

*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 include 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)

| | total height | max. width | length of extension | width at base of extension |
|---|---|---|---|---|
| Bo. 311.2: 17 | 318 | 127 | 77 | 54 |
| Bo. 311.2: 1183 | 325 | 120 | 85 | 55 |
| Bo. 311.2: 1184 | 365 | 130 | 100 | 60 |
| Bo. 311.2: 1185 | 346 | 150 | 95 | 65 |
| Bo. 311.2: 1186 | 310 | 125 | 90 | 55 |
| Bo. 311.2: 1190 | 330 | 125 | 95 | 65 |
| Bo. 311.2: 1191 | 305 | 125 | 95 | 60 |
| Bo. 323.2: 41 | 319 | 140 | 94 | 55 |
| V. -6.0: 43 | 310 | 131 | 100 | 62 |
| V. -6.0: 229 | 308 | 154 | 100 | 59 |
| V. -6.5: 1248 | 340 | 140 | 90 | 55 |
| V. -6.5: 1250 | 417 | 158 | 129 | 64 |
| V. -6.5: 1251 | 388 | 170 | 117 | 64 |
| V. -6.5: 1256 | 284 | 117 | 82 | 66 |
| Pi. 10.0: 786 | 304 | 127 | 86 | 59 |
| Pi. 10.0: 789 | 310 | 123 | 85 | 59 |
| Pi. 10.0: 794 | 322 | 136 | 86 | 68 |
| Pi. 57.5: 824 | 248 | 88 | 60 | 36 |
| Pi. 57.5: 825 | 274 | 04 | 68 | 40 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 417 | av. 323 | min. 248 | max. 417 |
| Max. width: | HT 158 | av. 131 | min. 88 | max. 170 |
| Length extension: | HT 129 | av. 91 | min. 60 | max. 129 |
| Width at base ext.: | HT 64 | av. 58 | min. 36 | max. 68 |

*Type Locality*.- Valdorbia, Umbria-Marche, Italy

*Range*.- U.A. 3-7

## Genus: **Bernoullius** BAUMGARTNER

*Bernoullius* BAUMGARTNER
BAUMGARTNER 1984, p. 759, 760

*Type species*: *Eucyrtis* (?) *dicera* BAUMGARTNER 1980.

### **Bernoullius (?) manica n. sp.**

*Pl. 4, Fig. 11*

*Holotype*: Bo. 580.10: 1323

*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.

*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 max.6 specimens)

| | max. width | max. height | length spine |
|---|---|---|---|
| Bo. 566.50: 308 | 413 | 200 | broken |
| Bo. 580.10: 1323 | 418 | 236 | 118 |
| Br. 141.55: 13 | 400 | 185 | 100 |
| Br. 141.55: 15 | 336 | 227 | 127 |
| Br. 141.55: 20 | 312 | 182 | broken |
| GC. 814.50: 724 | 419 | 209 | 100 |

| | | | | |
|---|---|---|---|---|
| Max. width: | HT 418 | av. 383 | min. 312 | max. 419 |
| Max. height: | HT 236 | av. 207 | min. 182 | max. 236 |
| Length spines: | HT 118 | av. 111 | min. 100 | max. 127 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 32-33

### Bernoullius (?) monoceros n. sp.

*Pl. 4, Figs. 12, 13*

*Holotype*: Bo. 566.50: 378.

*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.

*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 into account as belonging to this species.

*Etymology*.- From the Greek *monos* = single and *keros* = horn

*Measurements* (in µm).-

(based on max. 8 specimens)

| | height test | width test | length apic. spine | thickness spine |
|---|---|---|---|---|
| Bo. 561.5: 1180 | 247 | incomplete | 141 | 50 |
| Bo. 566.5: 375 | 229 | 329 | 129 | 43 |
| Bo. 566.5: 376 | 207 | 273 | broken | - |
| Bo. 566.5: 378 | 236 | 374 | 128 | 49 |
| Bo. 566.5: 388 | 257 | 300 | 105 | 48 |
| GC. 887.0: 919 | 192 | 272 | 120 | 40 |
| GC. 887.0: 921 | 162 | 259 | 76 | 38 |
| GC. 887.0: 937 | 172 | 259 | 69 | 38 |

| | | | | |
|---|---|---|---|---|
| Tot. height test: | HT 236 | av. 213 | min. 162 | max. 252 |
| Max. width test: | HT 374 | av. 304 | min. 272 | max. 374 |
| Length ap.spine: | HT 128 | av. 110 | min. 69 | max. 141 |
| Thickn.ap. spine: | HT 49 | av. 44 | min. 38 | max. 50 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 11-35

### Bernoullius spelae n. sp.

*Pl. 4, Figs. 14, 15*
*Pl. 5, Figs. 1, 2*

*gen. et sp. indet.*
SCHAAF 1981, pl. 17, fig. 4

*Holotype*: Br. 28.85: 29

*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.

*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 max. 5 specimens)

| | length test | width test | max. length spine | min. length spine | thick-ness test |
|---|---|---|---|---|---|
| GC. 887.0: 98 | 170 | 163 | 110 | 55 | - |
| GC. 887.0: 936 | 110 | 166 | 100 | 72 | 68 |
| Br. 28.85: 29 | 167 | 141 | 141 | 34 | 75 |
| Bo. 561.5: 1103 | 96 | 148 | 88 | 76 | - |
| Bo. 561.5: 1149 | 48 | 178 | 112 | 54 | - |

| | | | | |
|---|---|---|---|---|
| Length of test: | HT 167 | av. 158 | min. 148 | max. 196 |
| Width of Test: | HT 141 | av. 159 | min. 141 | max. 178 |
| Max. length spine: | HT 141 | av. 110 | min. 88 | max. 141 |
| Min. length spine: | HT 34 | av. 58 | min. 34 | max. 76 |
| Thickness of test: | HT 75 | | | |

*Type Locality*.- Breggia Gorge, Ticino, Southern Switzerland

*Range*.- U.A. 9-35

## Genus: **Bistarkum** YEH

*Bistarkum* YEH
YEH 1987a, p.42.

*Type species*: *Bistarkum rigidum* YEH 1987a

## **Bistarkum brevilatum n. sp.**

*Pl. 5, Figs. 3-6*

*Holotype*: Bo. 311.2: 15

*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.

*Remarks*.- *Bistarkum brevilatum*, n. sp. differs from *Amphibrachium* sp. A of 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*.- From the Latin *brevis* = short and *latus* = broad

*Measurements* (in µm).-

(based on max. 8 specimens, measured without spines)

| | total length | length rays | width rays | width tips |
|---|---|---|---|---|
| Bo. 311.2: 1200 | 1000 | 470 | 50 | 340 |
| Bo. 311.2: 21 | 990 | 514 | 40 | brok. |
| Bo. 311.2: 22 | 876 | 428 | 33 | 276 |
| Bo. 323.2: 54 | 737 | 434 | 52 | 262 |
| V. -6.0: 4 | 729 | 364 | 79 | 321 |
| V. -6.0: 15 | 627 | 340 | 27 | 200 |
| V. -6.9: 23 | 973 | 454 | 68 | 373 |
| V. -6.0: 217 | 680 | 343 | 24 | 233 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 627 | av.735 | min.627 | max. 1000 |
| Length rays only: | HT 340 | av.418 | min.340 | max. 514 |
| Width of rays: | HT 127 | av.147 | min.124 | max. 179 |
| Width of tips: | HT 200 | av.286 | min.200 | max. 373 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 5-6

## **Bistarkum irazuense** (AITA)

*Pl. 5, Fig. 7*

*Amphibrachium amphigyum* LI
LI 1986, p. 312, pl. 1, fig. 9
*Amphibracchium irazuense* AITA
AITA 1987, p. 63, 68, 69, pl. 1, figs. 1-2, pl. 8, figs. 1-2

*Range*.- U.A. 8-33

## **Bistarkum valdorbiense n. sp.**

*Pl. 5, Figs. 8, 9*

*Holotype*: V. -6.0: 8

*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.

*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 max. 6 specimens)

| | total length | width of rays | width of tips |
|---|---|---|---|
| V. -6.0: 8 | 807 | 100 | 146 |
| V. -6.0: 29 | 900 | 80 | 120 |
| V. -6.0: 49 | 814 | 76 | 100 |
| V. -6.0: 214 | 900 | 113 | 141 |
| V. -6.5: 1262 | 647 | 88 | 147 |
| V.-10.0: 1291 | 900 | 117 | 192 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 807 | av. 828 | min. 647 | max. 900 |
| Width of rays: | HT 100 | av. 96 | min. 76 | max. 117 |
| Width of tips: | HT 146 | av. 141 | min. 100 | max. 192 |
| Thickn. of rays: | PT 66 | | | |

*Type Locality*.- Valdorbia, Umbria-Marche, Italy

*Range*.- U.A. 3-22

## Genus: **Canoptum** PESSAGNO

*Canoptum* PESSAGNO
PESSAGNO et al. 1979, p. 182, 184

*Type species*: *Canoptum poissoni* PESSAGNO et al. 1979

### **Canoptum banale n. sp.**

*Pl. 5, Figs. 10*

*Holotype*: Br. 28.85: 289

*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.

*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 is a latinized from of the French *banal* = commonplace, uninteresting

*Measurements* (in µm).-

(based on 14 specimens)

| | length to 8th segm | height 1st pabd segm. | heigth of 8 segm. | width of 8 segm. |
|---|---|---|---|---|
| Pi. 10.0: 788 | 311 | 22 | 55 | 168 |
| Pi. 57.5: 837 | 315 | 20 | 55 | 175 |
| Pi. 67.7: 796 | 300 | 20 | 50 | 165 |
| Pi. 67.7: 798 | 325 | 25 | 45 | 165 |
| Pi. 67.7: 801 | 325 | 20 | 75 | 170 |
| Pi. 67.7: 802 | 320 | 20 | 70 | 190 |
| Pi. 67.7: 804 | 325 | 20 | 55 | 175 |
| V. -6.0: 234 | 310 | 20 | 55 | 165 |
| Br. 1330: 100 | 340 | 25 | 63 | 165 |
| Br. 1330: 388 | 319 | 25 | 66 | 176 |
| Br. 1330: 466 | 306 | 20 | 50 | 183 |
| Br. 28.85: 289 | 325 | 26 | 60 | 166 |
| Bo. 370.1: 149 | 370 | 26 | 74 | 174 |
| Bo. 370.1: 1018 | 300 | 22 | 60 | 150 |

| | | | | |
|---|---|---|---|---|
| L. to 8th segm.: | HT 325 | av. 320 | min. 300 | max. 370 |
| H. 1st pab. segm.: | HT 26 | av. 22 | min. 20 | max. 26 |
| H. of 8th segm.: | HT 60 | av. 60 | min. 45 | max. 75 |
| W. of 8th segm.: | HT 166 | av. 170 | min. 150 | max. 183 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 5-17

## Genus: **Cecrops** PESSAGNO

*Cecrops* PESSAGNO
PESSAGNO 1977b p. 32.

*Type species*: *Staurosphaera septemporata* PARONA 1890.

### **Cecrops septemporatus** (PARONA)

*Pl. 5, Figs. 11, 12*

*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, 54, 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 1981b, p. 439, pl. 7, figs. 8a, b, pl. 16, figs. 10a, b
NAKASEKO & NISHIMURA 1981, p. 161, pl. 1, fig. 2
OKAMURA & UTO 1982, pl. 7, fig. 19
KIMINAMI et al. 1985, pl. 2, fig. 7
TUMANDA 1989, p. 8, pl. 1, fig. 5
Staurolonche robusta RUST
FISCHLI 1916, textfig. 36
Staurolonche sp. FISCHLI
FISCHLI 1916, textfig. 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
THUROW 1988, p. 398, pl. 9, fig. 18
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 15.
*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
"*Cecrops*" *septemporatus* (PARONA)
KITO 1987, pl. 1, fig. 1
IGO et al. 1987, textfig. 2, no. 6

*Range*.- U.A. 18-34

### **Cecrops (?) sexaspina n. sp.**

*Pl. 5, Figs. 13, 14*

*Holotype*: Ru. 135.50: 1823

*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.

*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 max. 8 specimens)

| | total length | height centr. part only | max. equat. width plus spines |
|---|---|---|---|
| Ru. 146.50: 129 | 293 | 79 | 161 |
| Ru. 135.50: 1794 | 311 | 93 | sp. broken |
| Ru. 135.50: 1798 | 267 | 93 | 141 |
| Ru. 135.50: 1797 | 311 | 106 | 213 |
| Ru. 135.50: 1799 | broken | 84 | 217 |
| Ru. 135.50: 1800 | 245 | 81 | 155 |
| Ru. 135.50: 1801 | 306 | 111 | sp.broken |
| Ru. 135.50: 1823 | 276 | 88 | 173 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 276 | av. 287 | min. 245 | max. 311 |
| H. central test: | HT 88 | av. 92 | min. 79 | max. 111 |
| Max. equat. w.: | HT 173 | av. 176 | min. 155 | max. 217 |

*Type Locality*.- Cava Rusconi, Cittiglio, Northern Italy

*Range*.- U.A. 20-31

## Genus: **Cinguloturris** DUMITRICA

*Cinguloturris* DUMITRICA
DUMITRICA 1982, p. 22

*Type Species*: *Cinguloturris carpatica* DUMITRICA & MELLO 1982

### Cinguloturris arabica n.sp.

*Pl. 5, Figs. 15, 16*

Cinguloturris *sp.*
KATO & IWATA 1989, pl. 2, fig. 7

*Holotype*: OMAN 25: 21

*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 secend 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.

*Remarks*.- *Cinguloturris arabica*, n. sp. 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*.- Named after the sampling-area which is situated on the Arabian Peninsula

*Measurements* (in µm).-

(based on max. 9 specimens)

| | height to 4th p.ab. seg. | height to 5th p.abd.segm. | max. width of test |
|---|---|---|---|
| Om. 25: 21 | - | - | 133 |
| Br. 1330: 93 | 275 | 345 | 159 |
| Pi. 10.0: 790 | 285 | 345 | 165 |
| Pi. 40.2: 860 | 280 | - | 125 |
| V. -6.0: 35 | 284 | 334 | 153 |
| V. -6.0: 203 | 313 | - | 169 |
| V. -6.0: 204 | 286 | 357 | 179 |
| V. -6.5: 1261 | 314 | - | 143 |
| V. -10.0: 1287 | 305 | 360 | 160 |

| | | | | |
|---|---|---|---|---|
| H. to 3rd p.abd.seg.: | HT 223 | | | |
| H. to 4th p.abd.seg.: | PT - | av. 293 | min. 275 | max. 314 |
| H. to 5th p.abd.seg.: | PT - | av. 348 | min. 334 | max. 357 |
| Max. width of test: | HT 133 | av. 154 | min. 125 | max. 179 |

Max. height longest spec. found: (to 6th p. abd. segm): 413
Max. width of longest specimen: 117

*Type Locality*.- Oman, Wahrah Formation, Hawasina-Complex

*Range*.- U.A. 3-18

## Genus: **Crolanium** PESSAGNO

Crolanium *PESSAGNO*
PESSAGNO 1977b, p. 53.

*Type Species*: *Crolanium triquetrum* PESSAGNO 1977b

### Crolanium pythiae SCHAAF

*Pl. 6, Figs. 1, 2*

*Dictyomitra* (?) sp.
FOREMAN 1975, p. 615, pl. 2H, fig. 4.
*Crolanium pythiae* SCHAAF
SCHAAF 1981, p. 432, 433, pl. 20, figs. 5a, b, c
SCHAAF 1984, p. 159, figs. 1-3
THUROW 1988, p.399, pl. 6, fig. 23

*Remarks*.- 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 rather 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.

*Range*.- U.A. 20-35

### Crolanium spp.

*Pl. 6, Figs. 3-6*

*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 spiny 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.

*Remarks*.- Included herein are all specimens with elongate conical test terminating with a triangular, pyramidal distal portion and with 5-6 transverse rows of small pores per segment. The surface of the test has 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.

*Range*.- U.A. 17-35

## Genus: **Crucella** PESSAGNO

*Crucella* PESSAGNO
PESSAGNO 1971, p. 52.

*Type Species*: *Crucella messinae* PESSAGNO 1971

### Crucella bossoensis n. sp.

*Pl. 6, Figs. 7-10*

*Crucella cachensis* PESSAGNO
TAKETANI 1982, p. 50, pl. 9, fig. 16
THUROW & KUHNT 1986, textfig. 9
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, fig. 5, 6

*Holotype*: Bo. 566.50: 458

*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.

*Remarks*.- *Crucella bossoensis,* n. sp. can be compared with *Crucella cachensis* PESSAGNO (1971b) 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) Length of rays with spines measured from the center of test

| | length of rays | width of rays | diam. lacuna |
|---|---|---|---|
| Bo. 566.50: 458 | 160-175 | 40 | 50 |
| Bo. 566.50:1678 | 180 | 50-55 | 50 |
| Bo. 566.50: 1679 | 150-170 | 50 | 60 |

| | |
|---|---|
| Length of rays: | HT 160-175 |
| Width of rays in prox. portion: | HT 40 |
| Diameter of lacuna: | HT 50 |

### Crucella collina n. sp.

*Pl. 6, Figs. 11, 12*
*Pl. 7, Figs. 1, 2*

*Crucella* sp.
Muzavor 1977, p. 62, pl. 3, fig. 5
*Crucella messinae* PESSAGNO
TAKETANI 1982, p. 50, pl.9, fig.
*Crucella espartoensis* PESSAGNO
Thurow 1988, p. 399, pl. 2, fig. 14, 15

*Holotype*: Br. 28.85: 79

*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 probably terminal spines have been observed. Interradial space filled with dense patagium.

*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)

| | length of rays |
|---|---|
| Br. 1330: 161 | 173 |
| Br. 28.85: 79 | 166 |
| Bo. 447.50: 1025 | 207 |
| Bo. 447.50: 1027 | 171 |
| Bo. 449.50: 85 | 176 |
| Bo. 449.50: 135 | 166 |
| Bo. 449.50: 137 | 232 |
| Bo. 449.50: 150 | 218 |
| Bo. 449.50: 987 | 178 |
| Bo. 556.40: 153 | 200 |
| Bo. 566.50: 479 | 186 |
| MN. 47.70: 31 | 207 |

Length of rays: HT 166 av. 190 min. 166 max. 232

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Switzerland

*Range*.- U.A. 7-34

## **Crucella sp. aff. C. espartoensis** PESSAGNO

*Pl. 6, Fig. 13*

?*Crucella espartoensis* PESSAGNO
PESSAGNO 1971b, p. 54, 55, pl. 18, figs. 1-4
PESSAGNO 1977a, pl.5, fig. 1
TAKETANI 1982a, p. 50, pl. 9, fig. 15, pl. 2, fig. 22
GORKA 1989, p. 331, pl. 11, fig. 6
*Crucella* cf. *espartoensis* PESSAGNO
GORKA 1989, p. 331, pl. 11, 2
Crucella cachensis PESSAGNO
GORKA 1989, p. 331, pl. 11, fig. 3, 4
*Crucella* spp.
NAKASEKO et al. 1979a, pl. 8, fig. 3, 4
*Crucella* sp.
GORKA 1989, p. 332, pl. 11, fig. 5
*Crucella* sp. cf. *C. cachensis* PESSAGNO
?OZVOLDOVA 1984, p. 264, pl. 5, figs. 5-7

*Definition*.- 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 pore frames. Interradial space partly filled with dense patagium, which is much thinner than the rays.

*Remarks*.- 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 has a length of rays of 244 µm, which means more than twice the length of the holotype of *Crucella espartoensis* PESSAGNO whose length of rays is of only 110 µm.

*Range*.- U.A. 22-33

## **Crucella (?) inflexa** (RÜST)

*Pl. 7, Figs. 3-6*

*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, fig. 1, 2.
*Hagiastrid* 2 gen. and sp. indet.
RENZ 1974, p. 792, 793, pl. 1, fig. 9

*Actualized Definition*.- Test four-rayed with interradial patagium, forming a flat square. Rays slender, with pores generally irregularly arranged, sometimes also disposed in sigmoidal rows. 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.

*Remarks*.- *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.

*Range*.- U.A. 18-35

## **Crucella lipmanae n. sp.**

*Pl. 7, Figs. 7, 8*

*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.
THUROW 1988, p. 404, pl. 10, fig. 6

*Holotype*: Ru. 146.50: 53

*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.

*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. KH. LIPMAN, honouring her contributions to the knowledge of Mesozoic radiolarians.

*Measurements* (in µm.-

(based on 3 specimens)

| | diagonal length of test | width of lacuna | length of spines |
|---|---|---|---|
| Ru. 146.50: 53 | 346 | 77 | - |
| Bo. 482.20: 1039 | 383 | 83 | - |
| Bo. 617.00: 45 | 377 | 77 | 83 |

| | | | | |
|---|---|---|---|---|
| Diag. length test: | HT 346 | av. 368 | min. 346 | max. 383 |
| Width of lacuna: | HT 77 | av. 79 | min. 77 | max. 83 |
| Length of spines: | PT 83 | | | |

*Type Locality.*- Cava Rusconi, Cittiglio, Northern Italy

*Range.*- U.A. 20-28

## Crucella remanei n. sp.

*Pl. 7, Figs. 9-12*

*Holotype*: Ru. 135.50: 1603

*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.

*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.*- The species is dedicated to Prof. Dr. Jürgen Remane, Institute of Geology, University of Neuchatel, 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)

| | length of rays from center of test to tips | length of spines |
|---|---|---|
| Bo. 449.50: 1707 | 268 | 143 |
| Bo. 566.50: 1677 | 200 | 83 |
| Bo. 566.50: 1812 | 172 | 81 |
| Bo. 566.50: 1820 | 204 | 77 |
| Ru. 135.50: 1603 | 214 | 107 |
| GC. 821.45: 1007 | 230 | 105 |

| | | | | |
|---|---|---|---|---|
| Total length rays: | HT 214 | av. 215 | min. 172 | max. 268 |
| Length of spines: | HT 107 | av. 99 | min. 77 | max. 143 |

*Type Locality.*- Cava Rusconi, Cittiglio, district Varese, Northern Italy

*Range.*- U.A. 21-33

### Genus: **Cyclastrum** RÜST

*Cyclastrum* RÜST
RÜST 1898, p. 28.

*Type Species*: *Cyclastrum infundibuliforme* RÜST 1898

## Cyclastrum infundibuliforme RÜST

*Pl. 8, Figs. 1-3*

*Cyclastrum infundibuliforme* RÜST
RÜST 1898, p. 28, pl. 9, fig. 5
HOLZER 1980, p. 162, pl. 2, fig. 6.
BAUMGARTNER 1992, p. 319, pl. 5, figs. 1, 6.

*Actualized Definition.*- 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 faces. Spongy network of patagium on external rim coarser than in the central part.

*Remarks*.- Our specimens correspond perfectly to the discription and illustration of RÜST (1898). The length of the rays varies between 210-300 μm.

*Range*.- U.A. 18-35

## Cyclastrum (?) luminosum n. sp.

*Pl. 8, Fig. 4*

*Holotype*: Bo. 581.65: 3685

*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 armes are only exceptionally and very weakly seen. Boundary between the outer border and the depression not distinctly sharp.

*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 *Cylastrum 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 7 specimens))

| | radius excl. spines | length of spines | thickness of test |
|---|---|---|---|
| Br. 141.55: 2 | 139 | 65 | - |
| Br. 141.55: 3 | 158 | 66 | 65 |
| Br. 141.55: 7 | 128 | 56 | - |
| Br. 141.55: 9 | 136 | 60 | - |
| Bo. 580.10: 1307 | 154 | 92 | 63 |
| Bo. 580.10: 1322 | 146 | 77 | 57 |
| Bo. 581.65: 3685 | 127 | 67 | |

| | | | | |
|---|---|---|---|---|
| Radius excl. spines: | HT 127 | av. 141 | min. 127 | max. 158 |
| Length spines: | HT 67 | av. 69 | min. 56 | max. 92 |
| Thickness of test: | HT 65 | | | |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 25-35

## Cyclastrum (?) planum n. sp.

*Pl. 8, Figs. 5-8*

*Cyclastrum* sp. B
HOLZER 1980, pl. 2, fig. 5 only
*Cyclastrum* sp. A
BAUMGARTNER 1992, p. 319, pl. 5, fig. 2

*Holotype*: Bo. 566.50: 381

*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 peryphery 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. Peryphery is ragged and bears numerous small thorns. Surface structure of the rays is always expressed on this part. Internal portion of test wide and depressed, with dense, thin patagium which may cover completely the three-rayed structure.

*Remarks*.- *Cyclastrum* (?) *planum*, n. sp. differs clearly from *Cyclastrum infundibuliforme* RUST 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* is very closed 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)

| | length of rays |
|---|---|
| Bo. 561.50: 1153 | 180 |
| Bo. 566.50: 380 | 218 |
| Bo. 566.50: 381 | 273 |
| Bo. 566.50: 389 | 214 |
| Bo. 566.50: 418 | 183 |
| Bo. 580.10: 1311 | 177 |
| Bo. 580.10: 1325 | 184 |

Length of rays: HT 273 av. 204 min. 180 max. 273

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 28-35

## **Cyclastrum rarum** (SQUINABOL)

*Pl. 8, Fig. 9*

*Dictyocoryne rara* SQUINABOL
SQUINABOL 1914, p. 279, pl. 2, fig. 8

*Actualized Definition.*- 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.

*Remarks.*- *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.

*Range.*- U.A. 9-33

## **Cyclastrum (?) trigonum** (RÜST)

*Pl. 8, Figs. 10, 11*

*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, figs. 4
*Paronaella* sp. A
MIZUTANI et al. 1982,p. 61, pl. 6, fig. 2

*Actualized Definition.*- 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.

*Remarks.*- By the structure of the three-rayed initial skeleton *Cyclastrum trigonum* (RÜST) indicates a close relationship to *Cyclastrum* (?) *planum*, n. sp. 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.

*Range.*- U.A. 15-34

## Genus: **Cyrtocapsa** HAECKEL

*Cyrtocapsa* HAECKEL
HAECKEL 1881, p. 439.

*Type Species*: *Cyrtocapsa ovalis* RUST 1885

## **Cyrtocapsa (?) grutterinki** TAN

*Pl. 8, Fig. 12*
*Pl. 9, Fig. 1*

*Cyrtocapsa grutterinki* TAN
TAN 1927, p. 65, pl. 13, fig. 111

*Actualized Definition.*- 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.

*Remarks.*- No specimens were found without terminal conical segment. The knowledge of the inner structure of our specimens are based on investigations of P. Dumitrica (personal communication), on samples from Rumania where specimens with the terminal part of test broken off were also found.

*Range.*- U.A. 3-10

## Genus: **Dibolachras** FOREMAN

*Dibolachras* FOREMAN
FOREMAN 1973, p. 265.

*Type Species*: *Dibolachras tytthopora* FOREMAN 1973

### **Dibolachras tytthopora** FOREMAN

*Pl. 9, Figs. 2-4*

*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. 1a, b, 2, 3a, b
THUROW 1988, p. 400, pl. 7, fig. 20

*Range.*- U.A. 22-35

## Genus: **Dicroa** FOREMAN

*Dicroa* FOREMAN
FOREMAN 1975, p. 609.

*Type Species*: *Dicroa periosa* FOREMAN 1975

### **Dicroa periosa** FOREMAN

*Pl. 9, Fig. 5*

*Dicroa periosa* FOREMAN
FOREMAN 1975, p. 609, pl. 2E, Fig. 8-11, pl. 3, fig. 8, 11
NAKASEKO ET AL. 1979, p. 21, pl. 4, fig. 8
ORIGLIA-DEVOS 1983, p. 40, pl. 1, figs. 6, 7
*Dicroa* sp. A FOREMAN
FOREMAN 1975, p. 609, pl. 2E, figs. 9-11, pl. 3, fig. 11
PESSAGNO 1977, p. 36, pl. 4, figs. 2, 3, 5
SCHAAF 1981, p. 433, pl. 16, fig. 8
SCHAAF 1984,p. 158, fig. 10a, b
LI & WU 1985, pl. 1, figs. 1, 6

*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.

*Range.*- U.A. 10-35

## Genus: **Dictyomitra** ZITTEL, emend. PESSAGNO

*Dictyomitra* ZITTEL
ZITTEL 1876, p. 77.
PESSAGNO 1976, p. 50.

*Type Species*: *Dictyomitra multicostata* ZITTEL 1876

### **Dictyomitra pseudoscalaris** TAN sensu SCHAAF

*Pl. 9, Figs. 6, 7*

*Archaeodictyomitra pseudoscalaris* (TAN)
SCHAAF 1981b, p. 432, pl. 4, fig. 5, pl. 21, figs. 13a, b
SUYARI 1986, pl. 2, figs. 3, 4
TUMANDA 1989, p. 36, pl. 2, fig. 12
*Archaeodictyomitra* ? spp.
SUYARI 1986, 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

*Actualized definition.*- 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.

*Remarks.*- 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 species 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 narrower and longer than that illustrated by SCHAAF (2,2) and ours (2,2, average of 6 complete specimens).

*Range.*- U.A. 23-35

## Genus: **Ditrabs** BAUMGARTNER

*Ditrabs* BAUMGARTNER
BAUMGARTNER 1980, p.293.

*Type species*: *Amphibrachium sansalvadorensis* PESSAGNO

### **Ditrabs (?) osteosa n. sp.**

*Pl. 9, Figs. 8-10*

*Amphibracchium* sp.
MUZAVOR 1977, pl. 3, fig. 7
*Angulobracchiine* gen. et sp: indet.
STEIGER 1992, p. 51, pl. 13, figs. 5-7

*Holotype*: Br. 1330: 53

*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.

*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)

| | length | width rays | width tips | height |
|---|---|---|---|---|
| Bo. 311.2: 1201 | 952 | - | - | 67 |
| Pi. 57.50: 847 | 717 | 48 | 151 | 82 |
| Pi. 57.50: 849 | 634 | 41 | 165 brok | - |
| Br. 1330: 53 | 655 | 52 | 221 | 60 |
| Br. 1330: 1583 | 725 | 58 | 138 | 50 |
| Br. 1330: 1585 | 933 | 50 | 166 | 50 |
| Br. 1330: 1587 | 933 | 50 | 190 | 67 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 655 | av. 793 | min. 634 | max. 952 |
| Width of rays: | HT 52 | av. 50 | min. 41 | max. 58 |
| Width of tips: | HT 221 | av. 172 | min. 138 | max. 221 |
| Height of rays: | HT 60 | av. 63 | min. 50 | max. 82 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino Southern Switzerland

*Range*.- U.A. 4-16

### **Ditrabs sansalvadorensis** (PESSAGNO)

*Pl. 9, Figs. 11*

*Amphibracchia sansalvadorensis* PESSAGNO
PESSAGNO 1971b, p. 21, pl. 19, figs. 9, 10.
*Amphibracchium petersoni* PESSAGNO
PESSAGNO 1971, p.
*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.

*Range*.- U.A. 2-33

## Genus: **Emiluvia** FOREMAN emend. FOREMAN emend. PESSAGNO

*Emiluvia* FOREMAN
FOREMAN 1973, p. 262, emend. FOREMAN, 1975, p. 612., emend. PESSAGNO, 1977a, p. 76

*Type species*: *Emiluvia chica* FOREMAN 1973.

### **Emiluvia chica gr.** FOREMAN

see subspecies

### **Emiluvia chica decussata** STEIGER

*Pl. 9, Figs. 12-14*

*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.

*Remarks*.- 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 solved we consider STEIGER's species as a subspecies of

*E. chica* and not an independent species, the differences between them being insignificant.

*Range*.- U.A. 3-25

## **Emiluvia hopsoni** PESSAGNO

*Pl. 9, Fig. 15*

*Emiluvia hopsoni* PESSAGNO
PESSAGNO 1977b, 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, figs. 3,4.
STEIGER 1992, p. 58, pl. 15, fig. 11
*Emiluvia* cf. *hopsoni* PESSAGNO
KATO & IWATA 1989, pl. 3, fig. 10.

*Range*.- U.A. 1-11

## **Emiluvia pessagnoi** FOREMAN

*Pl. 10, Figs. 1, 2*

*Emiluvia pessagnoi* FOREMAN
FOREMAN 1973, p. 262, pl. 8, fig. 6.
FOREMAN 1975, p. 612.
PESSAAGNO 1977a, p. 76, pl. 5, fig. 8.
FOREMAN 1978, p. 744, pl. 1, fig. 1-2.
BAUMGARTNER et al. 1980, p. 53, pl. 1, fig. 10.
BAUMGARTNER 1984, p. 762, pl. 3, fig. 3.

*Remarks*.- At the time of investigation for biostratigraphical data we did not yet distinguish the two subspecies: *E. pessagnoi pessagnoi* FOREMAN and *E. pessagnoi multipora* STEIGER. Both are present in our material but the latter is more frequent in the Berriasian and Valanginian portion of the studied sections, whereas *E. pessagnoi pessagnoi* FOREMAN seems to occurr especially in the Tithonian or older portions.

*Range*.- U.A. 1-19

## Genus: **Eucyrtis** HAECKEL

*Eucyrtis* HAECKEL
HAECKEL 1881, p. 438.
HAECKEL 1887, p. 1488.

*Type Species*: *Eucyrtis conoidea* RÜST 1885

## **Eucyrtis columbaria** RENZ

*Pl. 10, Figs. 3-6*

*Eucyrtis columbarius* RENZ
RENZ 1974, p. 792, pl. 12, figs. 13a-c, not: 14-20
*Eucyrtis columbaria* RENZ
FOREMAN 1975, p. 615, pl. 2I, fig. 19
SCHAAF 1981b, p. 434, pl. 5, figs. 1a-b, pl. 27. figs. 3a-b, not, figs. 2a-b.
SCHAAF 1984, p. 100, 101, figs.
BAUMGARTNER 1992, p. 320, pl. 6, figs. 1-3.

*Remarks*.- The specimens found in our material have numerous longitudinal ribs all over the half of test opposite to the inflated part.

*Range*.- U.A. 16-35

## Genus: **Foremanella** MUZAVOR

*Foremanella* MUZAVOR
MUZAVOR 1977, p. 67

*Type species*: *Foremanella alpina* MUZAVOR 1977.

## **Foremanella diamphidia** (FOREMAN)

*Pl. 10, Figs. 7-9*

*Paronaella* (?) *diamphidia* FOREMAN
FOREMAN 1973, p. 262, pl. 8, fig. 3-4.
RIEDEL & SANFILIPPO 1974, pl. 12, fig. 4.
FOREMAN 1975, p. 612, pl. 5, fig. 4-5.
FOREMAN 1978, p. 744, pl. 1, figs. 5, 6.
BAUMGARTNER et. al. 1980, p. 302, pl. 4, fig. 4.
SCHAAF 1981, p. 436, pl. 13, fig. 4.
*Paronaella* (?) *hipposidericus* FOREMAN
FOREMAN 1975, p. 612, pl. 2E, fig. 1-2, pl. 5, fig. 3, 7, 10.
BAUMGARTNER 1980, p. 302, pl. 4, figs. 1-3
BAUMGARTNER et. al. 1980, pl. 2, fig. 4
*Foremanella alpina* MUZAVOR
MUZAVOR 1977, 67, pl. 3, fig. 8.
*Foremanella diamphidia* (FOREMAN)
BAUMGARTNER 1984b, p. 765, pl. 6, fig. 18.
MATSUOKA & YAO 1985, pl. 2, fig. 9.
SANFILIPPO & RIEDEL 1985, p. 593, figs. 5.4a, 5.4b.
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. 436, pl. 13, fig. 4.
STEIGER 1992, p. 46, pl. 10, figs. 13, 14.
*Foremanella hipposidericus* (FOREMAN)
BAUMGARTNER 1984b, p. 765, pl. 6, fig. 19.
RIEDEL & SANFILIPPO 1985, p. 593, fig. 5. 3.
AITA 1987, p. 63, pl. 12, fig. 8.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, figs. 2, 3.
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
*Foremanella diamphidia hipposidericus* (FOREMAN)
BAUMGARTNER 1992, p. 321, pl. 7, fig. 5
*Foremanella* sp. A
STEIGER 1992, p. 46, pl. 10, fig. 16
*Foremanella* sp. B
STEIGER 1992, p. 46, pl. 10, fig. 17

*Remarks*.- The large number of morphotypes of the two subspecies - *Foremanella diamphidia diamphidia* (FOREMAN) and *Foremanella diamphidia hipposidericus* (FOREMAN), and the difficultiy of distinguishing them under the binocular forced us to synonymize them herein.
*Range*.- U.A. 1-35

## Genus: **Godia** WU

*Godia* WU
WU 1986, p.356.

*Type species*: *Godia floreusa* WU 1986

### Godia lenticulata n. sp.

*Pl. 10, Figs. 10, 11*

*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

*Holotype*: Bo. 566.50: 454
*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.
*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*.- From the Latin *lenticulatus* = lens-shaped
*Measurements* (in µm).-

(based on 5 specimens

| | diameter test excl. spines | max. length of spines |
|---|---|---|
| Bo. 566.50: 201 | 248 | 26 |
| Bo. 566.50: 252 | 316 | 13 |
| Bo. 566.50: 386 | 329 | 38 |
| Bo. 566.50: 454 | 241 | 26 |
| Bo. 566.50: 1838 | 333 | - |

| | | | | |
|---|---|---|---|---|
| Diameter excl. sp.: | HT 241 | av. 293 | min. 241 | max. 333 |
| Max. length of sp.: | HT 26 | av. 25 | min. 13 | max. 38 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 12-35

### Godia tecta (TUMANDA)

*Pl. 10, Fig. 12*

*Orbiculiforma tecta* TUMANDA
TUMANDA 1989, p. 30, pl. 5, fig. 10
OZVOLDOVA & PETERCAKOVA 1992, pl. 2, figs. 11, 12.

*Range*.- U.A. 29-35

## Genus: **Halesium** PESSAGNO emend. BAUMGARTNER

*Halesium* PESSAGNO
PESSAGNO 1971, p. 207.
*Halesium* PESSAGNO emend.
BAUMGARTNER 1980, p. 314.

*Type species*: *Halesium sexangulum* PESSAGNO

### Halesium biscutum n. sp.

*Pl. 10, Figs. 13, 14*

*?Homoeoparonaella* sp. D
STEIGER 1992, p. 43, pl. 9, fig. 12

*Holotype*: Bo. 566.50: 1676
*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.
*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* (?) *ineatum* n. sp. under binocular. A bracchiopyle, characteristic of the genus, was never observed.
*Etymology*.- Latinized from the Italian *biscottum* = biscuit

*Measurements* (in µm).-

(based on 10 specimens)

| | max. length of rays |
|---|---|
| Bo. 566.5: 333 | 290 |
| Bo. 566.5: 335 | 245 |
| Bo. 566.5: 1676 | 280 |
| Bo. 566.5: 1680 | 256 |
| Bo. 569.6: 89 | 304 |
| Br. 141.55: 10 | 263 |
| Br. 141.55: 22 | 267 |
| Br. 141.55: 1573 | 275 |
| Br. 141.55: 1575 | 333 |
| Br. 141.55: 1577 | 250 |

Max. length of rays: HT 280 av. 276 min. 245 max.333

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 7-35

## Halesium (?) lineatum n. sp.

*Pl. 11, Figs. 1-3*

*Homoeoparonaella sp. B*
STEIGER 1992, p. 42, pl. 9, fig. 9

*Holotype*: Br. 28.85: 49

*Definition*.- Three-rayed test with bulbous, spiny tips. Rays of equal length, composed of 6 beams, 3 on the upper and 3 on the 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.

*Remarks*.- *Halesium* (?) *lineatum*, n. sp. was compared with *Halesium biscutum*, n. sp. under the latter species.

*Etymology*.- From the Latin *lineatus* = linear

*Measurements* (in µm).-

(based on 4 specimens)

| | max. length of rays | width of rays | width of tips |
|---|---|---|---|
| Br. 28.85: 49 | 284 | 61 | 122 |
| Br. 28.85: 457 | 253 | 53 | 93 |
| Br. 28.85: 47 | 275 | 81 | 125 |
| V. -6.0: 36 | 400 | 84 | 200 |

| | | | | |
|---|---|---|---|---|
| Max. length of rays: | HT 284 | av. 271 | min. 284 | max. 400 |
| Width of rays: | HT 61 | av. 65 | min. 81 | max. 84 |
| Width of tips: | HT 122 | av. 93 | min. 125 | max. 200 |

*Range*.- U.A. 6-35

## Genus: **Hexapyramis** SQUINABOL

*Hexapyramis* SQUINABOL
SQUINABOL 1903.

*Type species*: *Hexapyramis pantanellii* SQUINABOL 1903.

## Hexapyramis (?) precedis n. sp.

*Pl. 11, Figs. 4-6*

*Holotype*: Bo. 561.50: 1111

*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.

*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)

| | total height | height of centr.part | width of centr.part | max.length of spines |
|---|---|---|---|---|
| GC. 887.0: 913 | 435 | 247 | 206 | 112 |
| GC. 887.0: 915 | 365 | 127 | 152 | 91 |
| GC. 887.0: 917 | 275 | 152 | 112 | 80 |
| Bo. 561.5: 1112 | 313 | 136 | 135 | 77 |
| Bo. 566.5: 187 | 246 | 133 | 126 | 72 |
| Bo. 566.5: 513 | 358 | 178 | 125 | 109 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 313 | av. 332 | min. 246 | max. 435 |
| H. centr. part: | HT 136 | av. 172 | min. 133 | max. 247 |
| W. centr. part: | HT 135 | av. 143 | min. 112 | max. 206 |
| Max. L. spines: | HT 77 | av. 90 | min. 72 | max. 112 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 22-35

### Genus: **Homoeoparonaella** BAUMGARTNER

*Homoeoparonaella* BAUMGARTNER
BAUMGARTNER 1980, p. 288.

*Type species*: *Paronaella elegans* PESSAGNO

### **Homoeoparonaella sp. aff. H. irregularis** (SQUINABOL)

*Pl. 11, Figs. 7, 8*

?*Rhopalastrum irregulare* SQUINABOL
SQUINABOL 1903b, p. 122, pl. IX, fig. 10.

*Definition*.- 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 (1903b), 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.

*Range*.- U.A. 7-35

### **Homoeoparonaella peteri n. sp.**

*Pl. 11, Figs. 9-12*

*Holotype*: GC. 882.40: 754

*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.

*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)

| | length of rays | width of rays | width of tips |
|---|---|---|---|
| GC. 887.0: 909 | 589 | 71 | 143 |
| GC. 887.0: 925 | 536 | 78 | 143 |
| GC. 887.0: 928 | 700 | 83 | 181 |
| GC. 882.40:754 | 487 | 75 | 143 |
| Bo. 580.10:1312 | 350 | 70 | 120 |

| | | | | |
|---|---|---|---|---|
| Length of rays: | HT 487 | av. 532 | min. 350 | max. 700 |
| Width of rays: | HT 75 | av. 75 | min. 71 | max. 83 |
| Width of tips: | HT 143 | av. 146 | min. 120 | max. 181 |

*Type Locality*.- Gorgo a Cerbara, Umbria-Marche, Italy

*Range*.- U.A. 27-35

### **Homoeoparonaella speciosa** (PARONA)

*Pl. 11, Figs. 13, 14*

*Dictyastrum speciosum* PARONA
PARONA 1890, p. 158, pl. 4, fig. 1
HINDE 1900, p. 24, 25, 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

*Actualized definition*.- 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 speciems.

*Remarks*.- 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* (RUST) 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 is also lacking terminal spines on rays.

*Range*.- U.A. 6-34

## Genus: **Hsuum** PESSAGNO emend. TAKEMURA

*Hsuum* PESSAGNO
PESSAGNO 1977a, p. 81
TAKEMURA 1986, p. 49, 50

*Type species*: *Hsuum cuestaensis* PESSAGNO 1977a

### Hsuum feliformis n. sp.

*Pl. 12, Figs. 1, 2*

*Protunuma* sp. B (part) STEIGER
STEIGER 1992, p. 90, pl. 27, fig. 8
gen. et sp. indet.
TUMANDA 1989, pl. 6, fig. 17

*Holotype*: Br. 1330: 292

*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.

*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 exist 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 specimens to the shape of a sitting cat

*Measurements* (in µm).-

(based on 3 specimens)

| | Height of test | max.width of test | max.length horns | width at base of horns |
|---|---|---|---|---|
| Br. 1330: 292 | 229 | 129 | 22 | 51 |
| Pi. 40.2: 855 | 224 | 110 | 20 | 51 |
| V. -10.0: 1286 | 217 | 120 | 27 | 62 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 229 | av. 223 | min. 217 | max. 229 |
| Max. width: | HT 129 | av. 120 | min. 110 | max. 129 |
| Length ap. horns: | HT 22 | av. 23 | min. 20 | max. 27 |
| W. base ap. horns: | HT 51 | av. 55 | min. 51 | max. 62 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 3-11

### Hsuum raricostatum n. sp.

*Pl. 12, Figs. 3-5*

*Hsuum* cf. *rutogense* YANG & WANG
YANG & WANG 1990, p. 207, 208, pl. 4, fig. 15
*Protunuma* sp. B (part)
STEIGER 1992, p. 90, pl. 27, figs. 5-7, not 8

*Holotype*: Pi. 10.00: 2

*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 part 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.

*Remarks*.- *Hsuum raricostatum*, n. sp. differs clearly from *H. rutogense* WANG & YANG 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)

| | height | max. width |
|---|---|---|
| Bo. 311.20: 2 | 259 | 179 |
| Bo. 311.20: 4 | 265 | 155 |
| V. -6.00: 39 | 262 | 153 |
| Pi. 10.00: 2 | 275 | 184 |
| Pi. 57.50: 839 | 268 | 168 |
| Pi. 57.50: 840 | 247 | 165 |

| | | | | |
|---|---|---|---|---|
| Height: | HT 274 | av. 263 | min. 247 | max. 275 |
| Max. width: | HT 184 | av. 167 | min. 153 | max. 184 |

*Type Locality*.- Pieia, Umbria-Marche, Italy
*Range*.- U.A. 3-12

## Genus: **Jacus** DE WEVER

*Jacus* DE WEVER
DE WEVER 1982, p. 204.

*Type species*: *Jacus coronatus* DE WEVER, 1981

### **Jacus (?) italicus n. sp.**

*Pl. 12, Figs. 6, 7*

*Holotype*:Bo. 566.50: 212
*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 the 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.
*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)

| | height test | width test | length velum | width velum | length feet |
|---|---|---|---|---|---|
| Br. 28.85: 565 | 246 | 117 | 57 | 95 | 70 |
| Bo. 561.65: 45 | 214 | 106 | 42 | 77 | 100 |
| Bo. 566.50: 212 | 200 | 113 | 20 | 58 | 83 |

| | | | | |
|---|---|---|---|---|
| Height test: | HT 200 | av. 220 | min. 200 | max. 246 |
| Width test: | HT 113 | av. 112 | min. 106 | max. 117 |
| Length velum: | HT 20 | av. 40 | min. 20 | max. 57 |
| Width velum: | HT 58 | av. 77 | min. 58 | max. 95 |
| Length feet: | HT 83 | av. 84 | min. 70 | max. 100 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 9-32

## Genus: **Katroma** PESSAGNO and POISSON, emend DE WEVER

*Katroma* PESSAGNO & POISSON
PESSAGNO & POISSON 1981, p. 62.
*Katroma* PESSAGNO & POISSON emend.
DE WEVER 1982, p. 193.

*Type species*: *Katroma neagui* PESSAGNO & POISSON

### **Katroma milloti** SCHAAF

*Pl. 12, Fig. 8*

*Katroma milloti* SCHAAF
SCHAAF 1984, p. 124, 125, pl. 19, figs. 1-4
STEIGER 1992, p. 77, pl. 21, figs. 1-5

*Range*.- U.A. 3-26

## Genus: **Lithatractus** HAECKEL

*Lithatractus* HAECKEL
HAECKEL 1887, p. 319.

*Type species*: *Stylosphaera fragilis* HAECKEL 1881, *Lithatractus fragilis* HAECKEL 1887

### **Lithatractus sp. aff. L. pusillus** (CAMPBELL & CLARK)

*Pl. 12, Figs. 9, 10*

*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, 6
?*Stylosphaera pusilla* CAMPBELL & CLARK
RENZ 1974, p. 798, pl. 9, fig. 20, not: pl. 2, figs. 17, *18*
?*Ellipsoxiphus pusilla* (Campbell)
FOREMAN 1978, p.742, 743, pl. 2, figs. 9, 10, 17
?*Praestylosphaera hastata* (CAMPBELL & CLARK)
EMPSON-MORIN 1981, p. 261, 262, pl. 4, figs. 4, 5a-c
?*Lithatractus pusillus* (CAMPBELL & CLARK)
TAKETANI 1982, p. 48, pl. 1, figs. 8a,b, pl. 9, fig. 5
TAKETANI 1982, pl. 2, fig. 6
IWATA & TAJIKA 1989, pl.3, fig.3

*Definition*.- 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. Base of spines wide conical, formed by prolonged pore bars.
*Remarks*.- Specimens occurring in our material differ

from *Lithatractus pusillus* CAMPBELL & CLARK by having conical, unbladed spines and a cortical shell with 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 279-360 µm, length of the longer spine 95-117 µm, of the shorter spine 51-100 µm and diameter of the sphere 123-143 µm.

*Range*.- U.A. 8-35

## Genus: **Milax** BLOME

*Milax* BLOME
*BLOME 1984, p. 372*

*Type species*: *Milax alienus* BLOME 1984

### Milax adrianae n. sp.

*Pl. 12, Fig. 11*

*Podocapsa* cf. *guembeli* RUST
KATO & IWATA 1989, pl. 5, fig. 10

*Holotype*: Br. 28.85:108

*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.

*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)

| | total height of test | height prox. part | width terminal segm. |
|---|---|---|---|
| Br. 28.85:108 | 219 | 95 | 121 |
| Br. 28.85:1560 | 212 | 100 | 112 |
| Bo. 370.1:94 | 244 | 110 | 162 |
| Bo. 370.1:118 | 210 | 90 | 140 |

| | | | | |
|---|---|---|---|---|
| Total h. of test: | HT 219 | av. 221 | min. 210 | max. 244 |
| H.of prox. part: | HT 95 | av. 99 | min. 90 | max. 110 |
| W. term. segment: | HT 121 | av. 134 | min. 112 | max. 162 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 7-31

## Genus: **Mirifusus** PESSAGNO emend. BAUMGARTNER

*Mirifusus* PESSAGNO
PESSAGNO 1977a, p. 83.
BAUMGARTNER 1984, p. 769

*Type species*: *Mirifusus guadalupensis* PESSAGNO 1977a.

### Mirifusus apenninicus n. sp.

*Pl. 12, Figs. 12-15*

*Dictyomitra* (?) sp.
FOREMAN, 1973b, p. 264, pl.9, fig.6
*Parvicingula boesii* (PARONA)
?TUMANDA 1989, p. 38, pl. 4, fig. 2

*Holotype*: Bo. 449.50: 49

*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.

*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 8 specimens)

| | height | max. width |
|---|---|---|
| Br. 28.85: 468 | 270 | 200 |
| Bo. 391.20: 36 | 302 | 187 |
| Bo. 449.50: 49 | 257 | 183 |
| Bo. 449.50: 974 | 273 | 196 |
| Ru. 146.50: 117 | 261 | 192 |
| Ru. 135.50: 1606 | 391 | 228 |
| Ru. 135.50: 1608 | 354 | 233 |
| GC. 786.70: 732 | 404 | 244 |

| | | | | |
|---|---|---|---|---|
| Height of test: | HT 257 | av. 314 | min. 257 | max. 404 |
| Max. width of test: | HT 183 | av. 207 | min. 183 | max. 244 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 6-33

## **Mirifusus chenodes** (RENZ)

*Pl. 12, Fig. 16*

*Pl. 13, Fig. 1*

*Lithocampe chenodes* RENZ
RENZ 1974, p. 793, pl. 7, fig. 30; pl. 12, fig. 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. 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, 98-99, figs. 1,2,3a-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.

*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. 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.

*Range*.- U.A. 1-35

## **Mirifusus dianae** (KARRER)

*Lagena dianae* KARRER
KARRER 1867, p. 365, pl. 3, fig. 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, 2b

## **Mirifusus dianae minor** BAUMGARTNER

*Pl. 13, Fig. 2*

*Theoperid* gen et sp. indet.
FOREMAN 1973, 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.
KATO & IWATA 1989, pl. 1, fig. 1.
*Mirifusus mediodilatatus* (RÜST) gr.
SANFILIPPO & RIEDEL 1985, fig. 2b.
*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, fig. 7, ?3.
*Mirifusus dianae* (KARRER)
DUMITRICA & DE WEVER 1991, p. 553-557, figs. 1, 2a, 2b

*Range*.- U.A. 1-31

## **Mirifusus odoghertyi n. sp.**

*Pl. 13, Figs. 3, 4*

*Mirifusus* cf. fasciata RUST
MUZAVOR 1977, p. 121, pl. 6, fig. 1

*Holotype*: Br. 28.85: 418

*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.

*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)

| | length except tube | max. width of tube |
|---|---|---|
| Bo. 311.2: 1198 | 350 | 170 |
| Bo. 449.5: 1 | 392 | 188 |
| Bo. 449.5: 50 | 410 | 215 |
| Bo. 449.5: 95 | 388 | 174 |
| Bo. 552.1: 96 | 381 | 250 |
| Bo. 556.4: 174 | 405 | 241 |
| Bo. 556.4: 177 | 357 | 178 |
| Bo. 569.6: 25 | 437 | 218 |
| Br. 28.85: 282 | 552 | 257 |
| Br. 28.85: 303 | 396 | 196 |
| Br. 28.85: 349 | 333 | 176 |
| Br. 28.85: 418 | 473 | 236 |
| Pi. 86.6: 11 | 375 | 200 |
| GC. 786.7: 735 | 330 | 175 |

| | | | | |
|---|---|---|---|---|
| Length without tube: | HT 473 | av. 398 | min. 330 | ax. 552 |
| Max. width: | HT 236 | av. 205 | min. 170 | ax. 257 |
| Length of tube: | PT 63 | | | |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Italy

*Range*.- U.A. 3-34

## **Mirifusus petzholdti** (RÜST)

*Pl. 13, Fig. 5*

*Stichocapsa petzholdti* RÜST
RÜST 1885b, p. 319 (49), pl. 42, fig. 7
?*Stichocapsa perpasta* RÜST
RÜST 1885b, p. 319 (49), pl. 42, fig. 10

*Actualized Definition*.- 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.

*Remarks*.- 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.

*Range*.- U.A. 13-23

## Genus: **Novixitus** PESSAGNO

*Novixitus* PESSAGNO
PESSAGNO 1977b, p. 54.

*Type Species*: *Novixitus mclaughlini* PESSAGNO 1977b

## **Novixitus (?) daneliani n. sp.**

*Pl. 13, Fig. 6*

*Holotype*: Br. 141.55: 21

*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

*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 to *Novixitus* (?) *tuberculatus*. Biostratigraphically the latter species occurrs in older samples than *Novixitus* (?) *daneliani*. The upper portion of *Novixitus* (?) *daneliani* differs however from *Novixitus* (?) *tuberculatus* WU 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 Mesozòic radiolarians.

*Measurements* (in µm).-

(based on 8 specimens)

| | total height | max. width |
|---|---|---|
| Br. 141.55: 21 | 213 | 110 |
| Bo. 580.1: 1363 | 238 | 125 |
| Bo. 580.1: 1367 | 238 | 125 |
| Bo. 580.1: 1397 | 268 | 127 |
| Bo. 580.1: 1400 | 254 | 122 |
| Bo. 580.1: 1401 | 257 | 129 |
| Bo. 580.1: 1403 | 271 | 129 |
| Bo. 580.1: 1407 | 253 | 111 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 213 | av. 249 | min. 213 | max. 271 |
| Max. width: | HT 110 | av. 122 | min. 110 | max. 129 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 25-35

## Novixitus (?) tuberculatus WU

*Pl. 13, Figs. 7-9*

*Xitus* sp. cf. *X. spicularius* (ALIEV)
SCHAAF 1981, p. 441, pl. 4, fig. 12
*Novixitus tuberculatus* WU
WU 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

*Actualized definition*.- 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.

*Remarks*.- 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.

*Range*.- U.A. 26-35

## Genus: Obesacapsula PESSAGNO

*Obesacapsula* PESSAGNO
PESSAGNO 1977a, p. 87.

*Type Species*: *Obesacapsula morroensis* PESSAGNO 1977a

## Obesacapsula breggiensis n. sp.

*Pl. 13, Fig. 10*

*Obesacapsula morroensis* PESSAGNO
OZVOLDOVA 1990, p. 267, pl. 4, figs. 4, 5

*Holotype*: Br. 1330: 321

*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.

*Remarks*.- *Obesacapsula breggiensis*, n. sp. differs from *Obesacapsula rusconensis rusconensis* BAUMGARTNER and *Obesacapsula rusconensis umbriensis*, n. sp., with which is 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 max. 10 specimens)

| | total height without tube | max. width of test |
|---|---|---|
| Pi. 67.7: 6 | 412 | 312 |
| Pi. 67.7: 11 | 311 | 209 |
| Pi. 67.7: 12 | 350 | 270 |
| Pi. 67.7: 1212 | 342 | 222 |
| Bo. 311.2: 1209 | 450 | 321 |
| Bo. 311.2: 1212 | 412 | 300 |
| Bo. 361.8: 998 | 430 | 307 |
| Bo. 370.1: 1015 | 335 | 280 |
| Br. 1330: 299 | 364 | 264 |
| Br. 1330: 321 | 461 | 273 |

Height excl. tube: HT 461 av. 382 min. 311 max. 461
Max. width test: HT 273 av. 276 min. 209 max. 321
Max. width tube: PT 178

*Locality*.- Breggia Gorge, near Chiasso, Ticino, Switzerland

*Range*.- U.A. 3-15

## Obesacapsula bullata STEIGER

*Pl. 14, Figs. 1-3*

*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

*Actualized definition*.- 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.

*Remarks*.- The species shows a wide morphological 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 µm, maximum width 452-504 µm, height of apical portion 77-103 µm, width of sutural depression 73-113 mm. 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.

*Range*.- U.A. 5-26

## Obesacapsula cetia (FOREMAN)

*Pl. 13, Fig. 11*

*Sethocapsa cetia* FOREMAN
FOREMAN 1973, 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.

*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 (personal communication, 1992) 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 exis 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.

*Range*.- U.A. 1-17

## Obesacapsula lucifer (BAUMGARTNER)

*Pl. 13, Figs. 12, 13*

*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

*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.

*Range*.- U.A. 5-17

## Obesacapsula morroensis PESSAGNO

*Pl. 13, Figs. 14, 15*

*Obesacapsula morroensis* PESSAGNO
PESSAGNO 1977b, 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.
SUYARI & ISHIDA 1985, pl. 2, fig. 3
OZVOLDOVA & PETERCAKOVA 1987, pl. 33, figs. 6,7.
OZVOLDOVA 1988, pl. 4, figs. 9, 11.
*Obesacapsula rotunda* HINDE
?NAKASEKO et al. 1979a, pl. 2, figs. 11a, 11b
*Obesacapsula* sp.
THUROW 1985, pl. 3, figs. u, v, w

*Remarks*.- In our material this species shows a wide variation in height, width and number of segments.

*Range*.- U.A. 5-33

## Obesacapsula polyedra (STEIGER)

*Pl. 14, Figs. 4-8*

*Sethocapsa cetia* (FOREMAN)
PESSAGNO 1977b, p. 52, pl. 9, fig. 11
*Sethocapsa polyedra* STEIGER
STEIGER 1992, p. 63, pl. 17, figs. 9, 10

*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).

*Range*.- U.A. 6-18

## Obesacapsula rusconensis BAUMGARTNER

see subspecies

## Obesacapsula rusconensis rusconensis BAUMGARTNER

*Pl. 14, Fig. 9*

*Obesacapsula rusconensis* BAUMGARTNER
BAUMGARTNER 1984, p. 776, pl. 6, figs. 7-9.
STEIGER 1992, p. 67, pl. 18, figs. 12-15

*Range*.- U.A. 5-27

## Obesacapsula rusconensis umbriensis n. ssp.

*Pl. 14, Figs. 10-13*
*Pl. 15, Fig. 1*

*Obesacapsula morroensis* PESSAGNO
STEIGER 1992, p. 67, pl. 18, figs. 10, 11.

*Holotype*: V. -6.50: 1243

*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 the distal part of the proximal portion of test; its pore frames finer than on the inflated segment.

*Remarks*.- *Obesacapsula rusconensis umbriensis*, n. ssp. 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 on the terminal segment.

*Etymology*.- Named after the Umbria-Marche region, Italy, where the type locality is located.

*Measurements* (in µm).-

(based on max. 13 specimens)

| | total height excl. tube | height prox. portion | width of test | width of tube |
|---|---|---|---|---|
| V- 6.0: 3 | 429 | 233 | 339 | 196 |
| V- 6.0: 20 | 435 | 270 | 348 | 183 |
| V- 6.0: 207 | 527 | 309 | 345 | - |

| | | | | |
|---|---|---|---|---|
| V- 6.5: 1242 | 400 | 207 | 297 | 193 |
| V- 6.5: 1243 | 393 | 200 | 290 | 197 |
| V- 6.5: 1246 | 424 | 218 | 285 | - |
| V- 6.5: 1296 | 424 | 218 | 285 | - |
| V- 10.0: 1272 | 495 | 267 | 367 | 238 |
| V- 10.0: 1275 | 333 | 200 | 228 | 102 |
| V- 10.0: 1277 | 455 | 209 | 382 | 300 |
| Bo.311.2: 105 | 443 | 230 | 244 | 141 |
| Bo.311.2: 1217 | 369 | 174 | 210 | - |
| Bo.311.2: 1210 | 400 | 271 | 271 | 171 |

| | | | | |
|---|---|---|---|---|
| H. test excl. tube: | HT 393 | av. 463 | min. 333 | max. 327 |
| H. prox. portion: | HT 200 | av. 230 | min. 174 | max. 309 |
| Max. w. of test: | HT 290 | av. 299 | min. 210 | max. 382 |
| W. terminal tube: | HT 197 | av. 181 | min. 107 | max. 238 |

*Type Locality*.- Valdorbia, Umbria-Marche, Italy
*Range*.- U.A. 5-9

### **Obesacapsula verbana** (PARONA)

*Pl. 15, Figs. 2-4*

*Stichocapsa verbana* PARONA
PARONA 1890, p. 171-172, pl. 6, fig. 14
RUST 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 1973, 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.

*Actualized definition*.- 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.

*Remarks*.- The species shows a wide variation of the ratio between the height and width of the segments. Most specimens possess 5 segments. 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.

*Range*.- U.A. 5-32

## Genus: **Pantanellium** PESSAGNO 1977a

*Pantanellium* PESSAGNO
PESSAGNO 1977a, p. 78.

*Type species*: *Pantanellium riedeli* PESSAGNO1977a

### **Pantanellium berriasianum** BAUMGARTNER

*Pl. 15, Figs. 5, 6*

*Pantanellium* (?) *berriasianum* BAUMGARTNER
BAUMGARTNER 1984, p. 776, 777, pl. 6, figs. 14-15.

*Range*.- U.A. 3-10

### **Pantanellium sp. aff. P. cantuchapai** PESSAGNO & MACLEOD

*Pl. 15, Figs. 7-9*

?*Pantanellium cantuchapai* PESSAGNO & MACLEOD
PESSAGNO et al. 1987a, 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

*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.

*Range*.- U.A. 3-34

## **Pantanellium squinaboli** (TAN)

*Pl. 15, Figs. 10-12*

*Staurosphaera squinaboli* TAN
TAN 1927, p. 35, pl. 6, figs. 9a-d.
*Sphaerostylus lanceola* (PARONA)
FOREMAN 1973, p. 258, pl. 1, figs. 7-11.
KANIE et al. 1981, pl. 1, fig. 6.
BOUYSSE et al. 1983, fig. 4, nr. 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.
*Pantanellium lanceola* (PARONA) gr.
DE WEVER & THIEBAULT 1981, p. 589, pl. 2, fig. 9.
SCHAAF 1981, pl. 7, fig. 6; pl. 16, figs. 5a-b.
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; non pl. 1, fig. 4.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, figs. 7-12.
*Pantanellium portovenerensis* CIARAPICA & ZANINETTI
CIARAPICA & ZANINETTI 1982, p. 169-170, 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.

*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.

*Range*.- U.A. 3-35

## Genus: **Parapodocapsa** STEIGER

*Parapodocapsa* STEIGER
STEIGER 1992, p. 62.

*Type species*: *Parapodocapsa furcata* STEIGER 1992.

## **Parapodocapsa furcata** STEIGER

*Pl. 15, Fig. 13*

*Parapodocapsa furcata* STEIGER
STEIGER 1992, p. 62, pl. 17, figs 2-4.

*Range*.- U.A. 5-13

## Genus: **Paronaella** PESSAGNO emend. BAUMGARTNER

*Paronaella* PESSAGNO
PESSAGNO 1971, p. 46, 47
*Paronaella* PESSAGNO emend.
BAUMGARTNER 1980, p. 300.

*Type species*: *Paronaella solanoensis* PESSAGNO 1971.

## **Paronaella (?) annemariae n. sp.**

*Pl. 15, Fig. 14*

gen. et sp. indet.
SCHAAF 1981, pl. 10, fig. 1a, b
THUROW 1988, pl. 10, fig. 16

*Holotype*: Bo. 566.50: 456

*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 similar tubercles. Corners of the triangle with rays formed of several longitudinal beams, of which 5 are visible on each 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.

*Remarks*.- *Paronaella* (?) *annemariae*, n.sp. 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 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 max. 4 specimens)

| | length of the longer rays | length of short ray | diameter of circle of nodes |
|---|---|---|---|
| Bo. 566.50: 432 | 203 | 152brok. | 85 |
| Bo. 566.50: 442 | 140brok. | 120 | 65 |
| Bo. 566.50: 446 | 180brok. | 150brok. | 65 |
| Bo. 566.50: 456 | 200 | 140brok. | 70 |

| | | | | |
|---|---|---|---|---|
| L. of longer rays: | HT 200 | PT 203 | 140 | 180 brok. |
| L. of short ray: | HT 140 brok. | PT 120 | 152 | 150 brok. |
| Diam. circle nodes: | HT 70 | PT 65 | 85 | |

*Type Locality.*- Fiume Bosso, Umbria-Marche, Italy
*Range.*- U.A. 8-34

## **Paronaella trifoliacea** OZVOLDOVA

*Pl. 15, Figs. 15-17*

*Paronaella trifoliacea* OZVOLDOVA
OZVOLDOVA & PETERCAKOVA 1992, p.316, pl. 5, figs. 1-5

*Actualized definition.*- 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° relative to the 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.

*Remarks.*- We included 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: length of the rays, av. 187 µm, min. 149 µm, max. 254 µm.

*Range.*- U.A. 7-35

## **Paronaella (?) tubulata** STEIGER

*Pl. 15, Figs. 18, 19*

*Paronaella* (?) *tubulata* STEIGER
STEIGER 1992, p. 45, pl. 10, fig. 10

*Remarks.*- We included in *Paronaella* (?) *tubulata* only forms with the characteristic nodose, tuberculate structure in the central part similar to the holotype.

*Range.*- U.A. 3-35

## Genus: **Parvicingula** PESSAGNO

*Parvicingula* PESSAGNO
PESSAGNO 1977a, p. 84
BAUMGARTNER 1984, p. 778

*Type species*: *Parvicingula santabarbarensis* PESSAGNO p.86

## **Parvicingula boesii gr.** (PARONA)

*Pl. 16, Figs. 1, 2*

*Dictyomitra boesii* PARONA
PARONA 1890, p. 170, pl. 6, fig. 9.
*Parvicingula boesii* (PARONA)
AOKI 1982, pl. 2, fig. 8
ISHIDA 1985, pl. 5, figs. 1,2.
KIMINAMI et al. 1985, pl. 2, fig. 9
PAVSIC & GORICAN 1987, p. 27, pl. 4, fig. 11.
OZVOLDOVA & PETERCAKOVA 1987, pl. 34, fig. 4.
OZVOLDOVA 1988, pl. 4, fig. 2; non pl. 7, fig. 7.
YASUDA 1989, pl. 1, fig. 20
OZVOLDOVA & PETERCAKOVA 1992, pl. 3, fig. 12.
STEIGER 1992, p. 86, pl. 23, figs. 2-5, 7, not 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, textfig. 2, nr. 2
KATO & IWATA 1989, pl. 1, fig. 4, pl. 4, fig. 6.
IWATA et al. 1990, pl. 1, fig. 2, ?pl. 2, fig. 11
*"Parvicingula" boesii* (PARONA)
VELLEDITS et al. 1986, pl. 4, fig. 1

*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.

*Range.*- U.A. 3-35

## **Parvicingula cosmoconica** (FOREMAN)

*Pl. 16, Fig. 3*

*Dictyomitra cosmoconica* FOREMAN
FOREMAN 1973, 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.
non KITO 1987, pl. 3, fig. 5.

PAVSIC & GORICAN 1987, p. 27, pl. 4, fig. 10.
STEIGER 1992, p. 86, pl. 24, figs. 4-6.
*Foremanina cosmoconica* (FOREMAN)
VELLEDITS et al. pl. 4, fig. 2

*Remarks*.- 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.

*Range*.- U.A. 3-35

## Parvicingula longa n. sp.

*Pl. 16, Figs. 4, 5*

*Holotype*: Bo. 449.50: 36

*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.

*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)

| | total height | height ap. part | max. width of test |
|---|---|---|---|
| Bo. 449.50: 36 | 343 | 47 | 119 |
| Bo. 449.50: 204 | 283 | 50 | 118 |
| Bo. 449.50: 952 | 330 | 45 | 102 |
| Bo. 449.50: 954 | 285 | 40 | 115 |
| Bo. 449.50: 955 | 275 | 40 | 118 |
| Bo. 449.50: 956 | 386 | 53 | 124 |
| Bo. 479.50: 1002 | 448 | 48 | 131 |
| Bo. 556.40: 93 | 414 | 46 | 129 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 343 | av. 346 | min. 275 | max. 448 |
| Height ap. part: | HT 47 | av. 46 | min. 40 | max. 53 |
| Max. width test: | HT 119 | av 120 | min. 102 | max. 131 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 6-30

## Parvicingula sphaerica STEIGER

*Pl. 16, Figs. 6, 7*

*Mirifusus mediodilatatus* (RÜST)
VELLEDITS et al. 1986, pl. 3, fig. 1
*Parvicingula* sp.
VISHNEVSKAYA 1989, pl. 8, fig. 2
*Parvicingula ananassa* ( )
VISHNEVSKAYA 1989, pl. 8, fig. 4
*Parvicingula sphaerica* STEIGER
STEIGER 1992, p. 86, pl. 24, figs. 1, 2.
*Parvicingula boesii* (PARONA)
STEIGER 1992, p. 86, pl. 23, fig. 6, not 1-5, 7

*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* is however distinctly larger and broader than *P. boesii* and cannot be confused with it.

*Range*.- U.A.6-13

## Parvicingula usotanensis TUMANDA

*Pl. 16, Fig. 8*

*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. 6a,b.
?*Parvicingula* sp. B
AITA 1982, pl. 2, fig. 14
*Parvicingula* sp.
SUYARI 1986, 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

*Remarks*.- In our material there were also found specimens with a wide terminal tube. Two such specimens measured (in µm) had a total length, with tube, of 239 and 389 respectively, a maximum width of 130 and 188, a length of the tube of 58 and 88 and a distal width of 44 and 90.

*Range*.- U.A. 11-35

## Genus: **Parvivacca** PESSAGNO & YANG

*Parvivacca* PESSAGNO & YANG
PESSAGNO & YANG 1989, p. 244.

*Type Species*: *Parvivacca blomei* PESSAGNO & YANG 1989

### **Parvivacca magna n. sp.**

*Pl. 16, Figs. 9-12*

*Holotype*: Bo. 566.5: 586

*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°, 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.

*Remarks*.- *Parvivacca magna*, n. sp. differs from *Parvivacca blomei* PESSAGNO & YANG and *Parvivacca simplex* PESSAGNO & YANG by its robust central test, bearing 2 robust shorter spines having more or less spiny ends.

*Etymology*.- From the Latin *magnus* = big

*Measurements* (in µm).-

(based on 8 specimens)

| | diameter of test | max. length of spines |
|---|---|---|
| Br. 28.85: 230 | 144 | 133 |
| Br. 28.85: 1559 | 200 | 181 |
| Ru. 146.5: 23 | 175 | 155 |
| Bo. 552.1: 70 | 183 | 167 |
| Bo. 561.5: 1115 | 200 | 155 |
| Bo. 566.5: 586 | 160 | 133 |
| Bo. 566.5: 1821 | 191 | 147 |
| Bo. 569.6: 104 | 211 | 172 |

| | | | | |
|---|---|---|---|---|
| Diameter of test: | HT 160 | av. 181 | min. 144 | max. 211 |
| Max. length spines: | HT 133 | av. 157 | min. 133 | max. 181 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 8-32

## Genus: **Phaseliforma** PESSAGNO

*Phaseliforma* PESSAGNO
PESSAGNO 1972, p. 274

*Type species*: *Phaseliforma carinata* PESSAGNO.

### **Phaseliforma ovum n. sp.**

*Pl. 16, Figs. 13-14*

*Holotype*: Bo. 566.50: 83

*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.

*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)

| | length | width |
|---|---|---|
| Bo. 561.50: 1106 | 235 | 196 |
| Bo. 561.50: 1124 | 260 | 211 |
| Bo. 566.50: 83 | 256 | 222 |
| Bo. 566.50: 263 | 243 | 180 |
| Bo. 566.50: 1670 | 287 | 228 |
| Bo. 566.50: 1672 | 309 | 255 |

| | | | | |
|---|---|---|---|---|
| Length of test: | HT 256 | av. 265 | min. 235 | max. 287 |
| Width of test: | HT 222 | av. 215 | min. 180 | max. 222 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 29-35

## Genus: **Podobursa** WISNIOWSKI, emend. FOREMAN

*Podobursa* WISNIOWSKI 1889
WISNIOWSKI 1889, p. 686.
FOREMAN 1973, p. 266.

*Type Species*: *Podobursa dunikowskii* WISNIOWSKI 1889 (by monotypy).

### **Podobursa multispina n. sp.**

*Pl. 16, Figs. 15-17*

*Holotype*: Bo. 566.50: 509

*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.

*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)

| | Total height | Width sphe. part | height prox. part | height dist. part |
|---|---|---|---|---|
| Bo. 561.50: 1118 | 364 | 164 | 109 | 127 |
| Bo. 566.50: 232 | 382 | 145 | 98 | 142 |
| Bo. 566.50: 509 | 366 | 162 | 83 | 121 |
| Bo. 566.50: 525 | 274 | 140 | 66 | 86 |
| Bo. 566.50: 587 | 385 | 167 | 100 | 130 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 366 | av. 354 | min. 274 | max. 385 |
| Width spher. part: | HT 162 | av. 155 | min. 140 | max. 167 |
| Ht. prox. con. part: | HT 83 | av. 91 | min. 66 | max. 109 |
| Ht. dist. con. part: | HT 121 | av. 121 | min. 86 | max. 142 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 29-32

## **Podobursa spinosa** (OZVOLDOVA)

*Pl. 17, Fig. 1*

*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, fig. 11.2a-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.
*Podobursa spinosa* (OZVOLDOVA) gr.
DE WEVER et al. 1986, pl. 10, figs. 5,6,8,10

*Range*.- U.A. 1-5

## Genus: **Podocapsa** RÜST, emend. FOREMAN

*Podocapsa* RÜST
RÜST 1885, p. 304.
emend. FOREMAN 1973, p. 267.

*Type Species*: *Podocapsa guembeli* RÜST 1885, (subsequent designation by CAMPBELL 1954). (lectotype of type species: RÜST, 1885, pl. 36, fig. 6, designated by FOREMAN 1973).

## **Podocapsa amphitreptera** FOREMAN

*Pl. 17, Figs. 2, 3*

*Podocapsa amphitreptera* FOREMAN
FOREMAN 1973, 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
STEIGER 1992, p. 61, pl. 17, fig. 1.
BAUMGARTNER 1992, p. 324, pl. 10, fig. 9.
*Nassellaria* gen et sp. indet.
NAKASEKO & NISHIMURA 1981, pl. 8, fig. 12a-b.
*Podocapsa* sp.
OZVOLDOVA 1987, pl. 2, fig. 9

*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, 1973.

*Range*.- U.A. 1-25

## Podocapsa (?) imperialis n. sp.

*Pl. 17, Figs. 4, 5*

*Holotype*: Bo. 566.50: 535

*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 from what could be considered as apical part. One very short spine is disposed on the 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.

*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 max. 5 specimens)

| | diameter sphere | length ap. horn | max. length extens. | max. width extens. |
|---|---|---|---|---|
| Bo. 561.50:1101 | 191 | - | 118 | 44 |
| Bo. 566.50: 519 | 185 | 45 | 130 | 54 |
| Bo. 566.50: 534 | 170 | 68 | 110 | 41 |
| Bo. 566.50: 535 | 220 | 40 | 147 | 60 |
| Bo. 566.50:1666 | 236 | 73 | 133 | 67 |

| | | | | |
|---|---|---|---|---|
| Diameter sp. only: | HT 220 | av. 200 | min. 170 | max. 236 |
| Length of ap. horn: | HT 40 | av. 57 | min. 40 | max. 73 |
| Max. L. extensions: | HT 147 | av. 154 | min. 110 | max. 147 |
| Max. W. extensions: | HT 60 | av. 53 | min. 41 | max. 67 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 25-32

## Genus: **Pseudoaulophacus** PESSAGNO

*Pseudoaulophacus* PESSAGNO
PESSAGNO 1963, p. 200
emend. PESSAGNO 1972, p. 303.

*Type species*: *Pseudoaulophacus floresensis* PESSAGNO 1963

## Pseudoaulophacus (?) florealis n. sp.

*Pl. 17, Figs. 6-8*

gen. et sp. indet.
SCHAAF 1981, pl. 10, figs. 8a, b
*Godia* (?) sp. D
THUROW 1988, p. 401, pl. 9,fig. 15

*Holotype*: Bo. 566.50: 434

*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 center. 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.

*Remarks*.- *Pseudoaulophacus* (?) *florealis*, n. sp. differs from *Pseudoaulophacus* (?) *pauliani*, n. sp. by possessing a circle of nodes around a central node and commonly a delicate peripherical 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 max. 5 specimens)

| | diameter of test only | diameter circle of nodes |
|---|---|---|
| Bo. 370.1: 34 | 256 | - |
| Bo. 566.5: 265 | 210 | - |
| Bo. 566.5: 434 | 230 | 93 |
| Bo. 566.5: 429 | 200 | 100 |
| Br. 28.85: 149 | 216 | - |

| | | | | |
|---|---|---|---|---|
| Diameter of test: | HT 230 | av. 222 | min. 210 | max. 256 |
| Diam. circle nodes: | HT 93 | PT 100 | | |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 15-35

## Pseudoaulophacus (?) pauliani n. sp.

*Pl. 17, Figs. 9*

*Holotype*: Br. 28.85: 218

*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, flattened, bladed spines connected at their basal portion by a wide, poreless membrane.

*Remarks*.- *Pseudoaulophacus* (?) *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 and Geophysics, Bucharest, Romania), honouring his contributions to the knowledge of Radiolaria and thanking him for his help and friendship.

*Measurements* (in µm).-

(based on 5 specimens)

| | diameter test excl. spines | max. length spines |
|---|---|---|
| Br. 28.85: 182 | 293 | 100 |
| Br. 28.85: 138 | 295 | 109 |
| Br. 28.85: 182 | 279 | 100 |
| Br. 28.85: 203 | 227 | 80 |
| Br. 28.85: 218 | 3001 | 25 |

| | | | | |
|---|---|---|---|---|
| Diameter of test: | HT 300 | av. 260 | min. 200 | max. 300 |
| Max. length spines: | HT 125 | av. 99 | min. 80 | max. 125 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 7-34

## Genus: **Pseudocrolanium n. gen.**

*Type species*: *Pseudocrolanium fluegeli* n. sp.

*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. Postabdominal 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.

*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*.-From the Greek *pseudo* = false and *Crolanium*.

### Pseudocrolanium cristatum n. sp.

*Pl. 17, Fig. 10*

*Holotype*: Bo. 566.50:119

*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.

*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)

| | total height | max. width excl. crests |
|---|---|---|
| Bo. 566.50:112 | 244 | 122 |
| Bo. 566.50:119 | 240 | 120 |
| Bo. 566.50:125 | 278 | 128 |
| Bo. 566.50:1654 | 282 | 140 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 240 | av. 261 | min. 240 | max. 282 |
| Max. width: | HT 120 | av. 128 | min. 120 | max. 140 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 24-35

### Pseudocrolanium fluegeli n. sp.

*Pl. 17, Figs. 11, 12*

*Holotype*: Bo. 566.50: 121

*Definition*.- Conical test of 9-10 segments, which can be divided into 3 main portions: a proximal, a middle and a distal one. Proximal part conical, smooth, consisting of cephalis, thorax and abdomen and probably the 1st postabdominal 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, Germany, honouring his friendship and his help by offering me the possibility to use the SEM of the institute.

*Measurements* (in µm).-

(based on max. 6 specimens)

| | height of test to spine base | width of test at spine base | length spines |
|---|---|---|---|
| Bo. 552.10: 33 | 257 | 137 | - |
| Bo. 561.50: 1100 | 189 | 103 | - |
| Bo. 566.50: 121 | 195 | 111 | 51 |
| Bo. 566.50: 117 | 223 | 133 | 51 |
| Gc. 814.50: 721 | 261 | 113 | 39 |
| Bo. 821.45: 761 | 300 | 141 | 70 |

| | | | | |
|---|---|---|---|---|
| H. test to spine-base | HT 195 | av.237 | min. 189 | max. 300 |
| Width at spine base: | HT 111 | av.123 | min. 103 | max. 141 |
| Length of spines: | HT 51 | av. 61 | min. 39 | max. 83 |

*Type Locality*.- Fiume Bosso, Umbria Marche, Italy

*Range*.- U.A. 29-34

## Genus: **Pseudocrucella** BAUMGARTNER

*Pseudocrucella* BAUMGARTNER
BAUMGARTNER 1980, p. 291

*Type Species*: *Crucella sanfilippoae* PESSAGNO 1977a

## **Pseudocrucella (?) elisabethae** (RÜST)

*Pl. 17, Fig. 13*
*Pl. 18, Figs. 1, 2*

*Histiastrum elisabethae* RÜST
RÜST 1898, p. 30, 31, pl. 10, fig. 8
*Crucella* sp.
PESSAGNO 1971, pl. 19, fig. 7

*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.

*Remarks*.- 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 µm (min. 278 µm, max. 328 µm), which is rather similar to the values mentioned by RÜST.

*Range*.- U.A. 6-35

## Genus: **Pseudodictyomitra** PESSAGNO

*Pseudodictyomitra* PESSAGNO
PESSAGNO 1977b, p. 50.

*Type Species*: *Pseudodictyomitra pentacolaensis* PESSAGNO 1977b

## **Pseudodictyomitra carpatica** (LOZYNIAK)

*Pl. 18, Figs. 3-5*

*Dictyomitra carpatica* LOZYNIAK
LOZYNIAK 1969, p. 38, pl. 2, figs. 11-12.
FOREMAN 1973, p. 263, pl. 10, figs. 1-3; pl. 16, fig. 5.
FOREMAN 1975, p. 614, pl. 2G, figs. 12-14, non fig. 11; pl. 7, fig. 7, non fig. 6.
*Pseudodictyomitra carpatica* (LOZYNIAK)
SCHAAF 1981, p. 436, pl. 3, figs. 1a-c, 2; pl. 20, fig. 4a-b.
NAKASEKO & NISHIMURA 1981, p. 158, pl. 9, figs. 6, 11.
DE WEVER & THIEBAULT 1981, p. 590, pl. 2, fig. 2.
MATSUYAMA et al. 1982, pl. 1, fig. 7.
YAO 1984, pl. 4, fig. 18.
BAUMGARTNER 1984, p. 782, pl. 8, fig. 1.
SCHAAF 1984, p. 94-95, figs. 1-3b.
ISHIDA 1985, pl. 6, figs. 1,2.
AITA & OKADA 1986, pl. 1, figs. 13, 14; pl. 7, fig. 10.
KAWABATA 1988, pl. 2, fig. 7
STEIGER 1992, p. 87, pl. 25, figs. 1-3, 7.
*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. 1984, pl. 4, fig. 14.

*Remarks*.- 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* (LOZYINIAK) but not exactly corrresponding to the type illustrations, are longer, with the postabdominal 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 (1973), species to which most authors assigned quite different specimens. Thus much more investigations are needed to classify properly all this variety of morphotypes.

*Range*.- U.A. 3-34

### **Pseudodictyomitra lanceloti** SCHAAF

*Pl. 18, Fig. 6*

*Dictyomitra carpatica* LOZYNIAK (?)
FOREMAN 1975, p. 614, pl. 2G, figs. 11-13, not 14
*Dictyomitra* sp. B (=Pseudodictyomitra sp. B)
NAKASEKO ET AL. 1979a, pl. 6, fig. 21
*Pseudodictyomitra lanceloti* SCHAAF
SCHAAF 1981b, p. 436, 437, pl. 18, figs. 9a, b
*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
*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

*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.

*Range*.- U.A. 31-35

### **Pseudodictyomitra sp. aff. P. lanceloti** SCHAAF

*Pl. 18, Fig. 7*

*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

*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. Postabdominal 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 postabdominal 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.

*Range*.- U.A. 34

### **Pseudodictyomitra leptoconica** (FOREMAN)

*Pl. 18, Fig. 8*

*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. 176-177, pl. 20, fig. 10
SCHAAF 1984, p. 117-118, figs. 1-7
SUYARA & ISHIDA 1985, pl. 3, fig. 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.

*Actualized definition*.- 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. The next following postabdominal segments are rounded in outline, smooth or with only slightly pronounced ribs. The last segment is smooth, subrounded in outline.

*Remarks*.- 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 specimens corresponds neither to the original description nor to the holotype. They resemble rather the specimen illustrated by FOREMAN (1973, pl. 16, fig. 6). It must be mentioned that 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 *Pseudodictyomitra carpatica* LOZYNIAK. More investigations are therefore needed to properly classify all these morphotypes.

*Range*.- U.A. 35

### **Pseudodictyomitra lilyae** (TAN)

*Pl. 18, Figs. 9-11*

*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 1981b, 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

*Actualized 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 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.

*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.

*Range*.- U.A. 30-35

### **Pseudodictyomitra nuda** SCHAAF

*Pl. 18, Figs. 12, 13*

*Archaeodictyomitra nuda* SCHAAF
SCHAAF 1981, p. 432, pl. 3, fig.
*Pseudodictyomitra nuda* (SCHAAF)
ORIGLIA-DEVOS 1983, p. 178, 179, pl. 20, fig. 16

*Remarks*.- The specimens herein assigned to *P. nuda* SCHAAF differ in that they have not exactly ribs but rather slightly marked, irregularly disposed tubercles.

*Range*.- U.A. 16-35

## Genus: **Pseudoeucyrtis** PESSAGNO

*Pseudoeucyrtis* PESSAGNO
PESSAGNO 1977b, p. 58.

*Type Species*: *Eucyrtis* (?) *zhamoidai* FOREMAN 1973

### **Pseudoeucyrtis acus n.sp.**

*Pl. 18, Figs. 14, 15*

*Holotype*: Br. 28.85: 109

*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 lenght 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, nonsegmented, 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.

*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 max. 2 specimens)

| | total length | min. width | max. width | height of ap. part | length ap. spine |
|---|---|---|---|---|---|
| Br. 28.85: 109 | 788 | 55 | 73 | 152 | 30 |
| Br. 28.85: 274 | Broken | - | 84 | 197 | 47 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 788 | av. - | min. - | max. - |
| Min. width: | HT 55 | av. - | min. - | max. - |
| Max. width: | HT 73 | av. 78 | min. 73 | max. 84 |
| Height ap. part: | HT 152 | av. 174 | min. 152 | max. 197 |
| Length ap. spine: | HT 30 | av. 38 | min. 30 | max. 47 |

*Type Locality*.- Breggia Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 10-33

## Pseudoeucyrtis (?) aspera n. sp.

*Pl. 18, Fig. 16*

*Holotype*: Bo. 566.50: 2

*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 dense spongy and slightly spiny meshwork.

*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 very slightly in width distally.

*Etymology*.- From the Latin *asper* = rough

*Measurements* (in µm).-

(based on 1 specimen)

| | max. length | length ap. inflated part | max. width | height ap. horn |
|---|---|---|---|---|
| Bo. 566.50:2 | 635 | 135 | 130 | 29 |

| | |
|---|---|
| Max. length: | HT 635 |
| Length ap. infl. part: | HT 135 |
| Maximum width: | HT 130 |
| Height ap. horn: | HT 29 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 17-33

## Pseudoeucyrtis (?) fusus n. sp.

*Pl. 18, Figs. 17-19*

*Holotype*: Br. 1330: 128

*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 segmentations 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.

*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

*Measurements* (in µm).-

(based on max. 5 specimens)

| | total length | length excl. ap. spine | max. width | length ap. spine |
|---|---|---|---|---|
| Br. 1330: 128 | 565 | 409 | 70 | 161 |
| Br. 28.85: 278 | broken | 386 | 82 | broken |
| Br. 28.85: 287 | 620 | 503 | 100 | 116 |
| Bo. 370.1: 53 | broken | - | 86 | 129 |
| Pi. 40.20: 852 | 600 | 483 | 92 | 117 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 565 | av. 595 | min. 565 | max. 620 |
| L. excl. ap. spine: | HT 409 | av. 495 | min. 386 | max. 503 |
| Max. width: | HT 70 | av. 86 | min. 70 | max. 100 |
| L. of ap. spine: | HT 161 | av. 131 | min. 116 | max. 161 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 5-19

## Pseudoeucyrtis sceptrum n. sp.

*Pl. 18, Fig. 20*

*Pseudocyrtis* sp.
SCHAAF 1984, p. 155, figs. 7a,b

*Holotype*: V. -6.0: 222

*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.

*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)

| | total length | max. width | length ap. horn |
|---|---|---|---|
| Bo. 311.2: 97 | 814 | 100 | 69 |
| V. -6.0: 222 | 723 | 100 | 71 |
| V. -10.0: 1284 | 619 | 90 | 48 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 723 | av. 719 | min. 619 | max. 814 |
| Max. width: | HT 100 | av. 97 | min. 90 | max. 100 |
| Length of horn: | HT 71 | av. 63 | min. 71 | max. 71 |

*Type Locality*.- Valdorbia, Umbria-Marche, Italy

*Range*.- U.A. 6-12

## Genus: **Ristola** PESSAGNO & WHALEN sensu BAUMGARTNER

*Ristola* PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 148.
emend. BAUMGARTNER 1984, p. 783.

*Type Species*: *Parvicingula* (?) *procera* PESSAGNO 1977a

## Ristola altissima (RÜST)

see subspecies

## Ristola altissima altissima (RÜST)

*Pl. 19, Fig. 1*

*Lithocampe altissima* RÜST
RÜST, 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.
*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* (RUST)
BAUMGARTNER 1984, p. 783, pl. 8, fig 3, non figs. 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; non pl. 11, fig. 9.
KITO 1987, pl. 3, fig. 11.
OZVOLDOVA 1988, pl.4, fig. 5.

*Range*.- U.A. 1

## Ristola asparagus n. sp.

*Pl. 19, Figs. 2, 3*

*Holotype*: Bo. 566.50: 21

*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 develop 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 sightly developed external circumferential ridges.

*Remarks*.- *Ristola asparagus*, n. sp. differs from *Ristola altissima altissimas* (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, fig. 8a, b) resembles stratigraphically older forms of this species. 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)

| | total length of test | max.width of test |
|---|---|---|
| Bo. 552.10: 88 | 693 | 171 |
| Bo. 566.50: 21 | 649 | 163 |
| Bo. 566.50: 67 | 774 | 162 |
| Bo. 566.50: 633 | 463 | 142 |

| | | | | |
|---|---|---|---|---|
| Total length of test: | HT 649 | av. 645 | min. 463 | max. 774 |
| Max. width of test: | HT 163 | av. 160 | min. 142 | max. 171 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 9-35

## **Ristola cretacea** (BAUMGARTNER)

*Pl. 19, Figs. 4-6*

*Lithocampe altissima* RÜST
RÜST 1885, p. 315 (45), pl. 40, fig. 2
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

*Remarks*.- 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.

*Range*.- U.A. 3-20

## **Ristola martae n. sp.**

*Pl. 19, Figs. 7, 8*

*Holotype*: Bo. 566.50: 170

*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.

*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 altissima* (RUST) 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, Departement of Earth Sciences, University of Florence, Italy, honouring her work on radiolaria and her friendship.

*Measurements* (in µm).-

(based on 7 specimens)

| | total length | max. width |
|---|---|---|
| Bo. 561.50: 1097 | 385 | 158 |
| Bo. 566.50: 53 | 361 | 121 |
| Bo. 566.50: 80 | 326 | 130 |
| Bo. 566.50: 170 | 375 | 132 |
| Ru. 146.50: 4 | 364 | 173 |
| Ru. 146.50: 8 | 364 | 131 |
| Ru. 146.50: 16 | 408 | 155 |

| | | | | |
|---|---|---|---|---|
| Total length: | HT 375 | av. 369 | min. 326 | max. 408 |
| Max. width: | HT 132 | av. 143 | min. 121 | max. 173 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 22-32

## Genus: **Saitoum** PESSAGNO

*Saitoum* PESSAGNO 1977a
PESSAGNO 1977a, p. 96, 98

*Type species*: *Saitoum pagei* PESSAGNO 1977a

## **Saitoum elegans** DE WEVER

*Pl. 19, Fig. 9*

*Saitoum elegans* DE WEVER
DE WEVER 1981, p. 9, pl. 1, figs. 3,4.
SCHAAF 1984, p. 153, fig. 3.
DE WEVER & CORDEY 1986, pl. 1, figs. 6, 7

*Range*.- U.A. 1-34

## Genus: **Savaryella n. gen.**

*Type species*: *Savaryella guexi*

*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 which are simple or may bear spines. 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.

## **Savaryella guexi n. sp.**

*Pl. 19, Figs. 10, 11*

*Holotype*: Bo. 449.50: 134

*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.

*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 clublike 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 Institut 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 max. 3 specimens)

| | length of rays | width tips | height test |
|---|---|---|---|
| Bo. 449.50: 134 | 292 | 115 | - |
| Bo. 370.1: 207 | 238 | 76 | - |
| Br. 28.85: 1562 | 250 | 77 | 160 |

| | | | | |
|---|---|---|---|---|
| Lenght of rays: | HT 292 | av. 260 | min. 238 | max. 292 |
| Width of rays: | HT 115 | av. 89 | min. 76 | max. 115 |
| Max. height of test: | PT 160 | | | |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 7-34

## Genus: **Sethocapsa** HAECKEL

*Sethocapsa* HAECKEL
HAECKEL 1881, p. 433.

*Type Species*: *Sethocapsa cometa* (PANTANELLI) in RUST 1885 (subsequent designation by Foreman 1973)

## **Sethocapsa (?) concentrica** (STEIGER)

*Pl. 19, Fig. 12*

*Podocyrtis concentrica* STEIGER
STEIGER 1992, p. 68, pl. 19, figs. 6-9.

*Range*.- U.A. 5-8

## **Sethocapsa dorysphaeroides** NEVIANI sensu SCHAAF

*Pl. 19, Figs. 13, 14*

*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.

*Actualized definition*.- 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 partly 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.

*Remarks*.- The specimens illustrated by SCHAAF (1984) resemble the specimen illustrated by NEVIANI. SCHAAF, 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) of 551 µm, a length without last globose segment of 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* only forms consisting of a slender proximal part bearing a cephalic horn and a globose distal part lacking a terminal aperture.

*Range*.- U.A. 5-35

## Sethocapsa sp. aff. S. kaminogoensis AITA

*Pl. 19, Fig. 15*
*Pl. 20, Fig. 1*

?*Sethocapsa* sp.
OKAMURA & UTO 1982, pl. 3, fig. 12
?*Tricolocapsa* sp.
OKAMURA & UTO 1982, pl. 9, figs. 1a-b
?*Sethocapsa kaminogoensis* AITA
AITA & OKADA 1986, p. 114, 115, pl. 3, figs. 1-8, pl. 4, *figs*. 5-8, pl. 7, figs. 4a-c
TUMANDA 1989, p. 39, pl. 4, figs. 13, 14, pl. 10, fig. 12

*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 tubercules with imperforate apices. These tubercules may be interconnected by ribs forming triangular meshes.

*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 |

*Range*.- U.A. 5-34

## Sethocapsa kitoi n. sp.

*Pl. 20, Figs. 3, 4*

?*Sethocapsa* sp. A
AITA & OKADA 1986, p. 118, pl. 3, fig. 13
*Sethocapsa uterculus* (PARONA)
STEIGER 1992, p. 63, pl. 17, fig. 14

*Holotype*: Br. 1330: 476

*Definition*.- Test composed of four segments of which the last segment is large and spheric. 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.

*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 pore frames. 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)

| | total height | height prox part | max.width |
|---|---|---|---|
| Br. 1330: 476 | 246 | 66 | 186 |
| Om. 25: 2 | 220 | 75 | 170 |
| N. K.: 36-4 | 251 | 73 | 197 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 246 | av. 239 | min. 220 | max. 251 |
| Height prox. part: | HT 66 | av. 71 | min. 66 | max. 75 |
| Max. width: | HT 186 | av. 184 | min. 170 | max. 197 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 5-15

### Sethocapsa leiostraca FOREMAN

*Pl. 20, Fig. 5*

*Sethocapsa leiostraca* FOREMAN
FOREMAN 1973, 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.

*Range*.- U.A. 1-32

### Sethocapsa (?) orca FOREMAN

*Pl. 20, Figs. 6, 7*

*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
*Sethocapsa orca* FOREMAN
SCHAAF 1981, p. 437, pl. 26, figs. 3a,b
SCHAAF 1984, p. 154, figs. 8a, b

*Range*.- U.A. 28-35

### Sethocapsa simplex TAKETANI

*Pl. 20, Fig. 8*

*Sethocapsa* sp.
FOREMAN 1975, p. 617, pl. 2I, figs. 10-12, 14
*Sethocapsa simplex* TAKETANI
TAKETANI 1982, pl. 1, fig. 7
*Sethocapsa* ssp.
FOREMAN 1975, p. 617, pl. 2I, figs. 10-12, 14

*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)

*Range*.- U.A. 29-35

### Sethocapsa trachyostraca FOREMAN

*Pl. 20, Fig. 9*

*Sethocapsa trachyostraca* FOREMAN
FOREMAN 1973, 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.
non BAUMGARTNER et al. 1980, pl. 6, fig. 2.
SCHAAF 1981, p. 437, pl. 23, figs. 1a-b.
non 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.
*Sethocapsa* cf. *trachyostraca* FOREMAN
OZVOLDOVA & PETERCAKOVA 1987, p. 122, pl. 35, fig. 3.

*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.

*Range*.- U.A. 7-35

### Sethocapsa tricornis n. sp.

*Pl. 20, Figs. 10, 11*

*Holotype*: Bo. 1330: 433

*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 with postabdominal segment constricted. The latter is 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.

*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. *Sethocapsa 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*.- From the Latin *tri* = three and *cornu* = horn

*Measurements* (in μm).-

(based on max. 9 specimens)

| | height of test | width of test | length of dist. spines | length ap. horn |
|---|---|---|---|---|
| Pi. 40.20: 871 | 238 | 190 | - | - |
| Pi. 57.50: 828 | 251 | 176 | 55 | 51 |
| Pi. 57.50: 829 | 316 | 204 | 80 | 62 |
| Pi. 57.50: 830 | 320 | 216 | 55 | 65 |
| Pi. 57.50: 850 | 247 | 169 | 49 | - |
| Br. 1330: 423 | 245 | 151 | 64 | 72 |
| Br. 1330: 433 | 278 | 178 | 73 | 67 |
| Br. 28.85: 263 | 246 | 157 | 63 | 43 |
| Bo. 370.1: 85 | 254 | 163 | - | 57 |

| | | | | |
|---|---|---|---|---|
| Height of test: | HT 278 | av. 266 | min. 246 | max. 320 |
| Width of test: | HT 178 | av. 178 | min. 151 | max. 216 |
| Length dist. spines: | HT 73 | av. 63 | min. 49 | max. 80 |
| Length apical horn: | HT 67 | av. 60 | min. 43 | max. 72 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 5-16

## Sethocapsa (?) zweilii n. sp.

*Pl. 20, Figs. 12-14*

*Sethocapsa lagenaria* WU & LI
AITA & OKADA 1986, p. 116, pl. 3, fig. 11

*Holotype*: Bo. 449.50: 200

*Definition*.- Test of 4 segments, the first three 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 hexagonal depression.

*Remarks*.- The specimen illustrated by WU & LI 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* sensu FOREMAN.

*Etymology*.- This species is dedicated to Fred Zweili, technician on the SEM at the Institute for Geology at University of Bern, honouring all his helpful advices for the work on the SEM and his friendship.

*Measurements* (in μm).-

(based on 4 specimens)

| | Total height | maximum width |
|---|---|---|
| Bo. 323.20: 10 | 183 | 127 |
| Bo. 449.50: 200 | 151 | 113 |
| Bo. 449.50: 212 | 209 | 142 |
| Om. 1: 31 | 177 | 139 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 151 | av. 180 | min. 151 | max. 209 |
| Maximum width: | HT 113 | av. 130 | min. 113 | max. 142 |

*Type Locality*.- Fiume Bosso, Umbria Marche, Italy

*Range*.- U.A. 6-26

## Sethocapsa uterculus (PARONA) sensu FOREMAN

*Pl. 20, Figs. 15, 16*

?*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 DE REGNY
VINASSA DE REGNY, 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 1981b, p. 437, pl. 5, figs. 8a, 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 1986, pl. 4, figs. 1, 2
KITO 1987, pl. 2, fig. 1
IGO et al. 1987, textfig. 2, no. 19
TUMANDA 1989, p. 39, pl. 5, fig. 7
*Sethocapsa* cf. *uterculus* (PARONA)
IGO et al. 1987, textfig. 2, no. 8

*Remarks*.- There is a remarkable number of different morphotypes in our samples; characteristic of all these morphotypes is always the flattened proximal part of the last globose segment.

*Range*.- U.A. 6-35

## Genus: **Solenotryma** FOREMAN

*Solenotryma* FOREMAN
FOREMAN 1968, p. 33.

*Type Species*: *Solenotryma dacryodes* FOREMAN 1968

## **Solenotryma ichikawai** MATSUOKA & YAO

*Pl. 20, Fig. 17*

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.

*Range*.- U.A. 19-34

## Genus: **Spongocapsula** PESSAGNO

*Spongocapsula* PESSAGNO
PESSAGNO 1977a, p. 88.

*Type Species*: *Spongocapsula palmerae* PESSAGNO 1977a

## **Spongocapsula coronata** (SQUINABOL)

*Pl. 20, Fig. 18*

*Theoconus coronatus* SQUINABOL
SQUINABOL 1904, p. 220, pl. 8, fig. 3
KUHNT et al. 1986, pl. 7, fig. Q
THUROW 1988, p. 407, pl. 4, fig. 2
*Stichomitra* (?) *zamoraensis* PESSAGNO
PESSAGNO 1976, p. 54, pl. 3, figs. 7-9
?*Spongocapsula zamoraensis* (Pessagno)
PESSAGNO 1977b, p. 53, pl. 9, figs. 5, 16
*Spongocapsula* (?) *zamoraensis* PESSAGNO
SCHAAF 1981, p. 438, pl. 24, figs. 2a, 2b
TAKETANI 1982, p.62, pl. 5, figs. 6a, 6b, pl. 12, figs. 12, 13
TAKETANI 1982, pl. 1, fig. 6

*Remarks*.- It is possible that *Dictyomitra nardaranensis ALIEV* (1961, p. 31, pl. 1, fig. 9), described from Valanginian deposits from Azerbaidzhan, corresponds also to *S. coronata* (SQUINABOL). Unfortunately the original illustration is not clear enough to prove this.

*Range*.- U.A. 22-35

## **Spongocapsula obesa n. sp.**

*Pl. 20, Figs. 19*
*Pl. 21, Fig. 1*

*Holotype*: Bo. 566.50: 163

*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.

*Remarks*.- *Spongocapsula obesa*, n. sp. is similar to *Spongocapsula coronata* (SQUINABOL) and to *Spongocapsula 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 *Spongocapsula 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)

| | total height | maximum width |
|---|---|---|
| Bo. 566.5: 163 | 240 | 140 |
| Bo. 566.50:1674 | 225 | 174 |
| Pr. 225.30:178 | 273 | 180 |

Total height: HT 240 av. 246 min. 225 max. 273
Max. width: HT 140 av. 164 min. 140 max. 180

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 26-35

## **Spongocapsula (?) tripes n. sp.**

*Pl. 21, Fig. 2*

*Spongocapsula* sp. A
MIZUTANI 1981, pl. 60, fig. 2

*Holotype*: Bo. 566.50: 106

*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 three corners of the test short protrusions are developed on some specimens.

*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*.- From Latin *tres,tria* = three and *pes* = foot

*Measurements* (in µm).-

(based on max. 6 specimens)

| | total height | max. width | length of apical horn |
|---|---|---|---|
| Bo. 552.10: 78 | 301 | 231 | - |
| Bo. 566.50: 106 | 333 | 223 | 21 |
| Bo. 569.60: 43 | 321 | 267 | - |
| Bo. 581.65: 33 | 289 | 200 | - |
| GC. 869.80: 764 | 333 | 236 | 8 |
| MN. 47.70: 14 | 298 | 221 | 8 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 333 | av. 312 | min. 289 | max. 333 |
| Max. width: | HT 223 | av. 230 | min. 200 | max. 267 |
| Length apical horn: | HT 21 | av. 12 | min. 8 | max. 21 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 29-33

## Genus: **Spongotripus** HAECKEL

*Spongotripus* HAECKEL
HAECKEL 1881, p. 461.

*Type Species*: *Spongotripus regularis* HAECKEL 1887 (no figure given):

### **Spongotripus (?) satoi** (TUMANDA)

*Pl. 21, Fig. 3*

*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.

*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 axis, 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.

*Range*.- U.A. 26-35

## Genus: **Stichocapsa** HAECKEL

*Stichocapsa* HAECKEL
HAECKEL 1881, p. 439.

*Type Species*: *Stichocapsa jaspidea* RUST 1885

### **Stichocapsa altiforamina** TUMANDA

*Pl. 21, Figs. 4, 5*

*Stichocapsa altiforamina* TUMANDA
TUMANDA 1989, p. 33, pl. 5, figs. 1,2, pl. 10, figs. 4a, b, 6

*Range*.- U.A. 25-34

### **Stichocapsa pulchella** (RÜST)

*Pl. 21, Figs. 6, 7*

*Archicorys pulchella* RÜST
RÜST 1898, p. 40, pl. 8, 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

*Actualized definition*.- 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 the pores on the surface of the test, which becomes very smooth.

*Remarks*.- In *Stichocapsa pulchella* we included all forms considered by previous authors as *Stichocapsa 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 *Stichocapsa 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 *Stichocapsa pulchella*. Our specimens (measurements based on 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 thus larger than those described by RÜST.

*Range*.- U.A. 21-35

## Genus: **Stichomitra** CAYEUX

*Stichomitra* CAYEUX
CAYEUX 1897, p. 204.

*Type Species*: *Stichomitra costata* CAYEUX 1897 (subsequent designation by Chediya 1959).

### **Stichomitra sp. aff. S. asymbatos** FOREMAN

*Pl. 21, Figs. 8, 9*

?*Stichomitra asymbatos* FOREMAN
FOREMAN 1968, p.73, pl. 8, figs. 10 a-c
DUMITRICA 1975, p. 87-89, textfig. 2. no. 13
FOREMAN 1978b, p.748, pl. 4, fig. 15
SCHAAF 1981, p. 439, pl. 22, figs. 6a, 6b
TAKETANI 1982, p. 54, pl. 4, fig. 13, pl. 11, figs. 3, 4
SUYARI & HASHIMOTO 1985, pl. 6, figs. 1, 2?, 3
SUYARI *1986*, 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,, textfig. 4, no. 1
*Xitus* (?) sp. A
IWATA & KATO 1986, textfig. 4, no. 2

*Definition*.- 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. Postthoracic 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 and 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*.- Two extrem 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)

| | |
|---|---|
| Total length: | 228-290 |
| Maximum width (measured on fifth segment): | 142-154 |

*Range*.- U.A. 9-35

### **Stichomitra (?) sp. aff. S. euganea** (SQUINABOL)

*Pl. 21, Fig. 10-13*

?*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.

*Definition*.- 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*.- 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 lenght: | 530-700 |
| Maximum width: | 200-270 |

*Range*.- U.A. 33-35

## Genus: **Stylosphaera** EHRENBERG

*Stylosphaera* EHRENBERG
EHRENBERG 1847

*Type species*: *Stylosphaera hispida* EHRENBERG 1854

### **Stylosphaera (?) macroxiphus** (RÜST)

*Pl. 21, Fig. 14*

*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

*Remarks*.- Our specimens resemble *Xiphosphaera macroxiphus* RÜST but differ from it in 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. Measurments of three 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.

*Range*.- U.A. 5-35

## Genus: **Stylospongia** HAECKEL

*Stylospongia* HAECKEL
HAECKEL 1862, p. 473

*Type species*: *Stylospongia Huxleyi* HAECKEL 1862

### **Stylospongia (?) titirez n. sp.**

*Pl. 21, Figs. 15-17*

*Actinommids*, gen et sp. indet.
FOREMAN 1975, p. 610, pl. 2F, figs. 12, ? 13 and 14

*Holotype*: GC. 821.45: 1791

*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 in the interval between the 4 equatorial spines.

*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 max. 4 specimens)

| | total width | total height | diam.centr . part | height centr. part |
|---|---|---|---|---|
| GC. 821.45: 1791 | 325 | 200 | 143 | 75 |
| GC. 837.15: 1764 | 271 | 221 | 142 | 79 |
| GC. 887.00: 778 | 278 | 186brok. | 165 | 103 |
| GC. 887.00: 781 | 263 | 225 | 150 | 100 |

| | | | | |
|---|---|---|---|---|
| Total width: | HT 325 | av. 284 | min. 263 | max. 278 |
| Total height: | HT 200 | av. 215 | min. 200 | max. 225 |
| Diameter centr. part: | HT 143 | av. 150 | min. 142 | max. 165 |
| Height centr. part: | HT 75 | av. 89 | min. 75 | max. 103 |

*Type Locality*.- Gorgo a Cerbara, Umbria-Marche, Italy

*Range*.- U.A. 29-35

## Genus: **Suna** WU

*Suna* WU
WU 1986, p.357.

*Type species*: *Suna geometrica* WU 1986

## **Suna echiodes** (FOREMAN)

*Pl. 22, Fig. 1*

*Triactoma echiodes* FOREMAN
FOREMAN 1973, 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, fig. 12, 13, ?1
BAUMGARTNER 1984, p. 789, pl. 10, fig. 2.
SCHAAF 1984, p. 108-109, figs. 1, ?2, ?3, 4.
STEIGER 1992, p. 30, pl. 3, figs. 6?, 7.
OZVOLDOVA & PETERCAKOVA 1992, pl. 1, fig. 14; pl. 2, figs. 1-5.
*Triactoma* sp. cf. *T. echiodes* FOREMAN
FOREMAN 1973, p. 260, pl. 3, figs. 2, 3.
OZVOLDOVA & SYKORA 1984, p. 272, pl. 13, fig. 3.
AITA 1987, p. 64, pl. 12, fig. 9.

*Range*.- U.A. 1-35

## **Suna hybum** (FOREMAN)

*Pl. 22, Figs. 2, 3*

*Triactoma hybum* FOREMAN
FOREMAN 1975, p. 609, 610, 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. 407, 408, pl. 9, fig. 11
TUMANDA 1989, p. 35, pl. 1, fig. 6
*Triactoma* sp. cf. *T. echiodes* FOREMAN
FOREMAN 1973b, pl. 3, fig. 2, not fig. 3
*Suna geometrica* WU
WU 1986, p. 357, pl. 2, fig. 12, 13
*Triactoma* cfr. *echiodes* Foreman
IGO et al. 1987, textfig. 2, no. 10

*Range*.- U.A. 25-35

## Genus: **Syringocapsa** NEVIANI

*Syringocapsa* NEVIANI
NEVIANI 1900, p. 662.

*Type Species*: *Theosyringium robustum* VINASSA 1900

## **Syringocapsa agolarium** FOREMAN

*Pl. 22, Fig. 4*

*Syringocapsa agolarium* FOREMAN
FOREMAN 1973, 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.

*Range*.- U.A. 3-32

## **Syringocapsa coronata** STEIGER

*Pl. 22, Fig. 5*

*Syringocapsa coronata* STEIGER
STEIGER 1992, p. 60, pl. 16, figs. 6, 7

*Range*.- U.A. 5-15

## **Syringocapsa sp. aff. S. coronata** STEIGER

*Pl. 22, Figs. 6-8*

*Syringocapsa* sp. A
AITA 1987, p. 68, pl. 12, fig. 5.

*Remarks*.- Included are herein two morphotypes, both of them with an antapical spine rather than a closed postabdominal tube. One morphotype (pl. 22, fig. 6) 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 (pl. 22, fig. 7, 8) 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 ap. horn and term. spine: | 285-400 |
| Maximum width of inflated segment: | 265-370 |

*Range*.- U.A. 5-29

## **Syringocapsa limatum** FOREMAN

*Pl. 22, Figs. 9, 10*

*Syringocapsa limatum* FOREMAN
FOREMAN 1973b, p. 268, pl. 11, figs. 6, 7, pl. 16, fig. 8
FOREMAN 1975, p. 617, pl. 2K, fig. 7
*Syringocapsa limata* FOREMAN
TUMANDA 1989, p. 40, pl. 2, fig. 2
*Morosyringium limatum* (FOREMAN)
STEIGER 1992, p. 85, pl. 22, fig. 12

*Range*.- U.A. 5-34

## Syringocapsa longitubus n. sp.

*Pl. 22, Figs. 11, 12*

*Holotype*: Br. 1330: 41

*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.

*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)

| | total length | max. width | length tube | max.width tube | height ap.part |
|---|---|---|---|---|---|
| Bo. 311.2: 50 | 583 | 156 | 306 | 44 | 100 |
| Bo. 311.2: 1195 | 746 | 207 | 420 | 73 | 100 |
| Br. 1330: 41 | 505 | 145 | 245 | 45 | 82 |

| | | | | |
|---|---|---|---|---|
| Length of test: | HT 505 | av. 207 | min. 505 | max. 746 |
| Max. width test: | HT 145 | av. 169 | min. 145 | max. 207 |
| Length of tube: | HT 245 | av. 322 | min. 245 | max. 420 |
| Max. width tube: | HT 45 | av. 52 | min. 44 | max. 73 |
| Height ap. part: | HT 82 | av. 94 | min. 82 | max. 100 |

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 3-16

## Syringocapsa spinosa (SQUINABOL)

*Pl. 22, Figs. 13, 14*

*Eusyringium spinosum* SQUINABOL
SQUINABOL 1903, p. 141, pl. 8, fig. 42
TAKETANI 1982, p. 64, pl. 6, figs. 2a-c, 3a, b, 4a, b, pl. *13*, figs. 4, 5
*Eucyrtis bulbosus* RENZ
RIEDEL & SANFILIPPO 1974, p. 778, pl. 5, fig. 8
*Eucyrtis spinosus* (SQUINABOL)
DUMITRICA 1975, p. 87-89, textfig. 2, no. 25

*Actualized 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 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.

*Range*.- U.A. 26-35

## Syringocapsa vicetina (SQUINABOL)

*Pl. 22, Figs. 15, 16*

*Theosyringium vicetinum* SQUINABOL
SQUINABOL 1914, p. 281, pl. 20, fig. 10

*Remarks*.- For distinction from other species see under *Syringocapsa longitubus*, n. sp.

*Range*.- U.A. 5-21

## Genus: **Tetratrabs** BAUMGARTNER

*Tetratrabs* BAUMGARTNER
BAUMGARTNER 1980, p. 294.

*Type species*: *Tetratrabs gratiosa* BAUMGARTNER, 1980

## Tetratrabs bulbosa BAUMGARTNER

*Tetratrabs bulbosa* BAUMGARTNER
BAUMGARTNER 1980, p. 295, pl. 5, fig. 1; pl. 6, figs. 1-3, 8.
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.

*Range*.- U.A. 1-2

## Tetratrabs radix n. sp.

*Pl. 23, Figs. 1, 2*

*Tetratrabs* sp. A STEIGER
STEIGER 1992, p. 41, pl. 8, fig. 9
*Tetratrabs* sp. B STEIGER
STEIGER 1992, p. 41, pl. 8, fig. 10

*Holotype*: V. -6.0: 14

*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.

*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)

| | max. length of rays |
|---|---|
| V. -6.0: 14 | 568 |
| V. -6.0: 32 | 430 |
| V. -6.0: 58 | 426 |
| Pi. 10.0: 787 | 433 |
| Br. 1330: 192 | 296 |
| Br. 28.85: 525 | 300 |

Max. length rays: HT 568 av. 408 min. 296 max. 568
Width of rays: HT 54

*Type Locality*.- Valdorbia, Umbria-Marche, Italy

*Range*.- U.A. 3-21

### **Tetratrabs zealis** (OZVOLDOVA)

*Crucella zealis* OZVOLDOVA
OZVOLDOVA 1979, p. 34, pl. 2, fig. 1.
*Tetratrabs gratiosa* BAUMGARTNER
BAUMGARTNER 1980, p. 295, pl. 1, fig. 11; pl. 5, figs. 2-7; pl. 6, fig. 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., pl. I, fig. 3.
*Tetratrabs zealis* (OZVOLDOVA)
KOCHER 1981, p. 99, pl. 17, fig. 1.

*Range*.- U.A. 1-4

## Genus: **Thanarla** PESSAGNO

*Thanarla* PESSAGNO
PESSAGNO 1977b, p. 45.

*Type species*: *Dictyomitra veneta* SQUINABOL 1903.

### **Thanarla elegantissima** (CITA) sensu SANFILIPPO & RIEDEL

*Pl. 23, Fig. 3*

*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, fig. 10
?OKAMURA 1980, pl. 21, fig. 1
SCHMIDT-EFFING 1980a, p. 246, figs. 2, 21, 22?
TAKETANI 1982, p. 59, pl. 4, fig. 12, pl. 11, figs. 17, 18
YAMAUCHI 1982, pl. 1, fig. 16
ORIGLIA-DEVOS 1983, p. 144, 145, pl. 17, figs. 6, 7
SCHAAF 1984, p. 163, figs. 11a, b
SANFILIPPO & RIEDEL 1985, p. 600, textfig. 8, no. 1a-e
SUYARI 1986, 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, 3?
*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 1982, 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

*Range*.- U.A. 24-35

### **Thanarla gutta n. sp.**

*Pl. 23, Figs. 4, 5*

*Mita* sp. A
TUMANDA 1989, pl. 3, fig. 13

*Holotype*: Bo. 566.50: 1830

*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.

*Remarks*.- *Thanarla gutta*, n. sp. differs from *Thanarla pulchra* SQUINABOL by having a shorter apical part as 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, 2 such specimens measured having a total length of 204 µm and 225 µm respectively and a width of 156 µm and 161 µm. By their size these specimens are on the upper limit of the average measurements of *Thanarla pulchra* CITA sensu SANFILIPPO & RIEDEL 1984. 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 paratpes 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, fact also recognized by P. Dumitrica (personal communication).

*Etymology*.- From the Latin *gutta* = drop

*Measurements* (in µm).-

(based on 10 specimens)

| | total height | maximum width |
|---|---|---|
| Bo. 566.50: 75 | 300 | 170 |
| Bo. 566.50: 81 | 320 | 200 |
| Bo. 566.50: 635 | 318 | 181 |
| Bo. 566.50: 612 | 295 | 286 |
| Bo. 566.50: 679 | 292 | 280 |
| Bo. 566.50: 642 | 272 | 172 |
| Bo. 566.50: 1658 | 345 | 218 |
| Bo. 566.50: 1663 | 327 | 200 |
| Bo. 566.50: 1696 | 309 | 200 |
| Bo. 566.50: 1830 | 350 | 205 |

| | | | | |
|---|---|---|---|---|
| Total height: | HT 350 | av. 312 | min. 272 | max. 345 |
| Max. width: | HT 205 | av. 211 | min. 170 | max. 286 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 30-34

## **Thanarla pulchra** (SQUINABOL) sensu SANFILIPPO & RIEDEL 1985

*Pl. 23, Figs. 6, 7*

*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, fig. 2
*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 1982, p. 59, pl. 11, fig. 19
SCHAAF 1984, p. 133, figs. 7a, b, not: all others
SANFILIPPO & RIEDEL 1985, p. 600-602, figs. 8.2 a-e
SUYARI 1986, 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, textfig. 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

*Remarks*.- Measurements of several specimens occurring in our samples have shown a total height of 180-211 µm, a width of 148-166 µm, a height of the proximal conical part of 63-72 µm, and a length of feet (1 specimen) of 31 µm. These dimensions correspond to those done by SANFILIPPO & RIEDEL 1985.

*Range*.- U.A. 9-35

## Genus: **Triactoma** RÜST

*Triactoma* RÜST
RÜST 1885, p. 289.

*Type Species*: *Triactoma tithonianum* RÜST 1885

## **Triactoma blakei** PESSAGNO

*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).
BAUMGARTNER 1984, p. 789, pl. 10, fig. 3.
YAMAMOTO et al. 1985, p. 39, pl. 8, fig. 5.
DE WEVER et al. 1986, pl. 6, figs. 15, 23.
OZVOLDOVA & PETERCAKOVA 1987, pl. 35, fig. 5.
PESSAGNO et al. 1989, p. 206, pl. 7, figs. 17, 19, 24
*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.

*Range*.- U.A. 1-2

## **Triactoma jonesi** (PESSAGNO)

*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, 45, pl. 2, figs. ?6, 7
BAUMGARTNER 1984, p. 790, pl. 10, fig. 4.
? OZVOLDOVA & SYKORA 1984, p. 272, pl. 11, fig. 5, non pl. 10, fig. 4.
? CARAYON et al. 1984, pl. 1, fig. 6

KISHIDA & HISADA 1986, fig. 2.22.
GORICAN 1987, p. 187, pl. 1, fig. 16.
*Tripocyclia trigonum* RUST
SASHIDA et al. 1982, pl. 1, fig. 5.
ISHIDA 1983, pl. 4, fig. 14.
*Tripoocyclia jonesi* PESSAGNO emend. PESSAGNO & YANG
PESSAGNO et al. 1989, p. 222, 223, pl. 7, figs. 5, 11, 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.

*Range*.- U.A. 1-3

## Triactoma luciae n. sp.

*Pl. 23, Figs. 8, 9*

*Triactoma echiodes* Foreman
SCHAAF 1984, p. 109, figs. 1-4, not: fig. 1
*Triactoma* sp. 2
ORIGLIA-DEVOS 1983, p. 47, 48, pl. 3, figs. 1, 2

*Holotype*: Br. 1330: 80

*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 almost 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 and yielding crown-like tips. Minute centrally placed short spine is frequently present.

*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*.- The 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)

| | Length of spines | width central part |
|---|---|---|
| Br. 1330: 80 | 238 | 95 |
| Br. 1330: 440 | 200 | 109 |
| Br. 1330: 1598 | 218 | 102 |
| Br. 28.85: 508 | 217 | 122 |
| Ru. 135.5: 1612 | 177 | 97 |
| Ru. 135.5: 1810 | 234 | 97 |
| Ru. 146.5: 74 | 209 | 127 |
| Bo. 566.5: 184 | 175 | 92 |
| V. -6.0: 244 | 256 | 154 |

Length of spines: HT 238 av. 213 min. 175 max. 256
Width central part: HT 95 av. 110 min. 92 max. 154

*Type Locality*.- Breggia-Gorge, near Chiasso, Ticino, Southern Switzerland

*Range*.- U.A. 6-33

## Triactoma tithonianum RÜST

*Pl. 23, Figs. 10, 11*

*Triactoma tithonianum* RÜST
RÜST 1885, p. 289, pl. 28, fig. 5.
FOREMAN 1973, p. 260, pl. 2, fig. 1.
FOREMAN 1975, p. 610, pl. 3, fig. 13.
ORIGLIA-DEVOS 1983, p. 45, 46, 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.
*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. 14, fig. 1.
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.

*Actualized definition*.- Spherical to subtriangular test with usually hexagonal to polygonal 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.

*Range*.- U.A. 1-35

## Genus: **Tritrabs** BAUMGARTNER

*Tritrabs* BAUMGARTNER
BAUMGARTNER 1980, p. 293.

*Type species*: *Paronaella* (?) *casmaliaensis* PESSAGNO.

### **Tritrabs ewingi** gr. (PESSAGNO)

*Pl. 23, Figs. 12, 13*

*Paronaella* (?) *ewingi* PESSAGNO
PESSAGNO 1971, 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.
*Tritrabs ewingi worzeli* PESSAGNO
STEIGER 1992, p. 38, pl. 7, fig. 5.

*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.

*Range*.- U.A. 1-35

## Genus: **Wrangellium** PESSAGNO

*Wrangellium* PESSAGNO & WHALEN
PESSAGNO & WHALEN 1982, p. 126.
emend. YEH 1987b, 67.

*Type species*: *Wrangellium thurstonense* PESSAGNO & WHALEN 1982

### **Wrangellium (?) columnarium n. sp.**

*Pl. 23, Figs. 14, 16*

*Lithocampe exaltata* RÜST
(?)*FISCHLI 1916, p. 46, 47, fig. 65, not 66*
*Lithocampe columna* RÜST
(?)FISCHLI 1916, p. 46, 47, fig. 67
*Dictyomitra apiarium* RÜST
(?)FISCHLI 1916, p. 46, 47, fig. 68

*Holotype*: Bo. 566.50: 71

*Definition*.- 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.

*Remarks*.- 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. By its shape this species resembles *Lithocampe columna* RUST, from which it differs in lacking the three rows of pores per each segment. This latter species (see *Parvicingula columna* (RUST), pl. 23, fig. 17) is extremely rare in our material, and could not be taken into account for biostratigraphic data.

*Etymology*.- From the Latin *columnarius*, -a, um = with columns

*Measurements* (in µm).-

(based on 5 short and 5 long specimens)

| | total length | | |
|---|---|---|---|
| short forms: | | | |
| Ru. 146.50: 5 | 263 | to | 6th ridge |
| Pi. 86.60: 4 | 271 | " | 6th ridge |
| Bo. 370.1: 198 | 273 | " | 7th ridge |
| Bo. 449.5: 32 | 280 | " | 7th ridge |
| MN. 24.5: 9 | 285 | " | 7th ridge |
| long forms: | | | |
| Br. 28.85: 377 | 337 | to | 8th ridge |
| Bo. 556.4: 134 | 386 | " | 10th ridge |
| Bo. 566.5: 71 | 427 | " | 11th ridge |
| Bo. 556.4: 137 | 491 | " | 12th ridge |
| Bo. 569.6: 8 | 512 | " | 11th ridge |

| | | | | |
|---|---|---|---|---|
| Total L. short forms: | | av. 274 | min. 263 | max. 285 |
| Total L. long forms: | HT 427 | av. 430 | min. 337 | max. 512 |
| Maximum width: | HT 110 | | | |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 6-32

### **Wrangellium depressum** (BAUMGARTNER)

*Pl. 23, Fig. 18*
*Pl. 24, Fig. 1*

*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, fig. 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.
STEIGER 1992, p. 87, pl. 25, figs. 4, 5.
*Pseudodictyomitra* cf. *carpatica* (LOZYNIAK)
?SUYARI & ISHIDA 1985, pl. 3, fig. 6

*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.

*Range*.- U.A. 5-24

### **Wrangellium puga** (SCHAAF)

*Pl. 24, Figs. 2, 3*

*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, 11b
THUROW 1988, p. 398, pl. 6, fig. 15
OZVOLDOVA 1990, p. 140, pl. 3, fig. 8, (not 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, textfig. 2, nr. 4
TUMANDA 1989, p. 39, pl. 2, fig. 6
*Pseudodictyomitra* sp.
OKAMURA & UTO 1982, pl. 5, fig. 1
*Pseudodictyomitra* cf. *puga*
IWASAKI,ISHIDA,IGO 1984, pl. 1, fig. 1, ?2
*Pseudidictyomitra* cf. *carpatica*
SUYARI & ISHIDA 1985, pl. 3, fig. 7, pl. 4, fig. 7, not: fig. 5, 6
*Wrangellium* (?) *medium* WU
WU 1986, p. 358, pl. 3, figs. 2, 7, 19, not 23

*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. depress*um* from which it differs only by the wide conical shape.

*Range*.- U.A. 7-35

## Genus: **Xitus** PESSAGNO

*Xitus* PESSAGNO
PESSAGNO 1977b, p. 55.

*Type Species*: *Xitus plenus* PESSAGNO 1977b

### **Xitus (?) alievi** (FOREMAN)

*Pl. 24, Fig. 4*

*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 1981b, 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

*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.

*Range*.- U.A. 5-35

### **Xitus (?) channelli n. sp.**

*Pl. 24, Figs. 5, 6*

*Parvicingula profunda* PESSAGNO & WAHLEN
ORIGLIA-DEVOS 1983, p. 175, pl. 20, figs. 12, 13

*Holotype*: Bo. 566.50: 17

*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.

*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 max. 9 specimens)

| | height ex. horn & tube | width test | length tube | min. width tube | height horn |
|---|---|---|---|---|---|
| Pr. 225.30: 15 | 326 | 171 | 94 | 126 | 91 |
| Bo. 552.10: 1079 | 324 | 135 | - | - | 71 |
| Bo. 566.50: 17 | 387 | 173 | - | - | 53 |
| Bo. 569.60: 2 | 461 | 191 | 87 | 91 | 52 |
| Bo. 569.60: 7 | 412 | 200 | - | - | 103 |
| Bo. 569.60: 19 | 359 | 166 | - | - | 90 |
| Bo. 581.65: 7 | 370 | 170 | - | - | 89 |
| GC. 786.70: 738 | 365 | 159 | - | - | - |
| GC. 817.90: 729 | 359 | 187 | 90 | 100 | 55 |

| | | | | |
|---|---|---|---|---|
| H. excl.horn & tube: | HT 387 | av. 373 | min. 324 | max. 461 |
| Max. Width of test: | HT 173 | av. 172 | min. 135 | max. 200 |
| Length of tube: | HT - | av. 90 | min. 87 | max. 94 |
| Min. width of tube: | HT - | av. 106 | min. 91 | max. 126 |
| H. of apical horn: | HT 53 | av. 79 | min. 52 | max. 103 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 14-34

## Xitus horridus n. sp.

*Pl. 24, Figs. 7, 8*

*Holotype*: Bo. 566.50: 102

*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. Postthoracic 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, obliqually directed spines.

*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)

| | height test | height excl. tube | width excl. spines |
|---|---|---|---|
| Bo. 552.10:104 | 273 | 229 | 138 |
| Bo. 552.10:105 | 332 | 289 | 150 |
| Bo. 552.10:106 | 315 | 252 | 153 |
| Bo. 552.10:108 | 326 | 252 | 147 |
| Bo. 561.50:1122 | 326 | 239 | 152 |
| Bo. 561.50:1182 | 340 | 250 | 165 |
| Bo. 566.50:102 | 323 | 255 | 167 |
| Bo. 566.50:161 | 373 | 280 | 153 |
| Bo. 569.60:57 | 335 | 269 | 162 |
| GC. 814.50:711 | 350 | 280 | 175 |

| | | | | |
|---|---|---|---|---|
| Heigth of test: | HT 323 | av. 329 | min. 273 | max. 373 |
| Height excl. tube: | HT 255 | av. 259 | min. 229 | max. 289 |
| Width excl. spines: | HT 167 | av. 156 | min. 138 | max. 175 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy
*Range*.- U.A. 26-31

## Xitus sandovali n. sp.

*Pl. 24, Figs. 9, 10*

*Xitus* sp. A
SCHAAF 1981, p. 441, pl. 5, figs 9a, 9b; pl. 18, figs. 7a, 7b.
*Parvicingula altissima* (RÜST)
ORIGLIA-DEVOS 1983, p. 170, 171, pl. 19, fig. 6, not: fig. 5

*Holotype*: Bo. 566.50: 66

*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.

*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. Jose Sandoval, Department of Paleontology at University Granada, Spain, honouring his contributions to the knowledge of ammonites.

*Measurements* (in µm).-

(based on max. 10 specimens)

| | length excl. tube | max. width of test | length of tube | min. width tube |
|---|---|---|---|---|
| GC. 814.50: 727 | 417 | 179 | 83 | 55 |
| GC. 882.40: 752 | 471 | 159 | 176 | 88 |
| GC. 882.40: 755 | 405 | 135 | 130 | 75 |
| Bo. 449.50: 7 | 473 | 189 | - | - |
| Bo. 449.50: 9 | 349 | 140 | - | - |
| Bo. 552.10: 1072 | 340 | 135 | - | - |
| Bo. 566.50: 7 | 450 | 195 | - | - |
| Bo. 566.50: 16 | 488 | 185 | - | - |
| Bo. 566.50: 26 | 349 | 133 | - | - |
| Bo. 566.50: 66 | 329 | 162 | 219 | 36 |

| | | | | |
|---|---|---|---|---|
| Height excl. tube: | HT 329 | av.407 | min.329 | max.488 |
| Max. width of tube: | HT 162 | av.161 | min.133 | max.195 |
| Length of tube: | HT 219 | av.152 | min. 83 | max.219 |
| Min. width of tube: | HT 36 | av. 63 | min. 36 | max. 88 |

*Type Locality*.- Fiume Bosso, Umbria-Marche, Italy

*Range*.- U.A. 26-31

## Xitus sp. aff. X. spicularius (ALIEV)

*Pl. 24, Fig. 11*

?*Dictyomitra spicularia* ALIEV
ALIEV 1965, p. 39, pl. 6, fig. 9.
*Dictyomitra* sp. cf. *D. spicularia* ALIEV
FOREMAN 1973, p. 264, pl. 9, figs. 8-9.
NAKASEKO et al. 1979, pl. 3, fig. 5.
*Xitus spicularius* (ALIEV)
non PESSAGNO 1977a, p. 56, pl. 9, fig. 7; pl. 10, fig. 5.
POLUZZI et al. 1983, p. 47, 48, 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, textfig. 2, no. 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 HAO-RUO & LI HONG-SHENG
WU HAO-RUO & LI HONG-SHENG 1982, pl. 2, fig. 7, non 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 1984b, pl. 10, figs. 5-8
*Xitus* aff. *plenum*
VISHNEVSKAYA 1984b, pl. 11, figs. 3, 4, 5

*Definition*.- 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 interconnected with each other to form in extrem cases a tuberculate to nodose ridge with a row of pores developed on each side of the ridge.

*Remarks*.- 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 in 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.

*Range*.- U.A. 7-35

## Zhamoidellum testatum n. sp.

*Pl. 24, Figs. 12-15*

gen. et sp. indet.
THUROW 1988, pl. 8, fig. 17

*Holotype*: Bo. 617.0: 40

*Definition*.- Spherical test of 3 segments. Cephalothorax conical, smooth, with short, blunt horn on well preserved specimens. Thorax latticed, partly incased within the 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.

*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* = possessing a head

*Measurements* (in µm).-
(based on 6 specimens)

| | Height of test | Width of test | Height ap. section | max. length of spines |
|---|---|---|---|---|
| Bo. 561.50: 1099 | 223 | 200 | 33 | 35 |
| Bo. 561.50: 1137 | 220 | 220 | 32 | 56 |
| Bo. 617.00: 40 | 215 | 204 | 27 | 54 |
| Bo. 619.90: 153 | 216 | 197 | 37 | 47 |
| GC. 882.40: 758 | 280 | 275 | 30 | 50 |
| GC. 887.00: 84 | 214 | 214 | 37 | 34 |

| | | | | |
|---|---|---|---|---|
| Height excl. spines: | HT 215 | av. 228 | min. 214 | max. 280 |
| Width of test: | HT 204 | av. 218 | min. 197 | max. 275 |
| Height of ap. part: | HT 27 | av. 31 | min. 27 | max. 37 |
| Max. length spines: | HT 54 | av. 46 | min. 34 | max. 56 |

*Type Locality*.- Fiume Bosso, Umbria-Marche Italy

*Range*.- U.A. 25-35

# REFERENCES


Adachi. M. 1982. Some considerations on the Mirifusus baileyi assemblage in the Mino terrain, central Japan. In Nakaseko, K. (Eds.), Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 211-225.

Aita, Y. 1982. Jurassic radiolarian biostratigraphy in Irazuyama district, Kochi Prefecture, Japan - a preliminary report. In Nakaseko, K. (Eds.), Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 255-270.

Aita, Y. 1985. Jurassic radiolarian biostratigraphy of the Irazuyama Formation (Takano Section), Shikoku, Japan. Scientific and Technical Reports of the Mining College, Akita University, no. 6, pp. 33-41.

Aita, Y. 1987. Middle Jurassic to Lower Cretaceous radiolarian biostratigraphy of Shikoku with reference to selected sections in Lombardy Basin and Sicily. Tohoku University Science Reports, Sendai, second series (Geology), vol. 58, no. 1, pp. 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, vol. 32, no. 2, pp. 97-128.

Aliev, Kh. Sh. 1961. Novye vidy Radiolyarii nizhnego mela severo-vostochnogo Azerbaidzhana (New radiolarian species of the Lower Cretaceous of northeastern Azerbaidzhan). Izvestiya Akademiya Nauk Azerbaidzhanskoi SSR, Seriya Geologo-Geograficheskikh Nauk i Nefti, no. 5, pp. 63-72.

Aliev, Kh. Sh. 1965. Radiolyarii nizhnemelovykh otlozheni severo-vostochnogo Azerbaidzhana i ikh stratigraficheskoe znachenie (Radiolarians of the Lower Cretaceous deposits of northeastern Azerbaidzhan and their stratigraphic significance). Baku, Azerbaidzhanskoi SSR, Izdatel'stvo Akademii Nauk, pp. 1-124.

Alvarez, W. 1989. Evolution of the Monte Nerone seamount in the Umbria-Marche Apennines: 1. Jurassic-Tertiary stratigraphy. Boll. Soc. Geol. It., 108, pp. 3-21.

Alvarez, W. 1989. Evolution of the Monte Nerone seamount in the Umbria-Marche Apennines: 2. Tectonic control of the seamount-basin transition. Boll. Soc. Geol. It., 108, pp. 23-39.

Andrey, J.D. 1974. Géologie de la partie orientale du massif des Bruns (Préalpes fribourgeoises). Thesis published at University of Fribourg.

Baumgartner, P. O. 1980. Late Jurassic Hagiastridae and Patulibracchiidae (Radiolaria) from the Argolis Peninsula (Peleponnesus, Greece). Micropaleontology, vol. 26, no. 3, pp. 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, vol. 77, no. 3, pp. 729-841.

Baumgartner, P. O. 1985. Jurassic sedimentary evolution and nappe emplacement in the Argolis Peninsula (Peloponnesus, Greece). Mem. Soc. Helvetique Sci. Nat., vol. 99, pp. 1-111.

Baumgartner, P. O. 1987. Age and genesis of Tethyan Jurassic Radiolarites.- Eclogae geologicae Helvetiae, vol. 80, no. 3, pp. 831-879.

Baumgartner, P. O. 1990. Genesis of Jurassic Tethyan radiolarites - The example of Monte Nerone (Umbria-Marche Apennines). In Pallini, G., Cecca, F., Cresta, S. & Santantonio, M. (Eds.), Atti II Conv. Int. F. E. A. Pergola, pp. 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, vol. 69, no. 3, pp. 601-626.

Baumgartner, P. O., De Wever, P. & Kocher, R. 1980. Correlation of Tethyan Late Jurassic-Early Cretaceous radiolarian events. Cahiers de Micropaléontologie, part 2, pp. 23-86.

Bernoulli, D., Kälin, O. & Patacca, E. 1979. A sunken continental margin of the Mesozoic Tethys: The Northern and Central Apennines. Symp. "Sédimentation jurassique W-européen", Publ. spéc. Assoc. Sédimentol. franç. 1, pp. 197-210.

Bernoulli, D., Weissert, H. & Blome, C.D. 1990. Evolution of the Triassic Hawasina Basin, Central Oman Mountains. Robertson, A.H.F., Searle, M.P. and Ries, A.C. (Eds), The geology and tectonics of the Oman Region, Geol. Soc. spec. Publ., no. 49, pp. 189-202.

Bieri, P. 1925. Der Bau der Klippendecke zwischen Gantrisch und Simmental. Jb. phil. Fak. II, Univ. Bern 5.

Birkelund, T., Hancock, J. M., Hart, M. B., Rawson, P. F., Remane, J., Robaszynski, R., Schmid, F. & Surlyk, F. 1984: Cretaceous stage boundaries-proposals. Bulletin of the Geological Society of Denmark 33, pp. 3-20.

Boller, K. 1963. Stratigraphische und mikropaläontologische Untersuchungen im Neocom der Klippendecke (östlich der Rhone).- Eclogae geologicae Helv., vol.56, no. 1, pp. 19-96.

Bosellini, A. & Winterer, E. L. 1975. Pelagic limestone and radiolarite of the Tethyan Mesozoic: A genetic model. Geology, 3/5, pp. 279-282.

Bralower, T. J. 1987. Valanginian to Aptian calcareous nannofossil stratigraphy and correlation with the upper M-sequence magnetic anomalies. Marine Micropaleontology, vol. 11, pp. 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, vol. 14, pp. 153-235.

Campbell, A. S. 1954. Radiolaria. In Moore, R. C. (Eds.), Treatise on Invertebrate Paleontology, Part D, Protista 3, Lawrence, Kansas, USA, Geological Society of America and University of Kansas Press, pp. D11-D195.

Campbell, A. S. & Clark, B. L. 1944. Radiolaria from Upper Cretaceous of Middle California. Geological Society of America, Special Papers, no. 57, pp. i-viii and 1-61.

Cayeux, L. 1897. Contribution a l'étude micrographique des terrains sédimentaires. 1. Etude de quelques depots 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, vol. 4, no. 2, pp. 1-591.

Cecca, F., Cresta, S., Pallini, G. & Santantonio, M. 1990. Il Giurassico di Monte Nerone (Appennino marchigiano, Italia Centrale): biostratigrafia, litostratigrafia ed evoluzione paleogeografica. Atti 2. Convegno, Fossili Evoluzione Ambiente. Editore Comitato Centenario Raffaele Piccinini, Pergola, pp. 63-139.

Cecca, F. , Pallini, G., Erba, E., Premoli-Silva, I. and Coccioni, R. (in press). Hauterivian-Barremian chronostratigraphy based on ammonites, nannofossils, planktonic foraminifera and magnetic chrons from Mediterranean Domain.

Ciarapica, G. & Zaninetti, L. 1982. Faune et radiolaires dans la sequence triasique/liasique de Grotta Arpaia, Portovenere (La Spezia), Apennin septentrional. Revue de Paléobiologie, vol. 1, no. 2, pp. 165-179.

Channell, J. E. T., Lowrie, W., Pialli, P. & Venturi, F. 1984. Jurassic magnetic stratigraphy from Umbrian (Italian) land sections. Earth and Planetary Science Letters, vol. 68, pp. 309-325.

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, vol. 85, pp. 203-221.

Channell, J. E. T. & Grandesso, P. 1987. A revised correlation of Mesozoic polarity chrons and calpionellid zones. Earth and Planetary Science Letters, vol. 85, pp. 222-240.

Channell, J. E. T. & Erba, E. 1992. Early Cretaceous polarity chrons CM0 to CM11 recorded in northern Italian land sections near Brescia. Earth Planet. Sci. Lett.,.vol. 108, pp. 161-179.

Channell, J. E. T., Erba, E. and Lini, A. 1993. Magnetostratigraphic calibration of the Late Valangingian carbon isotope event in pelagic limestones from Northern Italy and Switzerland. Earth Planet. Sci. Lett., vol. 118, pp. 145-166.

Ciarapica, G. & Zaninetti, L. 1982. Faune à Radiolaires dans la séquence triasique/liasique de Grotta Arpaia, Portovenere (la Spezia), Apennin septentrional (Radiolarians of Triassic/Liassic in Grotta Arpaia, Portovenere, La Spezia, Northern Apennines). Revue de Paléobiologie, vol. 1, no. 2, pp. 165-179.

Cirilli, S., Marton, P. & Vigli, L. 1984. Implications of a combined biostratigraphic and paleomagnetic study of the Umbrian Maiolica Formation. Earth and Planetary Science Letters 69, pp. 203-214.

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, pp. 1-182.

Cita, M. B. and Pasquare, G. 1959. Studi stratigrafici sul sistema Cretaceo in Italia. Nota IV. Osservazioni micropaleontoligiche sul Cretaceo delle Dolomiti. Rivista italiana di paleontologia e stratigrafia, vol. 65, no. 4, pp. 385-443.

Coccioni, R., Franchi, R., Nesci, O., Wezel, F.-C., Battistini, F. & Pallecchi, P. 1989. Stratigraphy and Mineralogy of the Selli Level (Early Aptian) at the Base of the Marne a Fucoidi in the Umbro-Marchean Apennines (Italy). In: Wiedman, J. (Ed.), Cretaceous of the western Tethys. Proceedings 3rd International Cretaceous Symposium, Tübingen 1987, pp. 563-584. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

Coccioni, R., Erba, E. and Premoli-Silva, I. 1992. Barremian-Aptian calcareous plankton biostratigraphy from the Gorgo Gerbara section (Marche, central Italy) and implications for plankton evolution. Cretaceous

Research, vol. 13, pp. 517-537.

Colloque, 1975. Colloque sur la limite Jurassique-Crétacé, Lyon, Neuchâtel, 1973. Mém. BRGM, vol. 86, pp. 1-393.

Conti, M. 1986. New data on the biostratigraphy of the Tuscan cherts at Monte Cetona (Southern Tuscany, Italy). Marine Micropaleontology, vol. 11, 1-3, pp. 107-112.

Conti, M. & Marcucci, M. 1986. The onset of radiolarian deposition in the ophiolite sequences of the Northern Apennine. Marine Micropaleontolgy, vol. 11, 1-3, pp. 129-138.

De Wever, P. 1981a. Une nouvelle sous-famille, les Poulpinae, et quatre nouvelles especes de Saitoum, radiolaires Mesozoiques Tethysiens. Geobios, vol. 14, no. 1, pp. 5-15.

De Wever, P. 1981b. Hagiastridae, Patulibracchiidae et Spongodiscidae (Radiolaires polycystines) du Lias de Turquie. Revue de Micropaléontologie, vol. 24, no. 1, pp. 27-50.

De Wever, P. 1981c. Parasaturnalidae, Pantanellidae et Sponguridae (Radiolaires polycystines) du Lias de Turquie. Revue de Micropaleontologie, vol. 24, no. 3, pp. 138-156.

De Wever, P. 1982a. Nassellaria (Radiolaires Polycystines) du Lias de Turquie. Revue de Micropaleontologie, vol. 24, no. 4, pp. 189-232.

De Wever, P. 1982b. Radiolaires du Trias et du Lias de la Tethys (Systematique, Stratigraphie). Société Géologique du Nord, Publication no. 7, 599 pp.

De Wever, P. 1989. Radiolarians, radiolarites, and Mesozoic paleogeography of the Circum-Mediterranean Alpine belts. In Hein, James R. and Obradovic, J. (Eds.), Siliceous deposits of the Tethys and Pacific regions. New York, USA, Springer-Verlag, pp. 31-49.

De Wever, P. & Caby, R. 1981. Datation de la base des schistes lustrés postophiolitiques par des radiolaires (Oxfordien superieur-Kimmeridgien moyen) dans les Alpes Cottiennes (Saint-Veran, France). Comptes rendus de l'Académie des Sciences (Paris), vol. 292, pp. 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, vol. 11, nos. 1-3, pp. 113-127.

De Wever, P. & Miconnet, P. 1984. Datations directes des radiolarites du bassin du Lagonero (Lucanie, Italie méridionale) Implications et conséquences. Revist. Espanola Micropaleont., vol. 17/3, pp. 373-402.

De Wever, P. & Thiébault, F. 1981. Les Radiolaires d'âge Jurassique supérieur à Crétacé supérieur dans les radiolarites du Pinde-Olonos (Prèsqu'île de Koroni; Péloponnèse méridional, Grèce) (Radiolaria of Upper Jurassic to Upper Cretaceous age in the radiolarites of Pindus-Olonus, Koroni Peninsula, southern Peloponnesus, Greece). Geobios, vol. 14, fascicolo 5, pp. 577-609.

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. Rev. Micropaléont., vol. 29/5, pp. 141-186.

Donofrio, D. & Mostler, H. 1978. Zur Verbreitung der Saturnalidae (Radiolaria) im Mesozoikum der Nördlichen Kalkalpen und Südalpen. Geologisch-Paläontologische Mitteilungen Innsbruck, vol. 7, no. 5, pp. 1-55.

Dosztaly, L. 1988. A paleontological study of the "Oregszirt" radiolarites in the Pilis Mountains. M. All. Foldtani Intezet Evi Jelentese az 1986, Evrol, pp. 229-239.

Dumitrica, P. 1970. Cryptocephalic and cryptothoracic Nassellaria in some Mesozoic deposits of Romania. Revue roumaine de géologie, géophysique et géographie, Série de géologie, vol. 14, no. 1, pp. 45-124.

Dumitrica, P. 1975. Cenomanian Radiolaria at Podul Dimbovitei. Micropaleontological guide to the Mesozoic and Tertiary of the Romanian Carpathians. 14th European Micropaleontological Colloquium, Bucharest, Romania, Institute of Geology and Geophysics, pp. 87-89.

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, Spavy vol. 77, pp. 17-28.

Ehrenberg, C. G. 1847a. Ueber eine halibiolithische, von Herrn R. Schomburgk entdeckte, vorherrschend aus mikroskopischen Polycystinen gebildete, Gebirgsmasse von Barbados. Königliche Preussische Akademie der Wissenschaften zu Berlin, Bericht, Jahre 1846, pp. 382-385.

Ehrenberg, C. G. 1847b. Ueber die mikroskopischen kieselschaligen Polycystinen als machtige Gebirgsmasse von Barbados und über das Verhältniss der aus mehr als 300 neuen Arten bestehenden ganz eigenthümlichen Formengruppe jener Felsmasse zu den jetzt lebenden Thieren und zur Kreidebildung Eine neue Anregung zur Erforschung des Erdlebens. Königliche Preussische Akademie der Wissenschaften zu Berlin, Bericht, Jahre 1847, pp. 40-60.

Ehrenberg, C. G. 1860a. Ueber die organischen und unorganischen Mischungsverhältnisse des Meeresgrundes in 19,800 Fuss Tiefe nach Lieut. Brookes Messung. Königliche Preussische Akademie der Wissenschaften zu Berlin, Monatsberichte, Jahre 1860, pp. 765-774.

Ehrenberg, C. G. 1860b. Ueber den Tiefgrund des stillen Oceans zwischen Californien und den Sandwich-Inseln aus bis 15'600 Tiefe nach Lieutenant Brooke. Königliche Preussische Akademie der Wissenschaften zu Berlin, Monatsberichte, Jahre 1860, pp. 819-833.

Empson-Morin, K. 1981. Campanian Radiolaria from DSDP Site 313, Mid-Pacific Mountains. Micropaleontology, vol. 27, no. 3, pp. 249-292.

Erba, E. & Quadrio, B. 1987: Biostratigrafia a nannofossili calcarei, calpionellidi e foraminiferi planctonici della Maiolica (Titoniano superiore-Aptiano) nelle Alpe Bresciane (Italia settentrionale). Riv. It. Paleont. Strat., v. 93, n.1, pp. 3-108.

Fischli, H. 1916. Beitrag zur Kenntnis der fossilen Radiolarien in der Riginagelfluh (Contribution to the knowledge of fossil Radiolaria of Riginagelfluh). Mitteilungen der Naturwissenschaftlichen Gesellschaft in Winterthur, Jahrgang 1915-1916, no. 11, pp. 44-47.

Foley et al. 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, vol. 29, no. 4, pp. 481-490.

Foreman, H. P. 1966. Two Cretaceous radiolarian genera. Micropaleontology, vol. 12, no. 3, pp. 355-359.

Foreman, H. P. 1968. Upper Maestrichtian Radiolaria of California. The Palaeontological Association, Special Papers in Palaeontology, London, no. 3, pp. iv + 1-82.

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, Volume 10, Washington, D.C.: U. S. Government Printing Office, pp. 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, Volume 20, Washington, D.C.: U. S. Government Printing Office, pp. 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, Volume 32, Washington, D.C.: U. S. Government Printing Office, pp. 579-676.

Foreman, H. P. 1978a. 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, Volume 40, Washington, D.C.: U. S. Government Printing Office, pp. 839-843.

Foreman, H. P. 1978b. 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, Volume 41, Washington, D.C.: U. S. Government Printing Office, pp. 739-761.

Foreman, H. P. 1978c. Appendix: Radiolaria at Site 368. In Lancelot, Y., Seibold, E., et al. (Eds.), Initial Reports of the Deep Sea Drilling Project, vol. 41, Washington, D.C.: U. S. Government Printing Office, pp. 783-789.

Gorican, S. 1987. Jurassic and Cretaceous radiolarians from the Budva zone (Montenegro, Yugoslavia). Revue de Micropaléontologie, vol. 30, no. 3, pp. 177-196.

Gorka, H. 1989. Les Radiolaires du Campanien Inférieur de Cracovie (Pologne). Acta Paleonto-logica Polonica, vol. 34, no. 4, pp. 327-354.

Guex, J. 1987. Corrélations biochronologiques et associations unitaires. Presses polytéchniques romandes, Lausanne, pp. 1-244.

Guex, J. & Davaud, E. 1984. Unitary associations method: use of graph theory and computer algorithm. Computers and Geosciences, vol. 10, no. 1, pp. 69-96.

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, vol. 15 (new series, vol. 8, pt. 3), pp. 418-472.

Haeckel, E. 1887a. 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, vol. 18, 2 parts, Atlas: clxxxviii + 1803 pp.

Haeckel, E. 1887b. Die Radiolarien (Rhizopoda Radiolaria). Eine Monographie. Pt. 2. Grundriss einer allgemeinen Naturgeschichte der Radiolarien. Berlin, Germany, Reimer, xiv + 248 pp.

Hallam, A., Hancock, J. M., LaBrecque, J. L., Lowrie, W. & Channell, J. E. T. 1985. Jurassic and Cretaceous geochronology and Jurassic to Paleogene magnetostratigraphy. In N. J. Snelling (ed.). Chronology of the Geological record. Geol. Soc.

London, Mem. 10, pp. 141-195.

Haq, B. U., Hardenbol, J. & Vail, P. R. 1988. Mesozoic and Cenozoic Chronostratigraphy and cycles of sea-level change. In: Wilgus, C. K. et al.: Sea-level changes: an integrated approach. Society of Economic Paleontologists and mineralogists, Spec. publ. 42, pp. 71-108.

Harland, W. B., Cox, A. V., Llewellyn, P. G., Pickton, C. A. G., Smith, A. G. & Walters, R. 1982. A geologic time scale. Cambridge University, 131 pp.

Hay, W. W. 1972. Probabilistic stratigraphy. Eclogae geologicae Helvetiae 65, pp. 255-266.

Heinz, R. A. & Isenschmid, C. 1988. Mikrofazielle und stratigraphische Untersuchungen im Massivkalk (Malm) der Préalpes médianes.- Eclogae geologicae Helvetiae, 81/1, pp. 1-62.

Hinde, G. J. 1900. Description of fossil Radiolaria from the rocks of Central Borneo. In Molengraaff, G. A. F. (Eds.), Borneo-Expeditie: Geologische verkenningstochten in Centraal Borneo (1893-94): Leiden, Amsterdam, The Netherlands, E.J. Brill and H. Gerlings, Appendix, pp. 1-51, 54-56.

Holzer, H. L. 1980. Radiolaria aus Aetzrückstanden des Malm und der Unterkreide der Nördlichen Kalkalpen (Oesterreich) (Radiolaria from acid residues of Malm and Lower Cretaceous rocks of the Northern Calcareous Alps; Austria). Annalen des Naturhistorischen Museums in Wien, vol. 83, pp. 153-167.

Igo, H. & Nishimura, H. 1984. The late Triassic and early Jurassic radiolarian biostratigraphy in the Karasawa, Kuzuu Town, Tochigi Prefecture (preliminary report). Bulletin of Tokyo Gakugi University, sect. 4, no. 36, pp. 173-193.

Igo, H., Adachi, S., Furutani, H. & Nishiyama, H. 1980. Ordovician Fossils first discovered in Japan. Proceedings of the Japan Acaddemy, vol. 56, Ser. B, no. 8, pp. 499-503.

Isenschmid, Ch. 1983. Der Malm im Mittelabschnitt der Préalpes Médianes zwischen Thuner- und Genfersee. Unpublished Thesis, University of Bern.

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, vol. 16, pp. 111-141.

Ishida, K. 1985a. Pre-Cretaceous sediments in the southern North Zone of the Chichibu Belt in Tokushima Prefecture, Shikoku. Journal of the Geological Society of Japan (Chishitsugaku Zasshi), vol. 91, no. 8, pp. 553-567.

Ishida, K. 1985b. 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, vol. 18, pp. 27-81.

Iwasaki, T., Sashida, K. & Igo, H. 1989. Mesozoic strata of the Kitaaiki-Kawakami area in Minamisaku County, Nagano prefecture, northwest Kanto mountains, central Japan. Chishitsugaku Zasshi (Journal of the Geological Society of Japan) vol. 95, no. 10, pp. 733-754.

Iwata, K. & Kato, Y. 1986. Upper Cretaceous radiolarians of the Yubetsu Group and the Hidaka Supergroup in the northern Hidaka Belt. Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan - News of Osaka Micropaleontologists, Special Volume No. 7, Osaka, Japan, pp. 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, vol. 22, no. 3, pp. 453-466.

Iwata, K., Watabe, M., Nakamura, K. & Uozumi, S. 1983b. Presence of Jurassic and Cretaceous radiolarians from the pre-Tertiary systems around Lake Saroma, Northeast Hokkaido, preliminary report. Earth Science (Chikyu Kagaku), vol. 37, no. 4, pp. 225-228.

Iwata, K., Uozumi, S., Nakamura, K. & Tajika, J. 1983b. Occurrence of Jurassic and Cretaceous radiolarians from the Pre-Tertiary systems around Lake Saroma, northeast Hokkaido (preliminary report). Journal of the Geological Society , vol. 89, pp. 55-56.

Iwata, K., Hariya, Y., Choi, J. H., Yagi, E. & Miura, T. 1990. Radiolarian age of the manganese deposits of the Tokoro Belt, northeast Hokkaido. Jour. Fac. Sci., Hokkaido Univ., Ser. IV, vol. 22, no. 4, 565-576.

Jud, R. 1983. Geologie des Stockhorngebietes. Unpublished Master thesis, pp. 1-120, 21 plates, 1 geologic map, University of Bern.

Känel, E., Perch-Nielsen von Salis, K. & Lindinger, M. 1989. The Cretaceous/Tertiary boundary in the Gurnigel-Flysch (Switzerland). Eclogae geologicae Helvetiae 82/2, pp. 555-581.

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, pp. 295-350.

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, vol. 87, pp. 527-533.

Karrer, F. 1867. Sitzungsberichte, mathematisch-naturwissenschaftliche Classe, kaiserliche Akademie der Wissenschaften, 55/1, Wien, pp. 364-368.

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, vol. 22, no. 3, pp. 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, vol. 43, pp. 1-13.

Kent, D. V. & Gradstein, F. M. 1985. A Cretaceous and Jurassic geochronology. Geol. Soc. Am. Bull. 96, pp. 1419-1427.

Kickmaier, W. & Peters, T.J. 1990. Manganese occurrences in the Al Hammah Range - Wahrah Formation, Oman Mountains. Robertson, A.H.F., Searle, M.P. and Ries, A.C. (Eds.), The geology and tectonics of the Oman Region, Geol. Soc. spec. Publ., no. 49, pp. 239-249.

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, vol. 91, pp. 27-42.

Kishida, Y. & Hisada, K. 1985. Late Triassic to Early Jurassic radiolarian assemblages from the Ueno-mura area, Kanto Mountains, central Japan. Memoirs of Osaka Kyoiku University, ser. III, vol. 34, no. 2, pp. 103-129.

Kishida, Y. & Hisada, K. 1986. Radiolarian assemblages of the Sambosan Belt in the western part of the Kanto Mountains, central Japan. Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan. News of Osaka Micropaleontologists, Special Volume No. 7, Osaka, Japan, pp. 25-34.

Kito, N. 1987. Stratigraphic relation between greenstones and clastic sedimentary rocks in the Kamuikotan Belt, Hokkaido, Japan. Journal of the Geological Society of Japan, vol. 93, no. 1, pp. 21-35.

Kito, N. 1989. Radiolaires Jurassiques Moyen et Supérieur de Sicilie (Italie): Biostratigraphie et Taxonomie. Mém. Sc. Terre Univ. Curie, Paris, n. 89-7, unpublished, pp. 1-239.

Kocher, R. N. 1981. Biochronostratigraphische Untersuchungen oberjurassischer radiolarienführender Gesteine, insbesondere der Südalpen. Mitteilungen aus dem Geologischen Institut der Eidgenossischen Technischen Hochschule und der Universität Zürich, Neue Folge, no. 234, pp. 1-184.

Kozlova, G. E. 1972. A find of Radiolaria in the lower Kimmeridgian of the Timan-Ural region. Doklady of the Academy of Sciences USSR, Earth Sciences Section, vol. 201, no. 1-6, pp. 118-120.

Kuhnt, W.,Thurow, J.,Wiedmann, J. & Herbin, J. P. 1986. Oceanic Anoxic Conditions around the Cenomanian/Turonian Boundary and the Response of the Biota. Mitt. Geol.-Paläont. Inst. Univ. Hamburg, 60, pp. 205-246.

Larson, R. L. & Hilde, T. W. C. 1975. A revised time scale of magnetic reversals for the Early Cretaceous and Late Jurassic. J. Geophys. Res. 80, pp. 2586-2549.

Le Hégarat, G. 1973. Le Berriasien de Sud-Est de la France. Documents, Laboratoire de Géologie, Faculté des Sciences de Lyon 43, 575 pp.

Le Hégarat, G. & Remane, J. 1968. Tithonique supérieur et Berriasien de la bordure cévenole. Corrélations des ammonites et des calpionelles. Géobios 1. pp. 7-70.

Li Hong-sheng, 1986. Upper Jurassic (early Tithonian) radiolarians from southern Bangong Lake, Xizang. Acta Micropalaeontologica Sinica (Wei Ti Ku Sheng Wu Hsueh Pao), vol. 3, no. 3, pp. 297-316.

Li Hong-sheng & Wu Hao-ruo, 1985. Radiolaria from the Cretaceous Congdu Formation in southern Xizang (Tibet). Acta Micropalaeontologica Sinica (Wei Ti Ku Sheng Wu Hsueh Pao), vol. 2, no. 1, pp. 61-76.

Lini, A., Weissert, H. and Erba, E. 1992. The Valanginian carbon isotope event: a first episode of greenhouse climate conditions during the Cretaceous. Terra Nova, vol. 4, pp. 374-384.

Lipman, R. Kh. 1952a. Materialy k monograficheskomu izucheniyu radiolyarii verkhnemelovykh otlozhenii Russkoi Platformy (Data on the monographic study of the radiolarians of the Upper Cretaceous deposits of the Russian Platform). Trudy Vsesoyuznogo Nauchno-Issledovatelskogo Geologicheskogo Instituta (VSEGEI), Paleontologiya i Stratigrafiya (Transactions of the All Union Scientific Research Institute of Geology (VSEGEI), Paleontology and Stratigraphy), pp. 24-51.

Lipman, R. Kh. 1952b. Novye dannye o vozraste kreminstych porod dalnego vostoka na osnovanii opredelennya radiolyarii (New data on the age of the siliceous rocks from the Far East based on radiolarians). Doklady Akademiya Nauk SSSR (Transactions of the USSR Academy of Sciences), vol. 86, no. 2, pp. 379-382.

Lipman, R. Kh. 1962. Pozdnemelovye radiolyarii Zapadno-Sibirskoi nizmennosti i Turgaiskogo progiba (Late

Cretaceous radiolarians of the western Siberian lowland and the Turgaisk trough). Materialy po Stratigrafi Mezo-Kainozoya Turgaiskogo Progiba, Severnogo Priaralya i Zapadno-Sibirskoi Nizmennosti, Trudy Vsesoyuznogo Nauchno-Issledovatelskogo Geologicheskogo Instituta (VSEGEI) (Transactions of the All Union Scientific Research Institute of Geology (VSEGEI), vol. 77, new series, pp. 271-323.

Lowrie, W. 1989. Magnetostratigraphy and the geomagnetic polarity record. Cuad. Geol. Iberica, Paleomagnetismo, vol. 12, 1988-1989, pp. 95-120.

Lowrie, W. & Alvarez, W. 1984: Lower Cretaceous magnetic stratigraphy in Umbrian pelagic limestone sections. Earth and Planetary Science Letters 71, pp. 315-328.

Lowrie, W. & Channell, J. E. T. 1984. Magnetostratigraphy of the Jurassic-Cretaceous boundary in the Maiolica limestone (Umbria, Italy). Geology, 12, pp. 44-47.

Lozynyak, P. Yu. 1969. Radiolyarii nizhnemelovykh otlozhenii Ukrainskikh Karpat (The radiolarians of the Lower Cretaceous deposits of the Ukrainian Carpathians). In Vyalov, O. S. (Eds.), Iskopaemye i Sovremennye Radiolyarii: Materialy vtorogo vsesoyuznogo seminara po radiolyariyam (Fossil and Recent Radiolarians: Materials of the Second All Union Seminar on Radiolaria): Izdatelstvo Lvovskogo Universiteta (Lvov University), pp. 29-41.

Lugeon, M. & Gagnebin, E. 1941. Observations et vues nouvelles sur la géologie des Préalpes romandes. Bull. Lab. Géol. Univ. Lausanne 72 and Mém. Soc. vaud. Sci. nat. 7/1.

Matsuoka, A. 1986a. Faunal change of radiolarians around the Jurassic-Cretaceous boundary - with special reference to some multi-segmented nassellarians. Fossils, vol. 40, no. 6, pp. 1-15.

Matsuoka, A. 1986b. Tricolocapsa yaoi Assemblage (Late Jurassic radiolarians) from the Togano Group in Shikoku, Southwest Japan. Journal of Geosciences, Osaka City University, vol. 29, pp. 101-115.

Matsuoka, A. & Yao, A. 1985. Latest Jurassic radiolarians from the Torinosu Group in Southeast Japan. Journal of Geoscience, Osaka City University, vol. 28, pp. 125-145.

Matsuoka, A. & Yao, A. 1986. A newly proposed radiolarian zonation for the Jurassic of Japan. Marine Micropaleontology, vol. 11, no. 1-3, pp. 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. (Eds.), Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 371-382.

Micarelli, A., Potetti, M. & Chiocchini, M. 1977. Ricerche microbiostratigrafiche sulla Maiolica della regione Umbro-Marchigiana.- Studi Geol. Camerti 3, pp. 57-86.

Mizutani, S. 1981. A Jurassic formation in the Hida-Kanayama Area, Central Japan. Bulletin of the Mizunami Fossil Museum, vol. 8, pp. 147-190.

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 Science, Nagoya University, vol. 30, pp. 31-107.

Mizutani, S., Uemura, T. & Yamamoto, H. 1984. Jurassic radiolarians from the Tsugawa Area, Nigata Prefecture, Japan. Earth Science (Chikyu Kagata), vol. 38, no. 5, pp. 352-358.

Monechi, S. 1981. Aptian-Cenomanian calcareous nannoplankton from some sections in the Umbrian Apennines.- Revista Ital. Paleontol. 87, pp. 13-19.

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, Volume 17, Washington, D.C.: U. S. Government Printing Office, pp. 797-869.

Murata, M., Ohishi, A., Nishizono, Y., Sato, T. & Takehara, T. 1982. Late Mesozoic radiolarian fauna from the Sakaguchi Formation. In Nakaseko, K. (Eds.), Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 327-337.

Murchey, B. 1984. Biostratigraphy and lithostratigraphy of cherts in the Franciscan Complex, Marin Headlands, California. In Blake, M. (Eds.), Franciscan Geology of Northern California: The Pacific Section, vol. 43, Los Angeles USA, Society of Economic Paleontologists and Mineralogists, pp. 51-70.

Muzavor, S. N. X. 1977. Die oberjurassische Radiolarienfauna von Oberaudorf am Inn. Dissertation, München: Ludwig-Maximilians-Universität, 163 pp.

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 Tokushima University (Natural Sci.), vol. 31, pp. 1-27.

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, vol. 30, no. 2, pp. 133-203.

Nakaseko, K., Nishimura, A. & Sugano, K. 1979. Cretaceous Radiolaria in the Shimanto Belt, Japan. News of Osaka Micropaleontologist, Special Volume No. 2, pp. 1-49.

Neviani, A. 1900. Supplemento alla fauna a Radiolari delle rocce mesozoiche del Bolognese (Additional observations of the radiolarian fauna of the Mesozoic rocks of the Bologna area). Bollettino della Societa geologica italiana, vol. 19, pp. 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, vol. 12, pp. 1-40.

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. (Eds.), Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 311-326.

Ogg, J. G. 1988. Early Cretaceous and Tithonian magnetostratigraphy of the Galicia Margin (Ocean Drilling Program Leg 103).- In Boillot, G. Winterer, E. L. et al., Proc. ODP, Sci. Results, 103, pp. 659-682.

Ogg, J. G., Steiner, M. B., Oloriz, F. & Tavera, J. M. 1984. Jurassic magnetostratigraphy: 1. Kimmeridgian-Tithonian of Sierra Gorda and Carcabuey, southern Spain. Earth and Planetary Science Letters 71, pp. 147-162.

Ogg, J. G. & Lowrie, W. 1986. Magnetostratigraphy of the Jurassic/Cretaceous boundary. Geology, vol. 14, pp. 547-550.

Ogg, J. G., Hasenyager, R. W., Wimbledon, W. A., Channell, E. T. & Bralower, T. J. 1991. Magnetostratigraphy of the Jurassic-Cretaceous boundary interval-Tethyan and English faunal realms. Cretaceous Research 12, pp. 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, pp. 205-215.

Okamura, M. 1980. Radiolarian fossils from the northern Shimanto Belt (Cretaceous) in Kochi Prefecture, Shikoku. In Rinya-Koseikai (Eds.), Geology and Paleontology of the Shimanto Belt, pp. 153-178.

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, vol. 31, pp. 87-94.

Okamura, M., Nakaseko, K. & Nakano, K. 1982. Radiolarians from the Kajisako Formation, Monobe area, Shikoku. Multidisciplinary Research of the Upper Cretaceous Monobe Area, Palaeontological Society of Japan, Special Papers, no. 25, pp. 93-102.

Oloriz, F. & Tavera, J. M. 1989. The significance of Mediterranean ammonites with regard to the traditional Jurassic-Cretaceous boundary. Cretaceous Research 10, pp. 221-237.

Origlia-Devos, I. 1983. Radiolaires du Jurassique supérieur-Crétacé inférieur: Taxonomie et révision stratigraphique (zone du Pinde-Olonos, Grèce, zone de Sciacca, Italie, Complexe de Nicoya, Costa Rica et forages du DSDP. Diplome de Docteur de 3ème Cycle: Université Pierre et Marie Curie, Paris 6, Unpublished, pp. 1-328.

Ozvoldova, L. 1975. Upper Jurassic radiolarians from the Kisuca Series in the Klippen Belt. Zapadne Karpaty Seriya Paleontologicheskii, Guds, Bratislava, vol. 1, pp. 73-86.

Ozvoldova, L. 1979a. Radiolarians from the Rudina beds of the Kysuca series in the Klippen belt from locality Brodno. Annotationes Zoologicae et Botanicae, vol. 128, pp. 1-15.

Ozvoldova, L. 1979b. Radiolarian assemblage of radiolarian cherts of Podbiel locality (Slovakia). Casopis pro mineralogii a geologii, vol. 24, no. 3, pp. 249-261.

Ozvoldova, L. 1987. Strucny prehlad vyskumu radiolarii v mesozoiku zapadnych Karpat (Investigations of Mesozoic Radiolarians from West Carpathians, brief review). Miscelanea micropaleontologica, vol. 2, no. 1, pp. 191-202.

Ozvoldova, L. 1988. Radiolarian associations from radiolarites of the Kysuca succession of the Klippen Belt in the Vicinity of Myjava - Tura Luka (West Carpathians). Geol. Carpathica, vol. 39/3, pp. 369-392.

Ozvoldova, L. 1990. Occurrence of Albian radiolaria in the underlier of the Vienna Basin. Geologica Carpathica, 41, 2, pp. 137-154.

Ozvoldova, L. & Petercakova, M. 1987. Biostratigraphic research of upper Jurassic limestones of the Cachtice Carpathians (locality Bzince pod Javorinou). Zapadne Karpaty, Ser. Paleont., vol. 12, pp. 115-124.

Ozvoldova, L. & Sykora, M. 1984. The radiolarian assemblage from Cachticke Karpaty Mts. limestones (the locality Sipkovsky Haj). Geologicky Sbornik, vol. 35, no. 2, pp. 259-290.

Parona, C. F. 1890. Radiolarie nei noduli selciosi del calcare giurese di Cittiglio presso Laveno (Radiolarians from siliceous nodules of the Jurassic limestones of Cittiglio near Laveno). Bollettino della Societa geologica italiana, vol. IX, fasciolo 1, pp. 132-175.

Pessagno, E. A. 1969. The Neosciadiocapsidae, a new family of Upper Cretaceous Radiolaria. Bulletins of American Paleontology, vol. 56, no. 253, pp. 377-439.

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. Bulletin of American Paleontology, vol. 60, no. 264, pp. 5-83.

Pessagno, E. A. 1971b. A new radiolarian from the Upper Cretaceous of the California Coast Ranges. Micropaleontology, vol. 17, no. 3, pp. 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). Bulletin of American Paleontology, vol. 61, no. 270, pp. 269-328.

Pessagno, E. A. 1973. Upper Cretaceous Spumellariina from the Great Valley Sequence, California Coast Ranges. Bulletins of American Paleontology, vol. 63, no. 276, pp. 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 No. 2, pp. 1-95.

Pessagno, E. A. 1977a. Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. Micropaleontology, vol. 23, no. 1, pp. 56-113.

Pessagno, E. A. 1977b. Lower Cretaceous radiolarian biostratigraphy of the Great Valley Sequence and Franciscan Complex, California Coast Ranges. Cushman Foundation for Foraminiferal Research, Special Publication No. 15, pp. 1-87.

Pessagno, E. A. & Poisson, A. 1979. Lower Jurassic Radiolaria from the Gumuslu Allochthon of southwest Turkey (Taurides Occidentales). Bulletin of the Mineral Research and Exploration Institute of Turkey, no. 92, pp. 47-69.

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, vol. 28, no. 2, pp.111-169.

Pessagno, E. A., Finch, W. & Abbott, P. L. 1979. Upper Triassic Radiolaria from the San Hipolito Formation, Baja California. Micropaleontology, vol. 25, no. 2, pp. 160-197.

Pessagno, E. A., Blome, C. & Longoria, J. 1984. A revised radiolarian zonation from Upper Jurassic of western North America. Bulletins of American Paleontology, vol. 87, no. 320, 51 pp.

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 No. 23, pp. 1-51.

Pessagno, E. A., Six, W. M. & Yang, Q. 1989. The Xiphostylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. Micropaleontology, vol. 35, no. 3, pp. 193-255.

Premoli Silva, I., Channell, J. E. T., Coccioni, R., Erba, E., Monechi, S. & Parisi, G. 1990. Integrated bio-magnetostratigraphy of Italian Cretaceous pelagic sequences. IGCP 262, Tethyan Cretaceous Correlation, Pelagic and Flysch Facies Meeting, Krakow, (abstract).

Remane, J. 1985. Calpionellids. In Bolli, H., Saunders, J. & Perch-Nielsen, K. (eds.): Cretaceous Plankton Stratigraphy. Cambridge University Press, pp. 555-572.

Remane, J. 1991. The Jurassic-Cretaceous boundary: problems of definition and procedure. Cretaceous Research 12, pp. 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, Volume 27, Washington, D.C.: U. S. Government Printing Office, pp. 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, pp. 383-431.

Rieber, H. 1977. Eine Ammonitenfauna aus der oberen Maiolica der Breggia-Schlucht (Tessin/Schweiz). Eclogae geol. Helv. Vol. 70/3, pp. 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, Volume 26, Washington, D.C.: U. S. Government Printing Office, pp. 771-814.

Rüst, D. 1885a. Ueber fossile Radiolarien aus Schichten des Jura. Jenaische Zeitschrift für Naturwissenschaft, vol. 18 (new ser., vol. 11), pp. 40-44.

Rüst, D. 1885b. Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen des Jura. Palaeontographica, vol. 31, ser. 3, pp. 269-321.

Rüst, D. 1888. Beiträge zur Kenntniss der fossilen Radiolarien aus Gesteinen der Kreide. Palaeontographica, Bd. 34, pp. 181-213.

Rüst, D. 1898. Neue Beiträge zur Kenntniss der Fossilen Radiolarien aus Gesteinen des Jura und der Kreide. Palaeontographica, vol. 45, pp. 1-67.

Sanfilippo, A. & Riedel, W. R. 1985. Cretaceous Radiolaria. In Bolli, H. M., Saunders, J. B. & Perch-Nielsen, K. (Eds.), Plankton Stratigraphy, Cambridge, UK, Cambridge University Press, pp. 573-630.

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, Volume 62, Washington, D.C.: U. S. Government Printing Office, pp. 419-470.

Schaaf, A. 1984. Les radiolaires du Crétacé inféreur et moyen: biologie et systématique. Sciences. Géologiques. Mém., vol. 75, pp. 1-189.

Schaaf, A. 1985. Un nouveau canevas biochronologique du Crétacé inférieur et moyen: les biozones à radiolaires. Sciences Géologique, Bulletin, vol. 38, no. 3, pp. 227-269.

Schardt, H. 1898. Les régions exotiques du versant N des Alpes suisses. Bull. Soc. vaud. Sci. nat. vol. 34, pp.114-219.

Schmidt-Effing, R. 1980. Radiolarien der Mittel-Kreide aus dem Santa Elena-Massiv von Costa Rica (Middle Cretaceous Radiolaria from the Santa Elena Massif, Costa Rica). Neues Jahrbuch für Geologie und Paläontologie. Abhandlungen, vol. 160, no. 2, pp. 241-257.

Spicher, J. P. 1965. Géologie des Préalpes Médianes dans le massif des Bruns. Eclogae geol. Helv., Vol. 58/2, 1965.

Squinabol, S. 1903. Le Radiolaire dei noduli selciosi nella Scaglia degli Euganei. Contribuzione I (Radiolaria from siliceous nodules of the Euganei shales). Rivista italiana di paleontologia, vol. IX, pp. 105-151.

Squinabol, S. 1904. Radiolarie cretacee degli Euganei. Atti e memorie dell'Accademia di scienze, lettere ed arti. Padova, new series, vol. 20, pp. 171-244.

Squinabol, S. 1914. Contributo alla conoscenza dei Radiolarii fossili del Veneto. Appendice - Di un genera di Radiolari caratteristico del Secondario (Contribution to the knowledge of fossil Radiolaria. Appendix - On a genus of Radiolaria characteristic of the Mesozoic). Memorie dell'Istituto geologico della R. Universita di Padova, vol. 2, pp. 249-306.

Steiger, T. (1991, in press). Systematik, Stratigraphie und Palökologie der Radiolarien des Oberjura-Unterkreide-Grenzbereiches im Osterhorn-Tirolikum (Nördliche Kalkalpen, Salzburg und Bayern). Zitteliana.

Suyari, K. 1986a. Restudy of the Northern Shimanto Subbelt in eastern Shikoku. Journal of Science, University of Tokushima, vol. 19, pp. 45-54.

Suyari, K. 1986b. Radiolarian assemblages from the Torinosu Group and the cherts of the North Subbelt of the Shimanto Belt. Recent Progress of Research on Radiolarians and Radiolarian Terranes of Japan. News of Osaka Micropaleontologists, Special Volume No. 7, Osaka, Japan, pp. 245-254.

Suyari, K. & Hashimoto, H. 1985. A radiolarian assemblage from the Izumi Group of Eastern Shikoku. Journal of Science, University of Tokushima, vol. 18, pp. 103-127.

Suyari, K. & Ishida, K. 1985. Radiolarian age of the Torinosu Group, Shikoku, Japan. Journal of Science, University of Tokushima, vol. 18, pp. 83-101.

Suyari, K. & Kuwano, Y. 1986. Radiolarian age of the Torinosu group, Shikoku, Japan, Part 2. Journal of Science, University of Tokushima, vol. 19, pp. 37-43.

Tajika, J. & Iwata, K. 1983. Presence of Cretaceous radiolarians in Hidaka Supergroup, Maruseppu, Northeast Hokkaido. Journal of the Geological Society of Japan (Chishitsugaku Zasshi), vol. 89, no. 3, pp. 535-538.

Taketani, Y. 1982a. Cretaceous radiolarian biostratigraphy of the Urakawa and Obira areas, Hokkaido. Science Reports of the Tohoku University, Sendai, Series 2. Geology, vol. 52, no. 1-2, pp. 1-75.

Taketani, Y. 1982b. Cretaceous Radiolaria from Hokkaido. In Nakaseko, K. (Eds.). Proceedings of the First Japanese Radiolarian Symposium, News of Osaka

Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 361-369.

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 (Chishitsugaku Zasshi), vol. 91, no. 8, pp. 569-571.

Tan, S. H. 1927. Over de samenstelling en het onstaan van krijt- en mergel-gesteenten van de Molukken (On the composition and formation of chalk and marlstone of the Moluccas). Jaarboek van het mijnwezen in Nederlandsch Oost-Indie, jaargang 55, 1926, verhandelingen, 3rd gedeelte, pp. 5-165.

Thieuloy, J.-P. 1977a. La zone à *callidiscus* du Valanginien supérieur vocontien (Sud-Est de la France). Lithostratigraphie, ammonitofaune, limite Valanginien-Hauterivien, correlations. Géol. Alpine vol. 53, pp. 83-143.

Thurow, J. 1987. Die kretazischen Turbiditserien im Gibraltarbogen: Bindeglied zwischen atlantischer und tethyaler Entwicklung. PhD UNPUBLISHED, Univ. Tübingen, pp. 1-500.

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, vol. 103, College Station, TX (Ocean Drilling Program), pp. 379-418.

Thurow, J. & Kuhnt, W. 1986. Mid-Cretaceous of the Gibraltar Arch Area. In Summerhayes, C. P. & Shackleton, N. J. (Eds.), North Atlantic Palaeoceanography, Geological Society Special Publication, no. 22, pp. 423-445.

Tumanda, F. P. 1989. Cretaceous radiolarian biostratigraphy in the Esashi Mountain area, Northern Hokkaido, Japan. Sci. Rep., Inst. Geosci., Univ. Tsukuba, Sec. B., vol. 10, Tsukuba, 1-44, pls. 1-10.

Thury, M. 1971. Geologische Untersuchung der Préalpes médianes plastiques im Gebiet der Schiebe (N Boltigen). Unpublished diploma, University of Bern.

Umiker, R.1952. Geologie der westlichen Stockhornkette (Berner Oberland). Unpublished thesis, University of Bern.

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, vol. 26, pp. 159-175.

Vinassa de Regny, P. E. 1898a. Nuove famiglie e nuove generi di radiolari (New families and new genera of Radiolaria). Rivista italiana di paleontologia, vol. 4, no. 2, pp. 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, vol. 7, semestre 2, pp. 34-39.

Vinassa de Regny, P. E. 1899. I radiolari delle ftaniti titoniane di Carpena (Spezia). Paleontolographica Italica, vol. 4, pp. 217-238.

Vishnevskaya, V. S. 1984. Radiolyarii roda Amphipyndaz iz olytorskoi zony SSSR i ikh stratigraficheskaya priurochennost (Radiolarians of the genus Amphipyndax from the Olutor Ridge of the USSR and their stratigraphical ranges affiliation). In Petrushevskya, M. G. and Stepanjants, S. D. (Eds.), Morfologiya, ekologiya i evolutsiya Radiolyarii. Materialy IV simpoziuma evropeiskikh radiolyaristov EURORAD IV (Morphology, ecology and evolution of radiolarians. Material from the IV symposium of European radiolarists EURORAD IV), Leningrad, USSR, Akademiya Nauk SSSR, Zoological Institute, pp. 187-193.

Vishnevskaya, V. S. 1986. Middle to Late Cretaceous radiolarian zonation of the Bering region, U.S.S.R. Marine Micropaleontology, vol. 11, no. 1-3, pp. 139-149.

Vishnevskaya, V. S. 1988. O vozmoshnostyakh rascheleniya yursko-paleotsenovykh bulkanogenno-kremnistykh formatsii severo-zapadnogo obramleniya Pacifiki (v predelakh SSSR) (On the possibility of subdividing the USSR siliceous volcanic formations surrounding the northwest Pacific). In Pushcharovskii, Yu. M. (Eds.), Ocherkii po geologii Kamchatki i Koryakskogo nagorya (Reports on the geology of the Kamchatka and the Koryak Plateau), Moscow, USSR, Nauka, pp. 8-15.

Vishnevskaya, V. S., Chejovich, V. & de Albear, J. 1982. Edad y condiciones de formacion de las silicitas de la zona de Camajuani (Cuba). Comunicaciones breves, Ciencias de la tierra y del Espacio, vol. 5, pp. 113-117.

Vishneskaya, V. S., Bogdanov, N. A., Sukhov, A. N., Chekhovich, V. D. & Fedorchuk, A. V. 1983. Vozrast vulkanogenno-Kremnistykh obrazovanii Olyutorskoi zony (Koryakskoe nagore) (Age of the volcanic siliceous formation of the Olyutorsk area (Koryak depression). Izvestiya Akademiya Nauk SSSR, Seriya Geologicheskaya, (Proceedings of the USSR Academy of Sciences, Geological Series), vol. 8, pp. 61-69.

Wakita, K. 1982. Jurassic radiolarians from Kuzuryo-ko-

Gujo-hachiman area. In Nakaseko, K. (Eds.). Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 153-171.

Watts, K.F. 1990. Mesozoic carbonate slope facies marking the Arabian platform margin in Oman: depositional history, morphology and paleogeography. Robertson, A.H.F., Searle, M.P. and Ries, A.C. (Eds), The geology and tectonics of the Oman Region, Geol. Soc. spec. Publ., no. 49, pp. 139-159.

Weissert, H. 1979. Die Paläozeanographie der südwestlichen Tethys in der Unterkreide. Mitt. geol. Inst. ETH u. Univ. Zürich, neue Folge 226, pp. 1-174.

Weissert, H. 1981. Depositional processes in an ancient pelagic environment: the Lower Cretaceous Maiolica of the Southern Alps. Eclogae geologicae Helvetiae, 74/2, pp. 339-352.

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, vol. 4, no. 4, pp. 483-494.

Weissert, H. & Lini, A. 1991. Ice Age Interludes During the Time of Cretaceous Greenhouse Climate?. Paleoenvironment and Evolutionary Change, pp. 173-191.

Winterer, E. L. & Bosellini, A. 1981. Subsidence and sedimentation on a Jurassic passive continental margin, Southern Alps, Italy. Bull. Amer. Assoc. Petroleum Geol. 65, pp. 394-421.

Wisniowski, T. 1888. Beitrag zur Kenntniss der Mikrofauna aus den oberjurassischen Feuersteinknollen der Umgegend von Krakau (Contribution to the study of the microfauna of the Upper Jurassic cherts of the surroundings of Krakow). Jahrbuch der Kaiserlich-Königlichen geologischen Reichsanstalt, vol. 38, no. 4, pp. 657-702.

Wright, V.P., Ries, A.C. & Munn, S.G. 1990. Intraplatform basin-fill deposits from the Infracambrian Huqf Group, east Central Oman. Robertson, A.H.F., Searle, M.P. and Ries, A.C. (Eds), The geology and tectonics of the Oman Region, Geol. Soc. spec. Publ., no. 49, pp. 601-616.

Wu, H. R. 1986. Some new genera and species of Cenomanian Radiolaria from southern Xizang (Tibet). Acta Micropalaeontologica Sinica (Wei Ti Ku Sheng Wu Hsueh Pao), vol. 3, no. 4, pp. 347-360.

Wu, H. R. & Li H. 1982. The Radiolaria of the olistostrome of Zongzhuo Formation, Gyangze, South Xizang, Tibet. Acta Palaeontologica Sinica (Ku Sheng Wu Hsueh Pao), vol.21, no. 1, pp. 64-71.

Yamamoto, H., Mizutani, S. & Kagami, H. 1985. Middle Jurassic radiolarians from Blake Bahama Basin, West Atlantic Ocean. Bulletin Nagoya University Museum, no. 1, pp. 25-49.

Yamauchi, M. 1982. Upper Cretaceous radiolarians from Northern Shimanto Belt along the course of Shimanto River, Kochi Prefecture, Japan. In Nakaseko, K. (Eds.). Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 383-397.

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, vol. 15, pp. 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, vol. 22, pp. 21-72.

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 Geoscience, Osaka City University, vol. 27, pp. 41-103.

Yao, A., Matsuoka, A. & Nakatani, T. 1982. Triassic and Jurassic radiolarian assemblages in southwest Japan. In Nakaseko, K. (Eds.). Proceedings of the First Japanese Radiolarian Symposium, News of Osaka Micropaleontologists, Special Volume No. 5, Osaka, Japan, pp. 27-43.

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 (Chishitsugaku Zasshi), vol. 95, no. 6, pp. 463-478.

Zittel, K. A. 1876. Ueber einige fossile Radiolarien aus der norddeutschen Kreide (Some fossil Radiolaria from the chalk of northern Germany). Zeitschrift der Deutschen geologischen Gesellschaft, vol. 28, pp. 75-86.

# DATABASE

# ALPHANUMERICAL RANGES OF TAXA

| MRD Nr. | U.A. | TAXA |
|---|---|---|
| 5032: | 20 - 35 | *Acaeniotyle (?) florea* |
| 5033: | 20 - 35 | *Acaeniotyle (?) glebulosa* |
| 3281: | 6 - 31 | *Acaeniotyle dentata* |
| 3090: | 1 - 35 | *Acaeniotyle diaphorogona gr.* |
| 3092: | 1 - 35 | *Acaeniotyle umbilicata* |
| 5012: | 25 - 35 | *Acanthocircus carinatus* |
| 5003: | 3 - 32 | *Acanthocircus furiosus n. sp.* |
| 3064: | 1 - 1 | *Acanthocircus suboblongus* |
| 3065: | 1 - 35 | *Acanthocircus trizonalis* |
| 5011: | 24 - 32 | *Acanthocircus variabilis* |
| 3228: | 3 - 35 | *Alievium helenae* |
| 3285: | 5 - 35 | *Angulobracchia (?) portmanni portmanni* |
| 3911: | 3 - 14 | *Angulobracchia (?) rugosa n. sp.* |
| 6121: | 5 - 35 | *Angulobracchia portmanni gr.* |
| 3263: | 1 - 35 | *Archaeodictyomitra apiarium* |
| 5582: | 31 - 35 | *Archaeodictyomitra chalilovi* |
| 3287: | 3 - 35 | *Archaeodictyomitra excellens* |
| 5595: | 8 - 35 | *Archaeodictyomitra lacrimula* |
| 5042: | 3 - 35 | *Archaeospongoprunum patricki n. sp.* |
| 5913: | 13 - 34 | *Archaeotritrabs gracilis* |
| 3924: | 3 - 7 | *Artocapsa (?) amphorella n. sp.* |
| 5357: | 32 - 33 | *Bernoullius (?) manica n. sp.* |
| 5359: | 11 - 35 | *Bernoullius (?) monoceros n. sp.* |
| 5369: | 9 - 35 | *Bernoullius spelae n. sp.* |
| 3918: | 5 - 6 | *Bistarkum brevilatum n. sp.* |
| 5199: | 8 - 33 | *Bistarkum irazuense* |
| 3919: | 3 - 22 | *Bistarkum valdorbiense n. sp.* |
| 5785: | 5 - 17 | *Canoptum banale n. sp.* |
| 5068: | 20 - 31 | *Cecrops (?) sexaspina n. sp.* |
| 5229: | 18 - 34 | *Cecrops septemporatus* |
| 6101: | 3 - 18 | *Cinguloturris arabica n.sp* |
| 5532: | 20 - 35 | *Crolanium pythiae* |
| 6123: | 17 - 35 | *Crolanium spp.* |
| 5902: | 18 - 35 | *Crucella (?) inflexa* |
| 5204: | 17 - 35 | *Crucella bossoensis n. sp.* |
| 5194: | 7 - 34 | *Crucella collina n. sp.* |
| 5628: | 20 - 28 | *Crucella lipmanae n. sp.* |
| 5143: | 21 - 33 | *Crucella remanei n. sp.* |
| 5196: | 22 - 33 | *Crucella sp. aff. C. espartoensis* |
| 5266: | 25 - 35 | *Cyclastrum (?) luminosum n. sp.* |
| 5903: | 28 - 35 | *Cyclastrum (?) planum n. sp.* |
| 5901: | 15 - 34 | *Cyclastrum (?) trigonum* |
| 5261: | 18 - 35 | *Cyclastrum infundibuliforme* |
| 5290: | 9 - 33 | *Cyclastrum rarum* |
| 5506: | 3 - 10 | *Cyrtocapsa (?) grutterinki* |
| 5422: | 22 - 35 | *Dibolachras tytthopora* |
| 5046: | 10 - 35 | *Dicroa periosa* |
| 5927: | 23 - 35 | *Dictyomitra pseudoscalaris* |
| 3912: | 4 - 16 | *Ditrabs (?) osteosa n. sp.* |
| 3227: | 2 - 33 | *Ditrabs sansalvadorensis* |
| 5132: | 3 - 25 | *Emiluvia chica decussata* |
| 3225: | 1 - 11 | *Emiluvia hopsoni* |
| 3066: | 1 - 19 | *Emiluvia pessagnoi* |
| 5620: | 16 - 35 | *Eucyrtis columbaria* |
| 4073: | 1 - 35 | *Foremanella diamphidia* |
| 5287: | 12 - 35 | *Godia lenticulata n. sp.* |
| 5274: | 29 - 35 | *Godia tecta* |
| 5243: | 6 - 35 | *Halesium (?) lineatum n. sp.* |
| 5166: | 7 - 35 | *Halesium biscutum n. sp.* |
| 5069: | 22 - 35 | *Hexapyramis (?) precedis n. sp.* |
| 5267: | 27 - 35 | *Homoeoparonaella peteri n. sp.* |
| 5253: | 7 - 35 | *Homoeoparonaella sp. aff. H. irregularis* |
| 5163: | 6 - 34 | *Homoeoparonaella speciosa* |
| 5824: | 3 - 11 | *Hsuum feliformis n. sp.* |
| 3591: | 3 - 12 | *Hsuum raricostatum n. sp.* |
| 5371: | 9 - 32 | *Jacus (?) italicus n. sp.* |
| 5436: | 3 - 26 | *Katroma milloti* |
| 5041: | 8 - 35 | *Lithatractus sp. aff. L. pusillus* |
| 5453: | 7 - 31 | *Milax adrianae n. sp.* |
| 5716: | 6 - 33 | *Mirifusus apenninicus n. sp.* |
| 3162: | 1 - 35 | *Mirifusus chenodes* |
| 3286: | 1 - 31 | *Mirifusus dianae minor* |
| 5721: | 3 - 34 | *Mirifusus odoghertyi n. sp.* |
| 5703: | 13 - 23 | *Mirifusus petzholdti* |
| 5524: | 25 - 35 | *Novixitus (?) daneliani n. sp.* |
| 5693: | 26 - 35 | *Novixitus (?) tuberculatus* |
| 3955: | 3 - 15 | *Obesacapsula breggiensis n. sp.* |
| 5568: | 5 - 26 | *Obesacapsula bullata* |
| 3203: | 1 - 17 | *Obesacapsula cetia* |
| 3266: | 5 - 33 | *Obesacapsula morroensis* |
| 5565: | 6 - 18 | *Obesacapsula polyedra* |
| 3282: | 5 - 27 | *Obesacapsula rusconensis rusconensis* |
| 5796: | 5 - 9 | *Obesacapsula rusconensis umbriensis n.s.* |
| 3202: | 5 - 32 | *Obesacapsula verbana* |
| 3280: | 3 - 10 | *Pantanellium berriasianum* |
| 5065: | 3 - 34 | *Pantanellium sp. aff. P. cantuchapai* |
| 5607: | 3 - 35 | *Pantanellium squinaboli* |
| 5396: | 5 - 13 | *Parapodocapsa furcata* |
| 5314: | 8 - 34 | *Paronaella (?) annemariae n. sp.* |
| 5186: | 7 - 35 | *Paronaella (?) trifoliacea* |
| 5183: | 3 - 35 | *Paronaella (?) tubulata* |
| 3185: | 3 - 35 | *Parvicingula boesii gr.* |
| 3255: | 3 - 35 | *Parvicingula cosmoconica* |
| 5578: | 6 - 30 | *Parvicingula longa n. sp.* |
| 3717: | 6 - 13 | *Parvicingula sphaerica* |
| 5712: | 11 - 35 | *Parvicingula usotanensis* |
| 3288: | 8 - 32 | *Parvivacca magna n. sp.* |
| 5362: | 29 - 35 | *Phaseliforma ovum n. sp.* |
| 5427: | 29 - 32 | *Podobursa multispina n. sp.* |
| 3230: | 1 - 5 | *Podobursa spinosa* |
| 5397: | 25 - 32 | *Podocapsa (?) imperialis n. sp.* |
| 3171: | 1 - 25 | *Podocapsa amphitreptera* |

# ALPHANUMERICAL RANGES OF TAXA

| MRD Nr. | U.A. | TAXA |
|---|---|---|
| 5334: | 15 - 35 | *Pseudoaulophacus (?) florealis n. sp.* |
| 5332: | 7 - 34 | *Pseudoaulophacus (?) pauliani n. sp.* |
| 5521: | 24 - 35 | *Pseudocrolanium cristatum n. gen. n. sp.* |
| 5522: | 29 - 34 | *Pseudocrolanium fluegeli n. sp.* |
| 3947: | 6 - 35 | *Pseudocrucella (?) elisabethae* |
| 3293: | 3 - 34 | *Pseudodictyomitra carpatica* |
| 5641: | 31 - 35 | *Pseudodictyomitra lanceloti* |
| 5973: | 35 - 35 | *Pseudodictyomitra leptoconica* |
| 5625: | 30 - 35 | *Pseudodictyomitra lilyae* |
| 5647: | 16 - 35 | *Pseudodictyomitra nuda* |
| 5642: | 34 - 34 | *Pseudodictyomitra sp. aff. P. lanceloti* |
| 5576: | 17 - 33 | *Pseudoeucyrtis (?) aspera n. sp.* |
| 5408: | 5 - 19 | *Pseudoeucyrtis (?) fusus n. sp.* |
| 5572: | 10 - 33 | *Pseudoeucyrtis acus n.sp.* |
| 5577: | 6 - 12 | *Pseudoeucyrtis sceptrum n. sp.* |
| 3241: | 1 - 1 | *Ristola altissima altissima* |
| 5575: | 9 - 35 | *Ristola asparagus n. sp.* |
| 3165: | 3 - 20 | *Ristola cretacea* |
| 5766: | 22 - 32 | *Ristola martae n. sp.* |
| 3022: | 1 - 34 | *Saitoum elegans* |
| 5193: | 7 - 34 | *Savaryella guexi n. gen. n. sp.* |
| 5433: | 5 - 8 | *Sethocapsa (?) concentrica* |
| 5553: | 28 - 35 | *Sethocapsa (?) orca* |
| 5464: | 6 - 26 | *Sethocapsa (?) zweilii n. sp.* |
| 5544: | 5 - 35 | *Sethocapsa dorysphaeroides* |
| 5481: | 5 - 34 | *Sethocapsa kaminogoensis* |
| 3264: | 5 - 15 | *Sethocapsa kitoi n. sp.* |
| 3062: | 1 - 32 | *Sethocapsa leiostraca* |
| 5469: | 29 - 35 | *Sethocapsa simplex* |
| 3063: | 7 - 35 | *Sethocapsa trachyostraca* |
| 5510: | 5 - 16 | *Sethocapsa tricornis n. sp.* |
| 5462: | 6 - 35 | *Sethocapsa uterculus* |
| 4037: | 19 - 34 | *Solenotryma ichikawai* |
| 5526: | 29 - 33 | *Spongocapsula (?) tripes n. sp.* |
| 5773: | 22 - 35 | *Spongocapsula coronata* |
| 5771: | 26 - 35 | *Spongocapsula obesa n. sp.* |
| 5262: | 26 - 35 | *Spongotripus (?) satoi* |
| 5761: | 25 - 34 | *Stichocapsa altiforamina* |
| 5744: | 21 - 35 | *Stichocapsa pulchella* |
| 5672: | 9 - 35 | *Stichomitra sp. aff. S. asymbatos* |
| 5550: | 33 - 35 | *Stichomitra sp. aff. S. euganea* |
| 5044: | 5 - 35 | *Stylosphaera (?) macroxiphus* |
| 5090: | 29 - 35 | *Stylospongia (?) titirez n. sp.* |
| 3094: | 1 - 35 | *Suna echiodes* |
| 5049: | 25 - 35 | *Suna hybum* |
| 3291: | 3 - 32 | *Syringocapsa agolarium* |
| 5417: | 5 - 15 | *Syringocapsa coronata* |
| 5426: | 5 - 34 | *Syringocapsa limatum* |
| 5410: | 3 - 16 | *Syringocapsa longitubus n. sp.* |
| 3283: | 5 - 17 | *Syringocapsa lucifer* |
| 5416: | 5 - 29 | *Syringocapsa sp. aff. S. coronata* |
| 5711: | 26 - 35 | *Syringocapsa spinosa* |
| 5409: | 5 - 21 | *Syringocapsa vicetina* |
| 3122: | 1 - 2 | *Tetratrabs bulbosa* |
| 5209: | 3 - 21 | *Tetratrabs radix n. sp.* |
| 3121: | 1 - 4 | *Tetratrabs zealis* |
| 5296: | 24 - 35 | *Thanarla elegantissima* |
| 5904: | 30 - 34 | *Thanarla gutta n. sp.* |
| 5073: | 9 - 35 | *Thanarla pulchra* |
| 3095: | 1 - 3 | *Triactoma jonesi* |
| 5055: | 6 - 33 | *Triactoma luciae n. sp.* |
| 3097: | 1 - 35 | *Triactoma tithonianum* |
| 3113: | 1 - 35 | *Tritrabs ewingi gr.* |
| 5580: | 6 - 32 | *Wrangellium columnarium n. sp.* |
| 3284: | 5 - 24 | *Wrangellium depressum* |
| 5636: | 7 - 35 | *Wrangellium puga* |
| 5674: | 5 - 35 | *Xitus (?) alievi* |
| 5673: | 14 - 34 | *Xitus channelli n. sp.* |
| 5725: | 26 - 31 | *Xitus horridus n. sp.* |
| 5668: | 10 - 35 | *Xitus sandovali n. sp.* |
| 3295: | 7 - 35 | *Xitus sp. aff. X. spicularius* |
| 5511: | 25 - 35 | *Zhamoidellum testatum n. sp.* |

# NUMERICAL RANGES OF TAXA

| MRD Nr. | U.A. | TAXA |
|---|---|---|
| 3022: | 1 - 34 | *Saitoum elegans* |
| 3062: | 1 - 32 | *Sethocapsa leiostraca* |
| 3063: | 7 - 35 | *Sethocapsa trachyostraca* |
| 3064: | 1 - 1 | *Acanthocircus suboblongus* |
| 3065: | 1 - 35 | *Acanthocircus trizonalis* |
| 3066: | 1 - 19 | *Emiluvia pessagnoi* |
| 3090: | 1 - 35 | *Acaeniotyle diaphorogona gr.* |
| 3092: | 1 - 35 | *Acaeniotyle umbilicata* |
| 3094: | 1 - 35 | *Suna echiodes* |
| 3095: | 1 - 3 | *Triactoma jonesi* |
| 3097: | 1 - 35 | *Triactoma tithonianum* |
| 3113: | 1 - 35 | *Tritrabs ewingi gr.* |
| 3121: | 1 - 4 | *Tetratrabs zealis* |
| 3122: | 1 - 2 | *Tetratrabs bulbosa* |
| 3162: | 1 - 35 | *Mirifusus chenodes* |
| 3165: | 3 - 20 | *Ristola cretacea* |
| 3171: | 1 - 25 | *Podocapsa amphitreptera* |
| 3185: | 3 - 35 | *Parvicingula boesii gr.* |
| 3202: | 5 - 32 | *Obesacapsula verbana* |
| 3203: | 1 - 17 | *Obesacapsula cetia* |
| 3225: | 1 - 11 | *Emiluvia hopsoni* |
| 3227: | 2 - 33 | *Ditrabs sansalvadorensis* |
| 3228: | 3 - 35 | *Alievium helenae* |
| 3230: | 1 - 5 | *Podobursa spinosa* |
| 3241: | 1 - 1 | *Ristola altissima altissima* |
| 3255: | 3 - 35 | *Parvicingula cosmoconica* |
| 3263: | 1 - 35 | *Archaeodictyomitra apiarium* |
| 3264: | 5 - 15 | *Sethocapsa kitoi n. sp.* |
| 3266: | 5 - 33 | *Obesacapsula morroensis* |
| 3280: | 3 - 10 | *Pantanellium berriasianum* |
| 3281: | 6 - 31 | *Acaeniotyle dentata* |
| 3282: | 5 - 27 | *Obesacapsula rusconensis rusconensis* |
| 3283: | 5 - 17 | *Syringocapsa lucifer* |
| 3284: | 5 - 24 | *Wrangellium depressum* |
| 3285: | 5 - 35 | *Angulobracchia (?) portmanni portmanni* |
| 3286: | 1 - 31 | *Mirifusus dianae minor* |
| 3287: | 3 - 35 | *Archaeodictyomitra excellens* |
| 3288: | 8 - 32 | *Parvivacca magna n. sp.* |
| 3291: | 3 - 32 | *Syringocapsa agolarium* |
| 3293: | 3 - 34 | *Pseudodictyomitra carpatica* |
| 3295: | 7 - 35 | *Xitus sp. aff. X. spicularius* |
| 3591: | 3 - 12 | *Hsuum raricostatum n. sp.* |
| 3717: | 6 - 13 | *Parvicingula sphaerica* |
| 3911: | 3 - 14 | *Angulobracchia (?) rugosa n. sp.* |
| 3912: | 4 - 16 | *Ditrabs (?) osteosa n. sp.* |
| 3918: | 5 - 6 | *Bistarkum brevilatum n. sp.* |
| 3919: | 3 - 22 | *Bistarkum valdorbiense n. sp.* |
| 3924: | 3 - 7 | *Artocapsa (?) amphorella n. sp.* |
| 3947: | 6 - 35 | *Pseudocrucella (?) elisabethae* |
| 3955: | 3 - 15 | *Obesacapsula breggiensis n. sp.* |
| 4037: | 19 - 34 | *Solenotryma ichikawai* |

| MRD Nr. | U.A. | TAXA |
|---|---|---|
| 4073: | 1 - 35 | *Foremanella diamphidia* |
| 5003: | 3 - 32 | *Acanthocircus furiosus n. sp.* |
| 5011: | 24 - 32 | *Acanthocircus variabilis* |
| 5012: | 25 - 35 | *Acanthocircus carinatus* |
| 5032: | 20 - 35 | *Acaeniotyle (?) florea* |
| 5033: | 20 - 35 | *Acaeniotyle (?) glebulosa* |
| 5041: | 8 - 35 | *Lithatractus sp. aff. L. pusillus* |
| 5042: | 3 - 35 | *Archaeospongoprunum patricki n. sp.* |
| 5044: | 5 - 35 | *Stylosphaera (?) macroxiphus* |
| 5046: | 10 - 35 | *Dicroa periosa* |
| 5049: | 25 - 35 | *Suna hybum* |
| 5055: | 6 - 33 | *Triactoma luciae n. sp.* |
| 5065: | 3 - 34 | *Pantanellium sp. aff. P. cantuchapai* |
| 5068: | 20 - 31 | *Cecrops (?) sexaspina n. sp.* |
| 5069: | 22 - 35 | *Hexapyramis (?) precedis n. sp.* |
| 5073: | 9 - 35 | *Thanarla pulchra* |
| 5090: | 29 - 35 | *Stylospongia (?) titirez n. sp.* |
| 5132: | 3 - 25 | *Emiluvia chica decussata* |
| 5143: | 21 - 33 | *Crucella remanei n. sp.* |
| 5163: | 6 - 34 | *Homoeoparonaella speciosa* |
| 5166: | 7 - 35 | *Halesium biscutum n. sp.* |
| 5183: | 3 - 35 | *Paronaella (?) tubulata* |
| 5186: | 7 - 35 | *Paronaella (?) trifoliacea* |
| 5193: | 7 - 34 | *Savaryella guexi n. gen. n. sp.* |
| 5194: | 7 - 34 | *Crucella collina n. sp.* |
| 5196: | 22 - 33 | *Crucella sp. aff. C. espartoensis* |
| 5199: | 8 - 33 | *Bistarkum irazuense* |
| 5204: | 17 - 35 | *Crucella bossoensis n. sp.* |
| 5209: | 3 - 21 | *Tetratrabs radix n. sp.* |
| 5229: | 18 - 34 | *Cecrops septemporatus* |
| 5243: | 6 - 35 | *Halesium (?) lineatum n. sp.* |
| 5253: | 7 - 35 | *Homoeoparonaella sp. aff. H. irregularis* |
| 5261: | 18 - 35 | *Cyclastrum infundibuliforme* |
| 5262: | 26 - 35 | *Spongotripus (?) satoi* |
| 5266: | 25 - 35 | *Cyclastrum (?) luminosum n. sp.* |
| 5267: | 27 - 35 | *Homoeoparonaella peteri n. sp.* |
| 5274: | 29 - 35 | *Godia tecta* |
| 5287: | 12 - 35 | *Godia lenticulata n. sp.* |
| 5290: | 9 - 33 | *Cyclastrum rarum* |
| 5296: | 24 - 35 | *Thanarla elegantissima* |
| 5314: | 8 - 34 | *Paronaella (?) annemariae n. sp.* |
| 5332: | 7 - 34 | *Pseudoaulophacus (?) pauliani n. sp.* |
| 5334: | 15 - 35 | *Pseudoaulophacus (?) florealis n. sp.* |
| 5357: | 32 - 33 | *Bernoullius (?) manica n. sp.* |
| 5359: | 11 - 35 | *Bernoullius (?) monoceros n. sp.* |
| 5362: | 29 - 35 | *Phaseliforma ovum n. sp.* |
| 5369: | 9 - 35 | *Bernoullius spelae n. sp.* |
| 5371: | 9 - 32 | *Jacus (?) italicus n. sp.* |
| 5396: | 5 - 13 | *Parapodocapsa furcata* |
| 5397: | 25 - 32 | *Podocapsa (?) imperialis n. sp.* |
| 5408: | 5 - 19 | *Pseudoeucyrtis (?) fusus n. sp.* |

## NUMERICAL RANGES OF TAXA

| MRD Nr. | U.A. | TAXA |
|---|---|---|
| 5409: | 5 - 21 | *Syringocapsa vicetina* |
| 5410: | 3 - 16 | *Syringocapsa longitubus n. sp.* |
| 5416: | 5 - 29 | *Syringocapsa sp. aff. S. coronata* |
| 5417: | 5 - 15 | *Syringocapsa coronata* |
| 5422: | 22 - 35 | *Dibolachras tytthopora* |
| 5426: | 5 - 34 | *Syringocapsa limatum* |
| 5427: | 29 - 32 | *Podobursa multispina n. sp.* |
| 5433: | 5 - 8 | *Sethocapsa (?) concentrica* |
| 5436: | 3 - 26 | *Katroma milloti* |
| 5453: | 7 - 31 | *Milax adrianae n. sp.* |
| 5462: | 6 - 35 | *Sethocapsa uterculus* |
| 5464: | 6 - 26 | *Sethocapsa (?) zweilii n. sp.* |
| 5469: | 29 - 35 | *Sethocapsa simplex* |
| 5481: | 5 - 34 | *Sethocapsa kaminogoensis* |
| 5506: | 3 - 10 | *Cyrtocapsa (?) grutterinki* |
| 5510: | 5 - 16 | *Sethocapsa tricornis n. sp.* |
| 5511: | 25 - 35 | *Zhamoidellum testatum n. sp.* |
| 5521: | 24 - 35 | *Pseudocrolanium cristatum n. gen. n. sp.* |
| 5522: | 29 - 34 | *Pseudocrolanium fluegeli n. sp.* |
| 5524: | 25 - 35 | *Novixitus (?) daneliani n. sp.* |
| 5526: | 29 - 33 | *Spongocapsula (?) tripes n. sp.* |
| 5532: | 20 - 35 | *Crolanium pythiae* |
| 5544: | 5 - 35 | *Sethocapsa dorysphaeroides* |
| 5550: | 33 - 35 | *Stichomitra sp. aff. S. euganea* |
| 5553: | 28 - 35 | *Sethocapsa (?) orca* |
| 5565: | 6 - 18 | *Obesacapsula polyedra* |
| 5568: | 5 - 26 | *Obesacapsula bullata* |
| 5572: | 10 - 33 | *Pseudoeucyrtis acus n.sp.* |
| 5575: | 9 - 35 | *Ristola asparagus n. sp.* |
| 5576: | 17 - 33 | *Pseudoeucyrtis (?) aspera n. sp.* |
| 5577: | 6 - 12 | *Pseudoeucyrtis sceptrum n. sp.* |
| 5578: | 6 - 30 | *Parvicingula longa n. sp.* |
| 5580: | 6 - 32 | *Wrangellium columnarium n. sp.* |
| 5582: | 31 - 35 | *Archaeodictyomitra chalilovi* |
| 5595: | 8 - 35 | *Archaeodictyomitra lacrimula* |
| 5607: | 3 - 35 | *Pantanellium squinaboli* |
| 5620: | 16 - 35 | *Eucyrtis columbaria* |
| 5625: | 30 - 35 | *Pseudodictyomitra lilyae* |
| 5628: | 20 - 28 | *Crucella lipmanae n. sp.* |
| 5636: | 7 - 35 | *Wrangellium puga* |
| 5641: | 31 - 35 | *Pseudodictyomitra lanceloti* |
| 5642: | 34 - 34 | *Pseudodictyomitra sp. aff. P. lanceloti* |
| 5647: | 16 - 35 | *Pseudodictyomitra nuda* |
| 5668: | 10 - 35 | *Xitus sandovali n. sp.* |
| 5672: | 9 - 35 | *Stichomitra sp. aff. S. asymbatos* |
| 5673: | 14 - 34 | *Xitus channelli n. sp.* |
| 5674: | 5 - 35 | *Xitus (?) alievi* |
| 5693: | 26 - 35 | *Novixitus (?) tuberculatus* |
| 5703: | 13 - 23 | *Mirifusus petzholdti* |
| 5711: | 26 - 35 | *Syringocapsa spinosa* |
| 5712: | 11 - 35 | *Parvicingula usotanensis* |
| 5716: | 6 - 33 | *Mirifusus apenninicus n. sp.* |
| 5721: | 3 - 34 | *Mirifusus odoghertyi n. sp.* |
| 5725: | 26 - 31 | *Xitus horridus n. sp.* |
| 5744: | 21 - 35 | *Stichocapsa pulchella* |
| 5761: | 25 - 34 | *Stichocapsa altiforamina* |
| 5766: | 22 - 32 | *Ristola martae n. sp.* |
| 5771: | 26 - 35 | *Spongocapsula obesa n. sp.* |
| 5773: | 22 - 35 | *Spongocapsula coronata* |
| 5785: | 5 - 17 | *Canoptum banale n. sp.* |
| 5796: | 5 - 9 | *Obesacapsula rusconensis umbriensis n.s.* |
| 5824: | 3 - 11 | *Hsuum feliformis n. sp.* |
| 5901: | 15 - 34 | *Cyclastrum (?) trigonum* |
| 5902: | 18 - 35 | *Crucella (?) inflexa* |
| 5903: | 28 - 35 | *Cyclastrum (?) planum n. sp.* |
| 5904: | 30 - 34 | *Thanarla gutta n. sp.* |
| 5913: | 13 - 34 | *Archaeotritrabs gracilis* |
| 5927: | 23 - 35 | *Dictyomitra pseudoscalaris* |
| 5973: | 35 - 35 | *Pseudodictyomitra leptoconica* |
| 6101: | 3 - 18 | *Cinguloturris arabica n.sp.* |
| 6121: | 5 - 35 | *Angulobracchia portmanni gr.* |
| 6123: | 17 - 35 | *Crolanium spp.* |

# LOCAL RANGES OF RADIOLARIAN TAXA

**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 - 42

**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

## INDEX OF SAMPLE-NUMBERS, SAMPLE-LEVELS AND UNITARY ASSOCIATIONS OF ALL SECTIONS

**SECTION 1**
Fiume Bosso

63: Selli L : 35 - 35
62: BO 2 : 35 - 35
61: 619.90 : 35 - 35
60: 619.05 : 35 - 35
59: 617.00 : 33 - 33
58: 615.20 : 33 - 33
57: 606.80 : 33 - 33
56: 588.20 : 31 - 33
55: 582.80 : 31 - 32
54: 581.65 : 31 - 32
53: 581.60 : 31 - 32
52: 580.40 : 31 - 32
51: 580.10 : 32 - 32
50: 575.05 : 31 - 32
49: 574.40 : 31 - 32
48: 573.00 : 31 - 32
47: 569.60 : 31 - 31
46: 566.50 : 31 - 31
45: 563.60 : 30 - 31
44: 561.80 : 30 - 31
43: 556.40 : 30 - 30
42: 552.10 : 30 - 30
41: 551.05 : 27 - 30
40: 547.50 : 27 - 27
39: 540.50 : 27 - 27
38: 537.90 : 26 - 27
37: 534.60 : 26 - 27
36: 533.30 : 26 - 27
35: 529.20 : 26 - 27
34: 525.30 : 26 - 27
33: 523.70 : 26 - 27
32: 520.10 : 26 - 27
31: 515.05 : 26 - 27
30: 490.60 : 26 - 27
29: 488.80 : 26 - 27
28: 486.50 : 26 - 27
27: 482.50 : 22 - 27
26: 482.20 : 22 - 22
25: 481.45 : 22 - 22
24: 479.50 : 22 - 22
23: 449.50 : 20 - 20
22: 447.50 : 18 - 18
21: 427.20 : 12 - 18
20: 409.00 : 12 - 12
19: 391.20 : 10 - 12
18: 382.00 : 10 - 12
17: 370.10 : 10 - 10
16: 361.80 : 10 - 10
15: 351.50 : 6 - 10
14: 336.20 : 6 - 10
13: 332.70 : 6 - 8
12: 323.20 : 6 - 6
11: 315.50 : 6 - 6
10: 312.90 : 6 - 6
9: 312.00 : 6 - 6
8: 311.20 : 6 - 7
7: 306.20 : 3 - 3
6: 305.00 : 3 - 3
5: 304.00 : 3 - 3
4: 294.60 : 2 - 2
3: 292.20 : 1 - 1
2: 289.80 : 1 - 1
1: artific. : 1 - 1

**SECTION 2**
Pieia

42: 97.35 : 13 - 17
41: 95.50 : 13 - 17
40: 94.30 : 13 - 17
39: 91.45 : 13 - 17
38: 89.40 : 13 - 17
37: 86.60 : 13 - 17
36: 84.75 : 13 - 17
35: 82.75 : 13 - 13
34: 81.60 : 13 - 13
33: 81.00 : 13 - 13
32: 78.50 : 13 - 13
31: 77.20 : 13 - 13
30: 75.60 : 13 - 13
29: 74.90 : 9 - 13
28: 74.60 : 9 - 13
27: 71.50 : 9 - 13
26: 69.10 : 9 - 13
25: 67.70 : 9 - 9
24: 66.60 : 9 - 9
23: 64.70 : 8 - 8
22: 63.00 : 8 - 8
21: 62.20 : 8 - 8
20: 61.10 : 8 - 8
19: 59.35 : 8 - 8
18: 59.00 : 8 - 8
17: 58.10 : 8 - 8
16: 57.50 : 8 - 8
15: 56.00 : 8 - 8
14: 40.20 : 8 - 8
13: 37.60 : 6 - 8
12: BiB2 : 6 - 8
11: 16.20 : 6 - 8
10: 13.25 : 6 - 8
9: 4mSL: 5 - 5
8: 18.70 : 5 - 5
7: 17.90 : 5 - 5
6: 17.50 : 5 - 5
5: 17.40 : 5 - 5
4: 17.15 : 5 - 5
3: 16.80 : 5 - 5
2: 16.04 : 5 - 5
1: 10.00 : 5 - 5

**SECTION 3**
Gorgo a Cerbara

25: 911.35 : 33 - 35
24: 911.10 : 33 - 35
23: 902.40 : 35 - 35
22: 901.30 : 35 - 35
21: 893.30 : 35 - 35
20: 889.30 : 35 - 35
19: 887.00 : 35 - 35
18: 882.40 : 33 - 33
17: 874.65 : 33 - 33
16: 869.80 : 33 - 33
15: 867.20 : 33 - 33
14: 859.75 : 31 - 32
13: 846.35 : 31 - 32
12: 840.30 : 31 - 32
11: 837.15 : 31 - 32
10: 832.10 : 31 - 32
9: 821.45 : 32 - 32
8: 819.75 : 31 - 31
7: 817.90 : 31 - 31
6: 814.80 : 30 - 31
5: 812.25 : 30 - 30
4: 801.20 : 30 - 30
3: 799.00 : 30 - 30
2: 791.70 : 30 - 30
1: 786.70 : 28 - 28

**SECTION 4**
Presale

10: 238.80 : 33 - 34
9: 225.30 : 34 - 34
8: 221.05 : 33 - 33
7: 220.75 : 33 - 33
6: 211.35 : 31 - 31
5: 204.30 : 29 - 29
4: 197.30 : 29 - 31
3: 187.15 : 22 - 31
2: 180.10 : 17 - 27
1: 174.80 : 17 - 17

# INDEX OF SAMPLE-NUMBERS, SAMPLE-LEVELS AND UNITARY ASSOCIATIONS OF ALL SECTIONS

**SECTION 5**
Ranchi Superiore

7: 47.70 : 32 - 32
6: 45.50 : 31 - 32
5: 39-40 : 26 - 27
4: 37.05 : 24 - 24
3: 30.20 : 18 - 24
2: 24.50 : 17 - 17
1: 18.70 : 5 - 15

**SECTION 6**
Campo al Bello

3: 1592 : 31 - 33
2: 1590 : 29 - 33
1: 1589 : 29 - 33

**SECTION 7**
Valdorbia

11: -10.00 : 7 - 7
10: - 6.50 : 6 - 7
9: - 6.20 : 6 - 7
8: - 6.00 : 6 - 6
7: + 0.40 : 6 - 6
6: + 2.00 : 6 - 6
5: + 5.00 : 6 - 6
4: +41.65 : 4 - 7
3: +47.60 : 4 - 4
2: +65.90 : 1 - 1
1: +71.00 : 1 - 1

**SECTION 8**
Bottaccione

1: 1602 : 31 - 32

**SECTION 9**
Cava Rusconi

11: 166.00 : 26 - 27
10: 146.50 : 26 - 26
9: 135.50 : 25 - 25
8: 128.80 : 25 - 25
7: 107.90 : 11 - 24
6: 91.50 : 19 - 19
5: 50.80 : 10 - 10
4: 38.60 : 10 - 10
3: 10.60 : 10 - 10
2: 1205 : 7 - 7
1: 0.50 : 5 - 5

**SECTION 10**
Breggia Gorge

13: 141.55 : 34 - 34
12: 12.40 : 30 - 31
11: 23.00 : 29 - 31
10: 74.80 : 23 - 23
9: 68.40 : 21 - 22
8: 62.80 : 21 - 21
7: 54.70 : 15 - 15
6: 49.05 : 15 - 15
5: 39.05 : 15 - 15
4: 34.05 : 15 - 15
3: 28.85 : 15 - 15
2: 1330 : 7 - 7
1: 0.03 : 5 - 6

**SECTION 11**
Capriolo

27: 10.60 : 28 - 34
26: 15.40 : 28 - 34
25: 18.40 : 29 - 31
24: 28.80 : 30 - 31
23: 37.50 : 28 - 28
22: 44.35 : 28 - 31
21: 46.60 : 28 - 31
20: 57.85 : 28 - 31
19: 64.30 : 20 - 25
18: 84.90 : 20 - 25
17: 99.75 : 22 - 22
16: 100.00 : 20 - 20
15: 109.60 : 16 - 16
14: 114.30 : 16 - 16
13: 118.40 : 16 - 16
12: 120.10 : 16 - 16
11: 129.80 : 16 - 16
10: 137.60 : 16 - 16
9: 139.80 : 16 - 16
8: 144.60 : 16 - 16
7: 145.60 : 11 - 15
6: 146.20 : 11 - 11
5: 146.50 : 11 - 11
4: 146.60 : 11 - 11
3: 154.00 : 9 - 11
2: 162.80 : 7 - 10
1: 163.00 : 7 - 10

**SECTION 12**
Pfaffengrat

13: 67.50 : 7 - 17
12: 64.40 : 7 - 17
11: 61.00 : 7 - 17
10: 54.00 : 7 - 17
9: 49.50 : 7 - 17
8: 49.40 : 7 - 17
7: 45.20 : 7 - 15
6: 41.75 : 7 - 13
5: 35.00 : 7 - 10
4: 33.00 : 8 - 12
3: 30.50 : 8 - 15
2: 28.80 : 7 - 15
1: 20.00 : 7 - 15

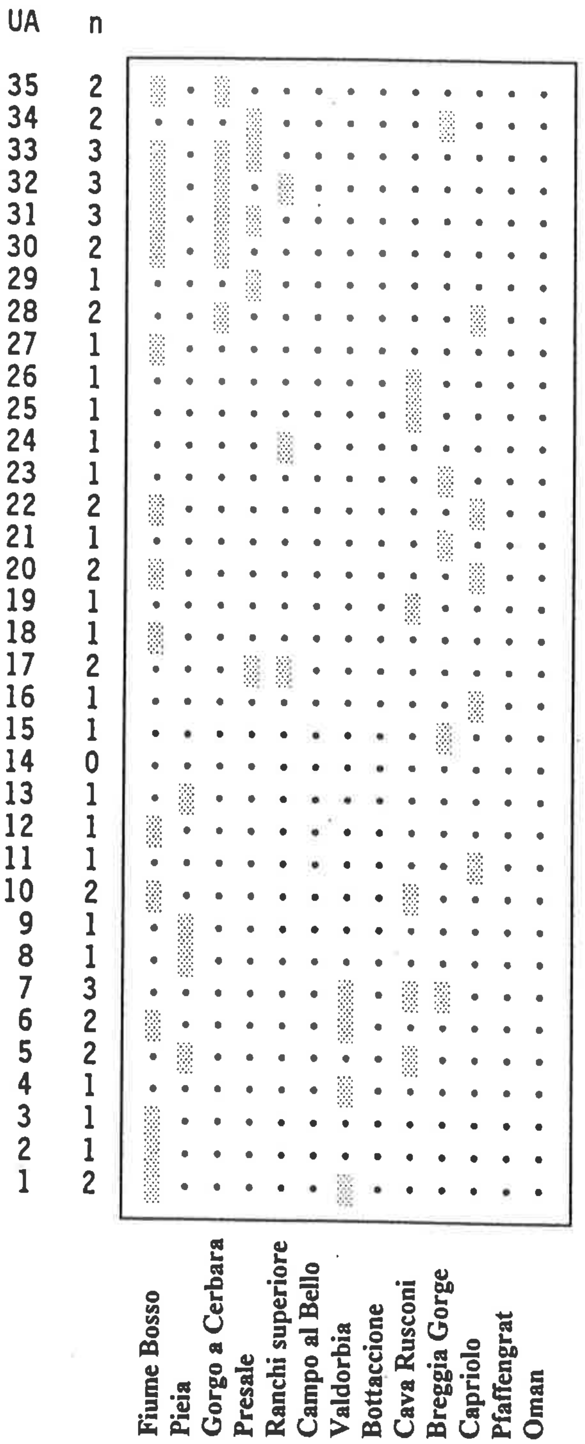
**SECTION 13**
Oman

19: 20 : 31 - 34
18: 19 : 25 - 34
17: 18 : 28 - 34
16: 17 : 24 - 34
15: 16 : 25 - 31
14: 15 : 30 - 31
13: 14 : 30 - 31
12: 13 : 30 - 31
11: 12 : 30 - 31
10: 11 : 11 - 25
9: 10 : 11 - 25
8: 3 : 11 - 14
7: 2 : 11 - 15
6: 1 : 14 - 15
5: 9 : 11 - 15
4: 7 : 10 - 12
3: 6 : 8 - 12
2: 5 : 8 - 12
1: 4 : 8 - 31

**BIOGRAPH v2.01**
**(c) 1990 by J.Savary & J.Guex**

## REPRODUCIBILITY OF THE UNITARY ASSOCIATIONS

13 sections
35 unitary associations



# PLATES

## PLATE 1

Fig. 1-2 ***Acaeniotyle dentata* BAUMGARTNER**
MRD 3281, range U.A. 6-31
1. Br. 28.85/48, 125x
2. Br. 28.85/465, 150x

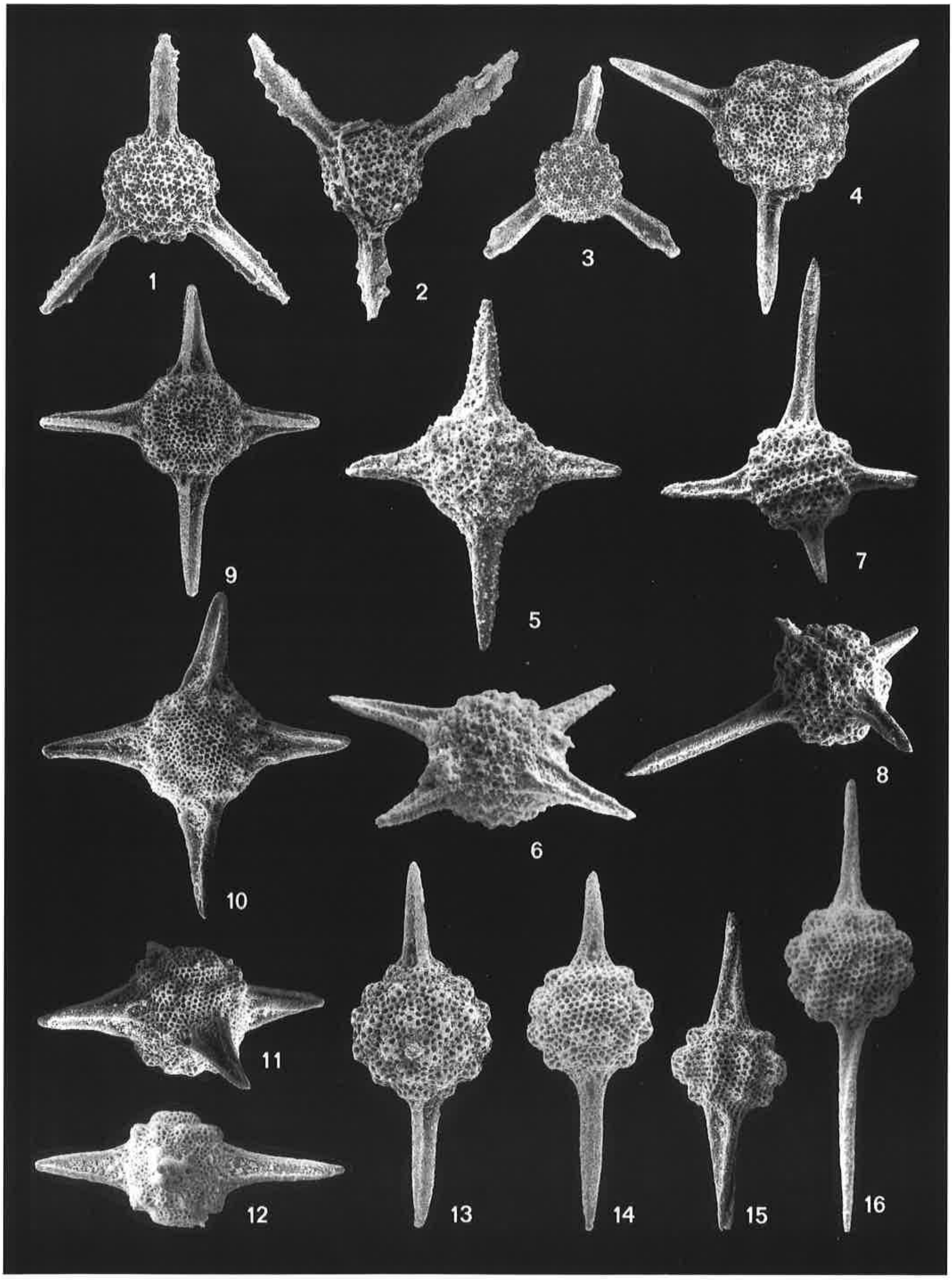
Fig. 3-4 ***Acaeniotyle diaphorogona* gr. FOREMAN sensu BAUMGARTNER**
MRD 3090, range U.A. 1-35
3. Bo. 566.50/540, 125x
4. Br. 28.85/7, 100x

Fig. 5-8 ***Acaeniotyle* (?) *glebulosa* FOREMAN**
MRD 5033, range U.A.20-35
5. Bo. 581.65/40, 200x
6. Bo. 561.50/1150, 200x
7. Bo. 566.50/1813, 150x
8. Bo. 566.50/1814, 150x
same specimen as fig. 7, lateral view

Fig. 9-12 ***Acaeniotyle* (?) *florea* OZVOLDOVA**
MRD 5032, range U.A. 20-35
9. Bo. 566.50/547, 150x
10. Bo. 566.50/1833, 150x
11. Bo. 566.50/1834, 150x
same specimen as fig. 10, lateral view
12. Bo. 566.50/1160, 150x

Fig. 13-16 ***Acaeniotyle umbilicata* (RÜST)**
MRD 3092, range U.A. 1-35
13. Bo. 566.50/538, 200x
14. Pr. 225.30/204, 150x
15. Bo. 566.50/1832, 150x
16. Pr. 225.30/6, 125x

**PLATE 1**



## PLATE 2

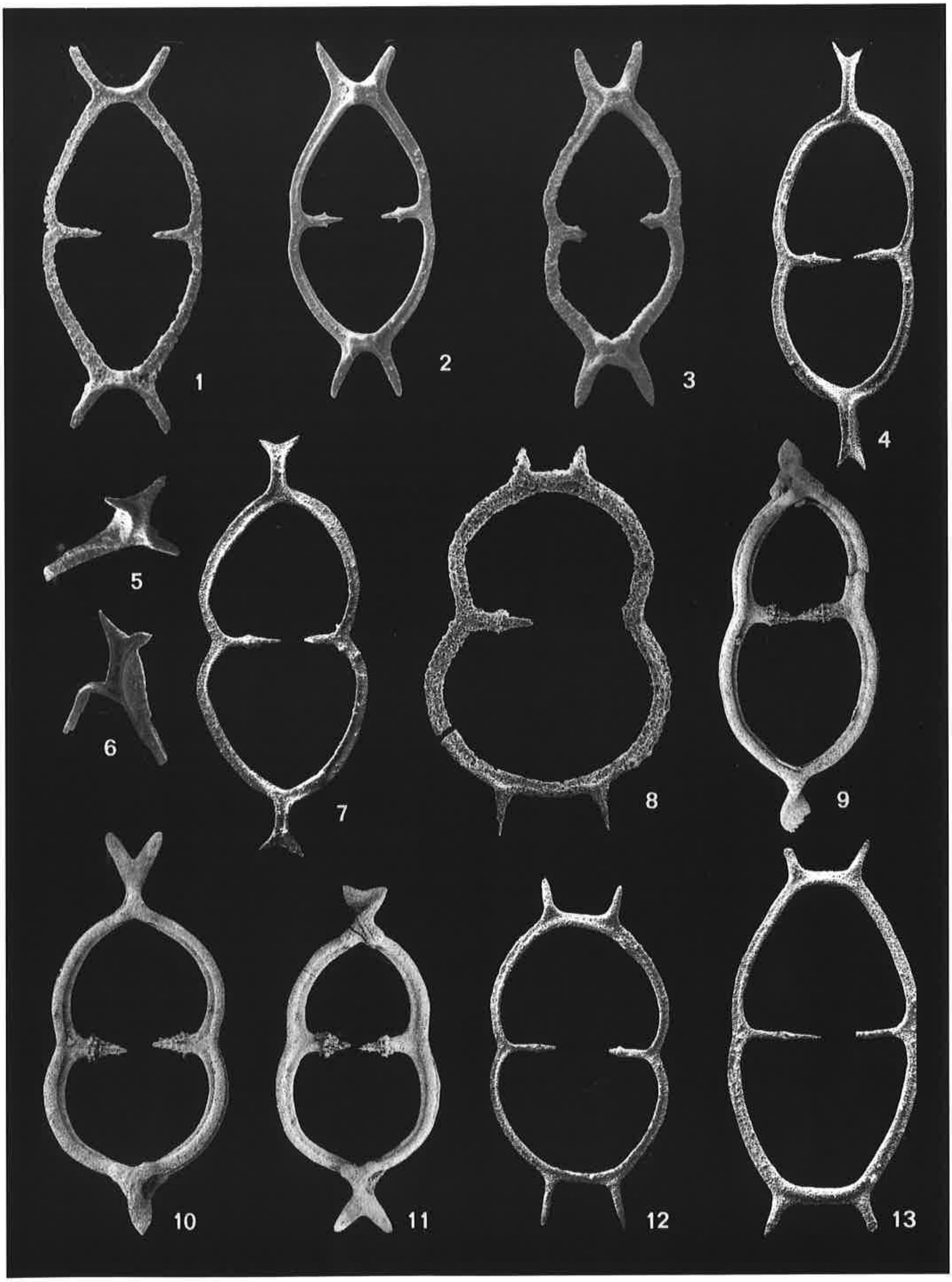
Fig. 1-3 ***Acanthocircus carinatus*** **FOREMAN**
MRD 5012, range U.A. 30-35
1. GC. 819.75/1760, 120x
2. Br. 141.55/1037, 120x
3. GC. 867.20/1055, 120x

Fig. 4-7 ***Acanthocircus furiosus*** **n. sp. JUD**
MRD 5003, range U.A. 3-32
4. Holotype: Ru. 135.50/2433, 120x
5. Paratype: Br. 1330/1591, 150x, oblique view
6. Paratype: Br. 1330/1592, 150x, same specimen as fig. 5, lateral view
7. Paratype: Br. 28.85/2353, 120x

Fig. 8 ***Acanthocircus suboblongus*** **(YAO)**
MRD 3064, range U.A. 1
SV. 16/3729, 120x

Fig. 9-11 ***Acanthocircus trizonalis*** **(RÜST)**
MRD 3065, range U.A. 1-35
9. Bo. 566.50/242, 100x
10. Bo. 566.50/237, 100x
11. Bo. 566.50/240, 100x

Fig. 12-13 ***Acanthocircus variabilis*** **(SQUINABOL)**
MRD 5011, range U.A. 24-32
12. Ru. 135.50/2405, 120x
13. Ru. 135.50/2427, 120x



## PLATE 3

Fig. 1 ***Alievium helenae* SCHAAF**
MRD 3603, range U.A. 3-35
Ru. 135.50/1827, 150x

Fig. 2-6 ***Angulobracchia* (?) *portmanni* gr. BAUMGARTNER**
MRD 6121, U.A. 5-35
2. Bo. 566.50/344, 100x
3. Bo. 566.50/340, 100x
4. Bo. 566.50/343, 100X
5. Br. 28.85/456, 100x
6. Br. 28.85/61, 100x

Fig. 7 ***Angulobracchia* (?) *portmanni portmanni* BAUMGARTNER**
MRD 3285, range U.A. 5-35
Bo. 566.50/1819, 150x

Fig. 8-9 ***Angulobracchia* (?) *rugosa* n. sp. JUD**
MRD 3911, range U.A. 3-14
8. Holotype: V. -6.50/1247, 125x
9. Paratype: Br. 1330/181, 140x

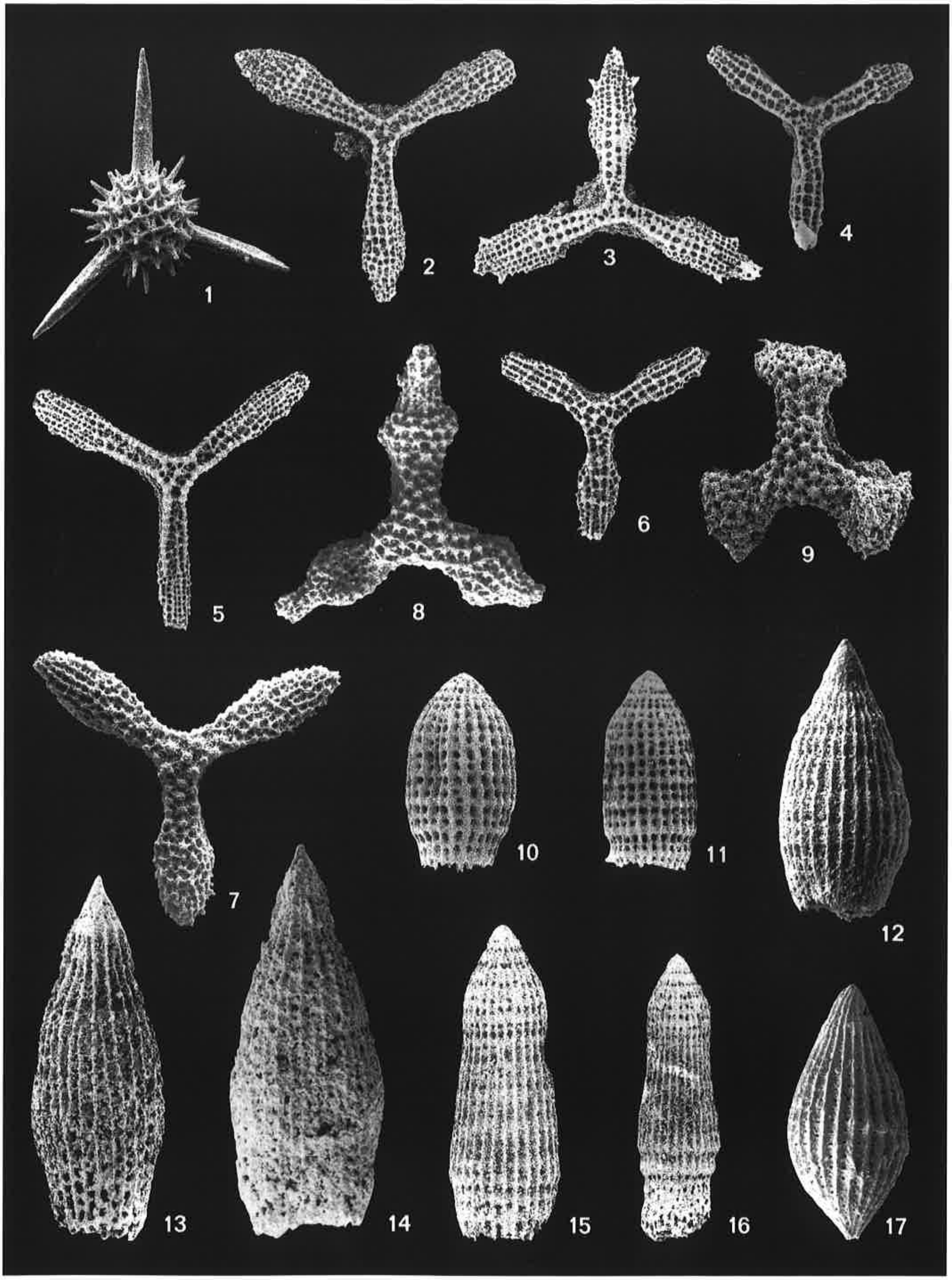
Fig. 10-11 ***Archaeodictyomitra apiarium* RÜST**
MRD 3263, range U.A. 1-35
10. Br. 28.85/277, 150x
11. Br. 28.85/301, 150x

Fig. 12-14 ***Archaeodictyomitra chalilovi* (ALIEV)**
MRD 5582, range U.A. 31-35
12. Bo. 566.50/2919, 150x
13. Bo. 566.50/35, 200x
14. Bo. 569.60/49, 200x

Fig. 15-16 ***Archaeodictyomitra excellens* (TAN)**
MRD 3287, range U.A. 3-35
15. Bo. 566.50/52, 150x
16. Bo. 566.50/34, 200x

Fig. 17 ***Archaeodictyomitra lacrimula* (FOREMAN)**
MRD 5595, range U.A. 8-35
Bo. 619.90/1497, 200x

**PLATE 3**



## PLATE 4

Fig. 1 ***Archaeodictyomitra lacrimula* (FOREMAN)**
MRD 5595, range U.A. 8-35
Pr. 225.30/18, 200x

Fig. 2-4 ***Archaeospongoprunum patricki* n. sp. JUD**
MRD 5042, range U.A. 3-35
2. Holotype: Br. 28.85/1, 150x
3. Paratype: Ru. 135.50/1809, 200x
4. Paratype: Br. 1330/133, 150x

Fig. 5-8 ***Archaeotritrabs gracilis* STEIGER**
MRD 5913, range U.A. 13-34
5. Bo. 566.50/336, 100x
6. Bo. 566.50/346, 100x
7. Mo. 46a/1084, 750x
8. Bo. 561.50/1143, 650x

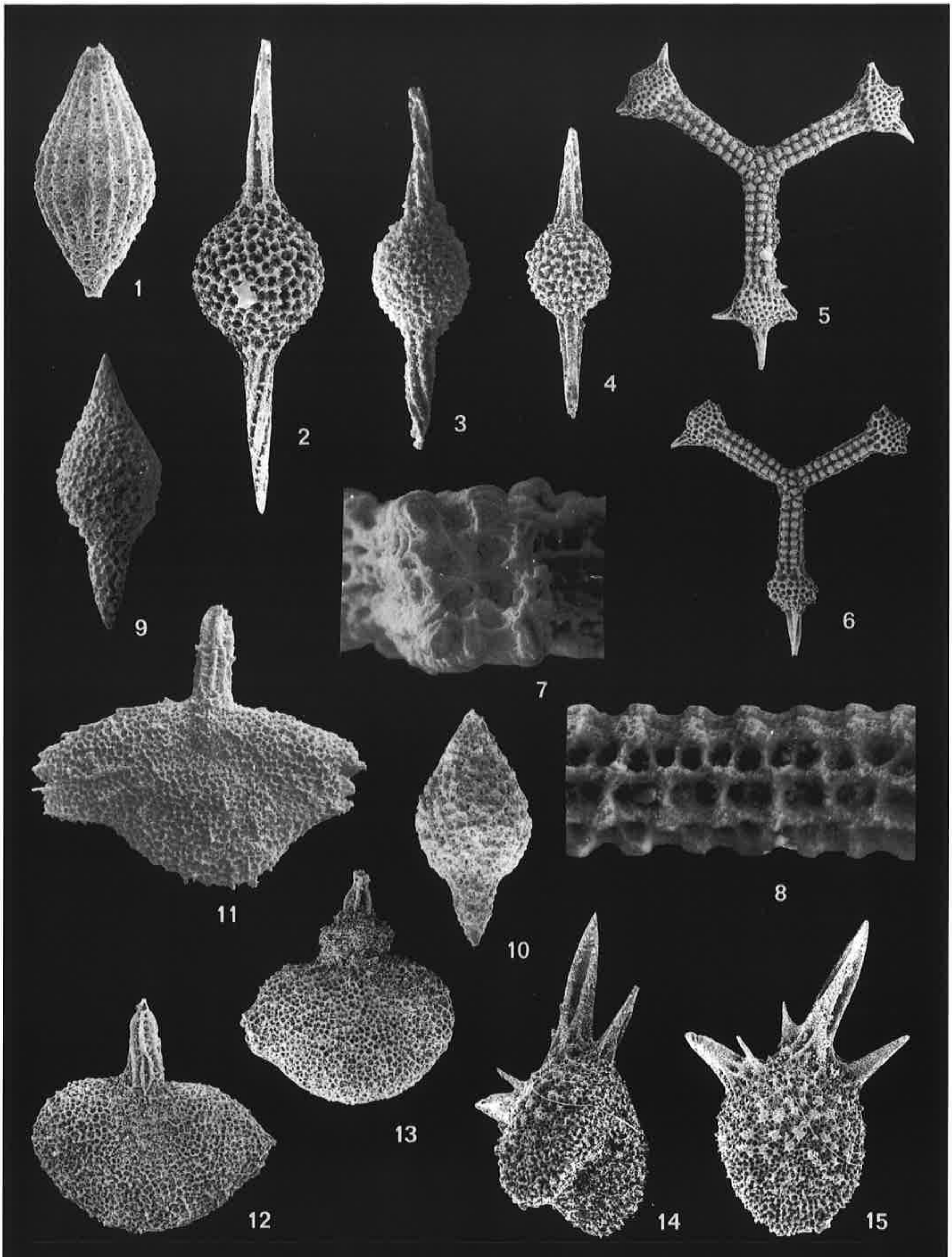
Fig. 9-10 ***Artocapsa amphorella* n. sp. JUD**
MRD 3924, range U.A. 3-7
9. Paratype: V -6.0/229, 150x
10. Holotype: V -6.50/1250, 125x

Fig. 11 ***Bernoullius* (?) *manica* n. sp. JUD**
MRD 5357, range U.A. 32-33
Holotype: Bo. 580.10/1323, 150x

Fig. 12-13 ***Bernoullius* (?) *monoceros* n. sp. JUD**
MRD 5359, range U.A. 11-35
12. Holotype: Bo. 566.50/378, 125x
13. Paratype: Bo. 566.50/375, 125x

Fig. 14-15 ***Bernoullius spelae* n. sp. JUD**
MRD 5369, range U.A. 9-35
14. Holotype: Br. 28.85/30, 200x, lateral view
15. Holotype: Br. 28.85/29, 200x, same specimen as fig. 14

**PLATE 4**



## PLATE 5

Fig. 1-2 ***Bernoullius spelae* n. sp. JUD**
MRD 5369, range U.A. 9-35
1. Paratype: GC. 824.00/1022, 170x
2. Paratype: Bo. 580.10/1334, 250x

Fig. 3-6 ***Bistarkum brevilatum* n. sp. JUD**
MRD 3918, range U.A. 5-6
3. Paratype: Bo. 311.2/21, 60x
4. Paratype: V. -6.0/4, 80x
5. Paratype: V. -6.0/10, 80x
6. Holotype: V. -6.0/15, 80x

Fig. 7 ***Bistarkum irazuense* (AITA)**
MRD 5199, range U.A. 8-33
Bo. 566.50/186, 150x

Fig. 8-9 ***Bistarkum valdorbiense* n. sp. JUD**
MRD 3919, range U.A. 3-22
8. Paratype: V. -6.0/214, 100x
9. Holotype: V. -6.0/8, 100x

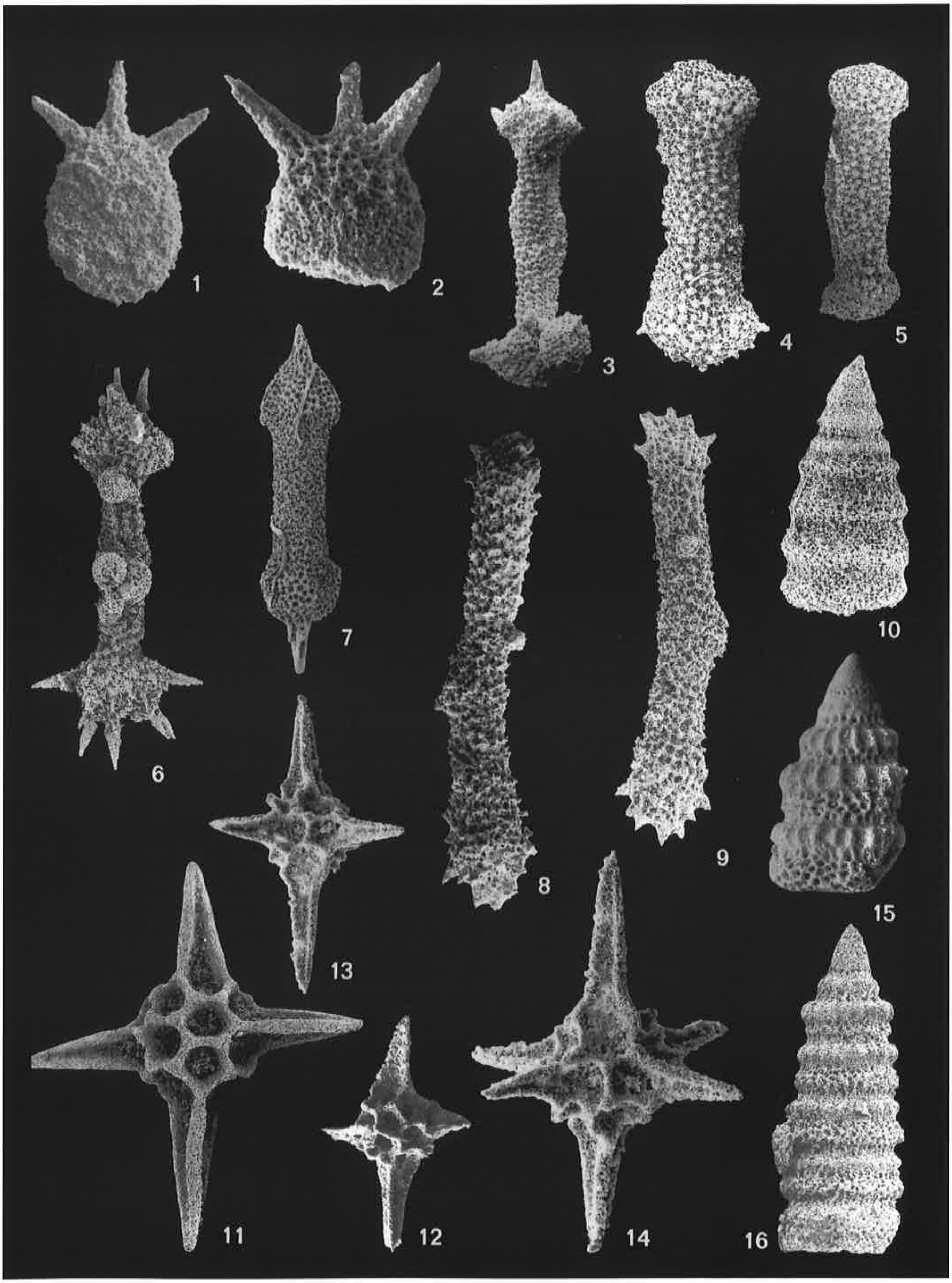
Fig. 10 ***Canoptum banale* n. sp. JUD**
MRD 5785, range U.A. 5-17
Holotype: Br. 28.85/289, 150x

Fig. 11-12 ***Cecrops septemporatus* (PARONA)**
MRD 5229, range U.A. 18-34
11. Bo. 566.50/579, 200x
12. Ru. 135.50/1793, 200x

Fig. 13-14 ***Cecrops* (?) *sexaspina* n. sp. JUD**
MRD 5068, range U.A. 20-31
13. Holotype: Ru. 135.50/1844, 200x
14. Holotype: Ru. 135.50/1823, 300x, same specimen as fig. 13, magnified and slightly inclined to show all spines

Fig. 15-16 ***Cinguloturris arabica* n. sp. JUD**
MRD 6101, range U.A. 3-18
15. Holotype: Om. 25/21, 200x
16. Paratype: Br. 1330/93, 150x

**PLATE 5**



## PLATE 6

Fig. 1-2 ***Crolanium pythiae* SCHAAF**
MRD 5532, range U.A. 20-35
1. GC. 887.00/877, 200x
2. GC. 887.00/878, 150x

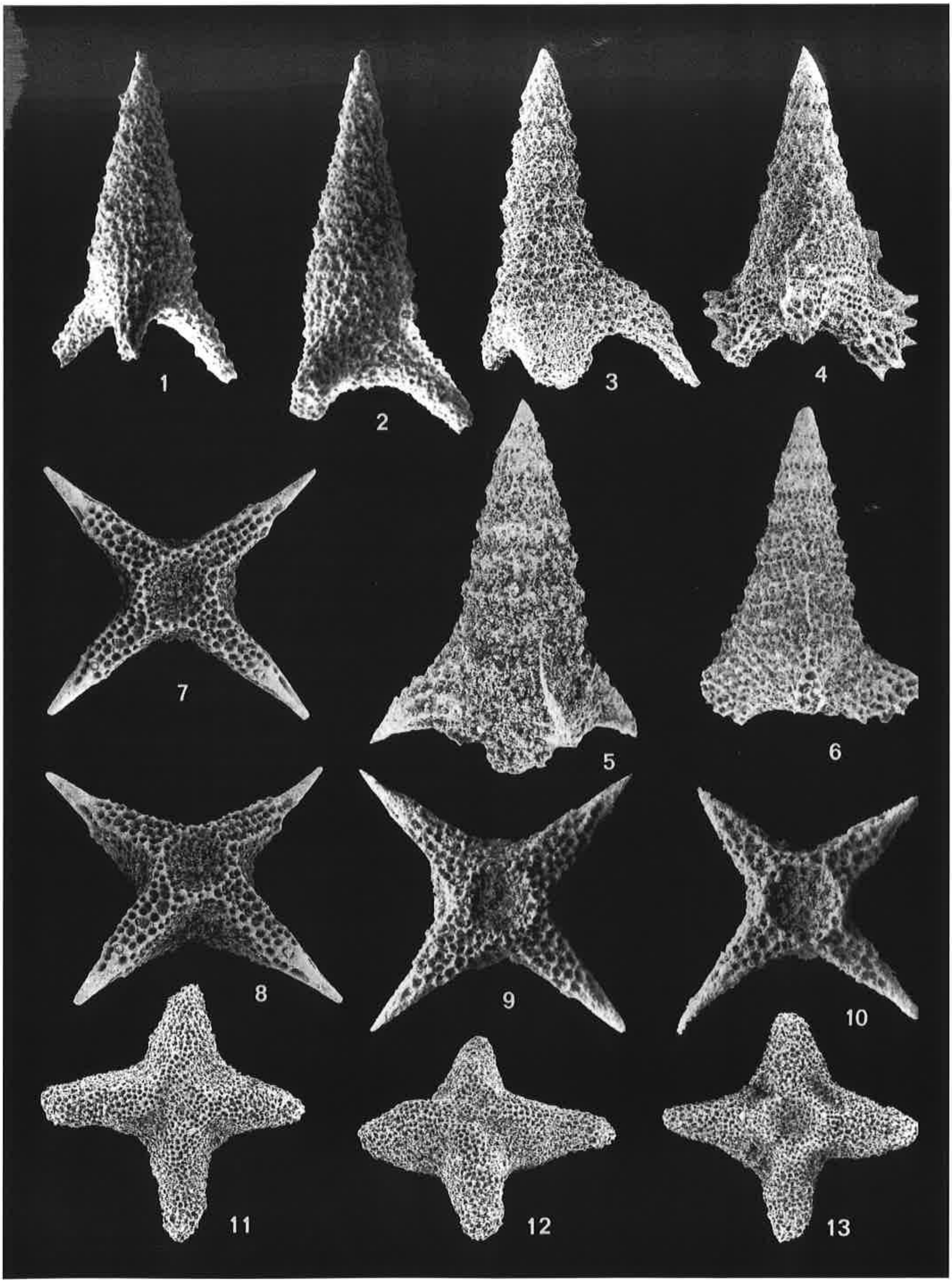
Fig. 3-6 ***Crolanium* spp.**
MRD 6123, range U.A. 17-35
3. Bo. 449.50/68, 200x
4. Br. 28.85/273, 200x
5. Bo. 566.50/114, 200x
6. Bo. 566.50/115, 200x

Fig. 7-10 ***Crucella bossoensis* n. sp. JUD**
MRD 5204, range U.A. 17-35
7. Holotype: Bo. 566.50/458, 200x
8. Holotype: Bo. 566.50/457, 200x
same specimen as fig. 7, lateral view
9. Paratype: Bo. 566.50/1678, 200x
10. Paratype: Bo. 566.50/1679, 200x

Fig. 11-12 ***Crucella collina* n. sp. JUD**
MRD 5194, range U.A. 7-34
11. Holotype: Br. 28.85/79, 150x
12. Holotype: Br. 28.85/80, 150x
same specimen as fig. 11, lateral view

Fig. 13 ***Crucella* sp. aff. *C. espartoensis* PESSAGNO**
MRD 5196, range U.A. 22-33
Br. 28.85/458, 100x

**PLATE 6**



## PLATE 7

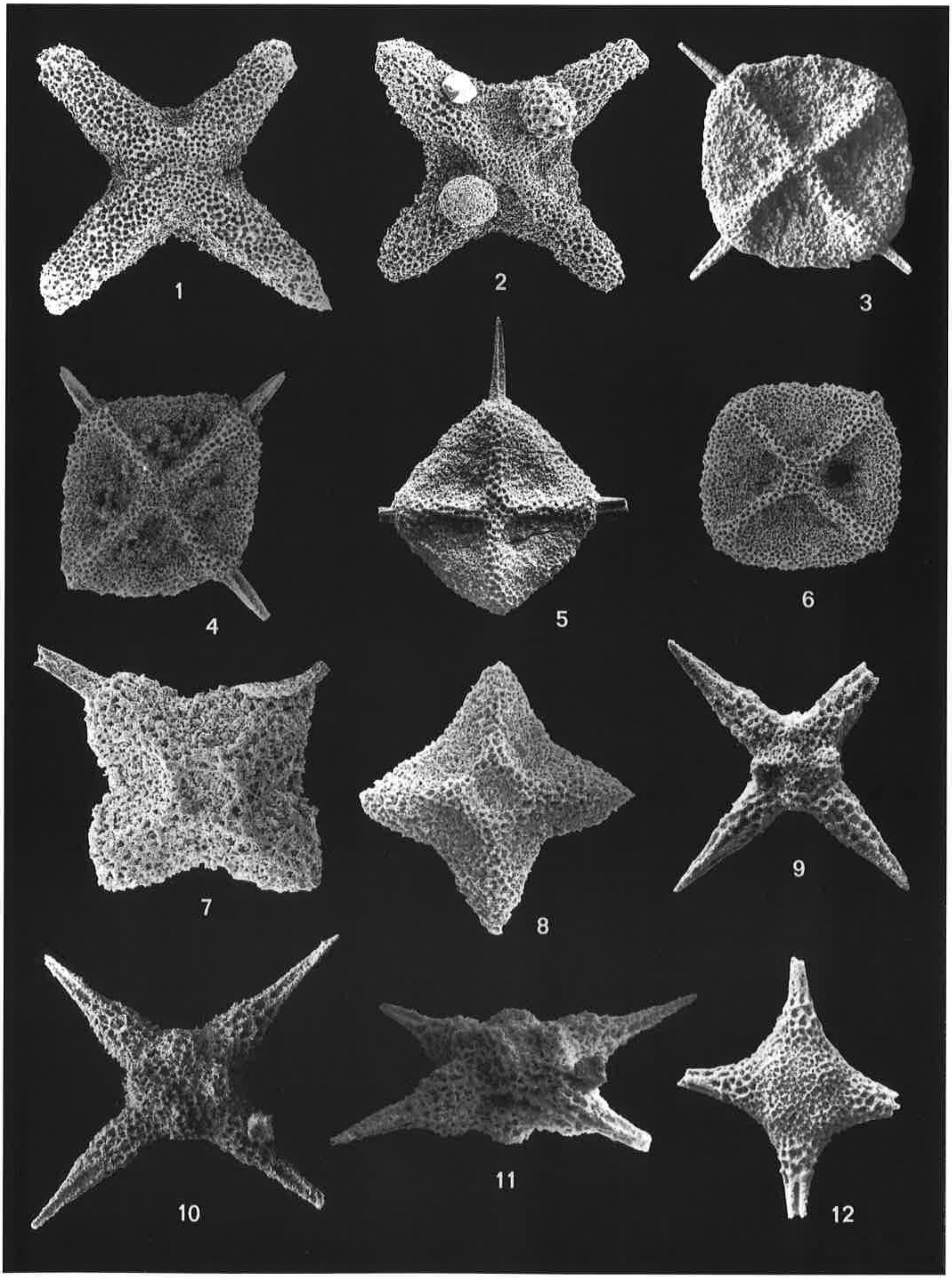
Fig. 1-2 ***Crucella collina* n. sp. JUD**
MRD 5194, range U.A. 7-34
1. Paratype: Br. 28.85/454, 150x
2. Paratype: Bo. 449.50/150, 150x

Fig. 3-6 ***Crucella* (?) *inflexa* (RÜST)**
MRD 5902, range U.A. 18-35
3. GC. 817.90/730, 100x
4. Bo. 566.50/402, 100x
5. Bo. 566.50/2909, 100x
6. Bo. 566.50/400, 100x

Fig. 7-8 ***Crucella lipmanae* n. sp. JUD**
MRD 5628, range U.A. 20-28
7. Holotype: Ru. 146.50/53, 150x
8. Paratype: Bo. 617.00/45, 150x

Fig. 9-12 ***Crucella remanei* n. sp. JUD**
MRD 5143, range U.A. 21-33
9. Paratype: Bo. 566.50/1812, 200x
10. Holotype: Ru. 135.50/1603, 200x
11. Holotype: Ru. 135.50/1604, 200x
same specimen as fig. 10. lateral view
12. Paratype: Bo. 561.50/1163, 150x

# PLATE 7



## PLATE 8

Fig. 1-3 ***Cyclastrum infundibuliforme* RÜST**
MRD 5261, range U.A. 18-35
1. Bo. 566.50/382, 100x
2. Bo. 566.50/383, 100x
3. Bo. 561.50/1154, 100x

Fig. 4 ***Cyclastrum* (?) *luminosum* n. sp. JUD**
MRD 5266, range U.A. 25-35
Holotype: Bo. 581.65/3685, 150x

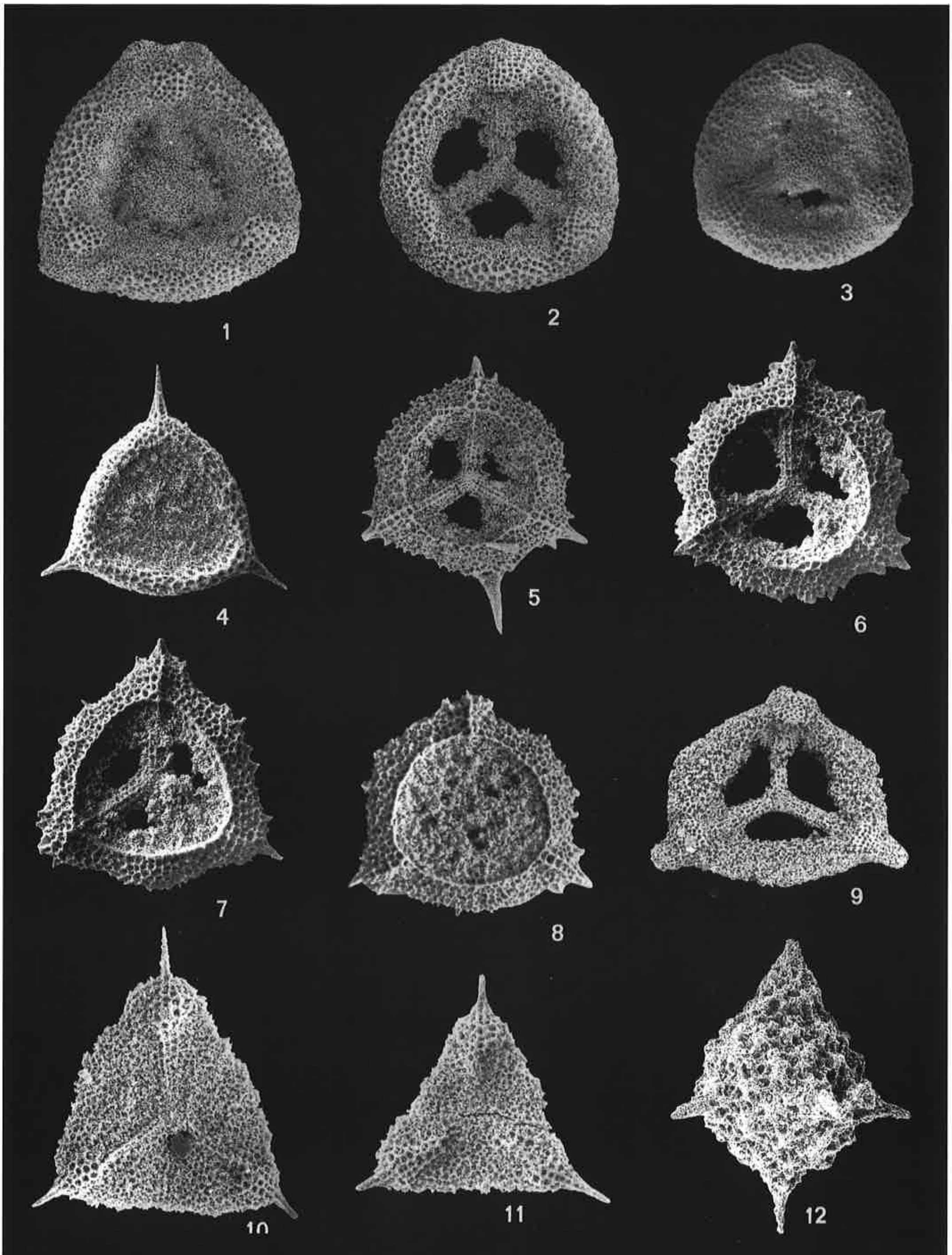
Fig. 5-8 ***Cyclastrum planum* n. sp. JUD**
MRD 5903, range U.A. 28-35
5. Holotype: Bo. 566.50/381, 100x
6. Paratype: Bo. 566.50/2905, 150x
7. Paratype: Bo. 566.50/2921, 150x
8. Paratype: Bo. 561.50/1153, 150x

Fig. 9 ***Cyclastrum rarum* (SQUINABOL)**
MRD 5290, range U.A. 9-33
9. Bo. 449.50/107, 100x

Fig. 10-11 ***Cyclastrum* (?) *trigonum* (RÜST)**
MRD 5901, range U.A. 15-34
10. Ru. 146.50/56, 125x
11. Ru. 146.50/59, 150x

Fig. 12 ***Cyrtocapsa* (?) *grutterinki* TAN**
MRD 5506, range U.A. 3-10
Bo. 370.10/296, 200x

**PLATE 8**



## PLATE 9

Fig. 1 ***Cyrtocapsa* (?) *grutterinki* TAN**
MRD 5506, range U.A. 3-10
Pi. 10.00/25, 200x

Fig. 2-4 ***Dibolachras tytthopora* FOREMAN**
MRD 5422, range U.A. 22-35
2. Pr. 225.30/210, 150x
3. Bo. 566.50/611, 150x
4. Bo. 566.50/537, 150x

Fig. 5 ***Dicroa periosa* FOREMAN**
MRD 5046, range U.A. 10-35
Bo. 566.50/615, 150x

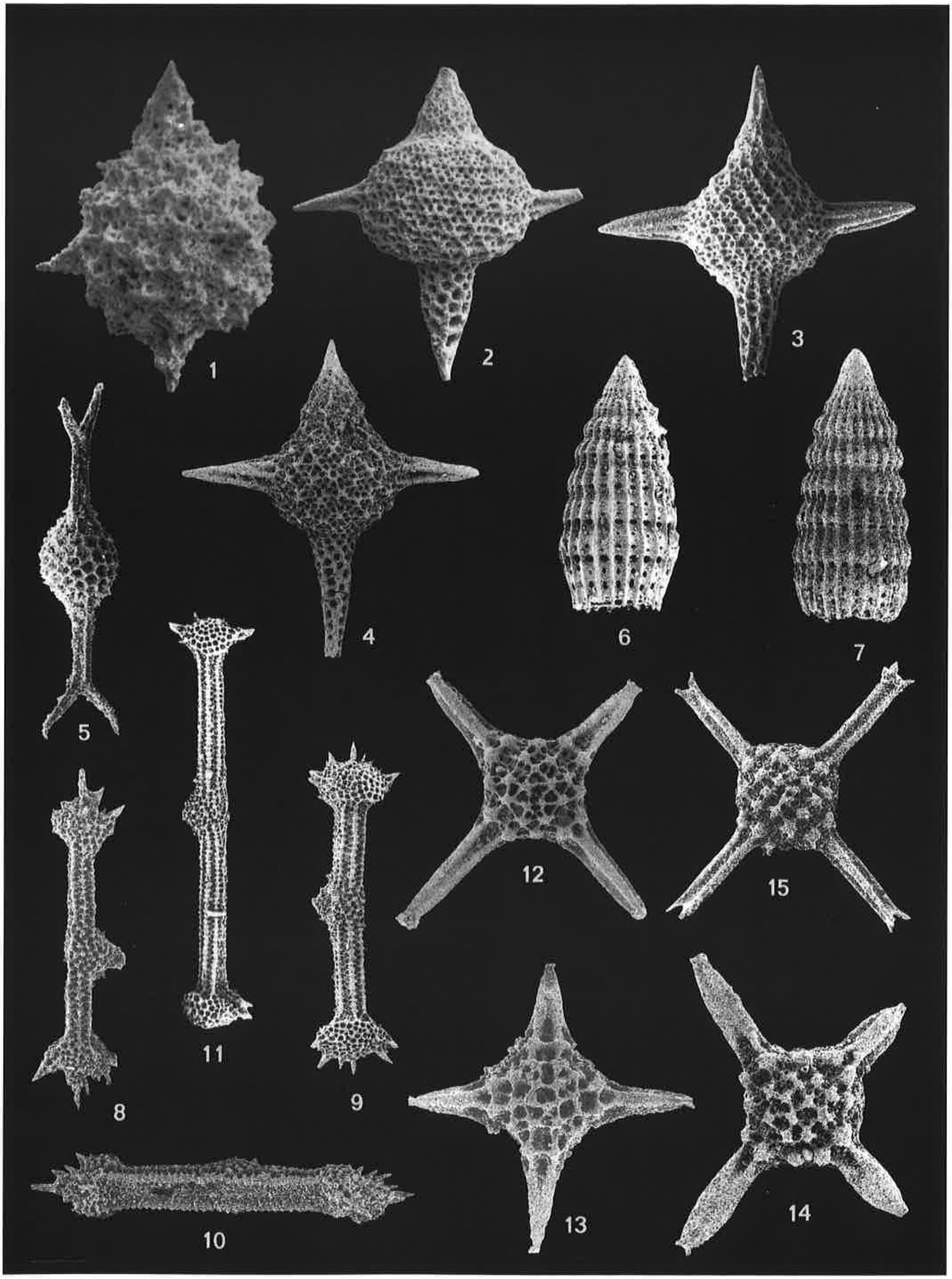
Fig. 6-7 ***Dictyomitra pseudoscalaris* TAN sensu SCHAAF**
MRD 5927, range U.A. 23-35
6. Br. 141.55/56, 150x
7. Bo. 566.50/144, 150x

Fig. 8-10 ***Ditrabs* (?) *osteosa* n. sp. JUD**
MRD 3912, range U.A. 4-16
8. Holotype: Br. 1330/53, 100x
9. Paratype: Br. 28.85/110,100x
10. Holotype: Br. 1330/55, 100x
same specimen as Fig. 8, lateral view

Fig. 11 ***Ditrabs sansalvadorensis* (PESSAGNO)**
MRD 3227, range U.A. 2-33
Br. 28.85/4, 80x

Fig. 12-14 ***Emiluvia chica decussata* (STEIGER)**
MRD 5132, range U.A. 3-25
12. Br. 28.85/118, 175x
13. Br. 1330/242, 150x
14. Br. 28.85/114, 150x

Fig. 15 ***Emiluvia hopsoni* PESSAGNO**
MRD 3225, range U.A. 1-11
Br. 28.85/115, 150x


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

## PLATE 10

Fig. 1-2 ***Emiluvia pessagnoi*** **FOREMAN**
MRD 3066, range U.A. 1-19
1. Br. 28.85/82, 100x
2. Br. 1330/37, 100x

Fig. 3-6 ***Eucyrtis columbaria*** **RENZ**
MRD 5620, range U.A. 16-35
3. Bo. 619.90/117, 300x
4. Bo. 619.90/118, 500x
5. Bo. 619.90/1501, 200x
6. Bo. 619.90/1491, 200x

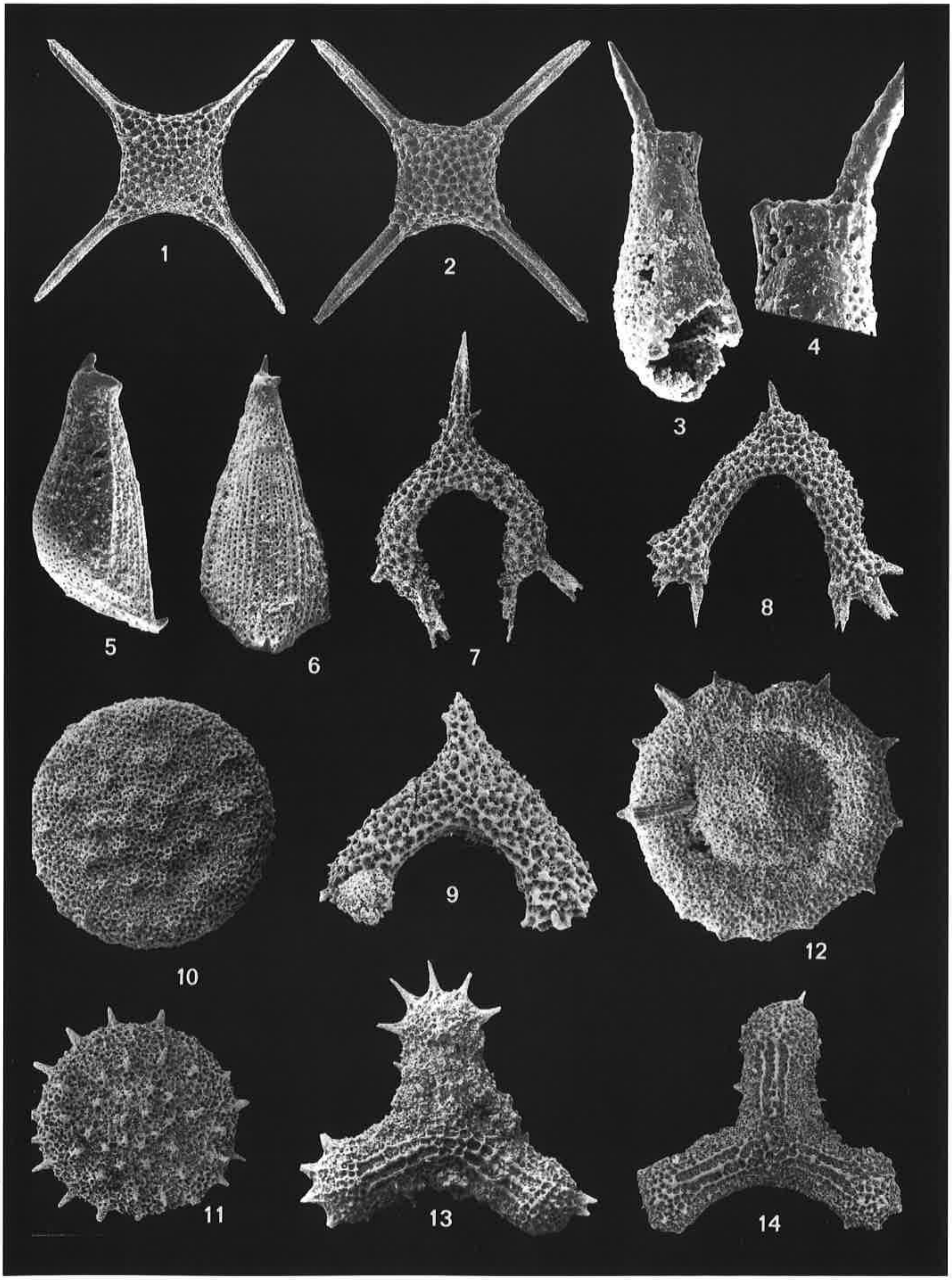
Fig. 7-9 ***Foremanella diamphidia*** **(FOREMAN)**
MRD 4073, U.A. 1-35
7. Br. 28.85/208, 150x
8. Br. 1330/130, 150x
9. Bo. 566.50/377, 200x

Fig. 10-11 ***Godia lenticulata*** **n. sp. JUD**
MRD 5287, U.A. 12-35
10. Paratype: Bo. 566.50/1838, 150x
11. Holotype: Bo. 566.50/454, 150x

Fig. 12 ***Godia tecta*** **(TUMANDA)**
MRD 5274, range U.A. 29-35
Bo. 581.65/ 39, 150x

Fig. 13-14 ***Halesium biscutum*** **n. sp. JUD**
MRD 5166, range U.A. 7-35
13. Holotype: Bo. 566.50/1676, 100x
14. Paratype: Bo. 566.50/334, 100x

PLATE 10



## PLATE 11

Fig. 1-3 ***Halesium* (?) *lineatum* n. sp. JUD**
MRD 5243, range U.A. 6-35
1. Paratype: Br. 28.85/457, 75x
2. Holotype: Br. 28.85/49, 100x
3. Paratype: Br. 28.85/47, 100x

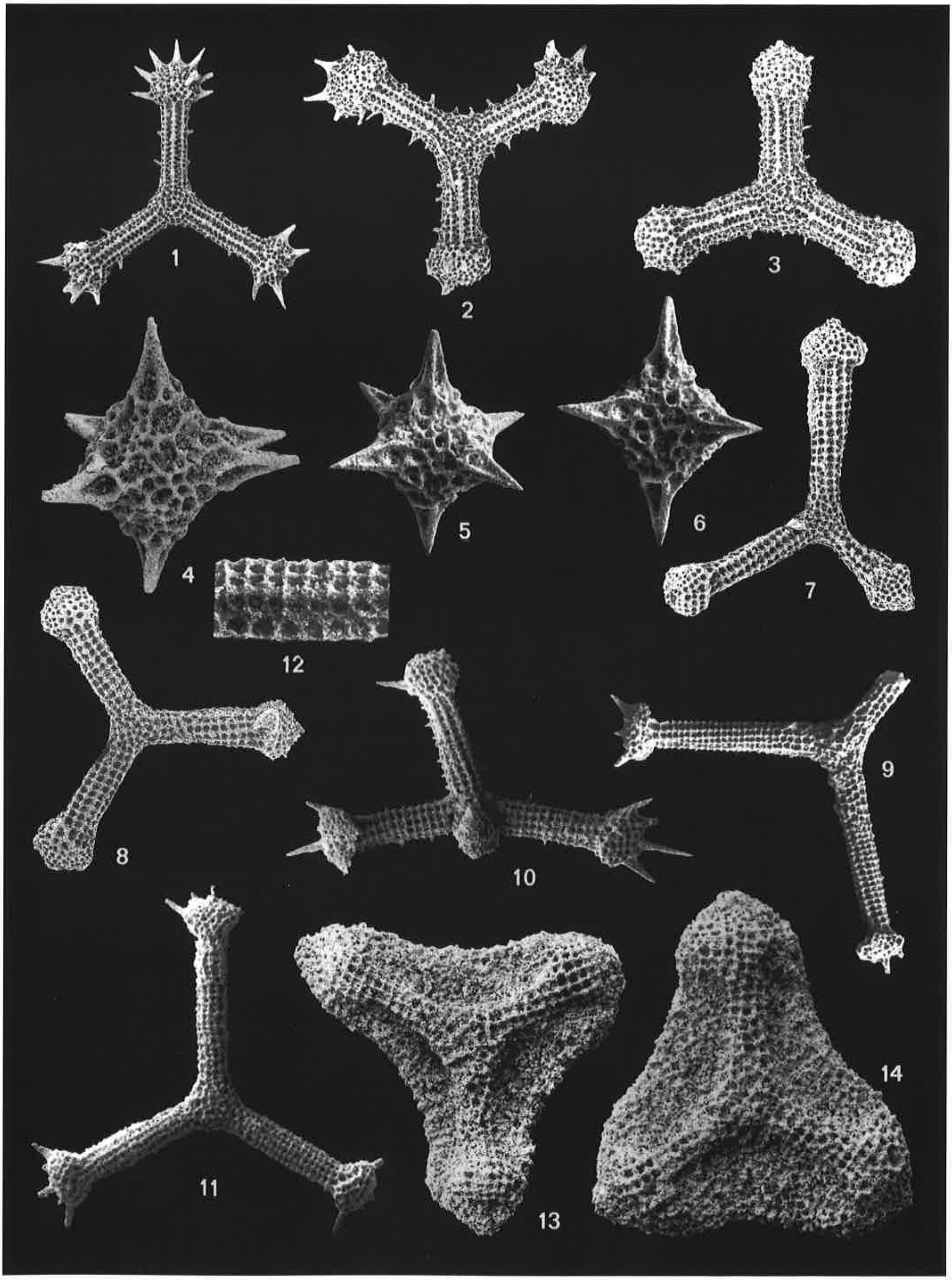
Fig. 4-6 ***Hexapyramis* (?) *precedis* n. sp. JUD**
MRD 5069, range U.A. 22-35
4. Paratype: Bo. 566.50/187, 200x
5. Holotype: Bo. 561.50/1111, 150x
6. Holotype: Bo. 561.50/1112, 150x, same specimen as fig. 5

Fig. 7-8 ***Homoeoparonaella* sp. aff. *H. irregularis* (SQUINABOL)**
MRD 5253, range U.A. 7-35
7. Br. 28.85/32, 100x
8. Br. 1330/26, 100x

Fig. 9-12 ***Homoeoparonaella peteri* n. sp. JUD**
MRD 5267, range U.A. 27-35
9. Paratype: GC. 887.00/925, 80x
10. Paratype: Bo. 580.10/1312, 100x
11. Holotype: GC. 882.40/754, 80x
12. Paratype: Bo. 566.50/1684, 340x, lateral view of rays

Fig. 13-14 ***Homoeoparonaella speciosa* (PARONA)**
MRD 5163, range U.A. 6-34
13. Bo. 569.60/95, 150x
14. Bo. 569.60/96, 150x

# PLATE 11



## PLATE 12

Fig. 1-2 ***Hsuum feliformis* n. sp. JUD**
MRD 5824, range U.A. 3-11
1. Holotype: Br. 1330/292, 200x
2. Paratype: Pi. 40.20/856, 200x

Fig. 3-5 ***Hsuum raricostatum* n. sp. JUD**
MRD 3591, range U.A.3-12
3. Holotype: Pi. 10.00/2, 150x
4. Paratype: Pi. 57.50/840, 200x
5. Paratype: Pi. 57.50/839, 200x

Fig. 6-7 ***Jacus* (?) *italicus* n. sp. JUD**
MRD 5371, range U.A. 9-32
6. Holotype: Bo. 566.50/ 212, 250x
7. Holotype: Bo. 566.50/ 213, 300x
same specimen as fig. 6, distal view

Fig. 8 ***Katroma milloti* SCHAAF**
MRD 5436, U.A. 3-26
Br. 1330/213, 150x

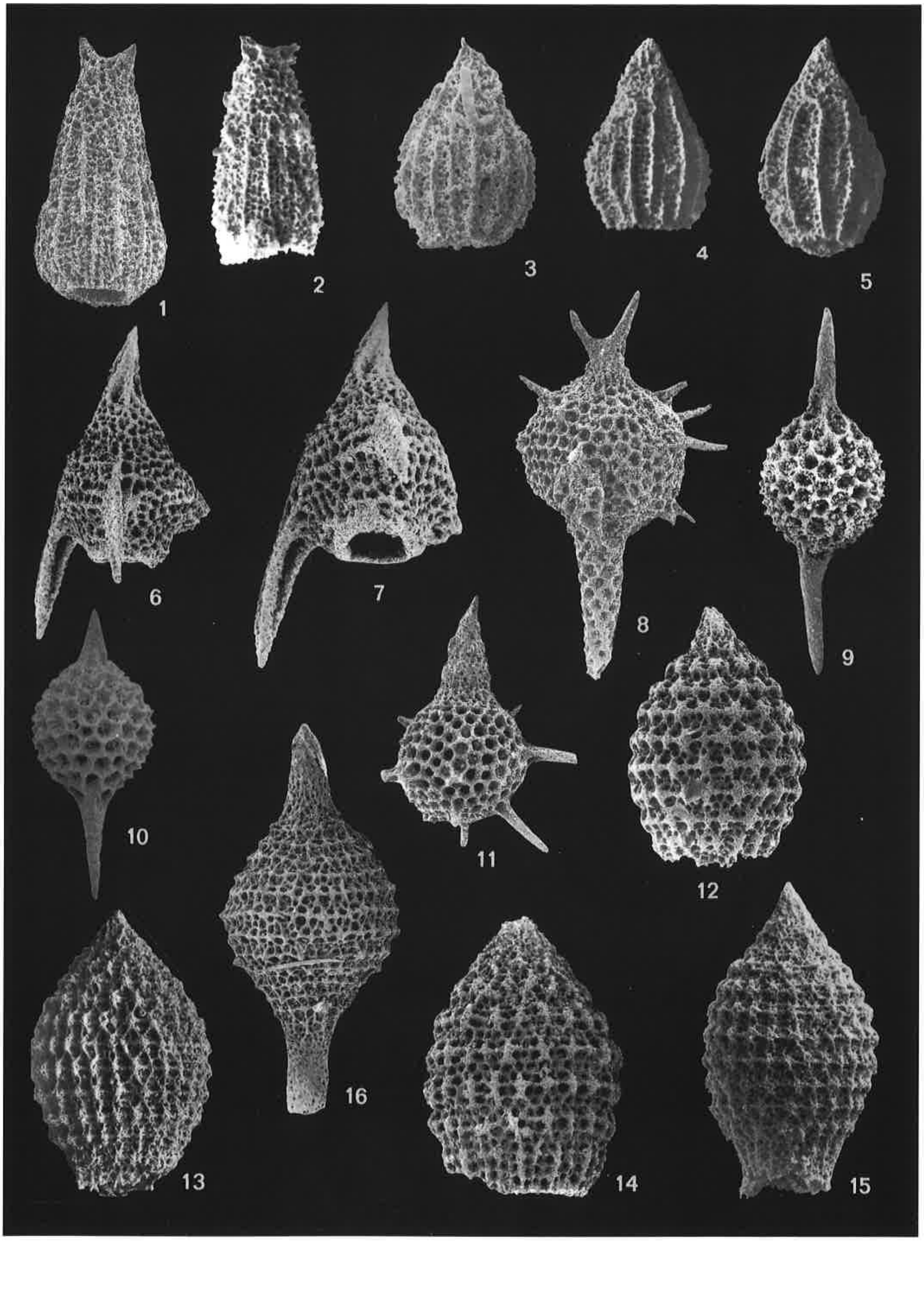
Fig. 9-10 ***Lithatractus* sp. aff. *L. pusillus* (CAMPBELL & CLARK)**
MRD 5041, range U.A. 8-35
9. Br. 141.55/142, 200x
10. Pr. 225.30/24, 200x

Fig. 11 ***Milax adrianae* n. sp. JUD**
MRD 5453, range U.A. 7-31
Holotype: Br. 28.85/108, 200x

Fig. 12-15 ***Mirifusus apenninicus* n. sp. JUD**
MRD 5716, range U.A. 6-33
12. Holotype: Bo. 449.50/49, 200x
13. Paratype: Ru. 135.50/1608, 200x
14. Paratype: Br. 28.85/468, 200x
15. Paratype: Ru. 135.50/1606, 200x

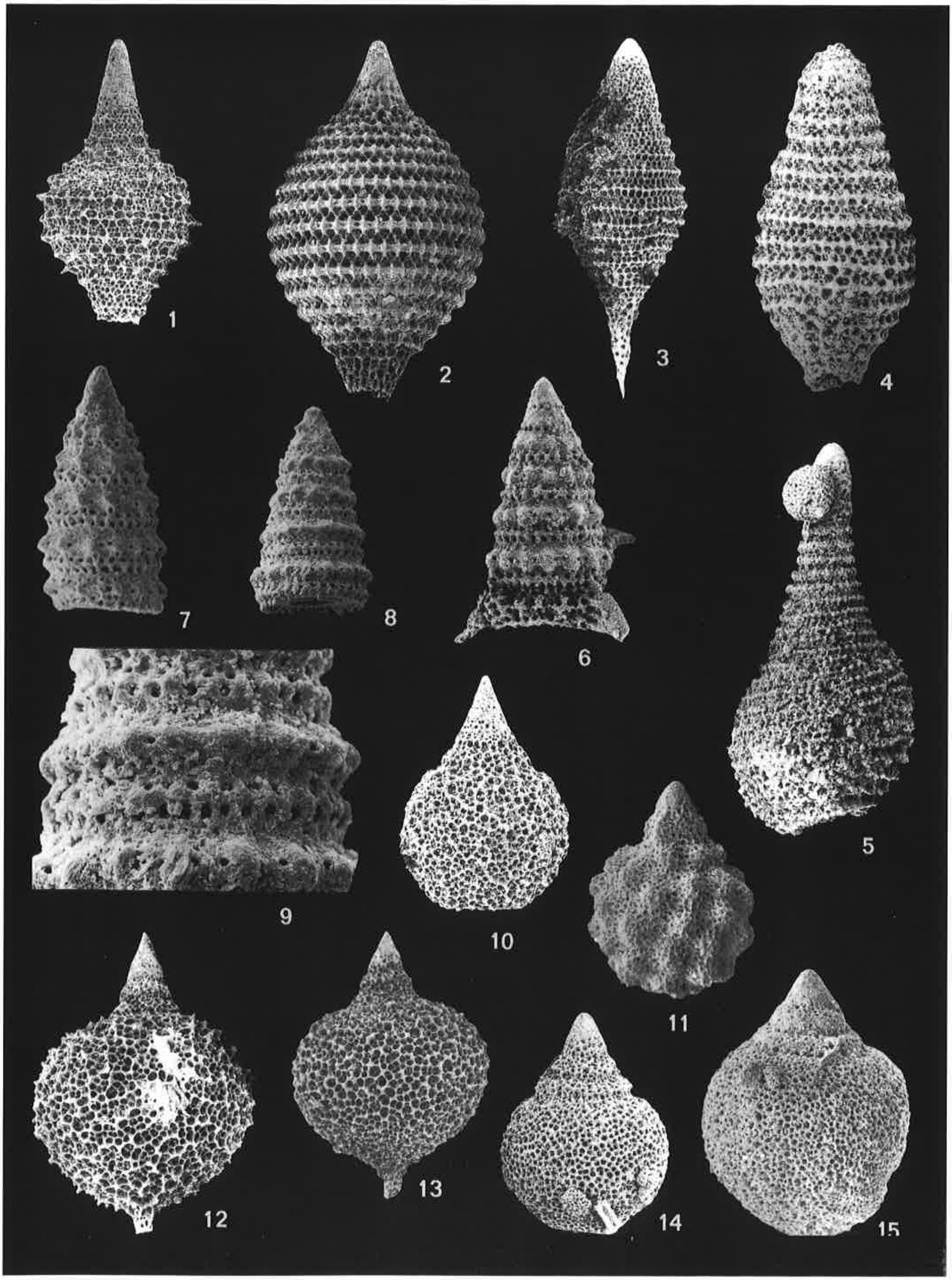
Fig. 16 ***Mirifusus chenodes* (RENZ)**
MRD 3162, range U.A. 1-35
Bo. 566.50/536, 150x

**PLATE 12**



## PLATE 13

| | |
|---|---|
| Fig. 1 | ***Mirifusus chenodes*** **(RENZ)**<br>MRD 3162, range U.A. 1-35<br>Br. 28.85/302, 150x |
| Fig. 2 | ***Mirifusus dianae minor*** **BAUMGARTNER**<br>MRD 3286, range U.A. 1-31<br>Br. 28.85/284, 100x |
| Fig. 3-4 | ***Mirifusus odoghertyi*** **n. sp. JUD**<br>MRD 5721, range U.A. 3-34<br>3. Holotype: Br. 28.85/418, 100x<br>4. Paratype: Bo. 449.50/50, 150x |
| Fig. 5 | ***Mirifusus petzholdti*** **(RÜST)**<br>MRD 5703, range U.A. 13-23<br>Bo. 449.50/226, 100x |
| Fig. 6 | ***Novixitus* (?) *daneliani*** **n. sp. JUD**<br>MRD 5524, range U.A. 25-35<br>Holotype: Br. 141.55/21, 200x |
| Fig. 7-9 | ***Novixitus* (?) *tuberculatus*** **W U**<br>MRD 5693, range U.A. 26-35<br>7. Pr. 225.30/129, 200x<br>8. Bo. 619.90/158, 200x<br>9. Bo. 619.90/159, 600x |
| Fig. 10 | ***Obesacapsula breggiensis*** **n. sp. JUD**<br>MRD 3955, range U.A. 3-15<br>Holotype: Br. 1330/321, 100x |
| Fig. 11 | ***Obesacapsula cetia*** **(FOREMAN)**<br>MRD 3203, range U.A. 1-17<br>V. -6.0/227, 100x |
| Fig. 12-13 | ***Obesacapsula lucifer*** **(BAUMGARTNER)**<br>MRD 3283, range U.A. 5-17<br>12. Br. 28.85/51, 80x<br>13. Br. 28.85/191, 80x |
| Fig. 14-15 | ***Obesacapsula morroensis*** **PESSAGNO**<br>MRD 3266, range U.A. 5-33<br>14. Br. 1330/419, 100x<br>15. Ru. 146.50/84, 80x |


1
2
3
4
7
8
6
5
9
10
11
12
13
14
15

## PLATE 14

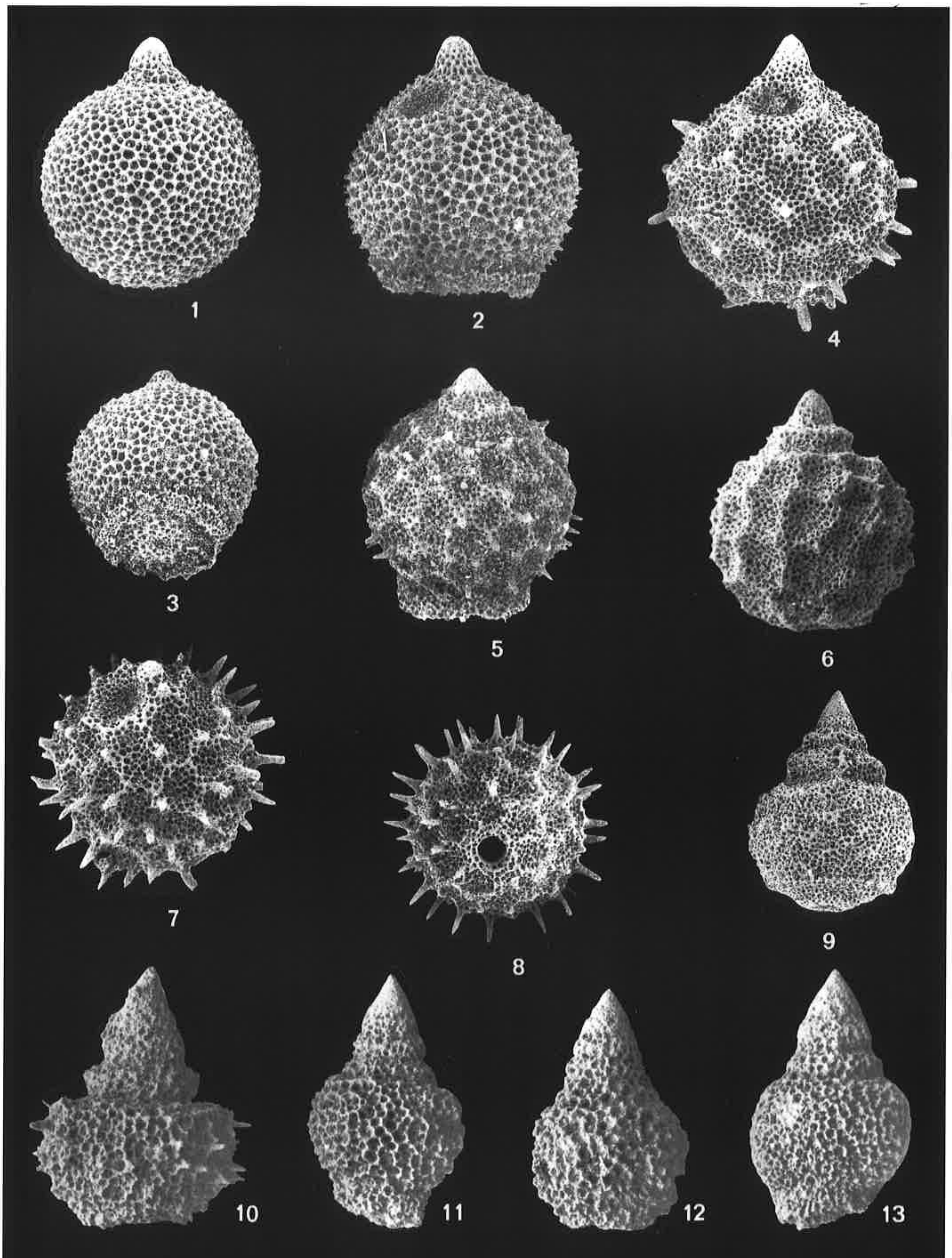
Fig. 1-3 ***Obesacapsula bullata* STEIGER**
MRD 5568, range U.A. 5-26
1. Br. 28.85/37, 80x
2. Br. 28.85/187, 100x
3. Br. 28.85/188, 80x

Fig. 4-8 ***Obesacapsula polyedra* (STEIGER)**
MRD 5565, range U.A. 6-18
4. Br. 28.85/67, 100x
5. Br. 28.85/176, 75x
6. Pi. 86.60/14, 75x
7. Br. 28.85/26, 90x
8. Br. 28.85/25, 85x

Fig. 9 ***Obesacapsula rusconensis rusconensis* BAUMGARTNER**
MRD 3282, range U.A. 5-27
Br. 28.85/ 244, 100x

Fig. 10-13 ***Obesacapsula rusconensis umbriensis* n. ssp. JUD**
MRD 5796, range U.A. 5-9
10. Paratype: Bo. 311.20/1225, 100x
11. Holotype: V. -6.50/1243, 100x
12. Paratype: V. -6.50/1245, 125x
13. Paratype: V. -6.50/1242, 100x

**PLATE 14**



## PLATE 15

Fig. 1 ***Obesacapsula rusconensis umbriensis* n. sp. JUD**
MRD 5796, range U.A. 5-9
V. -6.50/1246, 100x

Fig. 2-4 ***Obesacapsula verbana* (PARONA)**
MRD 3202, range U.A. 5-32
2. Ru. 146.50/51, 100x
3. Ru. 146.50/90, 80x
4. Pi. 56.00/23, 100x

Fig. 5-6 ***Pantanellium berriasianum* BAUMGARTNER**
MRD 3280, range U.A. 3-10
5. Br. 1330/390, 200x
6. Br. 1330/1599, 200x

Fig. 7-9 ***Pantanellium* sp. aff. *P. cantuchapai* PESSAGNO & MC LEOD**
MRD 5065, range U.A. 3-34
7. Ru. 146.50/84, 200x
8. Ru. 135.50/1804, 200x
9. Ru. 135.50/1805, 200x

Fig. 10-12 ***Pantanellium squinaboli* (TAN)**
MRD 5607, range U.A. 3-35
10. Ru. 135.50/1807, 200x
11. Ru. 135.50/1806, 200x
12. Ru. 135.50/1803, 200x

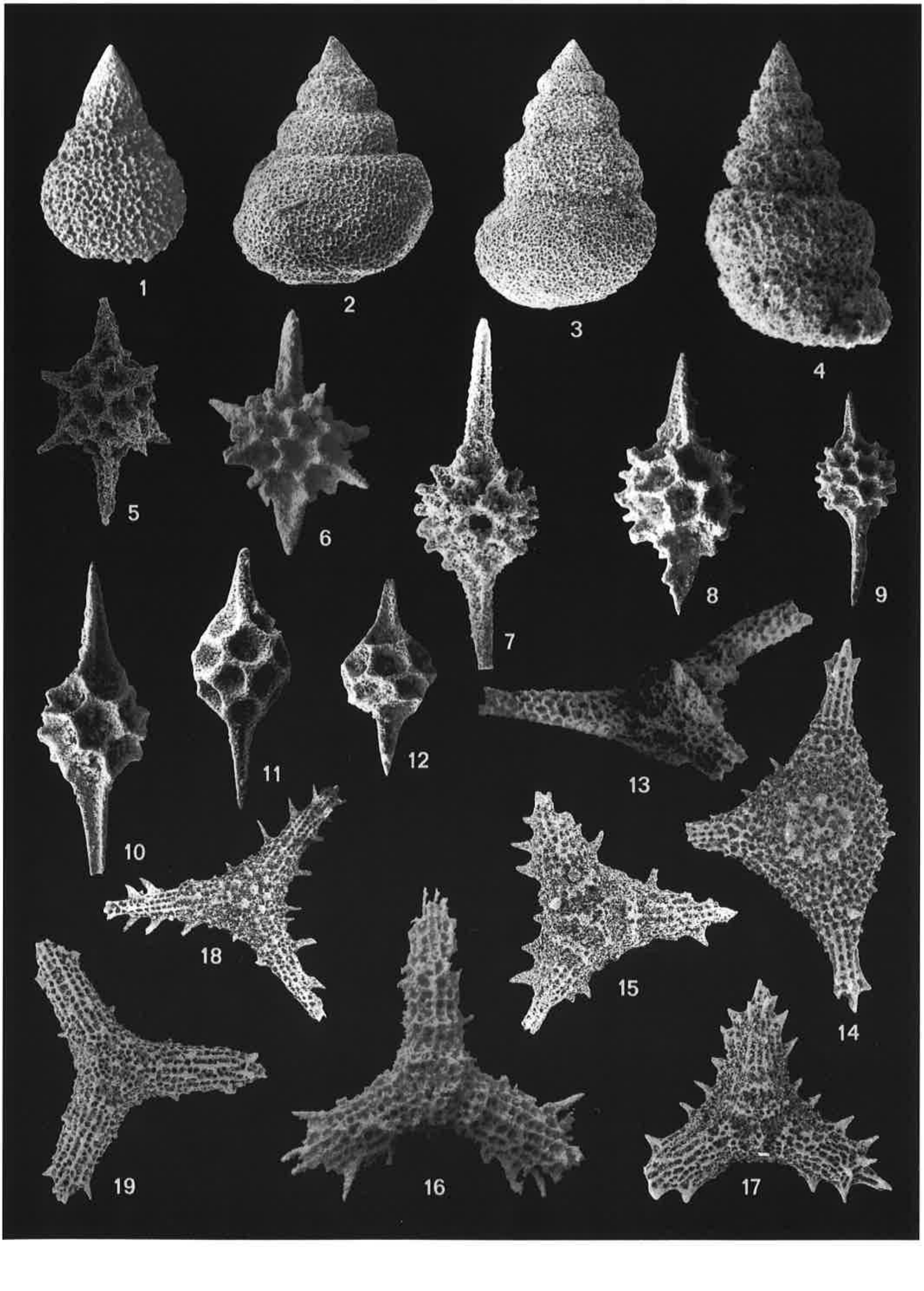
Fig. 13 ***Parapodocapsa furcata* STEIGER**
MRD 5396, range U.A. 5-13
Pi. 40.20/866, 150x

Fig. 14 ***Paronaella* (?) *annemariae* n.sp. JUD**
MRD 5314, range U.A. 8-34
Holotype: Bo. 566.50/456, 200x

Fig. 15-17 ***Paronaella* (?) *trifoliacea* OZVOLDOVA**
MRD 5186, range U.A.7-35
15. Br. 28.85/166, 150x
16. Ru. 135.50/1611, 200x
17. Bo. 566.50/345, 150x

Fig. 18-19 ***Paronaella* (?) *tubulata* STEIGER**
MRD 5183, range U.A. 3-35
18. Br. 28.85/76, 125x
19. Bo. 566.50/337, 150x

**PLATE 15**



## PLATE 16

Fig. 1-2 ***Parvicingula boesii* gr. (PARONA)**
MRD 3185, range U.A. 3-35
1. Br. 1330/361, 200x
2. Bo. 566.50/2926, 150x

Fig. 3 ***Parvicingula cosmoconica* (FOREMAN)**
MRD 3255, range U.A. 3-35
Br. 1330/91, 150x

Fig. 4-5 ***Parvicingula longa* n. sp. Jud**
MRD 5578, range U.A. 6-30
4. Holotype: Bo. 449.50/36, 200x
5. Paratype: Br. 28.85/303, 200x

Fig. 6-7 ***Parvicingula sphaerica* STEIGER**
MRD 3717, range U.A. 6-13
6. Br. 1330/430, 150x
7. Pi. 40.20/859, 150x

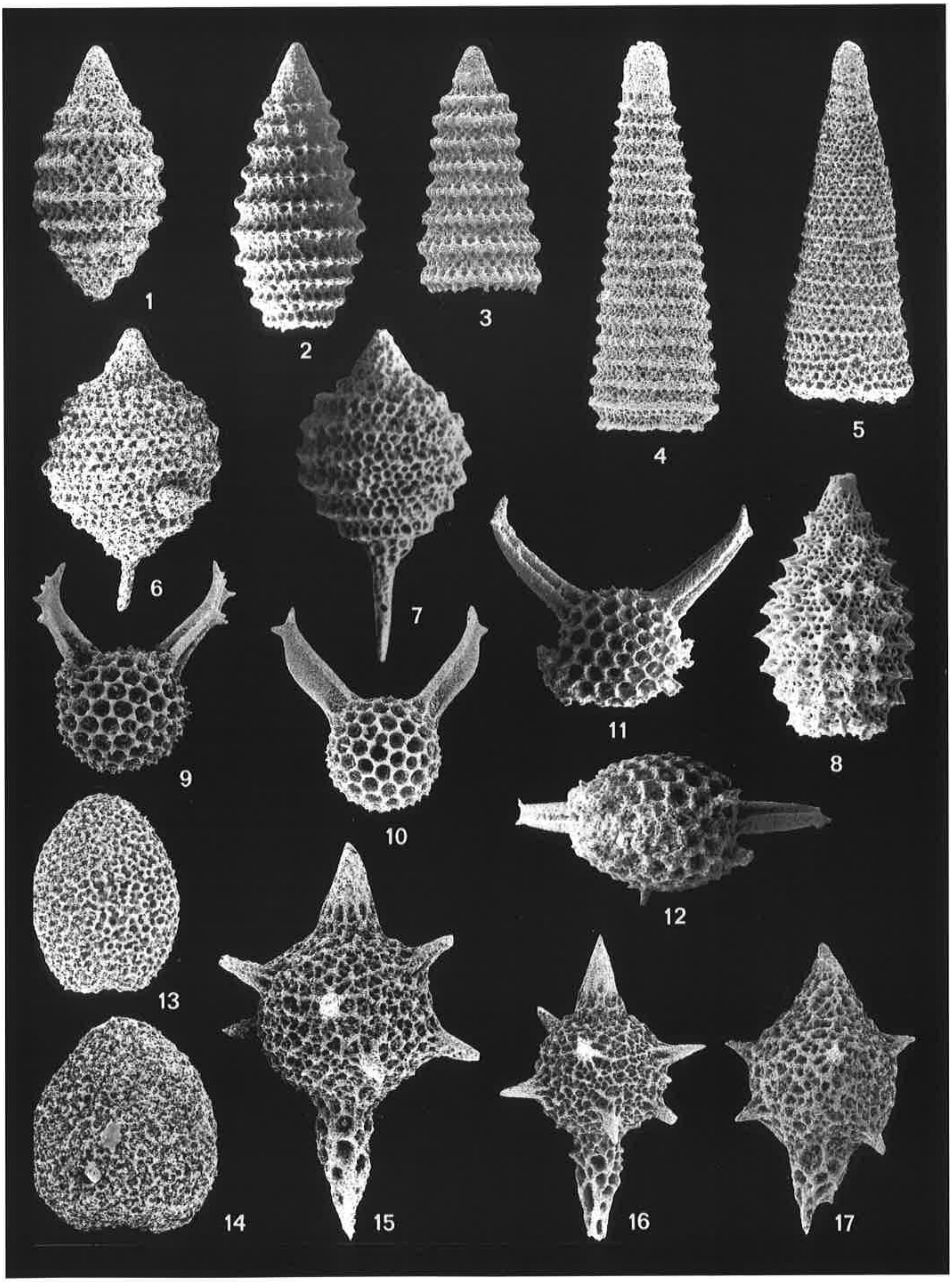
Fig. 8 ***Parvicingula usotanensis* TUMANDA**
MRD 5712, range U.A. 11-35
Bo. 619.90/108, 200x

Fig. 9-12 ***Parvivacca magna* n. sp. JUD**
MRD 3288, range U.A. 8-32
9. Paratype: Bo. 566.50/586, 150x
10. Holotype: Br. 28.85/230, 150x
11. Paratype: Bo. 566.50/1816, 125x
12. Paratype: Bo. 566.50/1817, 150x
same specimen as fig. 9, lateral view

Fig. 13-14 ***Phaseliforma ovum* n. sp. JUD**
MRD 5362, range U.A. 29-35
13. Paratype: Bo. 566.50/267, 165x
14. Holotype: Bo. 566.50/83, 160x

Fig. 15-17 ***Podobursa multispina* n. sp. JUD**
MRD 5427, range U.A. 29-32
15. Holotype: Bo. 566.50/509, 200x
16. Paratype: Bo. 566.50/587, 150x
17. Paratype: Bo. 566.50/525, 200x

# PLATE 16



## PLATE 17

Fig. 1 ***Podobursa spinosa*** **(OZVOLDOVA)**
MRD 3230, range U.A. 1-5
Pi. 10.00/41, 125x

Fig. 2-3 ***Podocapsa amphitreptera*** **FOREMAN**
MRD 3171, range U.A. 1-25
2. Bo. 311.20/83, 125x
3. Br. 28.85/420, 150x

Fig. 4-5 ***Podocapsa*** **(?)** ***imperialis*** **n. sp. JUD**
MRD 5397, range U.A. 25-32
4. Paratype: Bo. 566.50/534, 125x
5. Holotype: Bo. 566.50/535, 125x

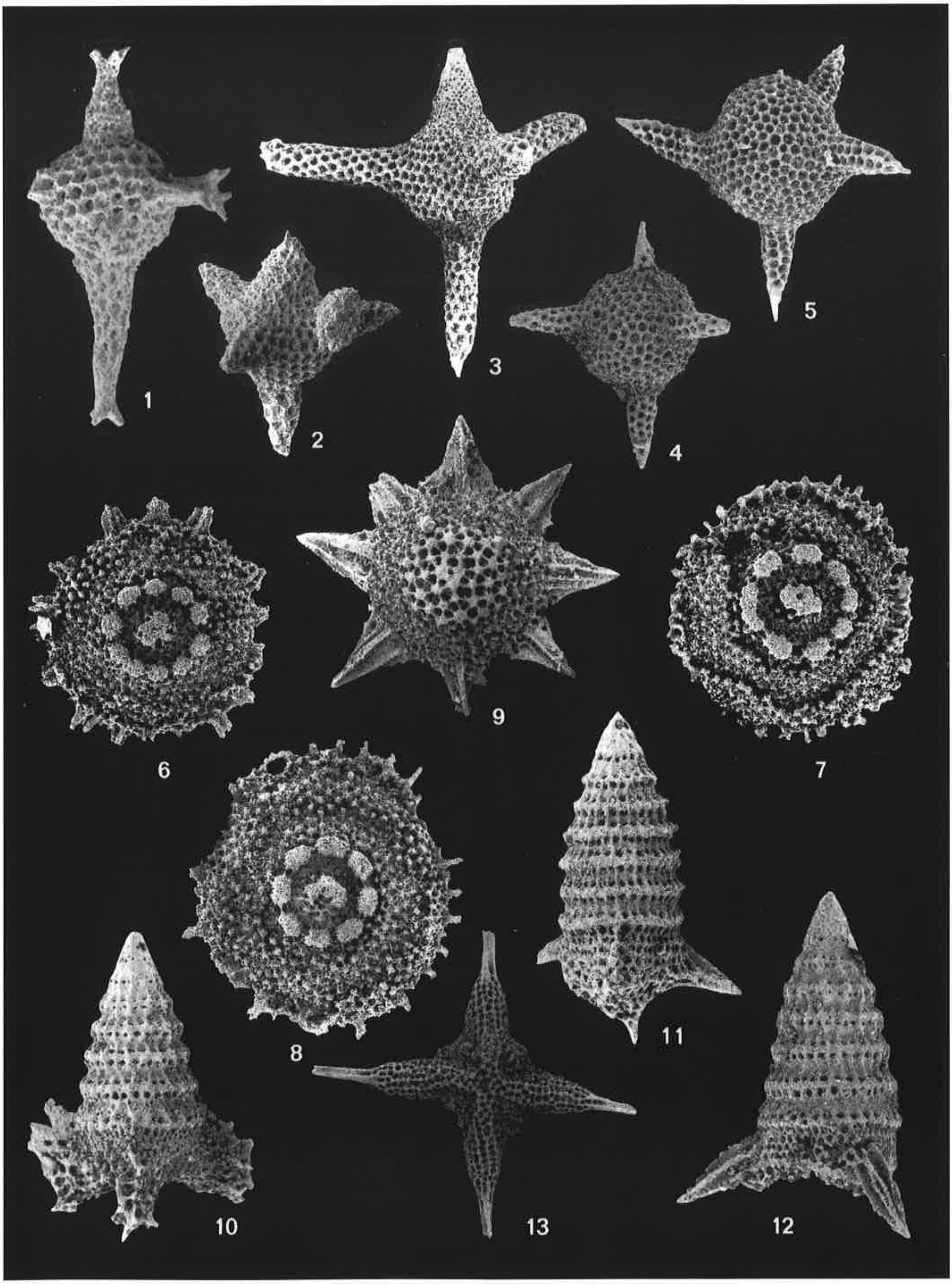
Fig. 6-8 ***Pseudoaulophacus*** **(?)** ***florealis*** **n. sp. JUD**
MRD 5334, range U.A. 15-35
6. Paratype: Bo. 566.50/438, 200x
7. Paratype: Bo. 566.50/429, 200x
8. Holotype: Bo. 566.50/434, 200x

Fig. 9 ***Pseudoaulophacus*** **(?)** ***pauliani*** **n. sp. JUD**
MRD 5332, range U.A. 7-34
Holotype: Br. 28.85/218, 125x

Fig. 10 ***Pseudocrolanium cristatum*** **n. gen., n. sp. JUD**
MRD 5521, range U.A. 24-35
Holotype: Bo. 566.50/119, 200x

Fig. 11-12 ***Pseudocrolanium flügeli*** **n. gen., n. sp. JUD**
MRD 5522, range U.A. 29-34
11. Holotype: Bo. 566.50/121, 200x
12. Paratype: Bo. 566.50/117, 200x

Fig. 13 ***Pseudocrucella*** **(?)** ***elisabethae*** **(RÜST)**
MRD 3947, range U.A. 6-35
Bo. 566.50/354, 100x


1
2
3
4
5
6
7
8
9
10
11
12
13

## PLATE 18

Fig. 1-2 ***Pseudocrucella* (?) *elisabethae* (RÜST)**
MRD 3947, range U.A. 6-35
1. Br. 28.85/9, 100x
2. Br. 28.85/41, 120x

Fig. 3-5 ***Pseudodictyomitra carpatica* (LOZYNIAK)**
MRD 3293, range U.A. 3-34
3. Om. 169/1647, 200x
4. Om. 1/24, 200x
5. Br. 28.85/1529, 200x

Fig. 6 ***Pseudodictyomitra lanceloti* SCHAAF**
MRD 5641, range U.A. 31-35
Bo. 619.90/53, 200x

Fig. 7 ***Pseudodictyomitra* sp. aff. *P. lanceloti* SCHAAF**
MRD 5642, range U.A. 34
Bo. 619.90/103, 200x

Fig. 8 ***Pseudodictyomitra leptoconica* (FOREMAN)**
MRD 5973, range U.A. 35
GC. 887.00/883, 250x

Fig. 9-11 ***Pseudodictyomitra lilyae* (TAN)**
MRD 5625, range U.A. 30-35
9. Bo. 566.50/2918, 200x
10. Bo. 566.50/2914, 200x
11. Br. 141.55/4, 200x

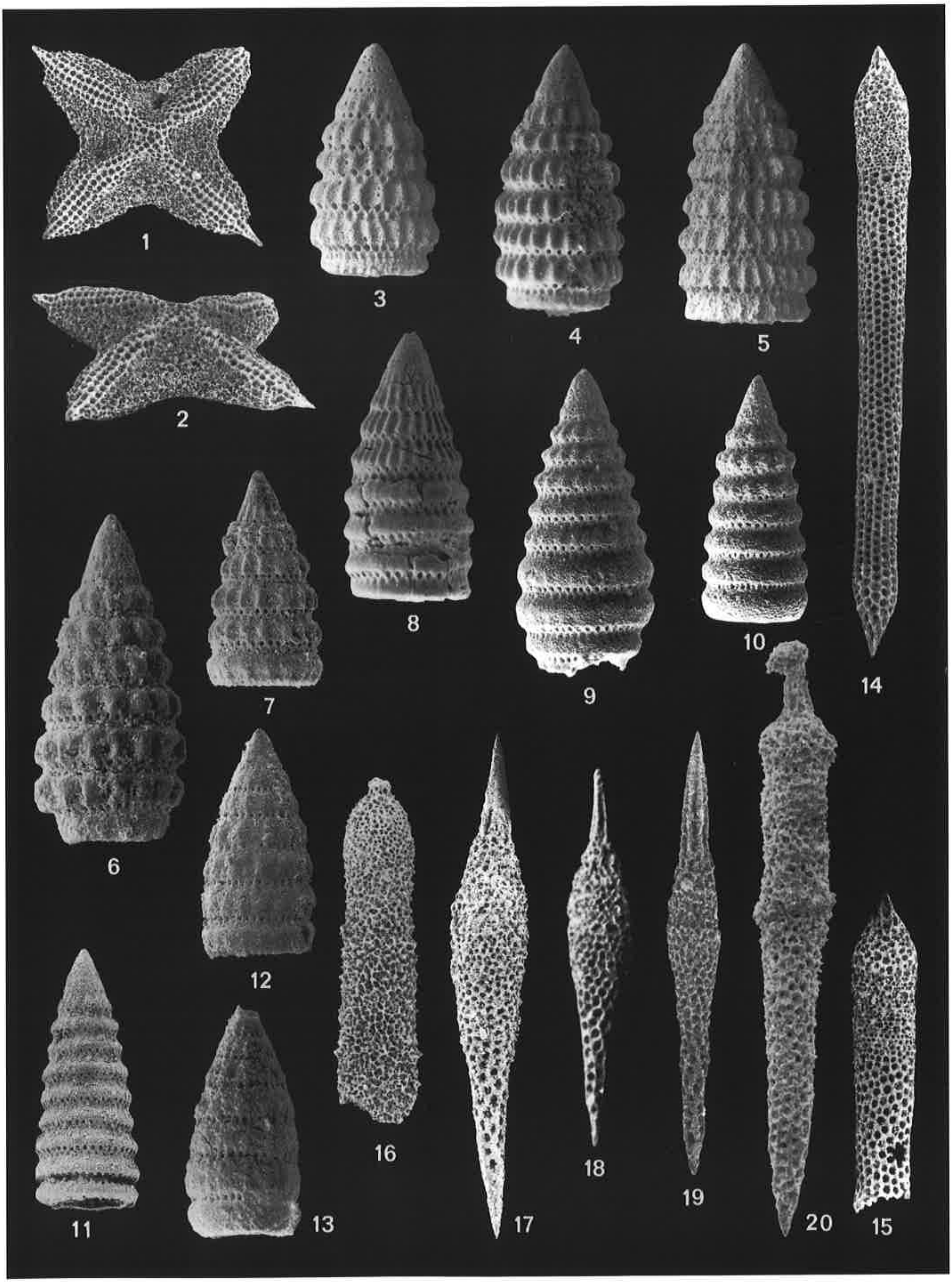
Fig. 12-13 ***Pseudodictyomitra nuda* SCHAAF**
MRD 5647, range U.A. 16-35
12. Bo. 619.90/5, 200x
13. Bo. 619.90/106, 200x

Fig. 14-15 ***Pseudoeucyrtis acus* n. sp. JUD**
MRD 5572, range U.A. 10-33
14. Holotype: Br. 28.85/109, 150x
15. Paratype: Br. 28.85/274, 150x

Fig. 16 ***Pseudoeucyrtis* (?) *aspera* n. sp. JUD**
MRD 5576, range U.A. 17-33
Holotype: Bo. 566.50/2, 100x

Fig. 17-19 ***Pseudoeucyrtis* (?) *fusus* n. sp. JUD**
MRD 5408, range U.A. 5-19
17. Paratype: Br. 28.85/287, 150x
18. Paratype: Pi. 40.20/852, 120x
19. Holotype: Br. 1330/128, 150x

Fig. 20 ***Pseudoeucyrtis sceptrum* n. sp. JUD**
MRD 5577, range U.A. 6-12
Holotype: V. -6.50/222, 150x


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

## PLATE 19

Fig. 1 ***Ristola altissima* s. l. (RÜST)**
MRD 3164, range U.A. 1
SV. 16/3728, 100x

Fig. 2-3 ***Ristola asparagus* n. sp. JUD**
MRD 5575, range U.A. 9-35
2. Holotype: Bo. 566.50/21, 150x
3. Paratype: Bo. 566.50/86, 150x

Fig. 4-6 ***Ristola cretacea* (BAUMGARTNER)**
MRD 3165, range U.A. 3-20
4. Br. 28.85/221, 150x
5. Br. 28.85/241, 150x
6. Br. 1330/263, 100x

Fig. 7-8 ***Ristola martae* n. sp. JUD**
MRD 5766, range U.A. 22-32
7. Holotype: Bo. 566.50/170, 150x
8. Paratype: Bo. 566.50/53, 150x

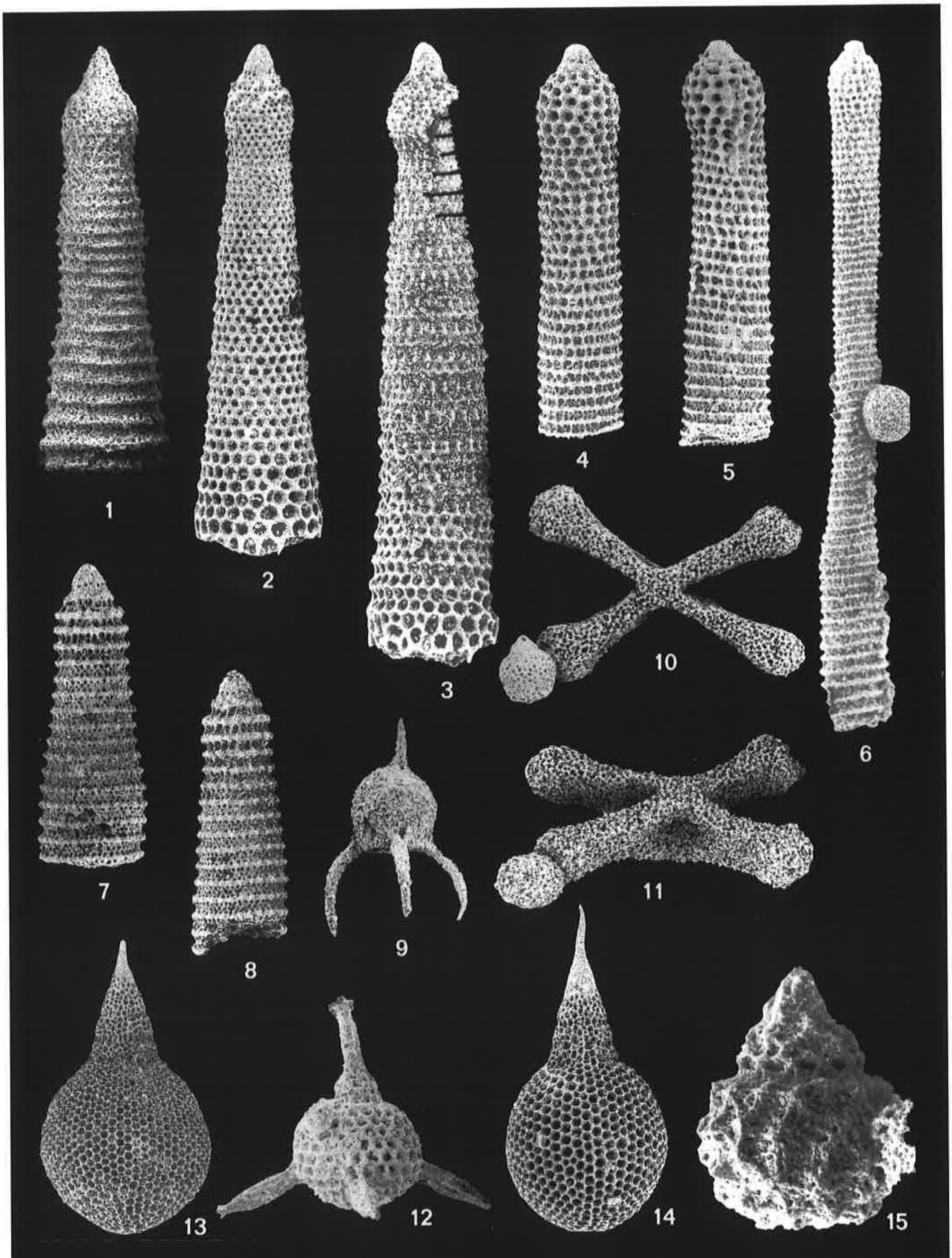
Fig. 9 ***Saitoum elegans* DE WEVER**
MRD 3022, range U.A. 1-34
Br. 28.85/512, 200x

Fig. 10-11 ***Savaryella guexi* n. gen, .n. sp. JUD**
MRD 5193, range U.A. 7-34
10. Holotype: Bo. 449.50/134, 100x
11. Holotype: Bo. 449.50/136, 100x
same specimen as fig. 10, lateral view

Fig. 12 ***Sethocapsa* (?) *concentrica* STEIGER**
MRD 5433, range U.A. 5-8
Pi. 10.0/43, 100x

Fig. 13-14 ***Sethocapsa dorysphaeroides* NEVIANI sensu SCHAAF**
MRD 5544, range U.A. 5-35
13. Bo. 566.50/501, 100x
14. Br. 28.85/142, 100x

Fig. 15 ***Sethocapsa* sp. aff. *S. kaminogoensis* AITA**
MRD 5481, range U.A. 5-34
Bo. 580.10/1368, 300x


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

## PLATE 20

Fig. 1-2 ***Sethocapsa* sp. aff. *S. kaminogoensis* AITA**
MRD 5481, range U.A. 5-34
1. Bo. 449.50/110, 200x
2. Pr. 225.30/202, 300x

Fig. 3-4 ***Sethocapsa kitoi* n. sp. JUD**
MRD 3264, range U.A. 5-15
3. Holotype: Br. 1330/476, 200x
4. Paratype: Om. 1/22, 200x

Fig. 5 ***Sethocapsa leiostraca* FOREMAN**
MRD 3062, range U.A. 1-32
Bo. 566.50/529, 150x

Fig. 6-7 ***Sethocapsa* (?) *orca* FOREMAN**
MRD 5553, range U.A. 28-35
6. Bo. 566.50/1835, 150x
7. Bo. 566.50/1839, 150x

Fig. 8 ***Sethocapsa simplex* TAKETANI**
MRD 5469, range U.A. 29-35
Pr. 225.30/20, 200x

Fig. 9 ***Sethocapsa trachyostraca* FOREMAN**
MRD 3063, range U.A. 7-35
Br. 28.85/480, 150x

Fig. 10-11 ***Sethocapsa tricornis* n. sp. JUD**
MRD 5510, range U.A. 5-16
10. Holotype: Br. 1330/433, 150x
11. Paratype: Br. 1330/423, 150x

Fig. 12-14 ***Sethocapsa zweilii* n. sp. JUD**
MRD 5464, range U.A. 6-26
12. Paratype: Bo. 449.50/212, 200x
13. Holotype: Bo. 449.50/200, 200x
14. Paratype: Om. 1/5, 200x

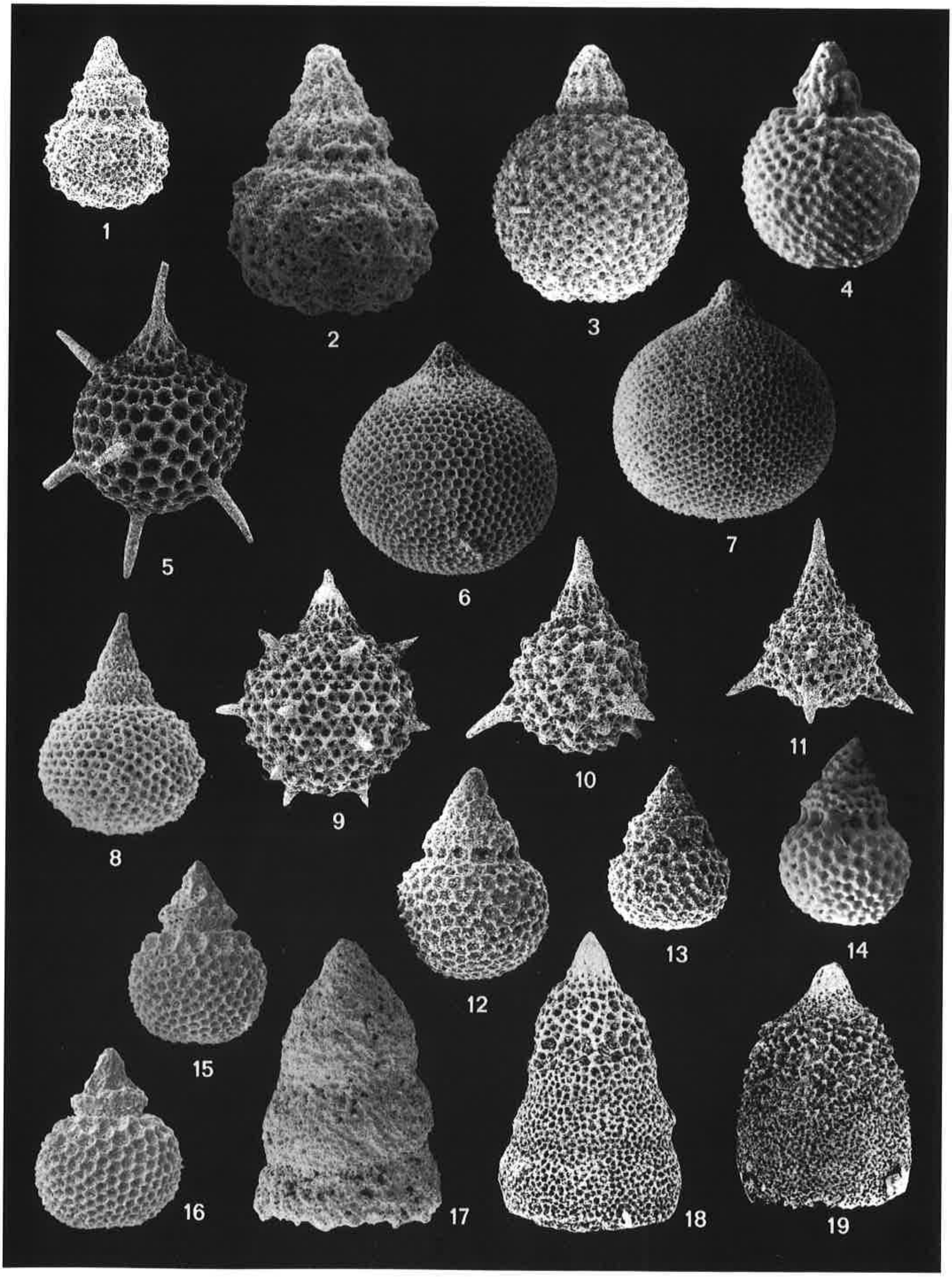
Fig. 15-16 ***Sethocapsa uterculus* (PARONA) sensu FOREMAN**
MRD 5462, range U.A. 6-35
15. Pr. 225.30/182, 200x
16. Pr. 225.30/183, 200x

Fig. 17 ***Solenotryma ichikawai* MATSUOKA**
MRD 4037, range U.A. 19-34
Bo. 569.60/47, 200x

Fig. 18 ***Spongocapsula coronata* (SQUINABOL)**
MRD 5773, range U.A. 22-35
Bo. 566.50/171, 150x

Fig. 19 ***Spongocapsula obesa* n. sp. JUD**
MRD 5771, range U.A. 26-35
Holotype: Bo. 566.50/163, 200x

## PLATE 20



## PLATE 21

Fig. 1 ***Spongocapsula obesa* n. sp. JUD**
MRD 5771, range U.A. 26-35
Paratype: Pr. 225.30/178, 150x

Fig. 2 ***Spongocapsula* (?) *tripes* n. sp. JUD**
MRD 5526, range U.A. 29-33
Holotype: Bo. 566.50/106, 150x

Fig. 3 ***Spongotripus* (?) *satoi* (TUMANDA)**
MRD 5262, range U.A. 26-35
Bo. 566.50/398, 150x

Fig. 4-5 ***Stichocapsa altiforamina* TUMANDA**
MRD 5761, range U.A. 25-34
4. Bo. 566.50/99, 200x
5. Pr. 225.30/16, 200x

Fig. 6-7 ***Stichocapsa pulchella* (RÜST)**
MRD 5744, range U.A. 21-35
6. Bo. 566.50/2904, 200x
7. Bo. 566.50/51, 200x

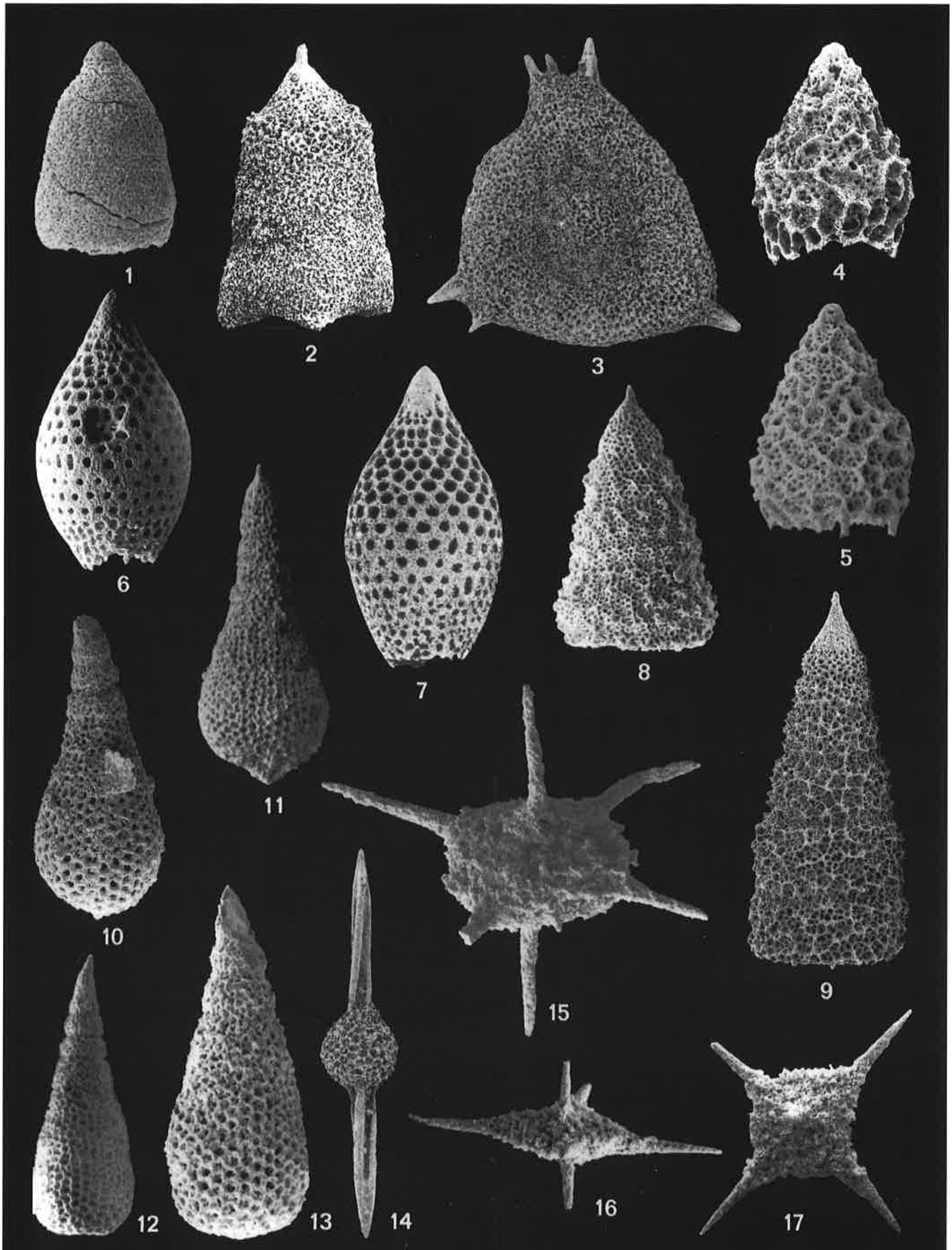
Fig. 8-9 ***Stichomitra* sp. aff. *S. asymbatos* FOREMAN**
MRD 5672, range U.A. 9-35
8. Bo. 566.50/613, 200x
9. Br. 28.85/347, 150x

Fig. 10-13 ***Stichomitra* (?) sp. aff. *S. euganea* (SQUINABOL)**
MRD 5550, range U.A. 33-35
10. Bo. 619.90/101, 125x
11. GC. 898.00/707, 100x
12. GC. 887.00/894, 100x
13. GC. 882.40/745, 100x

Fig. 14 ***Stylosphaera* (?) *macroxiphus* (RÜST)**
MRD 5044, range U.A. 5-35
Br. 141.55/63, 125x

Fig. 15-17 ***Stylospongia* (?) *titirez* n. sp. JUD**
MRD 5090, range U.A. 29-35
15. Paratype: GC. 824.80/1031, 250x
16. Holotype: GC. 821.45/1791, 170x, lateral view
17. Holotype: GC. 821.45/1790, 150x, apical view

PLATE 21



## PLATE 22

Fig. 1 ***Suna echiodes*** **(FOREMAN)**
MRD 3094, range U.A. 1-35
Bo. 566.50/541, 100x

Fig. 2-3 ***Suna hybum*** **(Foreman)**
MRD 5049, range U.A. 25-35
2. Bo. 619.90/138, 145x
3. GC. 887.00/93, 200x

Fig. 4 ***Syringocapsa agolarium*** **FOREMAN**
MRD 3291, range U.A. 3-32
Bo. 566.50/1837, 200x

Fig. 5 ***Syringocapsa coronata*** **STEIGER**
MRD 5417, range U.A. 5-15
Br. 1330/20, 100x

Fig. 6-8 ***Syringocapsa*** **sp. aff.** ***S. coronata*** **STEIGER**
MRD 5416, range U.A. 5-29
6. Br. 28.85/33, 150x
7. Br. 28.85/476, 100x
8. Br. 28.85/385, 125x

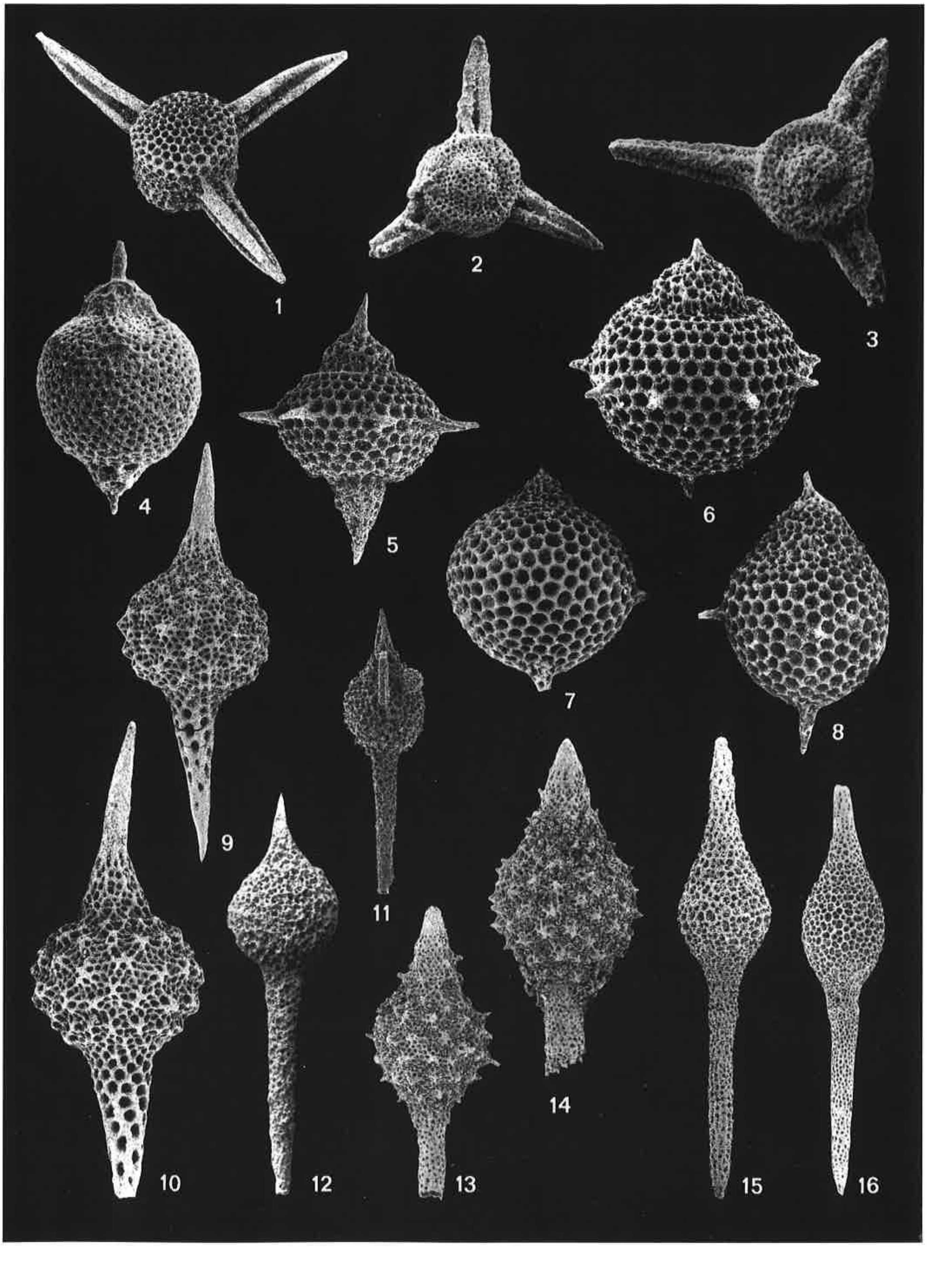
Fig. 9-10 ***Syringocapsa limatum*** **FOREMAN**
MRD 5426, range U.A. 5-34
9. Bo. 566.50/483, 150x
10. Bo. 566.50/234, 150x

Fig. 11-12 ***Syringocapsa longitubus*** **n. sp. JUD**
MRD 5410, range U.A. 3-16
11. Holotype: Br. 1330/41, 100x
12. Paratype: Bo. 311.20/1195, 100x

Fig. 13-14 ***Syringocapsa spinosa*** **(SQUINABOL)**
MRD 5711, range U.A. 26-35
13. Bo. 566.50/533, 150x
14. Bo. 566.50/532, 150x

Fig. 15-16 ***Syringocapsa vicetina*** **(SQUINABOL)**
MRD 5409, range U.A. 5-21
15. Bo. 449.50/211, 125x
16. Br. 28.85/231, 100x

**PLATE 22**



## PLATE 23

Fig. 1-2 ***Tetratrabs radix* n. sp. JUD**
MRD 5209, range U.A. 3-21
1. Paratype: Pi. 10.00/787, 80x
2. Holotype: V. -6.00/14, 75x

Fig. 3 ***Thanarla elegantissima* (CITA) sensu SANFILIPPO & RIEDEL**
MRD 5296, range U.A. 24-35
GC. 786.70/743, 275x

Fig. 4-5 ***Thanarla gutta* n. sp. JUD**
MRD 5904, range U.A. 30-34
4. Paratype: Bo. 566.50/70, 150x
5. Holotype: Bo. 566.50/1830, 150x

Fig. 6-7 ***Thanarla pulchra* (SQUINABOL) sensu SANFILIPPO & RIEDEL**
MRD 5073, range U.A. 9-35
6. Bo. 566.50/2902, 200x
7. Pr. 225.30/146, 200x

Fig. 8-9 ***Triactoma luciae* n. sp. JUD**
MRD 5055, range U.A. 6-33
8. Paratype: Ru. 135.50/1810, 150x
9. Holotype: Br. 1330/80, 125x

Fig. 10-11 ***Triactoma tithonianum* RÜST**
MRD 3097, range U.A. 1-35
10. Br. 28.85/60, 150x
11. Ru. 146.50/74, 150x

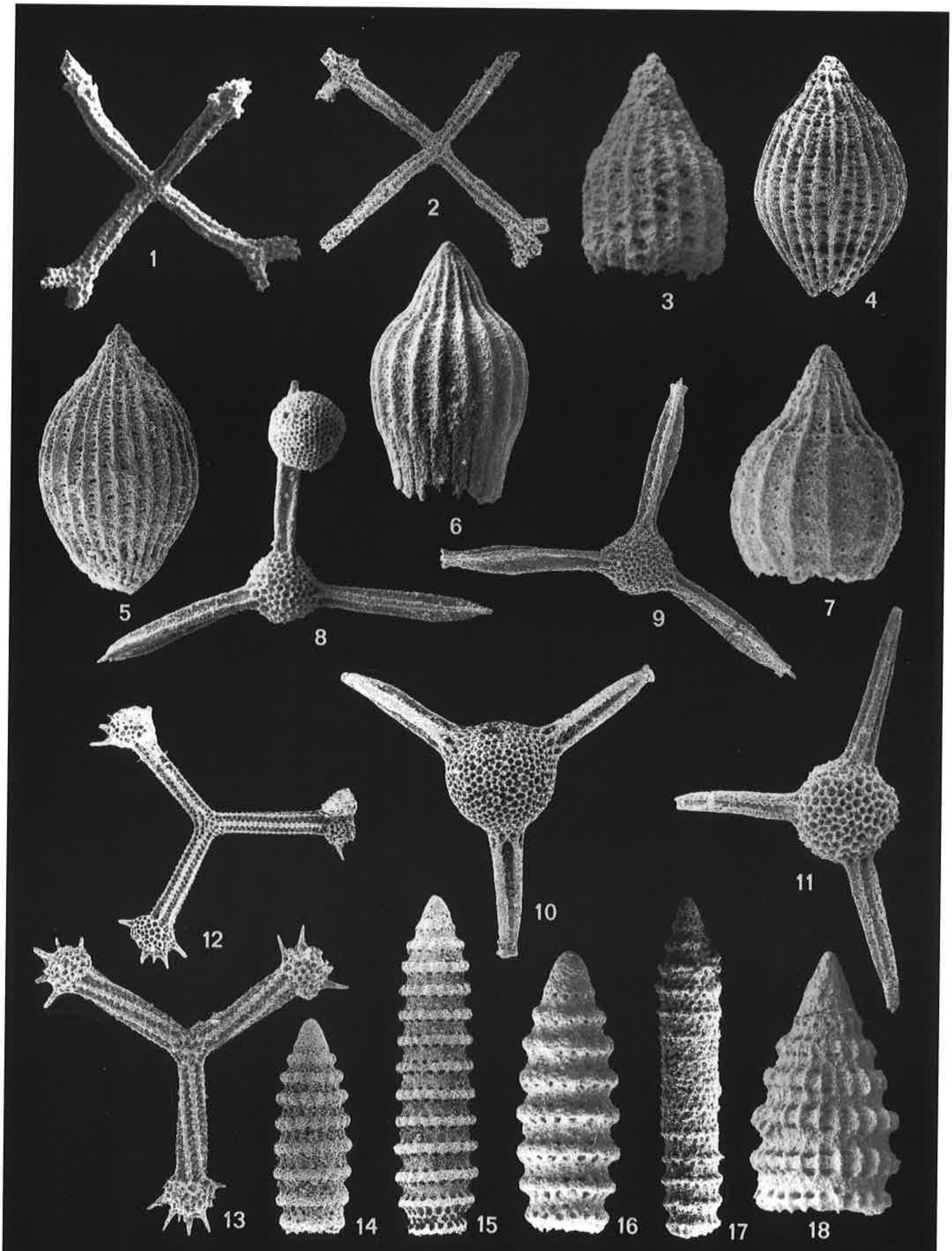
Fig. 12-13 ***Tritrabs ewingi* gr. (PESSAGNO)**
MRD 3113, range U.A. 1-35
12. Br. 28.85/31, 80x
13. Br. 1330/7, 100x

Fig. 14-16 ***Wrangellium* (?) *columnarium* n. sp. JUD**
MRD 5580, range U.A. 6-32
14. Paratype: Bo. 449.50/32, 150x
15. Holotype: Bo. 566.50/71, 150x
16. Paratype: Ru. 146.50/5, 200x

Fig. 17 ***Parvicingula columna* (RÜST)**
Capr. 146.50/2075, 150x

Fig. 18 ***Wrangellium* (?) *depressum* (BAUMGARTNER)**
MRD 3284, range U.A. 5-24
Br. 28.85/1527, 230x

PLATE 23



## PLATE 24

Fig. 1 ***Wrangellium* (?) *depressum* (BAUMGARTNER)**
MRD 3284, range U.A. 5-24
Br. 28.85/1530, 200x

Fig. 2-3 ***Wrangellium* (?) *puga* (SCHAAF)**
MRD 5636, range U.A.7-35
2. Bo. 566.50/39, 200x
3. Bo. 449.50/37, 200x

Fig. 4 ***Xitus* (?) *alievi* (FOREMAN)**
MRD 5674, range U.A. 5-35
Bo. 566.50/179, 150x

Fig. 5-6 ***Xitus channelli* n. sp. JUD**
MRD 5673, range U.A. 14-34
5. Holotype: Bo. 566.50/17, 150x
6. Paratype: Pr. 225.30/15, 150x

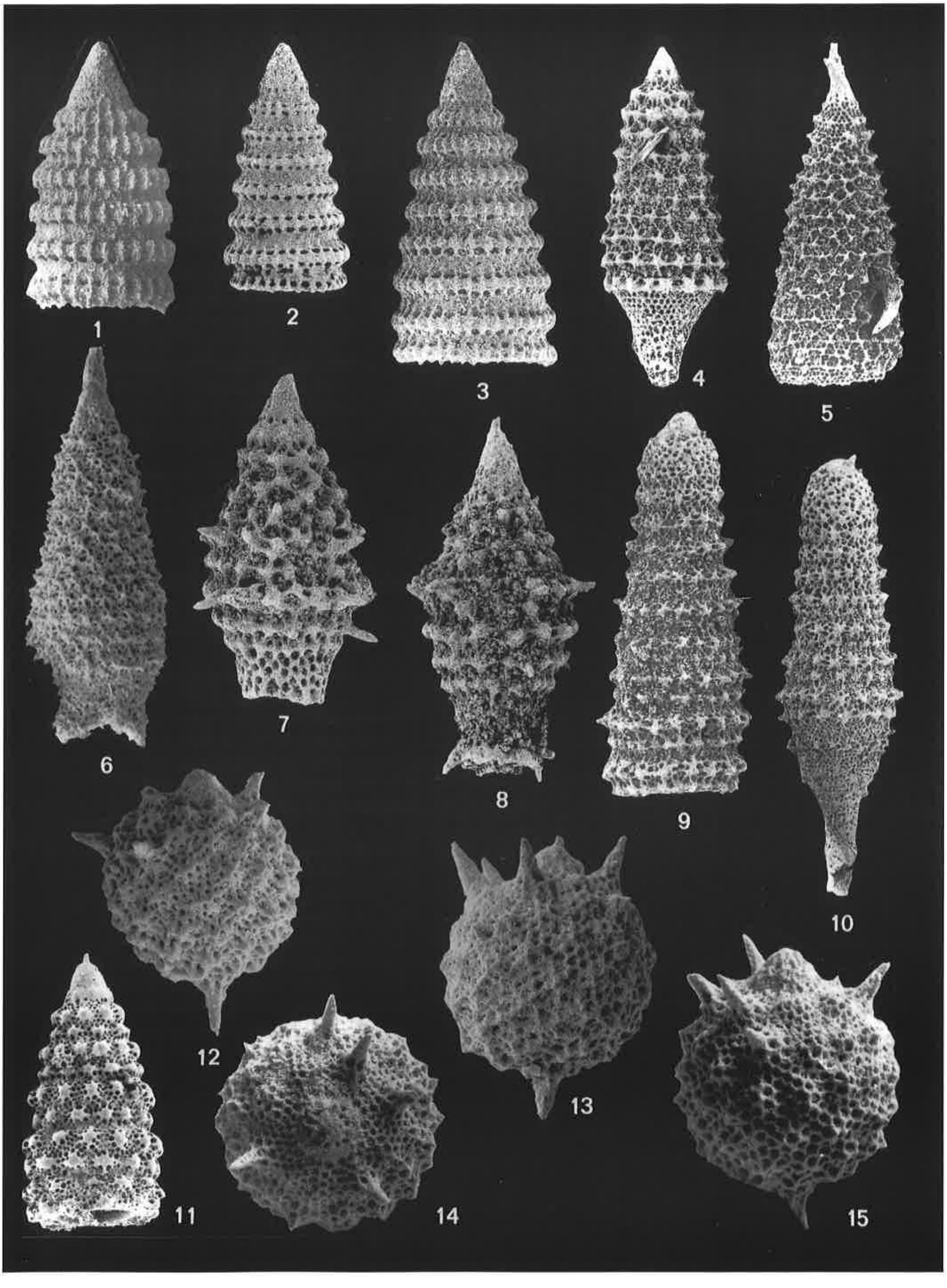
Fig. 7-8 ***Xitus horridus* n. sp. JUD**
MRD 5725, range U.A. 26-31
7. Holotype: Bo. 566.50/102, 200x
8. Paratype: Bo. 566.50/162, 200x

Fig. 9-10 ***Xitus sandovali* n. sp. JUD**
MRD 5668, range U.A. 26-31
9. Paratype: Bo. 566.50/16, 150x
10. Holotype: Bo. 566.50/66, 150x

Fig. 11 ***Xitus* sp. aff. *X. spicularius* (ALIEV)**
MRD 3295, range U.A. 7-35
Br. 141.55/48, 150x

Fig. 12-15 ***Zhamoidellum testatum* n. sp. JUD**
MRD 5511, range U.A. 25-35
12. Paratype: Bo. 619.90/153, 200x
13. Holotype: Bo. 619.00/40, 200x
14. Paratype: Bo. 566.50/1514, 200x, apical view
15. Paratype, same as Fig. 14: Bo. 566.50/1517, 200x, lateral view

## PLATE 24



# 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 Development on Triassic Stratigraphy. 184 pp.

No. 23 INTERRAD Jurassic -Cretaceous Working Group. BAUMGARTNER, P.O. et al. (Eds.) 1994. Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronolgy. env. 900 pp., 400 pls.

Order from **Institut de Géologie et Paléontologie, Université de Lausanne. BFSH-2. CH-1015, SWITZERLAND.**
Bank Transfer: Banque Cantonale Vaudoise 1002 Lausanne
Account Number: **C. 323.52.56** Institut de Géologie, rubrique: Mémoires

Price $ 20 or CHF 30 per volume (volume 23 price on request) includes postage and handling.
Payment in U.S. Dollars or Swiss Francs

- Please do not send check -