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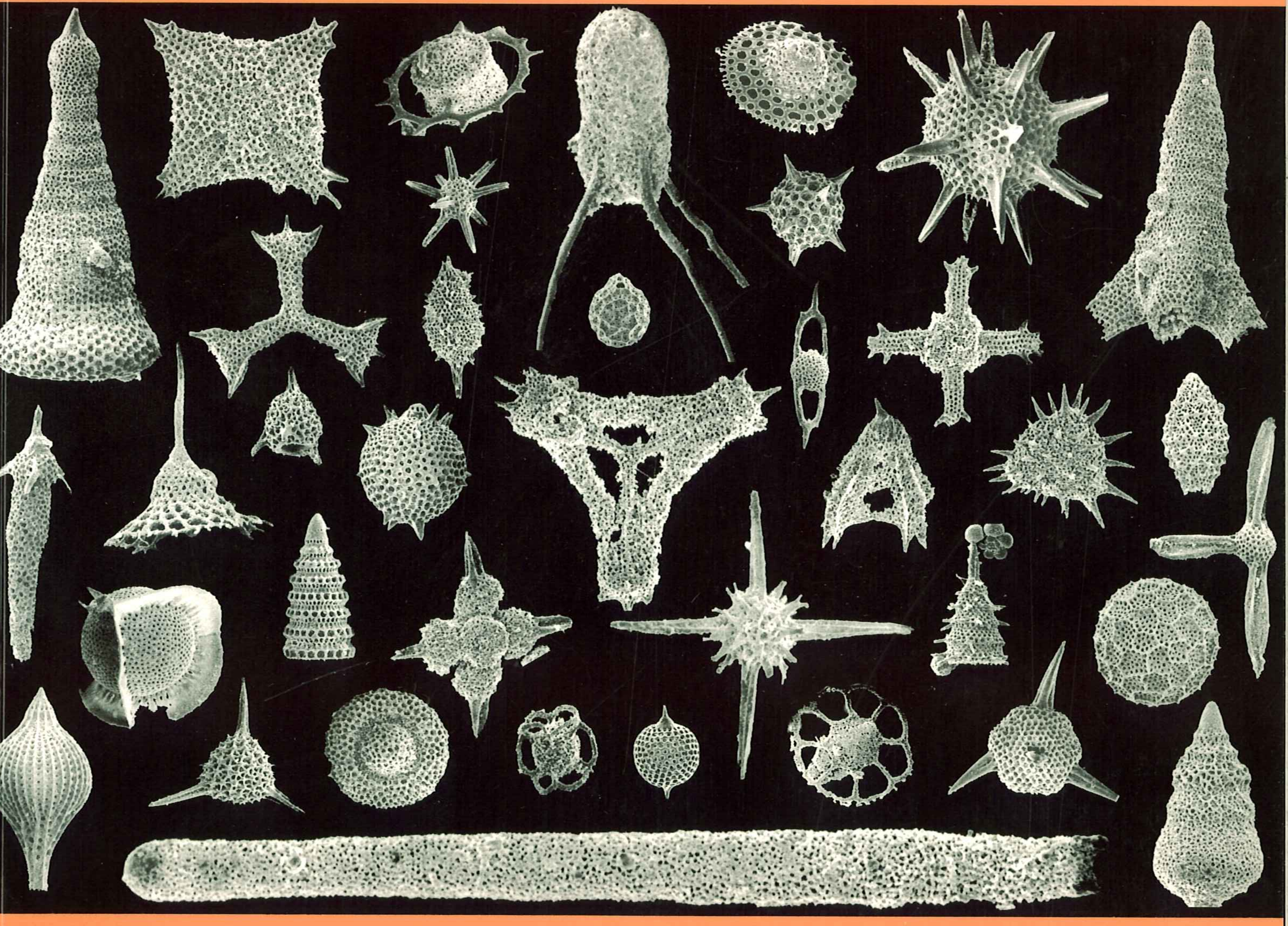
Biochronology and Paleontology of Mid-Cretaceous Radiolarians from Northern Apennines (Italy) and Betic Cordillera (Spain)

by Luis O'Dogherty



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Cover photo: Diversity of Mid-Cretaceous Radiolaria from various stratigraphic levels. All Radiolaria illustrated at the same magnification; longest specimen (center bottom) approximately 2 mm. Arrangement of figures follows Squinabol, early 1900's (Design by A. Pillevuit)

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

par **Luis O'Dogherty**

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Dante Pantanelli

Portrait of *Dante Pantanelli* (1844-1913) Italian pioneer on radiolarian studies.

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Biochronology and Paleontology of Mid-Cretaceous Radiolarians from Northern Apennines (Italy) and Betic Cordillera (Spain)

Abstract

Highly diverse radiolarian faunas of middle Cretaceous age have been recovered from pelagic and hemipelagic sequences recording the Barremian-Turonian interval in Mediterranean Regions. Several lithologies (limestones, cherty limestones, marls and siliceous shales) were thoroughly examined for radiolarian occurrences in continuous successions of deep-water facies. The study includes localities in the Umbria-Marche Apennines (Apulian Block) and on the External Zones of the Betic Cordillera (Southern Iberian Paleomargin).

The taxonomy and biochronology of the Mid-Cretaceous radiolarians has been studied in order to construct a precise radiolarian zonation in the Western Mediterranean, on the basis of their vertical distribution. Only the true sequence of species in the fossil record allows one to establish the order in which they evolved. Therefore a detailed biochronological analysis was used as a basis for tracing evolutionary lineages and to elucidate the phylogenetic relationships of the examined taxa. Finally, generic and suprageneric classifications have been partly revised based on my own analysis of the faunal succession.

The biochronology has been carried out by means of Unitary Association Method (Guex 1977, 1991). A database recording the appearance of 303 species in 29 superposed horizons selected from six hundred samples of seven sections has been used to establish a sequence of 21 Unitary Associations. Each of these associations is defined by the totality of characteristic species pairs. The biochronological analysis has allowed the definition of nine new radiolarian biochronologic units for the middle Cretaceous, each of which is labelled either as a zone or a subzone. These biochronologic units are tied to chronostratigraphy by means of planktonic Foraminifera and calcareous nannofossils previously studied by other authors at the same localities.

Two major radiolarian faunal changes coincide with well established major Cretaceous oceanic anoxic events (OAE): early Aptian to late Albian (OAE 1A- OAE 1C) and Cenomanian-Turonian boundary (OAE 2).

All radiolarian species (303) used in the biochronology have been described with complete synonymies. Illustrations include several specimens of each species in order to elucidate the morphologic variability. Three families, 16 genera and 84 species are described as new.

Biochronologie et Paléontologie des radiolaires du Crétacé moyen de l'Apennin septentrional (Italie) et de la Cordillère Bétique (Espagne)

Résumé

Une étude détaillée de séquences pélagiques et hémipélagiques des régions méditerranéennes de l'intervalle Barrémien-Turonien a permis de décrire des faunes très diversifiées de radiolaires du Crétacé moyen. Plusieurs lithologies (calcaires, calcaires à chert, marnes et argiles) ont été examinées avec soin dans des niveaux de sections choisies en raison de leurs successions sédimentaires continues en faciès marin profond. Les localités étudiées se trouvent dans l'Apennin septentrional (bloc apulien) et dans les Zones Externes de la Cordillère Bétique (paléomarge sud ibérique).

La taxonomie et la biochronologie des radiolaires du Crétacé moyen ont été étudiées afin de construire une zonation précise dans la Méditérranée Occidentale. La séquence des espèces dans l'enregistrement fossile reflète l'ordre dans lequel elles ont évolué. Ainsi, grâce à l'analyse biochronologique détaillée, des lignées évolutives ont pu être construites afin de comprendre les relations phylogénétiques d'une partie des espèces étudiées. La classification générique et supragénérique est basée sur les travaux antérieurs ainsi que sur ma propre étude des successions de faunes.

Une étude biochronologique des radiolaires du Crétacé moyen établie grâce à la méthode des Associations Unitaires (Guex, 1977, 1991) est présentée ici. Une base de données, comprenant 303 espèces provenant de 29 horizons superposés, sélectionnés parmi six cents échantillons dans sept sections, a été utilisée pour construire une zonation comprenant neuf unités (zones ou subzones) chronologiquement significatives. Ces biozones sont corrélées à la chronostratigraphie à l'aide des foraminifères planctoniques et nannofossiles calcaires précédemment étudiés par d'autres auteurs dans les mêmes localités.

Deux renouvellements majeurs sont enregistrés dans les faunes de radiolaires. Ces changements fauniques coïncident avec les évènements anoxiques majeurs bien connus au Crétacé: ceux de l'Aptien inférieur à l'Albien supérieur (OAE 1A- OAE 1C) et celui de la limite Cénomanien-Turonien (OAE 2).

Toutes les espèces de radiolaires utilisées (303) dans la biochronologie sont décrites avec une synonymie complète. Elles sont largement illustrées afin de présenter clairement leur spectre de variations morphologiques. Trois nouvelles familles, 16 nouveaux genres et 84 espèces nouvelles ont été décrites.

Biocronologia e Paleontologia dei radiolari del Cretaceo medio dell' Appennino settentrionale (Italia) e della Cordigliera Betica (Spagna)

Riassunto

Faune a radiolari eccezionalmente diversificate sono state trovate in sequenze pelagiche ed emipelagiche delle regioni mediterranee nell'intervallo Barromiano-Turroniano. L'intervallo stratigrafico delle diverse specie a radiolari é stato esaminato in diversi litotipi (calcari, calcari selciferi, marne ed argille) appartenenti a successioni sedimentarie continue in facies di mare profondo. Le località interessate da questo studio si trovano nell' Appennino umbro-marchigiano (blocco apulo) e nei settori esterni della Cordigliera Betica (paleomargine meridionale iberico).

Al fine di ricostruire una zonazione a radiolari del Cretacico medio valida per il Mediterraneo Occidentale, sono stati effettuati studi tassonomici e biocronologici, sulla base della distribuzione verticale dei radiolari. Solamente uno studio molto preciso della sequenza stratigrafica dei fossili permette di risalire all'ordine con il quale essi si sono evoluti . Per cui, un'analisi biocronologica di dettaglio ha permesso di ricostruire le linee evolutive e le relazioni filogenetiche dei taxa studiati. La classificazione dei generi e dei supergeneri é stata basata sopratutto sull'analisi delle succesioni faunistiche presentate in questo lavoro.

La biocronologia a radiolari è stata realizzata grazie all'uso del metodo delle Associazioni Unitarie (Guex, 1977, 1991). Da un database comprendente 303 specie provenienti da 29 livelli sovrapposti e selezionati a partire da seicento campioni di sette sezioni differenti, è stata ricostruita una zonazione comprendente nove unità (zone e subzone) cronologicamente significative. Queste biozone a radiolari sono state correlate alla cronostratigrafia grazie allo studio di foraminiferi planctonici e di nannofossili calcarei precedentemente studiati da altri autori nelle medesime località.

Sono stati evidenziati nelle popolazioni a radiolari due principali cambi faunistici. Tali cambi coincidono con i maggiori "eventi anossici" del Cretaceo, quello compreso tra l'Aptiano inferiore e l'Albiano superiore (OAE 1A-OAE 1C) e quello situtato al limite Cenomaniano-Turroniano (OAE 2).

Tutte le specie di radiolari utilizzati nella biocronologia (303) sono state descritte con una completa sinonimia. Inoltre una stessa specie é stata illustrata con piu' individui, in modo da rappresentare chiaramente lo spettro di variazioni morfologiche. Sono state infine descritte 3 nuove famiglie, 16 nuovi generi, nonchè 84 nuove specie.

Biocronolgía y Paleontología de los radiolarios del Cretácico medio del Apenino septentrional (Italia) y de la Cordillera Bética (España)

Resumen

El análisis bioestratigráfico detallado de diversas secuencias pelágicas y hemipelágicas, de edad Barremiense-Turoniense localizadas en el ámbito Mediterráneo, ha permitido realizar un estudio paleontológico continuo y detallado de las asociaciones de radiolarios fósiles registradas durante dicho intervalo de tiempo. Diversos tipos de litofacies (calizas micríticas, calizas con sílex, margas y pelitas silíceas) fueron minuciosamente examinadas con el propósito de seleccionar el mayor numero de muestras representativas del intervalo considerado. Las áreas estudiadas están situadas en el Apenino septentrional (bloque Apúlico) y en las Zonas Externas de la Cordillera Bética (paleomargen sudibérico).

El estudio taxonómico y biocronológico de los radiolarios del "Cretácico medio" permite establecer un esquema zonal preciso para el dominio mediterráneo occidental. Indudablemente, la sucesión temporal de las especies en el registro estratigráfico permite establecer el orden en el que éstas realmente aparecieron y evolucionaron. Por tanto, el estudio biocronológico detallado permite establecer las líneas evolutivas y las relaciones de filogenias entre los diversos taxones estudiados. La clasificación genérica y supragenérica está fundamentalmente basada en trabajos precedentes, así como en mis propios análisis paleontológicos.

La biocronolgía ha sido establecida mediante el método de Asociaciones Unitarias (Guex, 1977, 1991). A partir del estudio de casi seiscientas muestras pertenecientes a siete secciones estratigráficas, se han seleccionado 29 horizontes superpuestos que eran bio- y cronostratigráficamente significativos. El registro de 303 especies fósiles de radiolarios distribuidas a lo largo del intervalo estudiado permitió la confección de un base de datos que nos ha servido para establecer una secuencia de 21 A.U.. El análisis biocronologico nos llevo a obtener una zonación donde se pueden diferenciar 9 unidades que son cronológicamente significativas, cada una de las cuales se ha tratado con el rango de zona o subzona. Estas unidades biocronológicas han sido correlacionadas con la cronoestratigrafía (escalas zonales) establecida por medio de foraminíferos planctónicos y nannofósiles calcáreos, estudiados previamente por otros autores en las mismas secciones.

Se observaron dos cambios faunisticos mayores que coinciden con los eventos anóxicos del Cretácico (OAE): uno en el intervalo Aptiense inferior-Albiense superior (OAE 1-OAE1C) y otro en el límite Cenomaniense-Turoniense.

Las 303 especies utilizadas en biocronología se han descrito con una sinonimia completa. Todas, además, fueron ilustradas empleando abundante documentación fotográfica, afin de poder presentar claramente su espectro de variabilidad morfológica. En esta monografía se describen y nominan 3 nuevas familias, 16 nuevos géneros y 84 nuevas especies.

I. GENERAL INTRODUCTION

The research presented here as a doctoral thesis was first begun towards the end of 1990. Its aim is to contribute to knowledge of the radiolarian faunas of the middle Cretaceous in the Mediterranean region, on the basis of data obtained from detailed study of sequences recording the Barremian-Turonian interval in the Umbria Apennines and the Betic Cordillera. This work also represents the logical continuation of other similar work carried out by members of the Institut de Géologie et Paléontologie de l'Université de Lausanne on biochronological and palaeontological aspects of the Mesozoic in Alpine chains around the Mediterranean.

My main objective in undertaking this study was to make a biochronological analysis as detailed as possible using middle Cretaceous radiolarians in the Mediterranean area, which necessarily implied the inclusion of paleontological aspects. Biochronology and palaeontology must be seen as complementary, as precise temporal distribution of a taxon, species or genus implies knowledge of the morphological change, or evolution, undergone by the taxon throughout the chosen time interval. In addition, it is also necessary to establish the relations between taxa through time, i.e. their phylogeny. It is therefore to carry out a paleontological analysis in the absence of precise information on the succession of the different genera and species. Equally, a detailed biochronological study must be based on the paleontological data obtained regarding the different taxa. This relation between biochronology and palaeontology is the reason for the manner in which the present work has been organised.

I.1 AIM AND SCOPE OF THE STUDY

The fossil faunas, mainly consisting of radiolarians, examined here were obtained by systematic sampling of different middle Cretaceous profiles in the Betic Cordillera and the Umbria Apennines. This fossil *corpus* was examined from different points of view in order to achieve a number of partial objectives, leading to the elaboration of a biochronological synthesis. I believe that this biochronology provides a satisfactory picture of the radiolarian faunal changes observed in the western Tethys.

In the chapter on biochronology, I have attempted to establish a biochronostratigraphic scale for the middle Cretaceous in the Western Mediterranean on the basis of the vertical distribution of the radiolarians studied. The zonation presented here seems valid for the Mediterranean realm and may be more or less correlatable with the scales established for other geographical areas.

By studying populations from specific layers at different locations, I have attempted to determine which morphological characteristics could be used as valid criteria for the differentiation of morphospecies and which others vary within a population, although we cannot use them to separate between specific or intraspecific groups. It is at times difficult to quantify these characteristics, but this does not mean that they have no taxonomic significance. Where numerical expressions have been unavailable to determine these characteristics, I have used numerous illustrations of each taxon in order to achieve an objective description and interpretation. As a complement to some of the descriptions, I have used bivariate biometrical plots to express quantitatively interspecific differences. Such methods have helped to verify the correlation of the values obtained in specimens from the same stratigraphic level or in those considered to belong to the same morphospecies. A biometric study is at present under way and I intend to present these results in the near future.

Given that the delimitation of morphospecies and its temporal ordering alone are not sufficient to complete the systematics of radiolarians, I have dealt as far as possible with other palaeobiological aspects such as intraspecific variability, changes in palaeontologic diversity, problems of heterochronous homoeomorphy, etc., in order to satisfactorily explain the observed succession of fossil organisms and integrate them in a rational interpretation.

I.2 PREVIOUS WORK

There are numerous publications on regional geology in which Cretaceous stratigraphic characteristics of the Umbria-Marche Apennines and the Betic Cordillera are described. Therein, radiolarian faunas of this age are frequently mentioned, generally as complement to the description of the lithological units recognized in the different studied areas. The main authors that have carried out previous stratigraphic or regional studies are cited in the chapter related to Stratigraphy (Chapter II).

Despite the tremendous diversity observed among Late Cretaceous radiolarians, few taxa have been described in the Mediterranean regions, mostly from isolated samples. The biochronological sketches that have been proposed resulted relatively imprecise.

Radiolarian occurrences from the Maiolica and Scaglia Formations in Italy were discovered and described principally more than one hundred years ago (see chapter IV.I.1). Except for these initial reports at the turn of the century, research was not restored until the 1980's with comprehensive studies of Cretaceous Radiolaria of the lower Neocomian (Baumgartner et. al., 1980; Baumgartner, 1984; Schaaf, 1985; Aita & Okada, 1986). Recently Jud (1994) carried out an extensive study on biochronology and paleontology of Early Cretaceous radiolarian faunas from the Maiolica formation (Tithonian to Barremian), at different localities in the central Apennines and southern Alps, being actually the only biochronological sketch available for this time interval in our regions. Late Cretaceous radiolarians in Italy has been scarcely illustrated from discrete levels (Cita, 1964; Kuhnt *et al.*, 1986; Coccioni *et al.*, 1987; Marcucci *et al.* 1991; Marcucci & Gardin, 1992), although, biostratigraphic analysis are not available in the mentioned papers.

In opposition, the study of the Cretaceous radiolarians in the Betic Cordillera was only initiated in late 1980's (Kuhnt *et al.*, 1986; Thurow & Kuhnt, 1986; O'Dogherty & Martínez-Gallego, 1990; Hernández-Molina et. al., 1991; Aguado *et al.*, 1991; Aguado *et al.*, 1993). In one of these (O'Dogherty & Martínez-Gallego, 1990) a preliminary zonal sketch for the Barremian-early Albian interval is available.

I.3 GEOLOGICAL AND PALEOGEOGRAPHICAL SETTING

Pelagic-carbonate sequences outcropping in the western Mediterranean regions form part of various tectonic units that make up the Betic Cordillera in Spain and the Apennines in Italy. These different paleogeographical realms were in many ways similar in depositional conditions during the Cretaceous and allow the integration of both palaeontological and biochronological studies.

The present-day western Mediterranean Alpine chains form a mountain belt which almost completely surrounds the area occupied by the sea (Fig. 1). In this western Mediterranean region, three main realms are distinguished: the southern realm is related to the North African Rif and Tell chains; the eastern realm is made up of the Apennines; and the northwestern realm corresponds to the Betic Cordillera and the Balearic range. There are other neighbouring Alpine chains that must be considered separately: Middle Atlas, Saharian Atlas and Tunisian Atlas in the African margin, and Iberian chain, Catalonian coastal range, Pyrinees and Provence chains in the European margin.

It is classically considered that the Alpine Peri-mediterranean chains have been formed by collision between the Eurasian and the African plate, in the region where a great sea, the Tethys, was formerly located.

At the beginning of the Triassic, all these elements were part of a single continent Pangea, that extended from Eurasia to Africa. The Triassic distension was marked by both volcanism and transgression of shallow-water seas which initiated the separation of Iberia from both Europe and Africa. After the Triassic, a major break existed also along the eastern flank of Apulia, and separated this continental mass from Europe (Ricou *et al.*, 1986).

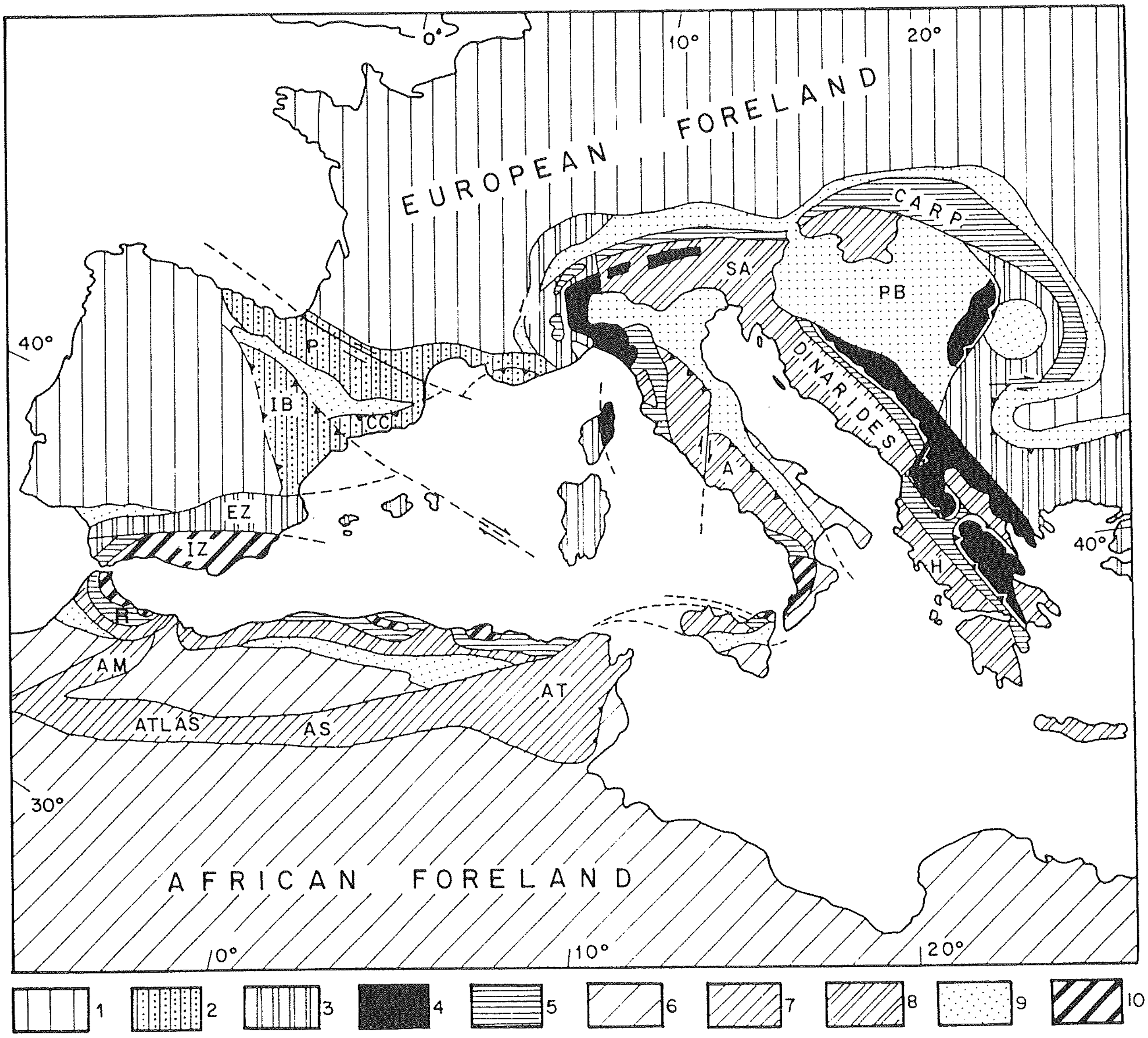

Fig. 1.- Distribution of the Mediterranean Alpine realms according to Ricou *et al.* (1986). Key: 1-3: European continent (1.- Foreland, 2.- Intracontinental chain, 3.- Tectonic margin.). 4-5: Tethyan ocean (4.- Ophiolitic nappes and related units, 5.- Flyschs nappes). 6-8: African continent (6.- Foreland, 7. - Intracontinental chain, 8.- Tectonic margin). 9.- Molasse foredeep and postorogenic basins. 10.- Internal Zones. Symbols: **EZ**.- Betic external zones. **IZ**.- Betic internal zones. **IB**.- Iberian cordillera. **CC**.- Catalonian coastal range. **PB**.- Pannonian basin. **AM**.- Middle Atlas. **AS**.- Saharian Atlas. **AT**.- Tunisian Atlas. **A**.- Apennines. **CARP**.- Carpathians. **H**.- Hellenides. **P**.- Pyrinees. **R**.- Rif.

The installation of a carbonate platform over the Triassic sediments accompanied the beginning of the Jurassic. The prevailing facies in the Betic Cordillera are shallow-marine carbonate platform with episodes of tidal-flat and supratidal deposition (García-Hernández *et al.*, 1980) as described also from the Apennines (Colaccichi *et al.*, 1975). During the Jurassic, the change from shallow water to pelagic facies occurred. This event coincides with the breakdown of the main carbonate platforms all over the Mediterranean domain and with early stages of opening of the Central Atlantic (Bernoulli & Jenkins, 1974).

This distensional stage established another major break between the Western Mediterranean blocks and both Africa and Apulia and gave rise to the creation of important basins and the individualisation of some continental blocks. Between the Alboran block and Iberia, the Jurassic distension created the Subbetic basin in which siliceous shales were deposited (García-Hernández *et al.*, 1980). In the Upper Jurassic, Apulia was separated from Eurasia by an oceanic basin and the northern side of Apulia was divided into swells and troughs (Ricou *et al.*, 1986). In northwestern Apulia, the Umbria-Marche basin was created, as well as other platforms and basins.

In the Lower Cretaceous the northern part of Apulia collided with the Eurasian margin as it drifted apart from Africa. To the west, the collision was incomplete and a deep water basin persisted between Europe and Apulia through the Upper Cretaceous to Lower Tertiary. A palaeographic sketch map of the middle Cretaceous (Aptian-Albian interval) is shown in Fig. 2, including the location of studied areas: the Northern Apennines (northwestern Apulia margin) and the Betic Cordillera (southern Iberian margin). In both the Betic Cordillera and the Apennines, Mesozoic sedimentation occurred in a passive continental margin of Atlantic type, which is analogous to other alpine regions (Bernoulli & Jenkins, 1974; D'Argenio, 1976).

In the central sector of the Betic Cordillera, the Cretaceous is relatively uniformly developed. In general, the Lower Cretaceous is formed by rhythmically deposited light-coloured marls and marly limestones with abundant ammonites (Vera *et al.*, 1982).

During the Aptian-Albian, the basins were invaded by black shales deposits that mark a "middle Cretaceous anoxic event", these are overlain by silica-rich sediments of Cenomanian-Turonian age. The Upper Cretaceous is present in "Capas Rojas" facies with planktonic foraminifers in the Betic Cordillera, similar to that of other Alpine Mediterranean regions like "Couches Rouges" in the Alps. In fact, García-Hernández *et al.* (1980) compared the former facies with the "Scaglia Rossa" in the Apennines. Overall, the deposits of the basins are much more variegated than previously: this probably marks a renewed organisation which can be linked to the displacement of Iberia relative to Eurasia and Apulia relative to Africa. That reorganisation must account for deformation in some areas (i.e., Pyrinean area, Tellian margin of Africa) but there were no fundamental changes in the general pattern.

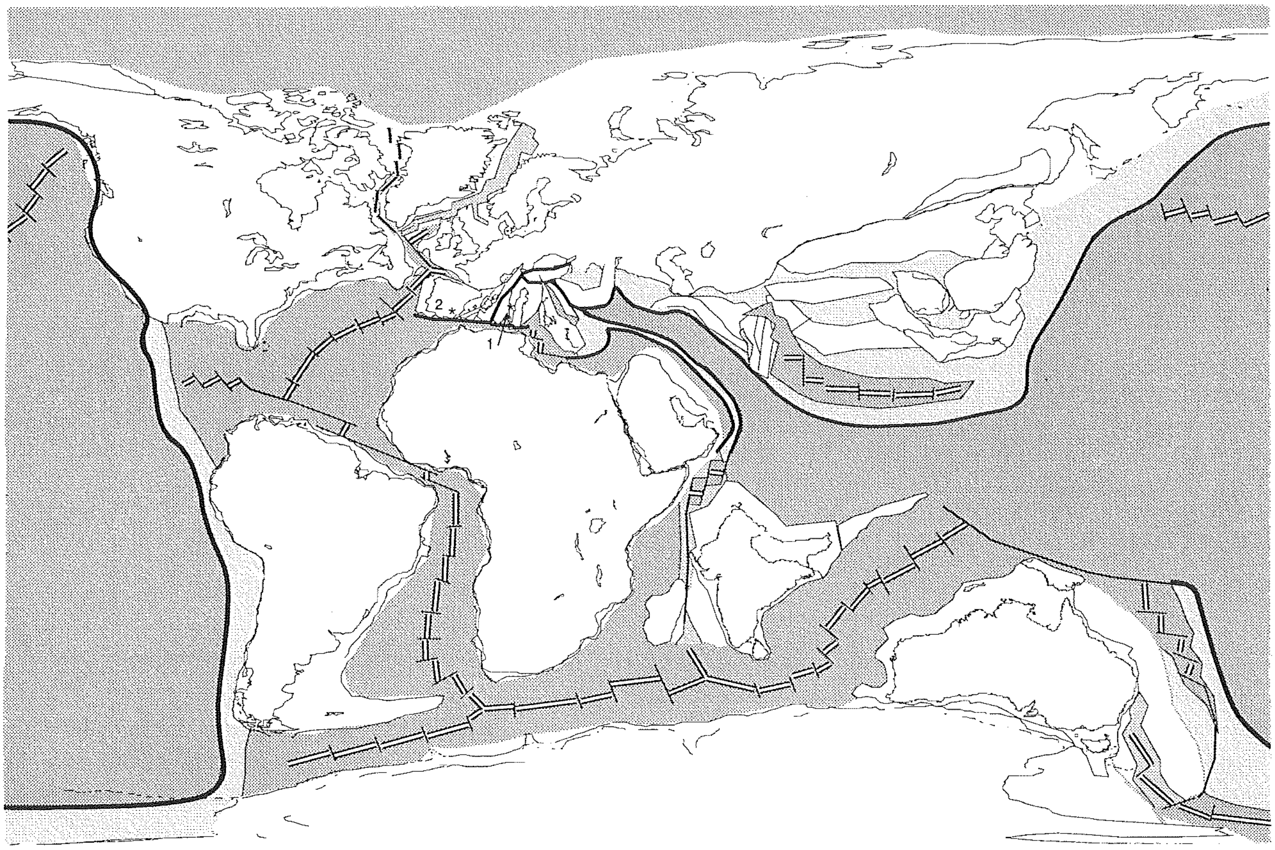

Fig. 2.- Palaeogeographic sketch map of the Mid-Cretaceous with location of studied areas: **1.** Northern Apennines; **2.** Betic Cordillera (from Pillevuit, 1993).

The collision between the renewed Eurasian and African plates took place during the Tertiary (Ricou *et al.*, 1986). This compressive tectonic event produced intensive deformations of the sediments deposited on both continental margins, which have been mostly incorporated into the different Peri-mediterranean Alpine chains.

I.3.1. UMBRIA-MARCHE APENNINES (NORTHERN APENNINES)

The Umbria-Marche Belt constitutes the most southerly external portion of the Northern Apennine Arc. The general structure of the Northern Apennine is that of an arcuate mountain chain convex to the east-northeast, which consists of a Northeast-verging thrust belt placed during the Late Tertiary (Figs. 1 and 3).

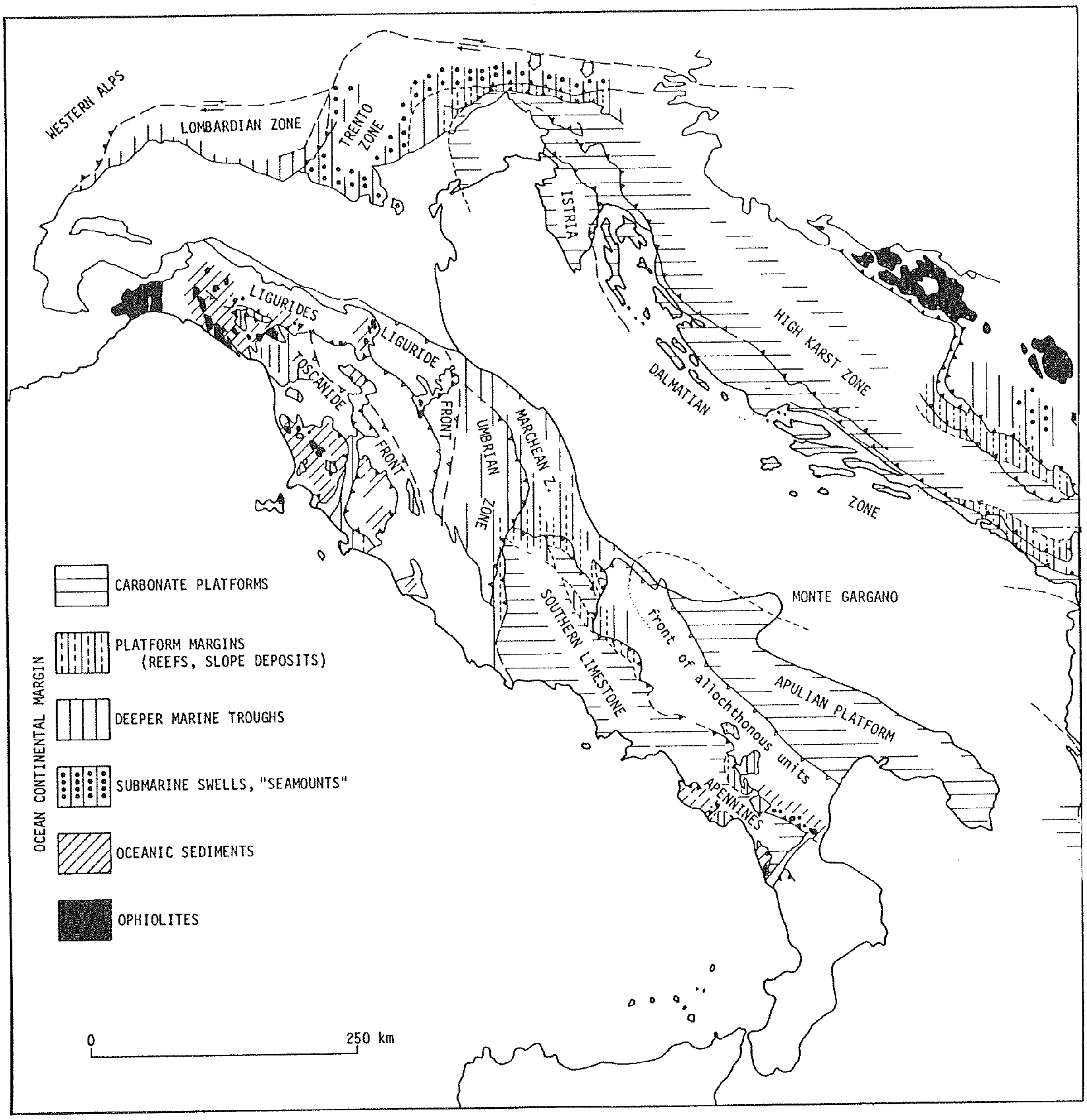

Fig. 3.- Geological sketch map of Italy with location of the Umbria-Marche Apennines arcuate thrust belt (from Bernoulli, 1972).

Two Mesozoic continental margins are recognized in the Periadriatic region. The mesozoic sedimentary sequence of the Umbria-Marche Apennine was deposited on the southern margin of the Tethys ocean; it is situated on the African Apulian plate, which belongs to the so called Adriatic Promontory (Channell *et al.*, 1979). During the Triassic, the morphology of that southern margin began to evolve as a consequence of the rifting between Africa and Europe: this evolution continued through the Jurassic and Early Cretaceous, it is related to the growth of Tethys and involved the early development of a widespread carbonate platform and evaporites.

The Umbria-Marche fold-and-thrust belt is usually described in terms of three superimposed lithotectonic groups which include, from bottom to top: the basement, the Triassic evaporites (considered as the major decollement level between the cover and the basement) and the Mesozoic-Tertiary sedimentary cover (Lavecchia *et al.*, 1988).

Triassic continental rifting predates the Jurassic oceanic rifting which gave rise to the Periadriatic continental margin. To the south, Permian shallow water marine carbonates and evaporites indicate a connection with Gondwana Domains.

The Triassic evaporites constitute the basal unit of the Northern Apennine which consists of a sequence of anhydrites, marls, dolomites and dolomitic limestones (Burano formation) of Late Triassic age. At the beginning of the Jurassic, evaporite sedimentation was replaced by the deposition of shallow-water platform carbonates. During the middle Liassic along the southern Periadriatic continental margin, carbonate platforms and seamount areas alternate with basins which trend parallel to the continent-ocean boundary (Bernoulli & Jenkins, 1974). A period of important subsidence in the Jurassic led to fault-bounded basins separated by topographic highs that resulted in the above mentioned alternating shallow and deeper water sedimentary domains (D'Argenio, 1976; D'Argenio & Alvarez, 1980). Alvarez (1989b) argues that this sedimentary pattern was controlled by listric normal faults, possibly complicated by diapiric movement of the Triassic evaporites.

Since the Jurassic, the sediments are mainly carbonate with little terrigenous influx and there are three types of stratigraphic sequences found in the region: complete sequences (characteristics of basins), condensed sequences (characteristic of structural highs) and composite sequences (Hirt & Lowrie, 1988). These topographic differences decreased from the Early Cretaceous on, and the basinal sequences remain uniform in their stratigraphy throughout the Northern Apennines. After a quiet interval in the middle Cretaceous, the Late Cretaceous and Tertiary stratigraphy shows synsedimentary slides and turbidites indicating that the sea floor was again articulated into shallower and deeper areas (Alvarez, 1989a).

The Apennine compressional deformation began in the Oligocene-early Miocene as the result of the collision of the continental margin of the Adriatic Promontory with the European plate. The large scale thrust motion during the Tertiary often used pre-existing Jurassic normal fault planes as ramps, these trend NW-SE or NNE-SSW (Koopman, 1983). The Umbria-Marche belt was formed during late Miocene-middle Pliocene time and has subsequently been affected by NNW-SSE trending normal faults (Calamita & Deiana, 1988). In Tortonian time, the major orogenic activity ceased in the Northern Apennines (Locardy, 1988).

I.3.2. BETIC CORDILLERA

The Betic Cordillera, the westernmost of the European Alpine Chains (Fig. 1), originated during the late Tertiary as a consequence of the drift of the African plate toward Iberia. This convergence caused the deformation of materials previously accumulated in two opposite continental margins, separated by a narrow fringe of oceanic or semioceanic character. Finally, an oblique collision of both took place as a consequence of the compressive orogenic activity (García-Hernández *et al.*, 1980; Martín-Algarra, 1987; Sanz de Galdeano, 1990). These continental margins had become separated throughout the Jurassic as a consequence of distensive tectonics, which were determined by the Central Atlantic opening and, in the Mediterranean regions, by the opening of the Ligurian-Thetys ocean.

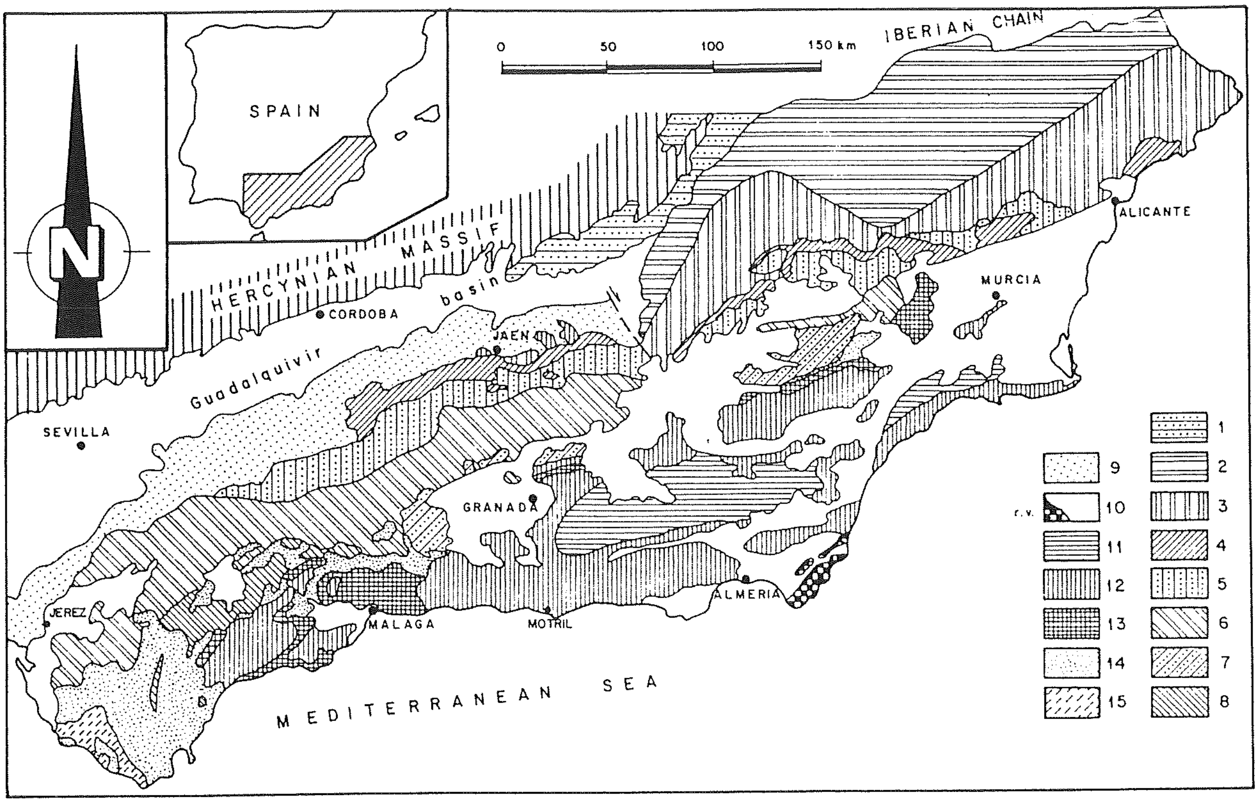

Fig. 4.- Geological sketch map of the Betic Cordillera showing the different geological units, equivalent to palaeogeographic domains (after Martín-Algarra *et al.*, 1992). *Key*: 1.- Non-folded cover (Mesozoic-Tertiary) of the Iberian Massif. 2-3: Prebetic (2.- External Prebetic, 3.- Internal Prebetic). 4.- Intermediate domain. 5-8: Subbetic (5.- External Subbetic, 6.- Median Subbetic, 7.- Internal Subbetic, 8.- Penibetic). 9.- Miocene Syntectonic deposits. 10.- Upper Miocene to Quaternary postorogenic deposits; **r.v.**- volcanic rocks). 11-13: Internal Zones (11.- Nevado-Filábride, 12.- Alpujárride, including Rondaide, 13.- Maláguide). 14.- Flysch units of the campo de Gibraltar Complex. 15.- Almarchal unit of the campo de Gibraltar Complex.

This process brought about the appearance of more or less deep basins and subbasins in both margins. From a palaeogeographical point of view, the geological realms that make up the present Betic Cordillera were the western extreme of the tethyan regions. Through them and also the north African domains, Rif and Atlas, must have existed the biogeographic connections between these regions and peri-pacific regions.

Palinspastic and palaeogeographical reconstructions of the western end of the European Alpine chains during the Cretaceous recognise various major tectonic-palaeogeographic domains (plates or subplates). To the north there was the Southern Iberian Paleomargin (Fig. 4), now structured into tectonic units corresponding to the External Zones of the Betic Cordillera (García-Hernández *et al.*, 1980; Vera, 1988). To the south, lay the margin adjacent to the African plate (Figs. 5a and 5b), corresponding to the External Zones of the Rif. Between these plates to the east, where they tend to come together, there was a domain which Durand-Delga & Fontboté (1980) named the "Mesomediterranean subplate". The tectonic deformation of this subplate gave rise to the formation of the Internal Zones of both the Betic and Rif chains.

As mentioned above, two great geological realms can be recognised in the Betic Cordillera: the External and Internal Zones (cf. Figs. 1 and 4). Between them and their westernmost point, the Campo de Gibraltar Complex crops out. The latter is comprised of a suite of mainly Tertiary rocks (with some Mesozoic at the base). These were deposited in a depression with an oceanic or semioceanic substrate (North African Flysch Trough) lying between the African and Iberian plates and the Mesomediterranean subplate, the structure of which is today a complex of thrust nappes. During the Cretaceous, the North African Flysch Trough was situated in an oceanic or semi-oceanic seaway between the Tethys and North Atlantic.

Cretaceous carbonate and siliceous pelagic sediments crop out in the southern Iberian paleomargin which forms part of various different tectonics units that make up the Betic Cordillera. They are found in two main areas (Figs. 5a and 5b): one of these was the subsiding realm which lay adjacent and parallel to the edge of the continental platform, the External Zones, and the other was the North African Flysch Trough mentioned above.

Betic External Zones (Southern Iberian Margin)

The external zones are made up of Triassic to early Miocene rocks which were deposited along the Southern Iberian Palaeomargin. The tectonic style of the external Zones of the Betic Cordillera is typical of a sheared-off sedimentary cover (Garçía-Hernández *et al.*, 1980). From the earliest studies of the External Zones (Blumenthal, 1927; Fallot, 1948), two major tectonic and paleogeographical domains have been recognised: the Prebetic and Subbetic (Fig. 4). The Subbetic, with an internal nappe structure, is allochtonous, in contrast to the para-autochtonous character of the Prebetic (García-Hernández *et al.*, 1980). There are also considerable differences between the Subbetic and Prebetic zones, both from a stratigraphic and palaeogeographical point of view.

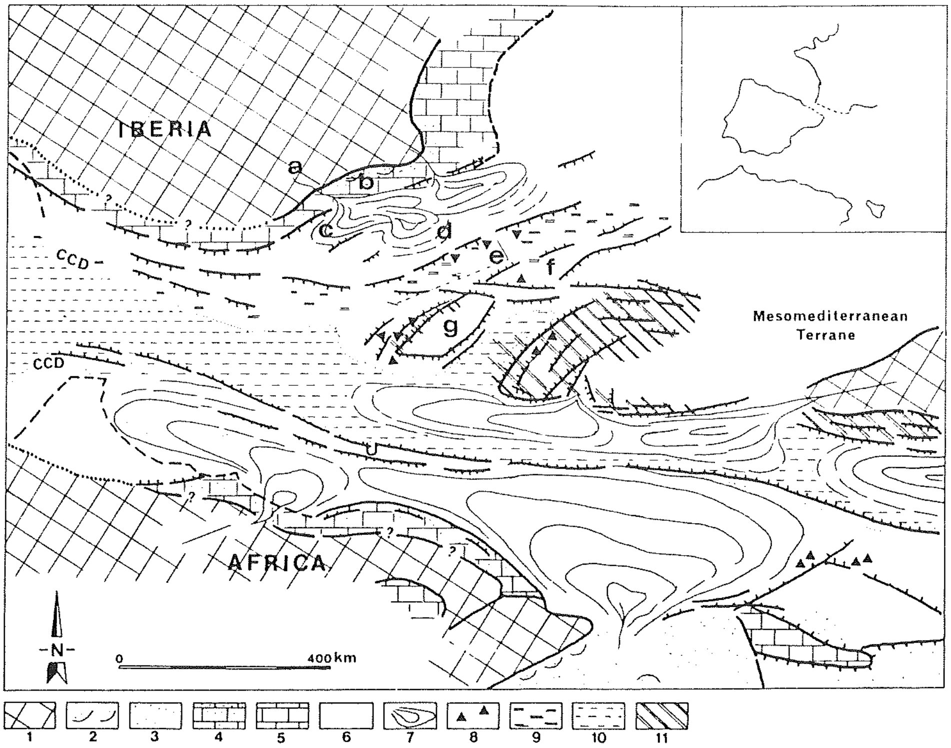

Fig. 5a.- Palaeogeographical reconstruction of the westernmost Tethys during the Aptian-Albian (according to Martín-Algarra, 1987; and López-Galindo & Martín-Algarra, 1992). *Key*: 1- Continental areas. 2.- Continental Clastics. 3.- Epicontinental clastics. 4.- Mixed carbonate-terrigenous platforms. 5.- Carbonate platform. 6.- Open marine marls and marly limestones of open platform, slope and basin. 7.- Siliciclastics turbidites deep sea fans. 8.- Calcareous turbidites and slope breccias. 9.- Basinal smectite clays. 10.- Oceanic basinal variegated clays. 11.- Starved areas. *Symbols*: **a-g: Southern Iberian Margin**. a.- Non folded cover (Mesozoic-Tertiary) of the Iberian massif. b.- Prebetic. c.- Intermediate Domain. d-g.- Subbetic Domain (d.- External Subbetic. e.- Median Subbetic. f.- Internal Subbetic. g.- Penibetic).

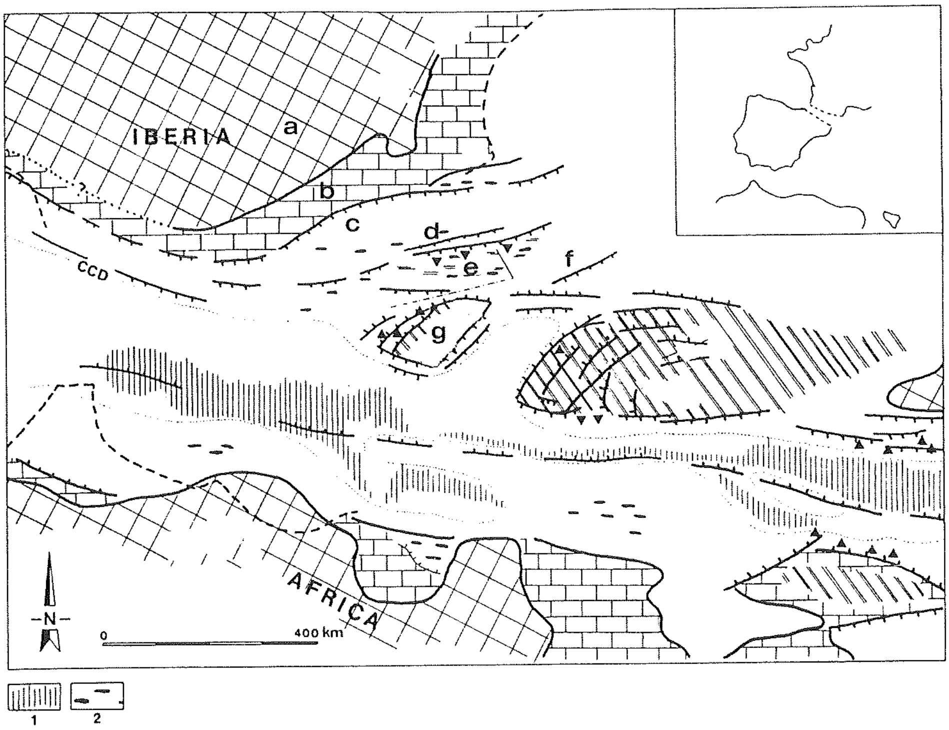

Fig. 5b.- Palaeogeographical reconstruction of the westernmost Tethys during the Cenomanian-Turonian (according to Martín-Algarra, 1987; and López-Galindo & Martín-Algarra, 1992). Symbol as in Figure 5a plus. 1.- Siliceous deposits. 2.- Cherty limestones.

During the Cretaceous the Prebetic formed a pericontinental platform bordering the southwest of the old Iberian continent, where shallow-water environments prevailed. It was the site of thick, mainly carbonate, sedimentation interrupted from time to time by the influx of terrigenous sediments (Azema *et al.*, 1979; Vera, 1988). Basinwards, between the Prebetic and Subbetic, there existed a smaller, individual, palaeogeographical domain (cf. Fig. 4), which has been called the Intermediate Domain (Foucalt, 1960, 1962; Ruiz-Ortiz, 1980). In the innermost area of the basin was the Subbetic. Throughout the Cretaceous this was a pelagic zone with mainly marly and marly-calcareous sedimentation, punctuated locally by calciturbidites (Martín-Algarra *et al.*, 1992).

These larger domains can be subdivided into smaller subdomains. Specifically, the morphology of the Subbetic basin was very irregular due to severe Jurassic intracontinental rifting along the Southern Iberian Paleomargin (García-Hernández *et al.*, 1989), which gave rise to high swells and deep troughs. These subdomains were the External Subbetic, the Median Subbetic and the Internal Subbetic. The sedimentary patterns of these subdomains were very different during the Jurassic and Lower Cretaceous (Martín-Algarra, 1987).

The External Subbetic subdomain was a high swell throughout the Middle and Upper Jurassic (Azema *et al.*, 1979; García-Hernández *et al.*, 1980; Vera, 1988) and was locally emergent during the Lower Cretaceous (Molina, 1987). This swell separated the subsiding basin of the Intermediate Domain from another trough further from the continent: the Median Subbetic (Fig. 4). The internal edge of the margin was made up of yet another swell, the Internal Subbetic, which, far from being a homogeneous domain, comprised a chain of humps (Martín-Algarra, 1987) with relatively different stratigraphic characteristics from one site to another. The westernmost of these domains, named Penibetic, tended to subside the least and even became emerged and largely karsted during the Lower Cretaceous (Company *et al.*, 1982; González-Donoso *et al.*, 1983; Martín-Algarra, 1987). The boundaries between the Subbetic troughs and swells were specially suitable sites for gravity resedimentation processes and they often contain considerable quantities of turbidites and other reworked sediments. These deposits are practically all carbonates because the siliciclastic sediments from the Iberian continent rarely reached as far as the outermost sectors of the Subbetic.

II. STRATIGRAPHY

II.1. UMBRIA-MARCHE APENNINES

II.1.1. CRETACEOUS STRATIGRAPHY

The Umbria-Marche region provides a continuous record of Jurassic to Paleocene pelagic to hemipelagic sediments deposited on the subsiding continental margin of the Adriatic Promontory. These sequences have become a classical reference for lithostratigraphic studies and regional biostratigraphy and magnetostratigraphy of Cretaceous sediments because of their continuous character and good exposure in numerous sections (i. e., Lowrie *et al.*, 1980; Monechi & Thierstein, 1985; Bralower, 1987; Channell *et al.*, 1987; Alvarez, 1989a-b; Cresta *et al.*, 1989; De Boer, 1991).

The Cretaceous of the Umbria-Marche realm has been subdivided into four formations (Premoli-Silva, 1977; Wonders, 1979; Arthur & Premoli-Silva, 1982; Cresta *et al.*, 1989). The Early Cretaceous stages are represented in the Umbria-Marche sequence by the Maiolica Formation, a compact white, pelagic limestone containing black chert beds. The Late Aptian and Albian are represented mainly by marls, with bedding planes occasionally marked by fucoids; this is the so called Scisti a Fucoidi Formation. This consists dominantly of a grey upper portion and a lower red one, both of which are characterized by indurated beds separated by marly intervals. The Late Cretaceous comprises two formations: the greyish-white, Cenomanian to early Turonian Scaglia Bianca limestone, and the pink to red Scaglia Rossa limestone which extends from the Early Turonian to the Paleocene.

Maiolica Formation:

This formation, of latest Jurassic to latest Barremian-earliest Aptian age (Bralower, 1987; Alvarez, 1989a; Coccioni *et al.*, 1992), consists of white to light and dark grey well bedded limestones with interbedded grey to black shales and chert lenses, nodules and layers. In the upper part of the unit, black to dark grey chert becomes more abundant and this lithology is associated with an increase in the radiolarian fauna (Erba & Quadrio, 1987; Premoli-Silva *et al.*, 1989).

The lower boundary of the Maiolica Formation coincides with a major change in the pelagic environment during the Late Tithonian that caused a synchronous change from siliceous or clay-rich to coccolith sedimentation in Atlantic and Tethys and is confirmed by a drastic radiolarian faunal change (Baumgartner, 1984b).

The Maiolica Formation has an average thickness of about 300 meters in the Umbria-Marche region. Nevertheless, there are considerable variations in thickness and facies between the basinal Maiolica sequences, composed mainly of calpionellids, calcareous nannofossils, radiolarians and siliceous sponge spicules, and the fault-block seamount Maiolica sequences (20-40 meters of thickness) which contain abundant ammonites, brachiopods, gastropods and echinoid fragments. These differences decreased towards the top of the unit (Cresta *et al.*, 1989).

In addition to the classical studies, a magnetostratigraphic calibration in this pelagic limestone has been recently established by correlation to nannofossil stratigraphy and carbon isotope data (Channell *et al.*, 1993; Cecca *et al.*, 1994). Furthermore, a very detailed biochronological analysis of radiolarian fauna was carried out by Jud (1994) who established six radiolarian zones for the Late Tithonian-Barremian interval.

The Scisti a Fucoidi Formation overlies the Maiolica through a gradate interval of cyclically alternating limestones and marls.

Scisti a Fucoidi Formation:

This latest Barremian-earliest Aptian to middle Albian formation, with 50-80 meters of average thickness, represents a varicoloured sequence consisting of thinly interbedded red and green marlstone and calcareous mudstones, marly claystone and marly limestone, with dark grey to black calcareous shales and light greenish-grey limestones

(Erba, 1988; Coccioni *et al.*, 1989; Tornaghi *et al.*, 1989). There is a predominance of the marly constituents in this formation.

The boundary between the Scisti a Fucoidi and the Maiolica formations is considered to be at the top of the last calcareous bed of the latter including a level of black chert (Coccioni *et al.*, 1989; Cresta *et al.*, 1989).

Six members, well correlated throughout the Umbria-Marche region, have been differentiated in the Scisti a Fucoidi sequence by Coccioni *et al.* (1987, 1990), on the basis of dominant lithotypes and colour. In this present work, I use only five members as the third and fourth members of the above referenced paper are considered together. This consideration is made on the basis of lithological similarity and significative variations in thickness. The latter is probably due to an important sinsedimentary tectonic activity related to extensional faulting at the margins of the seamounts (Alvarez, 1989b). These members are named, from the bottom to the top:

1) Greenish-grey cherty Member, characterized by greenish-grey cherty limestones and marly limestones. The Selli Level occurs in the lower part of this member (I do not exclude the possibility of a discontinuity at the base of this interval).

2) Lower reddish marly Member, composed of alternating marls and calcareous marls, dominantly reddish in colour, and including a single black shale layer in the upper portion.

3) Greenish marly Member, consisting of marls, clays and greenish-grey calcareous marls, with abundant black shale layers; characteristic reddish-brown layers are prevalent in the middle part.

4) Upper reddish marly Member, consisting of reddish marls and subordinate calcareous marls and marly limestones, with rare black shale layers.

5) Whitish marly limestone Member, characterized by predominantly whitish calcareous marls, marly limestones and frequent black shale layers.

These rhythmically deposited pelagic sediments are characterized by the accumulation of organic matter, which produced unusual organic-carbon rich facies (Arthur & Premoli-Silva, 1982). An important radiolaritic bituminous regional lithostratigraphic marker, "Livello Selli" (Wezel, 1985), appears in the lowermost part of the formation, in the lower portion of the Greenish-grey cherty Member. The Selli horizon is 1 to 3 meters thick and consists of laminated to bioturbated black mudstone and shale that alternate with radiolarian sandy and silty layers, whose entire microfauna is constituted by radiolarians (Coccioni *et al.*, 1989, 1992). This horizon is comparable with the "Niveau Goguel" in the Vocontian basin (Bréhéret, 1988; Bréhéret & Crumière, 1989; Bréhéret & Delamette, 1989).

The upper portion of the Scisti a Fucoidi consists of typical Cretaceous limestone-marlstones redox cycles. On the basis of carbon isotope data, Weissert & Lini (1991) related the black-shale limestone deposition to periods of stable, stratified anoxic environment, whereas limestones are considered the sedimentary expression of a more oxygenated water mass. Anoxic episodes become more frequent and thicker during the latest Aptian-middle Albian interval, decreasing progressively to the boundary with the overlaying Scaglia Bianca formation. In the uppermost part of the Scisti a Fucoidi, black shales are replaced by more oxygenated sediments (Coccioni *et al.*, 1989).

On the basis of dominant colour alternation, presence of black shales and calcium carbonate percentage, the Scisti a Fucoidi Formation has been subdivided in 18 lithostratigraphic sub-units (Erba, 1988). Detailed biostratigraphic studies have been carried out on calcareous nannofossils and planktonic foraminifera (Monechi, 1981; Erba, 1988; Premoli-Silva *et al.*, 1989; Erba, 1992). In addition, investigation of magnetic stratigraphy has been used to analyzed the pattern of this rhythmical sequence in cyclostratigraphic studies (Lowrie *et al.*, 1980; Monechi & Thierstein, 1985; Tornaghi *et al.*, 1989).

Stable oxygen and carbon isotope composition of these rhythmic sediments is presented by De Boer (1982, 1991), who related cyclic lithologic changes with regular variations of temperature produced by orbital climatic forcing. Time series analysis of several geological, biological, chemical and physical parameters have demonstrated that Milankovitch climatic cycles produced these Cretaceous limestone-marlstone rhythmic sequences (Herbert & Fischer, 1986; Eicher & Diner, 1991; Fischer, 1991; Fischer *et al.*, 1991) .

Scaglia Bianca Formation:

This unit, ranging in age from middle Albian to early Turonian, has an average thickness of 65-70 meters. The Scaglia Bianca consists of thin bedded, often laminated, whitish to beige and reddish limestones with nodular and bedded cherts. The Scaglia Bianca Formation is equivalent to the "Capas Blancas" in the Penibetic (Martin-Algarra, 1987). Its lower limit is set by convention at the last greenish-grey marly bed of the Scisti a Fucoidi, which coincides with the first appearance of a chert layer. The boundary with the Scaglia Rossa is placed where both limestones and cherts become pink (Cresta *et al.*, 1989).

On the basis of the limestone and chert colour, the Scaglia Bianca has been subdivided into four members which are, from the bottom to the top of the formation:

1) Whitish limestones and beige chert Member, with a reddish chert layer in the lower part.

2) Reddish limestone and red chert Member.

3) Whitish limestone and beige-grey chert Member.

4) White-beige limestone and black chert Member.

In the uppermost portion of the Scaglia Bianca, in a strongly variable position 2.5-8 meters below the contact with the Scaglia Rossa, there is a black horizon of 45 to 200 cm. of thickness (Cresta *et al.*, 1989; Piergiovanni, 1989). This horizon, called "Livello Bonarelli" by Bortolotti *et al.* (1970), is widespread throughout the Umbria-Marche Apennines and is considered a characteristic stratigraphic marker in this region. It reflects a world-wide anoxic event known in the Alpine Tethys and in the Northern Atlantic (i.e., CTOAE: Cenomanian-Turonian Oceanic Anoxic Event; CTBE: Cenomanian-Turonian Boundary Event; E 2 Event; Bahloul Horizon; CTBSH: Cenomanian-Turonian Black Shale Horizon).

The Bonarelli horizon consists of black cherts, argillites, grey greenish radiolarian-rich siltstones and black shales, rich in organic carbon. The black shales are rich in phosphate nodules and also contain some well preserved fish remains. The abundance of organic matter reflects the anoxic conditions prevailing during its deposition. Three intervals have been distinguished in the Bonarelli horizon (Arthur & Premoli-Silva, 1982):

a) The basal interval (from 30 to 100 cm) consists of light coloured clayely, muddy radiolarian sandy silt layers with relatively small amount of carbonate and dark organic matter in the matrix;

b) The middle interval has a thickness from 30 to 100 cm and consists almost entirely of very thinly laminated black shales, very rich in organic matter and with abundant phosphatic debris, mainly as fish remains;

c) The upper interval (10 to 30 cm of thickness) consists of light grey and light creme-coloured radiolarian mudstone and radiolarian sandy silt layers, with a lower organic carbon content than the previous interval. The carbonate content increase gradually towards the top of the bed.

Planktonic and benthonic foraminifers, calcareous nannofossils and radiolarians are present throughout the Scaglia Bianca, although foraminifers usually disappear about 50 to 10 cm beneath the Bonarelli horizon. Moreover, the plankton present in this horizon consists mainly of radiolarians and there is an almost complete lack of planktonic foraminifers (only small hedbergellids have been found in this level), which reappear about 30-50 cm above the Bonarelli horizon (Piergiovanni, 1989). Recently, a preliminary biostratigraphic study of the radiolarian fauna has been presented by Marcucci *et al.* (1991). My own biostratigraphical analysis indicates a noticeable change in the radiolarian faunas took place during the latest Cenomanian-early Turonian. Some of the species that make their first or last appearance at this interval seem to occur toward the middle part of the Bonarelli horizon (cf. Marcucci *et al.*, 1991). I do not exclude the possibility of a stratigraphic discontinuity at the base of this interval.

Scaglia Rossa Formation:

This unit comprises about 250 meters of pink to red micritic limestones interbedded with red marly limestones and marls. It is of early Turonian to Paleocene age.

Bed surfaces in this unit are normally flat and parallel but bedding is disturbed by slides and slumps in places. There are also layers composed by calcarenite turbidites and other carbonate detrital deposits which have been related to the tectonic activity along the margin (Colacicchi *et al.*, 1985; Colacicchi & Baldanza, 1986).

The Scaglia Rossa Formation has been subdivided in four members that consist of: 1) limestones with red chert, 2) red limestones without chert, 3) marly limestones without chert and 4) red limestones with chert (Premoli-Silva, 1977; Alvarez *et al.*, 1977). This latter unit marks the upper limit of the Scaglia Rossa (Cresta *et al.*, 1989).

Calcareous plankton stratigraphy and magnetostratigraphic data have been correlated by Premoli-Silva (1977) and Monechi & Thierstein (1985) in order to recognize significant stratigraphic events.

II.1.2 STUDIED SECTIONS

The present biostratigraphic study concerns particularly four sections in the Umbria-Marche Apennines for which lithology, biostratigraphy and radiolarian content have allowed an accurate correlation: Gorgo a Cerbara, Apecchiese, Gola del Bottaccione and Monte Casalini sections (Fig. 6). A detailed sampling has been carried out in each above mentioned section mainly in the Scisti a Fucoidi Formation and Scaglia Bianca Formation (Figs. 7a-d), in order to study the Mid-Cretaceous radiolarian fauna. Some samples from the sections at Poggio le Guaine and Fiume Bosso have also been analyzed.

Gorgo a Cerbara Section

The Gandiolono river which cuts through the northern limb of the Gorgo a Cerbara anticline provides excellent outcrops of the Maiolica, Scisti a Fucoidi, Scaglia Bianca and Scaglia Rossa Formations. The Gorgo a Cerbara section is located 4 km north-east of the town of Piobicco, on the road to Aqualagna; this was surveyed along both hydrological margins of the Gandiolono river. Small folds and faults are occasionally present in this section.

The measured interval is 140 meters thick and spans the Scisti a Fucoidi Formation (55 m), the Scaglia Bianca Formation (78 m) and the lower meters of the Scaglia Rossa Formation. The Bonarelli horizon appears at 3.4 meters below the Scaglia Rossa Formation and it has a thickness of 122 cm. A detailed log of this section is shown in Fig. 7a. The Scaglia Bianca consists, from bottom to top, of whitish limestones with beige chert (21 meters), reddish limestones with red chert (25.5 meters), whitish limestones with beige-greyish chert (6.5 meters) and white-beige limestones with grey-black chert (26 meters).

Fig. 6.- Stratigraphic correlation of the Umbrian-Marche sections. The position of samples studied for biochronology is indicated by the corresponding Unitary Associations. The column of numbers at the right of the Marne a Fucoidi and Scaglia Bianca Formations refer to the lithologically differentiated members (see text). *Legend Colours*: black: anoxic events (**SH:** Selli horizon, **BH:** Bonarelli horizon). Dotted: red lithologies in the Marne a Fucoidi Formation. Oblique hatched (left): red lithologies in the Scaglia Bianca Formation. Oblique hatched (right): red lithologies in the Scaglia Rossa Formation. Correlation among sections is shown by solid lines. Oblique hatched fields between radiolarian zones indicate uncertain position of zonal boundaries.

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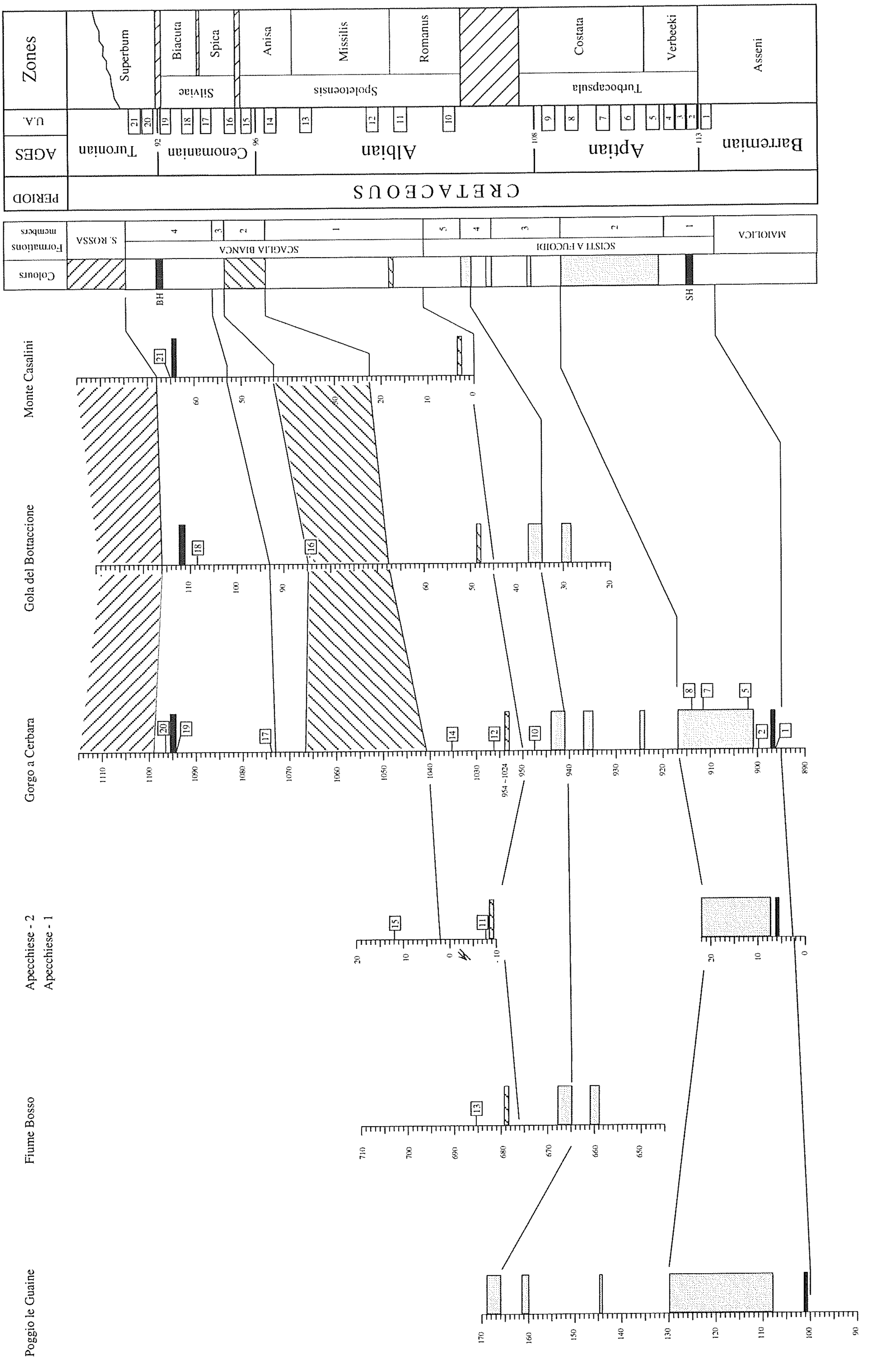

Zones
U.A.
AGES
PERIOD
CRETACEOUS
Turonian
Cenomanian
Albian
Aptian
Barremian
Superbum
Biacuta
Spica
Silviae
Anisa
Missilis
Romanus
Spoletoensis
Costata
Verbeeki
Turbocapsula
Asseni
Colours
Formations members
S. ROSSA
SCAGLIA BIANCA
SCISTI A FUCOIDI
MAIOLICA
BH
SH
Monte Casalini
Gola del Bottaccione
Gorgo a Cerbara
Apecchiese - 2
Apecchiese - 1
Fiume Bosso
Poggio le Guaine

Apecchiese Section

The Apecchiese section is located on the western limb of the Monte Nerone anticline, 3 km west of the town of Piobbico, along the Apecchiese state road 257. I have considered two sections (Apecchiese 1 and Apecchiese 2) because the outcrop is not adequate for a complete continuous section (Fig. 7b). The lower section (Apecchiese 1) outcrops along the northern side of the road and includes 25 meters of the Scisti a Fucoidi Formation. The upper section (Apecchiese 2) is situated along a little valley toward the west and comprises 30 meters of the Scaglia Bianca Formation.

Gola del Bottaccione Section

The Gola del Bottaccione section is located close to the town of Gubio, along the road from Gubio to Scheggia and forms the right hydrological margin of the river Bottaccione. This apparently continuous section has been the objet of several sedimentologic, geochemical, magnetostratigraphic, planktonic foraminifera and calcareous nannofossil biostratigraphic studies (Cresta *et al.*, 1989). It has also been proposed as the magnetostratigraphic standard for the Cretaceous-Tertiary interval. In the present work, the studied section comprises the upper 50 meters of Scisti a Fucoidi, the overlying Scaglia Bianca and the first meters of Scaglia Rossa.

The Scaglia Bianca Formation reaches a total thickness of 71 meters, integrally studied in this work (Fig. 7c). It consists, from bottom to top, of whitish limestones with beige chert (22.5 meters), reddish limestones with red chert (17 meters), whitish limestones with beige-greyish chert (8.5 meters) and white-beige limestones with grey-black chert (23 meters). The Bonarelli horizon appears in the latter member and is 103 cm. thick in this section; its upper limit is situated about 4.5 meters below the boundary between the Scaglia Bianca and Scaglia Rossa Formations.

Monte Casalini Section

In the Umbria-Marche region, about 15 km. southeast of Assisi, there is a regional road from the town of Foligno to Sasso Vivo Abbey. The Monte Casalini section is situated close to this abbey and has been sampled along the road. The studied interval comprises the uppermost part of the Scisti a Fucoidi Formation, the Scaglia Bianca Formation and the lower meters of the Scaglia Rossa Formation. The Scaglia Bianca Formation includes, from bottom to top (Fig. 7d): 22.5 meters of white limestones with beige chert (Member 1), 20.5 meters of reddish limestones with red chert (Member 2), 10 meters of whitish limestones with beige chert (Member 3) and 15 meters of white-beige limestones with grey-black chert (Member 4). In this section, the Bonarelli horizon is only 80 cm of thick; its upper limit is located about 2.5 meters below the Scaglia Bianca-Scaglia Rossa boundary.

Fiume Bosso and Poggio le Guaine Sections

Samples have also been studied from the transition between the Scisti a Fucoidi and Scaglia Bianca Formations in the Fiume Bosso section (43°31'11" N, 0°07'07" E) and from the Scisti a Fucoidi Formation in the Poggio le Guaine section (43°32'32" N, 0°08'02" E). The former outcrops in the road between Cagli and Pianello and the latter is located near the road from the village of Via Strata to Poggio le Guaine, both in the Monte Nerone area.

Litho-biostratigraphic correlation led to a Poggio le Guaine-Fiume Bosso composite section of 86.2 meters of thickness. A detailed description of this composite section can be found in Coccioni *et al.* (1990).

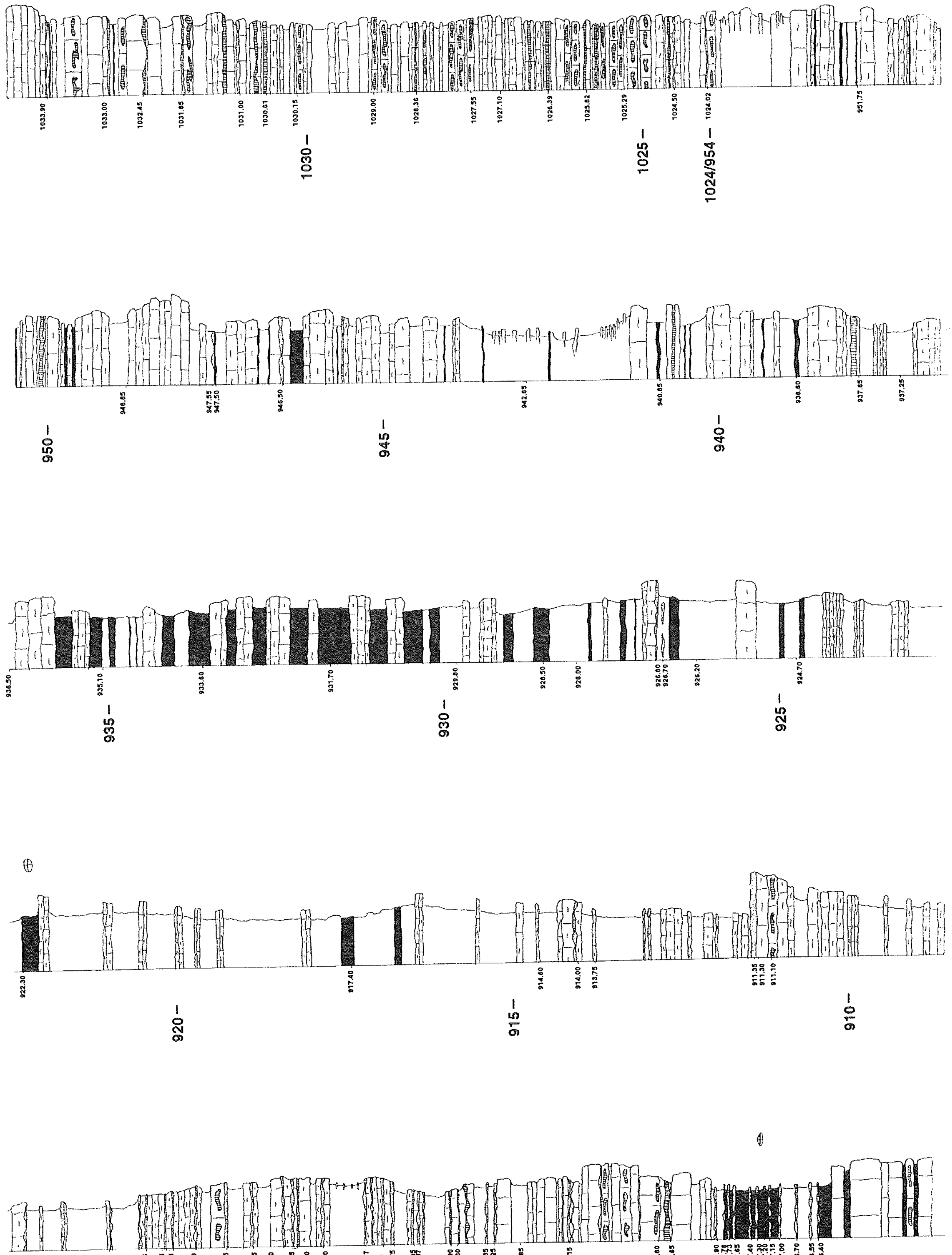
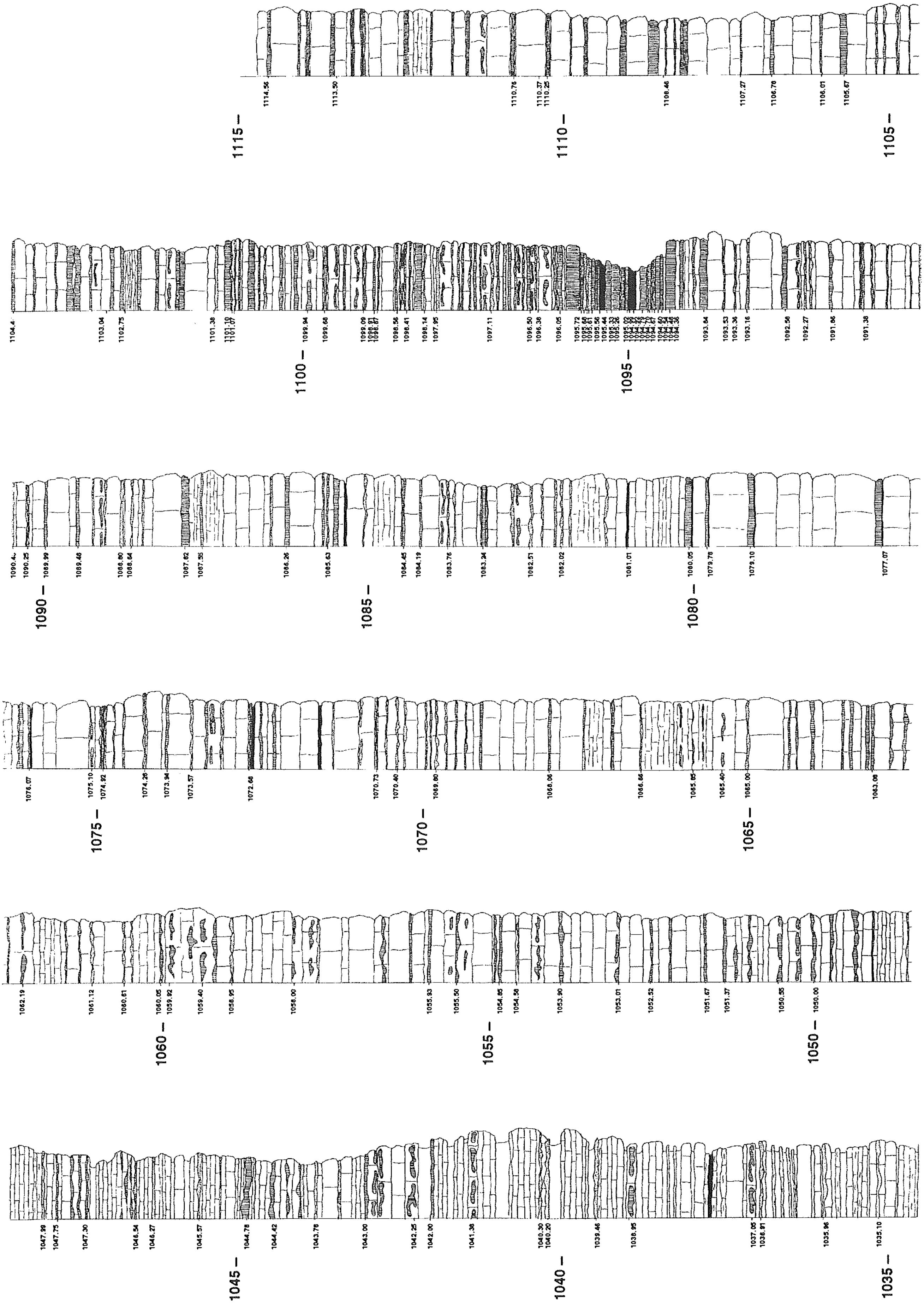


Fig. 7a.- Stratigraphic log of Gorgo a Cerbara section.

Fig. 7a.- Stratigraphic log of Gorgo a Cerbara section (continued).



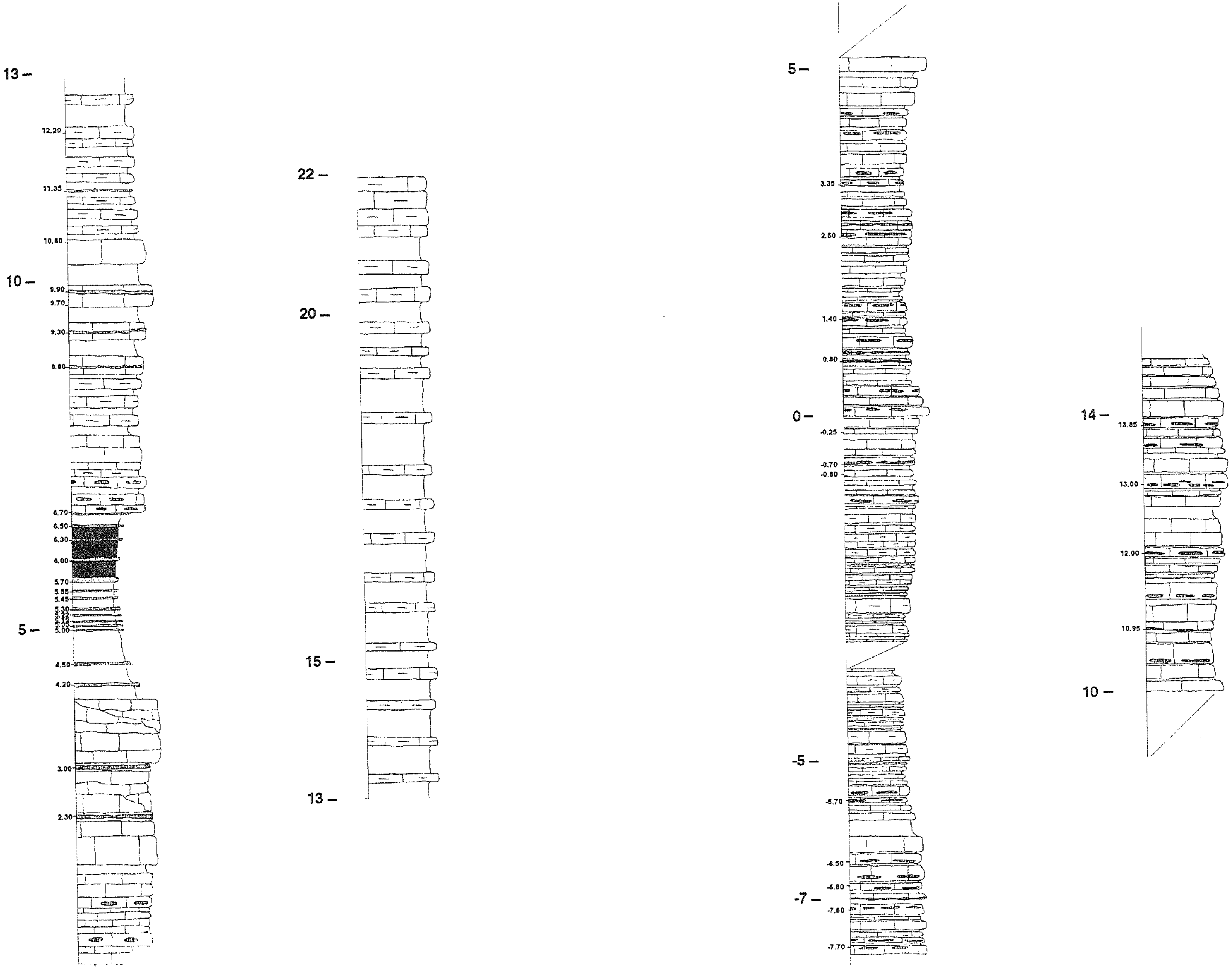
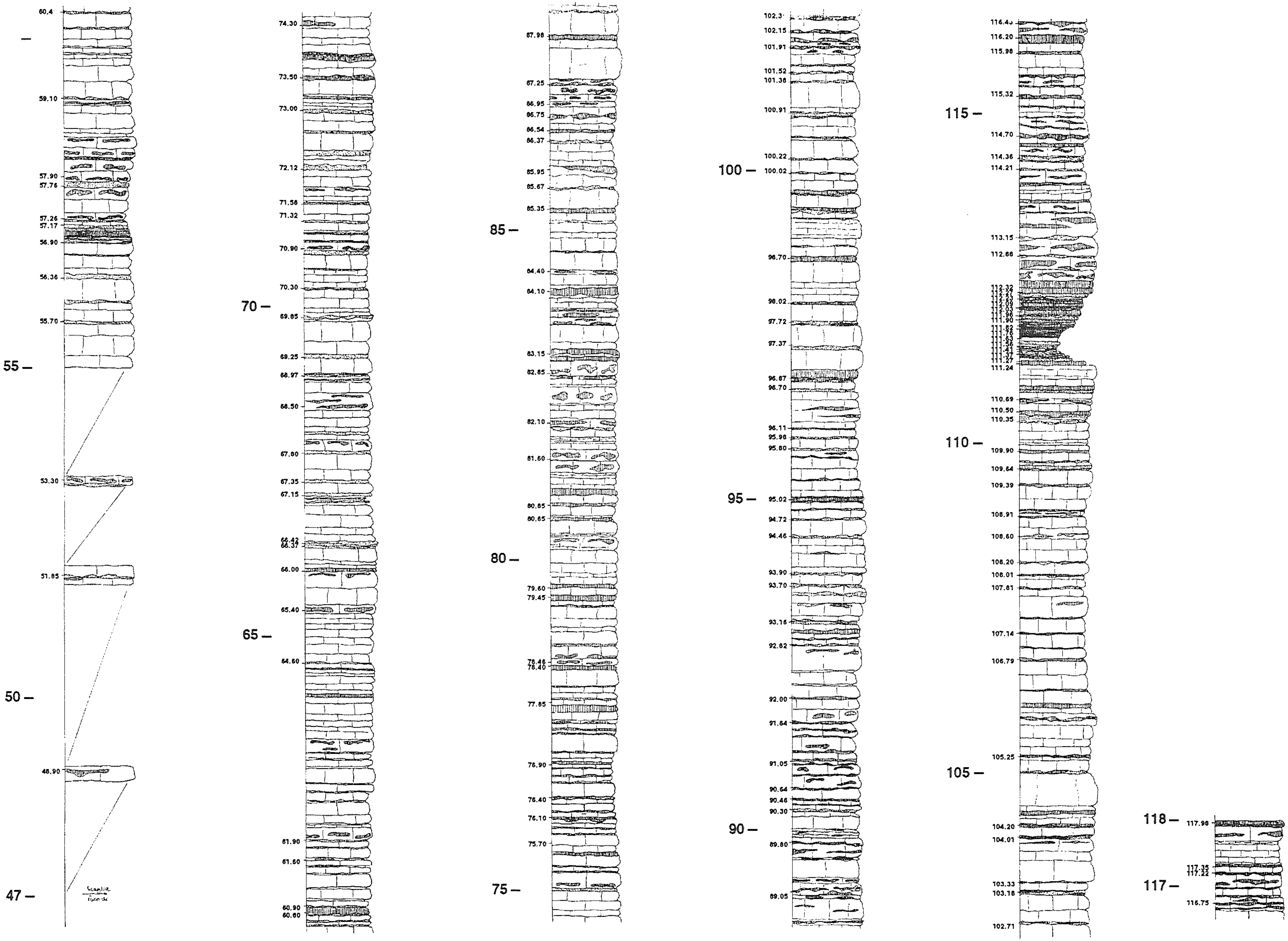


Fig. 7b.- Stratigraphic log of Apecchiese-1 and Apecchiese-2 sections.

Fig. 7c.- Stratigraphic log of Gola del Bottaccione section.



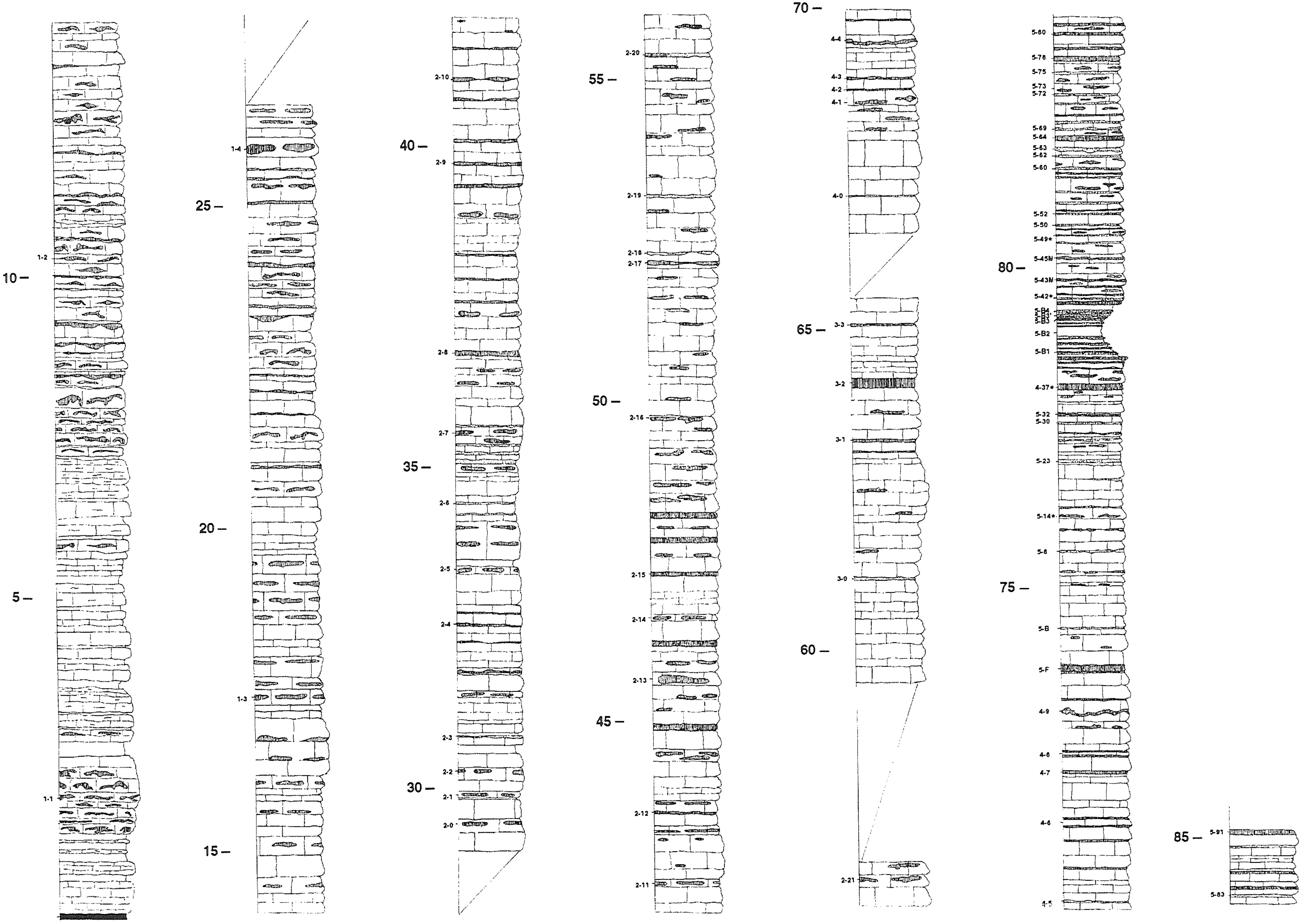


Fig. 7d.- Stratigraphic log of Monte Casalini section.

II. 2. EXTERNAL ZONES OF THE BETIC CORDILLERA

II. 2. 1. CRETACEOUS STRATIGRAPHY

Two main domains have been distinguished in the Betic External Zones: the Prebetic Zone and the Subbetic Zone (cf. section I.3.2). The first is characterized by shallow water facies as opposed to the second where pelagic facies prevail during the latest Jurassic through the Cretaceous (García-Hernández *et al.*, 1980).

It should be note that there are no outcrops with a continuous record of Cretaceous sedimentation in the Subbetic Zone because of the tectonic complexity in the region. The stratigraphic sequences are usually well exposed in a continuous way from the Barremian to early Albian and from late Cenomanian to Turonian, whereas the rest of Albian and part of Cenomanian are not well represented. Nevertheless, a general stratigraphic Cretaceous sequence can be inferred from different partial sections.

In spite of the different facies and sediments related to each Subbetic Zone (Internal, Middle and External Subbetic), four main formations can be differentiated in the Cretaceous (see fig. 8a). These are, from bottom to top: 1, the Carretero Formation (Vera *et al.*, 1982), consisting of limestones and marls rhythmite; 2, Fardes Formation (Comas, 1978), characterized by predominant marly constituents; 3, Capas Blancas Formation (Martín-Algarra, 1987), composed of white marls and marly limestones, and 4, Capas Rojas Formation (Vera *et al.*, 1982), consisting of interbedded reddish marls and marly limestones. This lithostratigraphic nomenclature has been used in order to homogenize the different local names of equivalent formations, according to Aguado *et al.* (1991).

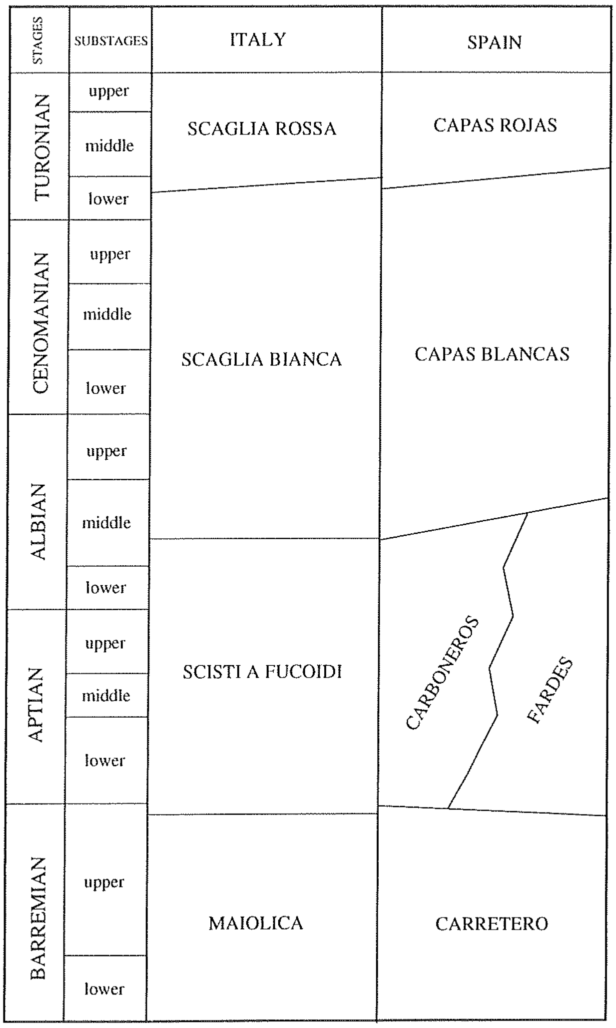
External Subbetic

Cretaceous sedimentation is relatively well represented in the External Subbetic realm and is characterized by frequent turbiditic levels of differing ages.

During the Neocomian to Barremian, light coloured marly and marl-limestone facies with abundant ammonites and nannofossils are dominant. These materials are equivalent to the Carretero Formation in other Subbetic zones and they have been compared to the Maiolica Formation in the Apennines (Comas *et al.*, 1982).

The Mid-Cretaceous, from Aptian to early Albian, is characterized predominantly by dark colour marls and marly clays with an average thickness of 250 meters. Frequently, calcarenitic turbidites and slumps are present in the lower part of the formation. This depositional unit corresponds to the above mentioned Fardes Formation.

Fig. 10a.- Chronostratigraphic correlation of Mid-Cretaceous formations between the Central Apennines and the Betic Cordillera. ⇒



The Capas Blancas Formation is early-middle Albian to Coniacian in age with approximately 40-60 meters of thickness. Sedimentation is relatively calcareous, with dominantly whitish-beige marly limestones and thin interbedded black chert.

The Capas Rojas Formation is of Coniacian to Eocene age and can reach 350 meters of thickness (Comas *et al.*, 1982).

Middle Subbetic

The Middle Subbetic Zone, a deep basinal marine environment, that has undergone the greatest subsidence in Subbetic region. Its thicker sediments are predominantly limestone, marl and radiolaritic and calcareous turbidite lithologies (Azema *et al.*, 1979; Vera, 1988).

The Carretero Formation consists of limestones, marls and marly limestones with an average thickness of about 200-300 meters (Sanz de Galdeano, 1973; Comas *et al.*, 1982). Clayely-marly lithology and interbbeded turbidites increase near the top of the unit.

In this subdomain, the Fardes Formation reaches a maximal thickness of 580 meters and has been divided into three members, according to the relative proportion of detritic and pelagic materials (Comas, 1978; Comas *et al.*, 1982). These are, from the bottom to the top: 1) Member I, mostly made up of green clays with sporadic turbidite insertions; 2) Member II, characterized by clastic lithologies predominating over the thin hemipelagic beds; 3) Member III, containing alternating layers of calcarenites, calcilutites and clay lithologies. Pelagic and hemipelagic facies typically coexisted with turbidites from the Middle Berriasian onwards and become more important from the Lower Cenomanian on. They disappear at the base of the Campanian when truly pelagic sedimentation is re-established (Hernández-Molina *et al.*, 1991; Hernández-Molina, 1992). The existing pelagic and hemipelagic sediment layers are dark green and black in colour, rich in clay minerals and poor in carbonates (López-Galindo, 1986). The mineralogical, geochemical and sedimentological features of these materials suggest that anoxic sedimentation prevailed in this sector of the Subbetic basin (Sebastián-Pardo *et al.*, 1984).

Another formation, equivalent in age to Fardes but deposited to the northernmost of the Middle Subbetic realm, has been distinguished: the Carbonero Formation. It overlies the Carretero Formation in the Middle Subbetic-External Subbetic transition where it presents a maximum thickness of 255 meters (Molina, 1987; Aguado *et al.*, 1993). It consists of three characteristic members: 1) member I, lower marly; 2) member II, middle radiolaritic; and 3) member III, upper turbiditic (Molina, 1987). These three members are separated by stratigraphic discontinuities which introduce important lithological changes.

The Capas Blancas Formation is mostly absent in the Middle Subbetic, corresponding in general with a stratigraphic discontinuity. In fact, the Capas Rojas Formation directly overlies the Fardes and the Carbonero Formations.

The Capas Rojas Formation, characterized by its reddish colour, is the most uniform and extended lithostratigraphic unit in the Betic Cordillera. It consists of rhythmically alternating micritic limestones, marly limestones and marls, which contain abundant planktonic foraminifers and calcareous nannoplankton and is similar to the other Subbetic zones. In the Middle Subbetic, this formation is restricted to the Maastrichtian and has a thickness of 300-350 meters. It can be thicker in other areas where it reaches the Paleocene (Comas *et al.*, 1982; Hernández-Molina *et al.*, 1991).

Internal Subbetic

Cretaceous sedimentation in the Internal Subbetic palaeogeographical domain is characterized by pelagic facies with an irregular distribution of interbedded turbidites and associated facies (Vera *et al.*, 1982).

The lowest Cretaceous unit, the Carretero Formation, outcrops only locally and it is very difficult to establish its average thickness (between 50 to 200 meters in some sections but stratigraphically absented in other ones). It is represented by rhythmically alternating white limestones and marls of Berriasian to Late Barremian age; calcareous layers are dominantly composed of radiolarian mudstone. The macrofauna is mainly constituted by belemnites, aptychi and ammonites; in the uppermost part of the formation, planktonic foraminifers appear (Aguado *et al.*, 1991).

The Fardes Formation can be located overlaying the Carretero Formation or directly over Jurassic carbonates. It is composed of dark greenish marls with interbedded turbidites and presents important thickness, which has been estimated in more than 300 meters. Calcareous nannoplankton, radiolarians and planktonic foraminifers indicate a Late Barremian to Early Cenomanian age for this formation (Hernández-Molina & Aguado, 1991; Aguado *et al.*, 1991).

The Upper Cretaceous pelagic sequence continues in the Internal Subbetic throughout the Capas Blancas Formation, which changes laterally to shallower carbonate turbidite facies, informally named Calcareous breccias of the Upper Cretaceous. The Capas Blancas Formation is characterized by rhythmically alternating whitish-yellowish marls and marly limestones with chert. It consists of a wackstone-packstone with planktonic (rarely benthonic) foraminifers and radiolarians of early Cenomanian-late Santonian age (Aguado *et al.*, 1991).

Finally, the Capas Rojas Formation outcrops above the Capas Blancas Formation or directly overlies the Jurassic basal unit. This formation is constituted of reddish marls and marly limestones (mudstone-wackstone) very rich in planktonic foraminifers and calcareous nannofossils (Aguado, 1993, 1994). It considerably resembles sediments of the same age in other alpine Mediterranean domains, i. e. "Scaglia Rossa" or "Couches Rouges" (Vera, 1981; Martín-Algarra *et al.*, 1992). In the lower part of the Capas Rojas Formation, the marly limestones present an evident rhythmicity which is masked at the top of the unit by increasing marls. The lowermost portion contains a planktonic foraminiferal association of late Santonian age (equivalent to the uppermost part of Capas Blancas). However, foraminifers from late Campanian appear immediately (Aguado *et al.*, 1991). The characteristic reddish facies continues into the Paleocene and its thickness can be greater than 600 metros (Vera *et al.*, 1982).

Penibetic

The Penibetic is the most internal and westernmost domain of the Internal Subbetic. During the Late Jurassic-early Valanginian, this subdomain was a relatively shallow pelagic platform area which emerged and was karstified during the Hauterivian, before gradually sinking again throughout the remainder of the Early Cretaceous (Martín-Algarra, 1987).

The main stratigraphic characteristic of the Penibetic is a generalized sedimentary rupture existing in the Early Cretaceous; for the greater part of the Barremian-Aptian there is no sedimentary record, except for some pelagic sediments found as infillings of fissures and neptunian dykes (González-Donoso *et al.*, 1983). Deposition was renewed during the Albian, directly overlying Jurassic limestones, in the form of Capas Blancas-Scaglia Bianca-type calcareous marly rhythms, occasionally rich in organic matter (López-Galindo & Martín-Algarra, 1992).

The calcareous-marly sedimentation of the Albian-Vraconian tended to become much more calcareous and cherty throughout the Cenomanian. The maximum silica content, which produced genuine radiolarites, was reached at the Cenomanian-Turonian boundary and during the Turonian (López-Galindo, 1986). This interval is characterized by interbedded limestones with black chert, sometimes including slump structures. Sediments are usually very dark in colour and bituminous layers with fish remains appear (Martín-Algarra & Vera, 1982). The Capas Blancas Formation can reach a thickness of about 70 meters in the Subbetic zone (Martín-Algarra, 1987).

The late Cretaceous-Eocene is represented by Capas Rojas facies, consisting of reddish marly limestones rich in planktonic foraminifers and radiolarians; its average thickness is about 150 meters. On the whole, this formation is more calcareous in the Penibetic than in the other Subbetic domains (Martín-Algarra & Vera, 1982). Furthermore, clay content increased during the Paleocene, characterising an upper marly member (Martín-Algarra, 1987).

II. 2. 2. STUDIED SECTIONS

In the External Zones of the Betic Cordillera sections belonging to the different subdomains have been studied. The best represented realm corresponds to the Middle Subbetic, including the Carbonero, Campillo de Arenas and Fardes sections. The Internal Subbetic is represented by the Pantano section. Finally, the Sierra de Estepa section in the External Subbetic and the Canutos section in the Penibetic were also included.

Carbonero Section

This section is located 2 km WSW of Cortijo Carbonero, at the southeast of Valdepeñas de Jaén, to the northern of a little valley situated close to Cortijo de Solana de Morales (UTM coordinates VG 292576). It comprises about 140 meters of the Carbonero Formation, which overlies limestones and marly limestones of the Carretero Formation. The uppermost part of the section is eroded and affected by inverse faults which allow the exposure of jurassic materials overthrusting the Carbonero Formation. As a consequence, the stratigraphic contact between Carbonero and Capas Rojas Formations does not appear in this outcrop.

Three members, easily distinguishable at the outcrop, were differentiated in the Carbonero Formation. In this section (Fig. 8b), they present the following characteristics:

1) Member I, lower marly: it reaches a thickness of 18.4 meters and consists of grey-blue marls with some interbedded calcarenites and conglomerates. Barite concretions are especially abundant in the upper 7.5 meters of this member.

2) Member II, middle radiolaritic: it is composed of dark grey-brown radiolarites, black or grey clays and marls, with 41 meters of thickness. Olistholites and megabreccias, about 4 meters thick, are quite frequent; calcite concretions are preferentially distributed in some levels in the upper part of the member.

3) Member III, upper turbiditic: it presents a thickness of 84 meters and consists of alternating grey-greenish marls and calcarenites with less abundant conglomeratic layers. Only the lower 40 meters have been sampled.

Campillo de Arenas Section

This Middle Subbetic section is located in the province of Jaén, about 3.5 km NE of Campillo de Arenas; geographic coordinates of the base of the section are 37°34'43" N and 3°36'28" W. The studied interval comprises the upper part of the Carretero Formation and the lower part of the Fardes Formation. This section has been studied in order to develop biostratigraphic analysis of the Barremian-early Albian (Aguado *et al.*, 1992).

The Campillo de Arenas section reaches a thickness of about 200 meters and can be divided lithologically into two clearly differentiated intervals. The lower interval consists of alternate layers of marls and grey marly-limestones (Carretero Formation) with some slumps observed in the lower part. The upper interval is basically marly, dark coloured and has very few interbedded marly limestone layers (Fardes Formation). Preliminary data on ammonites, planktonic foraminifers, calcareous nannofossils and radiolarians have been published in Aguado *et al.* (1992); the reader is referred to that paper for more detailed information.

Río Fardes Section

The Río Fardes section belongs to the Middle Subbetic domain and comprises the members II and III of the Fardes Formation (Fig. 8c). It is located in the province of Granada, along the road leading from Huélago to Villanueva de las Torres, about 1.3 km to the south of the junction to Alicún de las Torres.

This section contains pelagic and hemipelagic sediments which appear together with turbidites and olistostromes. The main characteristics of each member are (Hernández *et al.*, 1991):

a) Member II consists of breccia and conglomerate layers, followed by layers and beds of microbreccias, calcarenites, calcilutites and dark green clays, with local slumps. It is about 57 meters thick;

b) Member III (about 31 meters of thickness) presents a clear alternation of fine-grained turbidite levels, consisting of calcarenites, calcilutites and purple-red clays.

Studied radiolarian samples belong to siliceous beds located in the lower part of the Río Fardes section. Calcareous nannofossils, planktonic foraminifers and the above mentioned radiolarians have been used for dating this section by Hernández-Molina *et al.* (1991). Another section that complements the stratigraphy of the studied Fardes Formation is the Río Gor section, located near the town of Gorafe (Fig. 8c).

Pantano Section

This section is located in the Pantano de Valdeinfierno sector, about 15 km to the northeast of the town of Vélez Blanco, in the province of Almería. The Pantano section includes the uppermost meters of the Carretero Formation and the late Barremian to early Aptian interval of the Fardes Formation (Aguado *et al.*, 1991).

The Carretero Formation presents its characteristic lithology of alternating white limestones and marls; radiolarian associations in the uppermost part of this formation are late Barremian. In the Pantano section, the Fardes Formation is composed of dark greenish marls, that become sometimes radiolaritic, with interbedded turbidites and rare slumps in the lower part.

Hernández-Molina *et al.* (1991) have carried out stratigraphic, sedimentological and biostratigraphic studies of this section, including planktonic foraminifers, nannoplankton and radiolarians.

Sierra de Estepa and Canutos Sections

Both the Sierra de Estepa section (External Subbetic) and the Canutos sections (Penibetic) have been sampled in the interval corresponding to the Capas Blancas Formation (late Albian-early Turonian). An integrated biostratigraphic analysis (calcareous nannofossils, planktonic foraminifers and radiolarians) is currently under preparation.

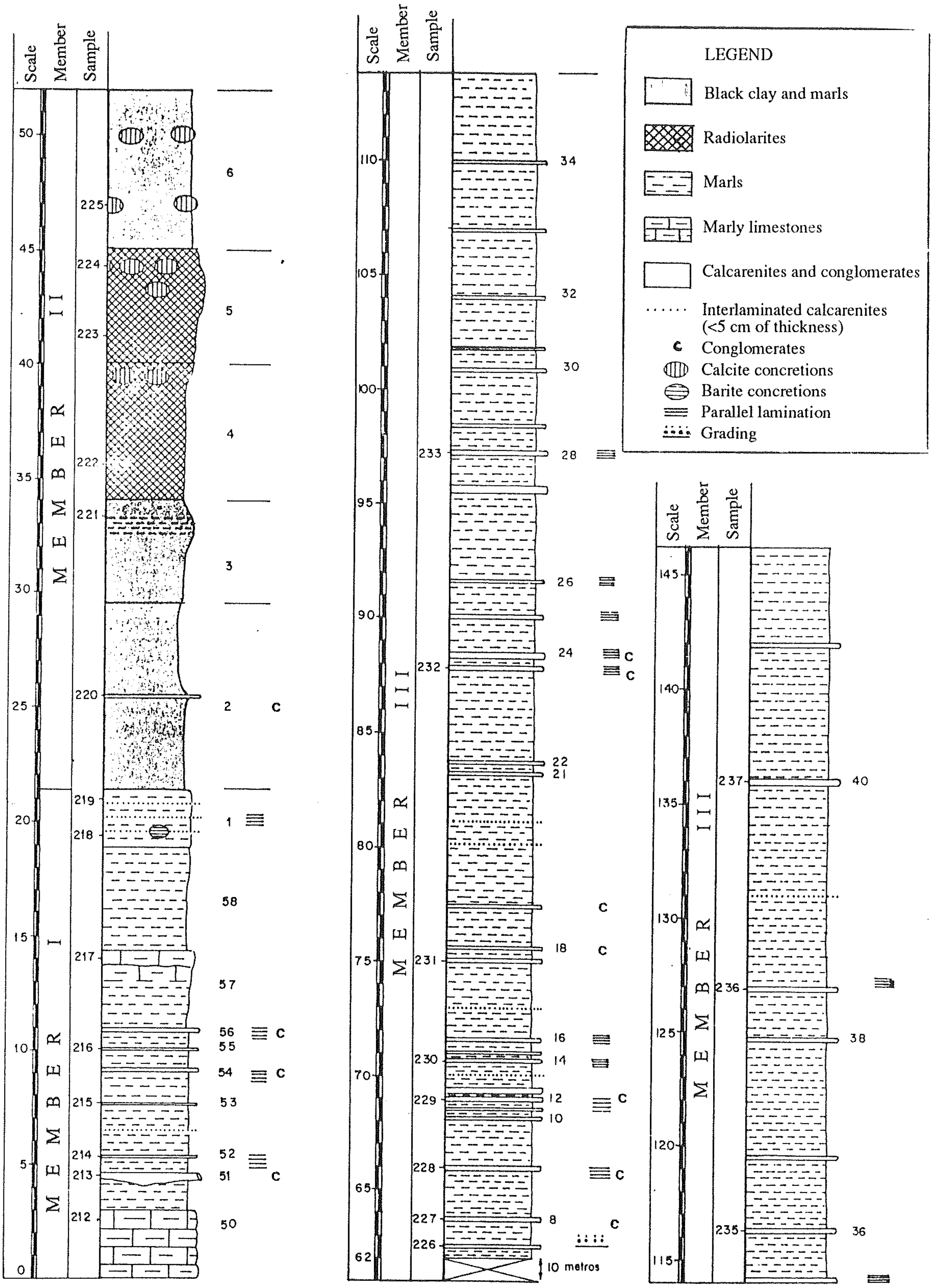


Fig. 8b.- Stratigraphic log of the Carbonero section (from Aguado *et al.*, 1993).

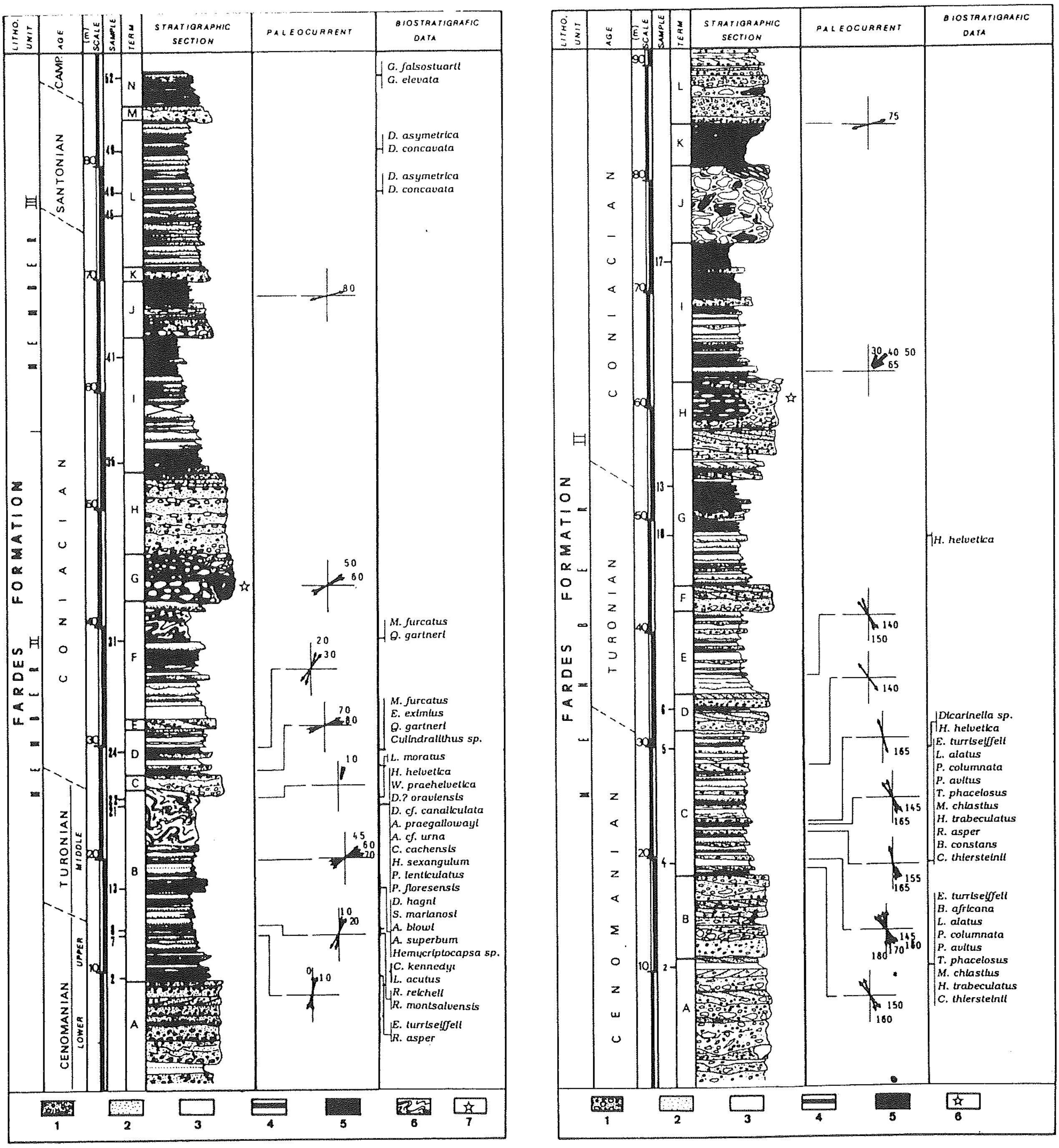


Fig. 8c.- Stratigraphic log of the Río Fardes (1) and Río Gor (2) sections. *Key*: 1.- Conglomerate. 2.- Calcarenites. 3.- Calcilutites. 4.- Black cherts. 5.- Argiles. 6.- Slumps (from Hernández-Molina *et al.*, 1991).

III. BIOCHRONOLOGY

III.1. INTRODUCTION

A two-fold division of the Cretaceous into an Early and a Late Epoch is generally accepted, the term middle Cretaceous being an informal unit (Birkelund *et al.*, 1984; Harland *et al.*, 1989). However, many authors frequently employ the term middle Cretaceous introducing in this manner a three-fold informal division, although the concept varies more or less from author to author, and often with a different sense. In this study an alternative three-fold division is used following the recommendation of Harland *et al.* (1989). The Mid-Cretaceous (coined for these authors with the term "Gallic") is thus considered as an informal division between Neocomian and Senonian. This is the sense in which middle Cretaceous is regarded in this work, i.e. comprising five stages: Barremian, Aptian, Albian, Cenomanian and Turonian.

In this chapter I have attempted to establish a radiolarian zonation based on the analysis of the vertical distribution of the taxa which were recognized in the studied sections. The sequence of species observed in the fossil record inevitably reflects the order in which this fauna evolved. Therefore, the relationship between biochronological analysis and paleontology was empirically used for tracing evolutionary lineages to elucidate the phylogenetic relationships of numerous examined taxa. In my opinion, this procedure allows the definition of zones with strong chronostratigraphic significance. I would like to stress that the zonation presented here seems useful exclusively for the middle Cretaceous of the western Mediterranean area. Though the purpose of this zonation does not pretend to be applicable to the whole Tethyan paleobiogeographic realm, it can be regarded as a tool-calibration to which local zonations from other regions could be compared. Finally the biozones are tied to chronostratigraphy by means of other coexisting fossil groups, such as planktonic Foraminifera and calcareous nannofossils that were studied previously by other authors at the same localities.

III.2. RADIOLARIAN BIOCHRONOLOGY: PROCEDURES

The empirical biostratigraphic treatment of the paleontological data led me to determine a preliminary zonal scheme on which the zonation proposed here is largely based. Because the number of data was important, a deterministic method was required in order to compare these empirical results with a mathematical treatment. Therefore, a more detailed biochronological analysis was carried out by means of Unitary Association Method (Guex 1977, 1991). The U.A. method defines maximal sets of exactly or virtually coexisting taxa. The resulting Unitary Associations differ from each other by containing unique and mutually exclusive assemblages of species or species pairs (see Guex, 1991 for details). These procedures were thoroughly discussed by Baumgartner (1984a,b), who applied the U.A. method for Middle Jurassic-Early Cretaceous radiolarians.

A database (see Appendix, Chapter VI) recording the distribution of 303 species in 29 horizons selected from six hundred samples collected in seven sections has been used to establish a biochronological scale (see chapter IV.1.2. for more details). The database was processed with the BioGraph computer program (Savary & Guex, 1991) based on the Unitary Association Method. The program produced a sequence of 21 U. A.'s (figs. 9-11). The resulting range chart ("protoreferential" of Guex, 1991, p. 2) is used to construct chronologically meaningful zones and subzones, in which each of these Unitary Associations is defined by the totality of its characteristic species pairs.

The classical paleontological work done at the initial stage of my study (picking, review of all samples, compilation of the database, photographic prints, etc.) led me to conceive a provisional empirical zonation. But, obviously the zonation has been ultimately established by means of the Unitary Association Method. Using the range chart (fig. 9a) as a starting point, together with the reproducibility table (fig. 9b), it is possible to complete (with precise additional information) the lateral traceablity of the Unitary Associations. The combination of both procedures (empirical and deterministic methods) enabled the establishment of the zonation proposed in the present chapter.

Species or pairs of species defining individual U.A.'s, as well as mutually exclusive species defining their limits, are evident from Fig. 9 and will not be systematically referred to in the text. (see Guex, 1991, p. 7, for properties of protoreferentials). The biochronological analysis has allowed the definition of nine new radiolarian biochronologic units (zones or subzones) for the middle Cretaceous. The zonal units presented here have typical characteristics of the Oppel zones or of the Concurrent Range zones. They are defined below in detail. Such zones have the advantage of being characterized by an association of selected taxa of restricted concurrent ranges, chosen as indicative of approximate contemporaneity. The body of each zone is marked largely by the concurrence of diagnostic taxa whose stratigraphic ranges are limited to the time interval comprised by the zone. Thus, these zones acquire a strong chronological and chronostratigraphic significance. Furthermore, I chose as markers of zonal boundaries those taxa which are distinctive and whose occurrence in different sequences does not represent gradual morphologic continuity with faunas from underlying or overlying levels.

For practical purposes, when possible, each unit is here arbitrarily named after a taxon occurring exclusively within the corresponding biochronologic unit. Formally defined biochronologic units are labelled either as zones or subzones.

III.3. PROPOSED ZONATION

ASSENI ZONE

Although the base of this zone has not been recognized in this synthesis (early Barremian), a provisional interval zone can be proposed since data available from Barremian samples from Gorgo a Cerbara and Fiume Bosso sections in Italy, together with data from the Middle Subbetic domain in Spain (O'Dogherty & Martínez-Gallego, 1991; Aguado *et al.*, 1991, Aguado *et al.*, 1992).

The lower limit of this biozone is defined by the first appearance of *Hiscocapsa asseni* (TAN). In the upper part of this zone, the extinction of several significant genera takes place, i.e. *Ristola* PESSAGNO & WHALEN, 1982; *Saitoum* PESSAGNO 1977b and *Cecrops* PESSAGNO 1977c. Also becoming extinct are the species: *Cecrops septemporatus* (PARONA, 1890), *Saitoum elegans* DE WEVER 1981 and *Ristola asparagus* JUD (1994). The first record of *Obeliscoites perspicuus* (SQUINABOL) seems to occur in the upper part of this zone, among the poor faunal replacement that takes place in this interval. The top of the zone is defined by the earliest occurrence of *Thanarla carboneroensis* nov. sp. together with the extinction of characteristic species such as: *Crolanium bipodium* (PARONA) and *Cyclastrum infundibuliforme* RÜST. This biozone represents an interval principally characterized by the scarcity of new taxa and it could be more or less equivalent to the G1 zone of Jud (1994).

In the Subbetic (cf. Aguado *et al.*, 1991, Aguado *et al.*, 1992) the last record of *Cecrops septemporatus* occurs toward the middle part of the Hugii ammonite zone (early Barremian). In the Umbria-Marche Apennines the last appearance of *Cecrops septemporatus* coincides with the first record of *Obeliscoites perspicuus*. This datum was observed at Gorgo a Cerbara section (Gc-882.40) and is associated with *Silesites* spp. and *Silesites seranonis* (D'ORBIGNY) (ammonite data of Bartolocci *et al.*, 1992) and probably corresponds to the lower part of the Astieri ammonite zone (upper part of late Barremian).

TURBOCAPSULA ZONE

Index taxon: *Turbocapsula* nov. gen.

This biozone is defined by the total range of genus *Turbocapsula* which coincides with the total range of *Turbocapsula fugitiva* nov. sp.; furthermore, some characteristic taxa are restricted exclusively to this zone (i.e. *Crucella gavalai* nov. sp., *Holocryptocapsa fallax* (TAN), *Trimulus parmatus* nov. sp.). This biochronological unit is characterized by an important faunal turnover among radiolarians and many significant genera and species become extinct. Two subzones can be identified: the Verbeeki zone and the Costata zone.

Verbeeki subzone

Index taxon: *Hiscocapsa verbeeki* (TAN, 1927)

This subzone is characterized by the co-occurrence of 188 characteristic pairs of species (i.e. *Savaryella sinistra* nov. sp. and *Hiscocapsa uterculus* (PARONA);*Thanarla carboneroensis* nov. sp. and *Diacanthocapsa betica* nov. sp. etc.). The lower part is characterized by the appearance of the first representatives of the genus *Turbocapsula* (*T. fugitiva*, *T. giennensis* nov. sp.) together with the first occurrence of *H. verbeeki*. Fragmentary specimens of *Aurisaturnalis carinatus* (FOREMAN) are still frequent in the lowermost part of this subzone. The upper part is characterized by the extinction of the genera *Podobursa* WISNIOWSKI and *Parvicingula* PESSAGNO; other important species make also their last occurrence: *Becus helenae* (SCHAAF), *Hiscocapsa uterculus* (PARONA), *Hsuum pectorale* nov. sp., *Pseudoeucyrtis apochrypha* nov. sp. and *Thanarla carboneroensis* nov. sp. Simultaneously, several other genera and species make their first appearance within the upper part of this subzone (*Diacanthocapsa* SQUINABOL 1903a, *Rhopalosyringium* CAMPBELL & CLARK and *Trimulus* nov. gen.).

Costata subzone

Index taxon: *Turbocapsula costata* (WU, 1986)

The Costata subzone is characterized by the total range of *Turbocapsula costata* (WU) and by the co-occurrence of many characteristic pairs of species. The lower boundary is defined by the first occurrence of the index species and this is simultaneous with the last occurrence of *Thanarla lacrimula* (FOREMAN) and the extinction of the genera *Pantanellium* PESSAGNO (its last representative *P. lanceola* (PARONA)) and *Holocryptocapsa* (*H. fallax* (TAN) and *H. hindei* TAN). Other species may make their final appearance in the lower part of this subzone, i.e. *Cryptamphorella gilkeyi* (DUMITRICA), *Triactoma hybum* FOREMAN and *Dicroa periosa* FOREMAN.

Within the upper part of this subzone *Dactyliosphaera* SQUINABOL and three new genera (*Torculum*, *Phalangites* and *Spongostichomitra*) make their first appearance. Furthermore, the first appearance of other distinct species such as *Hexapyramis pantanellii* SQUINABOL, *Trimulus fossilis* (SQUINABOL) and *Godia decora* (LI & WU) is noted. Many species present in older zones make their final appearance at or near the top of this subzone and several genera become extinct (*Mirifusus* PESSAGNO, *Cyclastrum* RÜST, *Deviatus* LI and *Dicerosaturnalis* DUMITRICA & JUD). The most important species among the numerous taxa last appearing toward the upper part of this subzone are : *Pseudoeucyrtis* ? *columbaria* (RENZ), *Dicerosaturnalis amissus* (SQUINABOL), *Hiscocapsa grutterinki* (TAN) and *Cyclastrum satoi* (TUMANDA).

An important faunal crisis takes place during the latest Barremian-Aptian interval. This period together with the late Cenomanian record two major turnovers of marine taxa (Jarvis *et al.*, 1988; Bréhéret & Delamette, 1989; Hart & Leary, 1989, 1991; Hart *et al.*, 1991) that coincide with: (1) major changes in sea level (Haq *et al.*, 1987), (2) development of an expanded oxygen minimum zone in the world ocean (Schlanger & Jenkyns, 1976; Jenkyns, 1980; Arthur *et al.*, 1987; Arthur *et al.*, 1990; Larson *et al.*, 1993), and high values on δ C13 (Schlanger *et al.* 1987; Weissert and Lini, 1991; Gale *et al.*, 1993). The trend of these extinctions seems not to be linear at all, but on the contrary, it exhibits some breaks: a lower one, which coincides with the "Selli level" and a second one becoming maximal between the upper part of this zone and the base of the Spoletoensis zone (late Aptian-early Albian). These faunal breaks are probably related to drastic changes in the environment, from well oxygenated to hypoxic or even anoxic conditions. Major turnovers have also been observed in other fossil groups, i.e. ostracods (Swain, 1992), planktonic foraminifera (Caron, 1985; Bréhéret & Delamette, 1989). For example, among planktonic foraminifera, this break is recognized when *Ticinella* and the normal-sized forms of *Hedbergella* disappear and only minute *Hedbergella* carry on. In other hand, these early Aptian and latest Aptian-earliest Albian faunal changes seem to be coincident with two well established major Cretaceous oceanic anoxic events (OAE-1a, OAE-1b respectively) established by Schlanger & Jenkyns (1976) and Jenkyns (1980). Furthermore these events occur simultaneously with high recorded values of δ C13. Two major incursions of δ C13 were recently correlated with planktonic foraminifera (L. cabri-G. algerianus zones and P. cheniourensis-T. bejaouensis zones respectively) by Wissert and

Lini, 1991, Channell *et al.* 1993. These events approximately coincide with the respective tops of the Verbeeki and Costata subzones.

SPOLETOENSIS ZONE

Index taxon: *Thanarla spoletoensis* nov. sp.

This biochronologic unit is the most diverse that we have studied. Over 126 species make their first appearance in this zone. Three subzones can be identified: Romanus subzone, Missilis subzone and Anisa subzone. This zonal assemblage is the most diverse studied. The beginning of this zone more or less coincides with the start of the Scaglia Bianca Formation and it represents an important period of faunal renewal. The change from blue-greenish marls and black shales (Scisti a Fucoidi Formation or Fardes Formation) to whitish-reddish limestones (Scaglia Bianca Formation) indicates a transition to a well oxygenated environment.

Romanus subzone

Index taxon: *Mallanites romanus* nov. sp.

This subzone is characterized by the co-occurrence of many characteristic pairs of species. The lower part of this subzone is recognized by the appearance of *Pseudodictyomitra pseudomacrocephala* (SQUINABOL), *Xitus mclaughlini* PESSAGNO, *Torculum coronatum* (SQUINABOL), *Stichomitra navalis* nov. sp. *Thanarla spoletoensis* nov. sp., *Rhopalosyringium euganeum* (SQUINABOL), *Obeliscoites turris* (SQUINABOL), *Phalangites calamus* nov. sp., *Dorypyle communis* (SQUINABOL), *Pogonias prodromus* nov. sp. and *Crolanium spineum* (PESSAGNO). Only few species become extinct in the lower part of this subzone: *Becus gemmatus* WU, *Stichomitra simplex* (SMIRNOVA & ALIEV), *Hiscocapsa asseni* (TAN).

Important genera make their first occurrence within this subzone: *Mallanites* nov. gen., *Pogonias* nov. gen., *Tubilustrium* nov. gen., *Distylocapsa* nov. gen., *Squinabollum* DUMITRICA, *Rotaforma* PESSAGNO, *Dorypyle* SQUINABOL, *Pseudoaulophacus* PESSAGNO, *Dispongotripus* SQUINABOL, and *Cavaspongia* PESSAGNO. The lower boundary of this assemblages is marked by the last occurrence of the new genus *Hiscocapsa*. Many species of *Rhopalosyringium* CAMPBELL & CLARK, *Obeliscoites* nov. gen. and *Crolanium* PESSAGNO make their first occurrences in this interval.

The index taxon of this subzone along with *Dictyomitra magnifica* (PESSAGNO) restricts its range toward the upper part of this interval. The upper part of this subzone is characterized by the last representatives of *H. crassum* (OZVOLDOVA), *Thanarla brouweri* (TAN) and *Thanarla conica* (SQUINABOL). Simultaneously, the first occurrence of *Squinabollum fossile* (SQUINABOL), *Crolanium cuneatum* (SMIRNOVA & ALIEV), *Savaryella quadra* (FOREMAN) and *Crolanium triangulare* (ALIEV) takes place.

Other genera first appearing in the upper part of this subzone are *Dispongotripus* (*D. acutispinus* SQUINABOL), *Cavaspongia* (*C. euganea* (SQUINABOL)) and the first representatives of the new genus *Tubilustrium* (*T. iracundum* and *T. transmontanum*).

This subzone represents the beginning of an important radiation of the Spumellariina families Saturnalidae, Neosciadiocapsidae and Rotaformidae. This development together with the occurrence of numerous other genera and species may be directly related to drastic changes in the environment, i.e. tendency toward more oxygenated mass of waters. This trend reflects an important change in oceanographic parameters in the western Tethys, induced by the general sea level rise of the mid-Cretaceous time.

Missilis subzone

Index taxon: *Pogonias missilis* nov. sp.

The lower part of this subzone is characterized by the first occurrence of important species: *Tugurium pagoda* (SQUINABOL), *Hsuum ? cataphracta* nov. sp., *Thanarla veneta* (SQUINABOL), *Dictyomitra obesa* (SQUINABOL), *Mallanites triquetrus* (SQUINABOL), *Spongostichomitra phalanga* nov. sp., *Stichomitra magna* (SQUINABOL), *Dactyliosphaera lepta* (FOREMAN) and *Acanthocircus multidentatus* (SQUINABOL). The range of the index taxon *Pogonias missilis* nov. sp. is restricted to this subzone. The genera *Vitorfus* PESSAGNO and *Quadrigastrum* nov. gen. make also their first occurrence at the lower part of this subzone.

The upper part of Missilis subzone is marked by the final appearance of *Rotaforma volatilis* nov. sp., *Rhopalosyringium perforaculum* nov. sp. and *Dorypyle elliptica* SQUINABOL. Other species that make their first occurrence at the upper part of this subzone are *Dorypyle ovoidea* (SQUINABOL), *Cavaspongia sphaerica* nov. sp. and *Dactyliodiscus longispinus* (SQUINABOL). Other abundant genera which make up the bulk of the subzone are *Obeliscoites* nov. gen., *Crolanium* PESSAGNO, *Diacanthocapsa* SQUINABOL, *Ultranapora* PESSAGNO, *Hexapyramis* SQUINABOL, *Dactyliodiscus* SQUINABOL, *Dactyliosphaera* SQUINABOL, *Halesium* PESSAGNO.

Anisa subzone

Index taxon: *Dorypyle ? anisa* (FOREMAN, 1978a)

This subzone is characterized by the total range of *Thanarla cucurbita* nov. sp. and *Dorypyle ? anisa* (FOREMAN). Only two genera, *Anachoreta* nov. gen. and *Pyramispongia* PESSAGNO, make their first occurrence during this subzone. The lower part of this subzone is recognized by the first occurrence of *Rhopalosyringium petilum* (FOREMAN), *Dorypyle ? anisa* (FOREMAN), *Rotaforma haeckeli* (SQUINABOL), *Pseudoaulophacus putahensis* PESSAGNO and *Dispongotripus triangularis* (SQUINABOL), *Tugurium pagoda* (SQUINABOL), *Trimulus fossilis* (SQUINABOL), *Stichomitra mediocris* (TAN), *Stichomitra navalis* nov. sp. and *Crolanium puga* (SCHAAF).

The upper part of the Anisa subzone is characterized by the last occurrence of *Hsuum ? cataphracta* nov. sp., *Thanarla spoletoensis, Pseudodictyomitra languida* nov. sp., and the last representatives of the genus *Mallanites*. Other genera that make their first occurrence at the top of this subzone are *Tetracanthellipsis* SQUINABOL (*T. euganeus* SQUINABOL) and *Patellula* KOZLOVA (*P. minuscula* nov. sp.).

SILVIAE ZONE

Index taxon: *Dactyliosphaera silviae* SQUINABOL, 1904

The Silviae zone is characterized by a relative decrease in the number of species and illustrates the transition of radiolarians from the Cenomanian to Turonian, with the consequent drastic radiolarian faunal changes that take place around this boundary. In general, the late Cenomanian records a major turnover of marine taxa (Jarvis *et al.*, 1988; Hart & Leary, 1989; Hart & Leary, 1991; Leary & Peryt, 1991; Hart *et al.*, 1992). This faunal turnover is correlated with a well established major Cretaceous oceanic anoxic event at the Cenomanian-Turonian boundary (OAE 2) (Jenkyns, 1980; Arthur *et al.*, 1987; Arthur *et al.*, 1988; Arthur *et al.*, 1990; Schlanger *et al.*, 1987). High values of δ C13 are also recorded in this interval (Cobban, 1985; Schlanger *et al.* 1987; Gale *et al.*, 1993).

In the studied sections, these major changes begin with the first occurrence of black cherts found towards the upper part of the Scaglia Bianca Formation (see Chapter II.I). The top of the zone is marked by the extinction of many genera: *Godia* WU, *Becus* WU, *Spongostichomitra* nov. gen., *Thanarla* PESSAGNO, *Torculum* nov. gen., *Obeliscoites* nov. gen., *Xitus* PESSAGNO, *Pogonias*, nov. gen. *Dactyliodiscus* SQUINABOL, *Dispongotripus* SQUINABOL, *Crolanium* PESSAGNO, *Tubilustrium* nov. gen. and *Rotaforma* PESSAGNO. Two subzones can be identified, the Spica subzone and the Biacuta subzone. Some taxa are exclusively restricted to this interval: these include *Pseudodictyomitra tiara* (HOLMES), *Cavaspongia californiaensis* PESSAGNO, *Cavaspongia helice* nov. sp., *Guttacapsa* nov. gen., *Pogonias ? hirsutus* (SQUINABOL), *Obeliscoites maximus* (SQUINABOL), *Diacanthocapsa euganea* SQUINABOL, *Diacanthocapsa matsumotoi* (TAKETANI) and *Dactyliosphaera silviae* SQUINABOL.

This interval is also characterized by important developments among the genera *Diacanthocapsa* SQUINABOL, *Patellula* KOZLOVA, *Halesium* PESSAGNO and *Cavaspongia* PESSAGNO. The assemblage presented in this zone is relatively small and illustrates the transition of radiolarians from the early to middle-late Cenomanian. Or, in other words, the transition from oxygenated conditions to a progressively more anoxic situation. This is the prelude to the late Cenomanian oceanic anoxic event.

Spica subzone

Index taxon: *Patellula spica* nov. sp.

The subzone is characterized by the total range of *Patellula spica* nov. sp. The lower part of this subzone is recognized by the co-occurrence of *Patellula spica* nov. sp., *Pyramispongia glascockensis* PESSAGNO, *costarricensis* (SCHMIDT-EFFING), *Dactyliodiscus cayeuxi* SQUINABOL, *Dictyomitra obesa* (SQUINABOL) and *Dorypyle* ? *anisa* (FOREMAN).

Biacuta subzone

Index taxon: *Guttacapsa biacuta* (SQUINABOL, 1903b)

This subzone is characterized by the total range of *Diacanthocapsa matsumotoi* (TAKETANI), *Sciadiocapsa pertica* nov. sp. and *Dictyomitra crassispina* (SQUINABOL). Also is characterized by the co-occurrence of *Sciadiocapsa pertica* nov. sp., *Diacanthocapsa antiqua* SQUINABOL, *Pseudoeucyrtis pulchra* (SQUINABOL). Numerous species make their last occurrence during this interval: *Rhopalosyringium petilum* (FOREMAN), *Spongostichomitra phalanga* nov. sp., *Torculum coronatum* (SQUINABOL), *Tubilustrium transmontanum* nov. sp., *Anachoreta sagitta* nov. sp., *Obeliscoites turris* (SQUINABOL), *Dorypyle ovoidea* (SQUINABOL), *Dactyliosphaera lepta* (FOREMAN) and *Dictyomitra turritum* (SQUINABOL). The upper part of this subzone is defined by the same taxa as define the zone.

SUPERBUM ZONE

Index taxon: *Alievium superbum* (SQUINABOL, 1914)

In general, this subzone is characterized by the first appearance of many species at the lower part and by the extinction of only few species. This faunal change seems to be a response to an oxygenated environment after a major episode of anoxia. The top of this zone has not been recognized in this work.

The base of this zone is characterized by the first appearance of *Alievium superbum* (SQUINABOL), *Crucella cachensis* PESSAGNO, *Eostichomitra bonum* (KOZLOVA), *Acanthocircus tympanum* nov. sp., *Rhopalosyringium scissum* nov. sp. and *Afens liriodes* RIEDEL & SANFILIPPO. Some of the most important new genera that occur within this zone are: *Protoxiphotractus* PESSAGNO, *Alievium* PESSAGNO, *Pseudotheocampe* EMPSON-MORIN. The last occurrence of the genera *Hexapyramis* SQUINABOL, *Pseudoeucyrtis* PESSAGNO, *Pogonias* nov. gen. and *Dicroa* FOREMAN takes place at the base of the Superbum zone. Their last representatives are *Hexapyramis pantanellii* SQUINABOL, *Pseudoeucyrtis pulchra* (SQUINABOL), *Pogonias incallidus* nov. sp. and *Dicroa rara* (SQUINABOL).

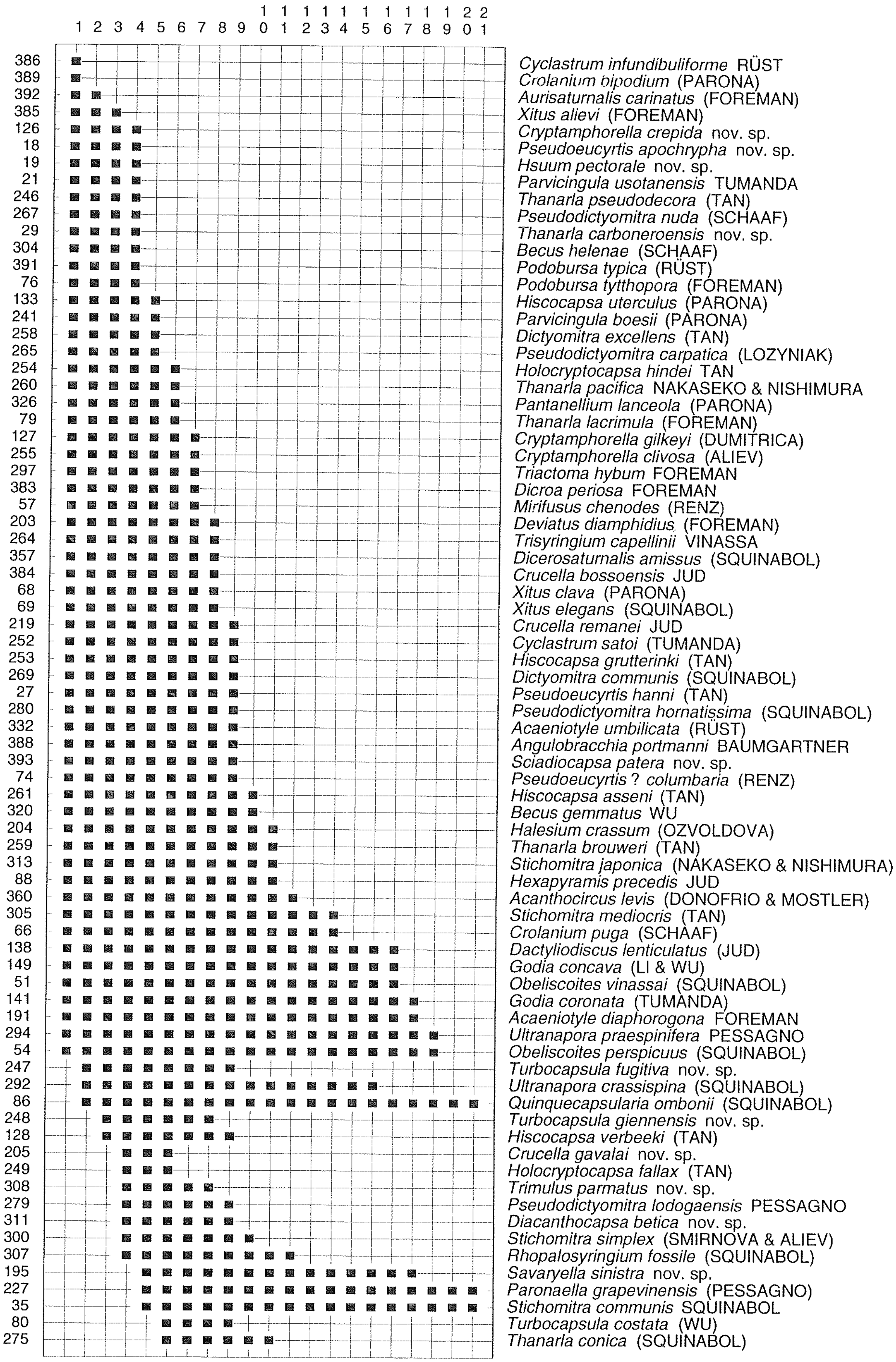


Fig. 9a.- Mid-Cretaceous radiolarian range chart based on Unitary Associations (output of BioGraph program v. 2.02, Savary & Guex, 1990). Correlation to standard chronostratigraphic stages is given in Fig. 9b.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
161						■	■	■	■	■	■	■	■	■	■	■	■					*Pessagnobrachia dalpiazii* (SQUINABOL)
78						■	■	■	■	■	■	■	■	■	■	■	■	■	■			*Xitus spicularius* (ALIEV)
148							■	■	■													*Godia decora* (LI & WU)
220							■	■	■													*Crucella hispana* nov. sp.
224							■	■	■													*Crucella baliarica* nov. sp.
70							■	■	■													*Torculum bastetani* nov. sp.
145							■	■	■	■	■	■	■									*Dactyliosphaera maxima* (PESSAGNO)
242							■	■	■	■	■	■	■									*Phalangites perspicuus* (SQUINABOL)
176							■	■	■	■	■	■	■	■	■	■	■	■				*Staurosphaeretta longispina* (SQUINABOL)
82							■	■	■	■	■	■	■	■	■	■	■	■	■	■		*Hexapyramis pantanellii* SQUINABOL
166							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Becus horridus* (SQUINABOL)
175							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Triactoma cellulosa* FOREMAN
196							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Crucella euganea* (SQUINABOL)
110								■	■	■	■	■	■	■								*Trimulus fossilis* (SQUINABOL)
62								■	■	■	■	■	■	■	■	■	■					*Spongostichomitra elatica* (ALIEV)
271								■	■	■	■	■	■	■	■	■	■	■	■			*Pseudodictyomitra pentacolaensis* PESSAGNO
90									■	■	■	■	■	■	■	■	■					*Diacanthocapsa fossilis* (SQUINABOL)
92										■	■	■	■	■								*Stichomitra navalis* nov. sp.
99										■	■	■	■	■								*Dorypyle communis* (SQUINABOL)
10										■	■	■	■	■	■							*Thanarla spoletoensis* nov. sp.
129										■	■	■	■	■	■							*Trisyringium echitonicum* (ALIEV)
15										■	■	■	■	■	■							*Phalangites calamus* nov. sp.
16										■	■	■	■	■	■							*Crolanium spineum* (PESSAGNO)
184										■	■	■	■	■	■							*Acaeniotyle tribulosa* FOREMAN
230										■	■	■	■	■	■							*Pseudoaulophacus sculptus* (SQUINABOL)
37										■	■	■	■	■	■							*Pseudodictyomitra paronai* (ALIEV)
9										■	■	■	■	■	■							*Stichomitra tosaensis* NAKASEKO & NISHIMURA
100										■	■	■	■	■	■	■						*Pogonias prodromus* nov. sp.
146										■	■	■	■	■	■	■						*Dactyliodiscus cayeuxi* SQUINABOL
53										■	■	■	■	■	■	■						*Obeliscoites giganteus* (ALIEV)
178										■	■	■	■	■	■	■	■					*Halesium nevianii* (SQUINABOL)
3										■	■	■	■	■	■	■	■					*Dictyomitra pulchra* (SQUINABOL)
61										■	■	■	■	■	■	■	■					*Dictyomitra gracilis* (SQUINABOL)
245										■	■	■	■	■	■	■	■	■				*Torculum coronatum* (SQUINABOL)
56										■	■	■	■	■	■	■	■	■				*Obeliscoites turris* (SQUINABOL)
58										■	■	■	■	■	■	■	■	■				*Xitus spinosus* (SQUINABOL)
101										■	■	■	■	■	■	■	■	■	■			*Rhopalosyringium mosquense* (SMIRNOVA & ALIEV)
13										■	■	■	■	■	■	■	■	■	■			*Xitus mclaughlini* PESSAGNO
208										■	■	■	■	■	■	■	■	■	■	■		*Staurosphaeretta euganea* (SQUINABOL)
314										■	■	■	■	■	■	■	■	■	■	■		*Dictyomitra montisserei* (SQUINABOL)
328										■	■	■	■	■	■	■	■	■	■	■		*Dicroa rara* (SQUINABOL)
124										■	■	■	■	■	■	■	■	■	■	■	■	*Archaeocenosphaera ? mellifera* nov.sp.
201										■	■	■	■	■	■	■	■	■	■	■	■	*Acaeniotyle amplissima* (FOREMAN)
39										■	■	■	■	■	■	■	■	■	■	■	■	*Pseudodictyomitra pseudomacrocephala* (SQUINABOL)
64										■	■	■	■	■	■	■	■	■	■	■	■	*Rhopalosyringium euganeum* (SQUINABOL)
121											■											*Mallanites romanus* nov. sp.
17											■											*Dictyomitra magnifica* (PESSAGNO)
295											■											*Saitoum ? mercuriale* nov. sp.
109											■	■										*Rhopalosyringium solivagum* nov. sp.
147											■	■										*Godia pelta* nov. sp.
34											■	■										*Tubilustrium iracundum* nov. sp.
102											■	■	■									*Rhopalosyringium perforaculum* nov. sp.
134											■	■	■									*Dorypyle elliptica* SQUINABOL
154											■	■	■									*Sciadiocapsa elegans* (SQUINABOL)
285											■	■	■									*Rotaforma volatilis* nov. sp.
77											■	■	■	■								*Eribotrys ?* sp. *1*
207											■	■	■	■	■							*Dactyliodiscus rubus* nov. sp.
226											■	■	■	■	■							*Falsocromyodrymus mirabilis* (SQUINABOL)
291											■	■	■	■	■							*Ultranapora durhami* PESSAGNO
322											■	■	■	■	■							*Dispongotripus acutispinus* SQUINABOL
324											■	■	■	■	■							*Dactyliosphaera acutispina* (SQUINABOL)
114											■	■	■	■	■	■						*Pogonias harpago* nov. sp.
240											■	■	■	■	■	■						*Staurosphaeretta grandipora* (SQUINABOL)
270											■	■	■	■	■	■						*Staurosphaeretta wisniowskii* (SQUINABOL)
95											■	■	■	■	■	■						*Pseudoacanthosphaera galeata* nov. sp.
168											■	■	■	■	■	■	■					*Pseudoacanthosphaera magnifica* (SQUINABOL)
193											■	■	■	■	■	■	■					*Savaryella quadra* (FOREMAN)
359											■	■	■	■	■	■	■					*Acanthocircus dendroacanthos* SQUINABOL
4											■	■	■	■	■	■	■					*Crolanium triangulare* (ALIEV)
7											■	■	■	■	■	■	■					*Crolanium cuneatum* (SMIRNOVA & ALIEV)
192											■	■	■	■	■	■	■	■				*Triactoma paronai* (SQUINABOL)
239											■	■	■	■	■	■	■	■				*Acaeniotyle macrospina* (SQUINABOL)
288											■	■	■	■	■	■	■	■				*Rotaforma mirabilis* PESSAGNO
32											■	■	■	■	■	■	■	■				*Tubilustrium transmontanum* nov. sp.
367											■	■	■	■	■	■	■	■				*Acanthocircus irregularis* SQUINABOL
41											■	■	■	■	■	■	■	■				*Distylocapsa micropora* (SQUINABOL)

Fig. 9a.- Mid-Cretaceous radiolarian range chart based on Unitary Associations (continued).

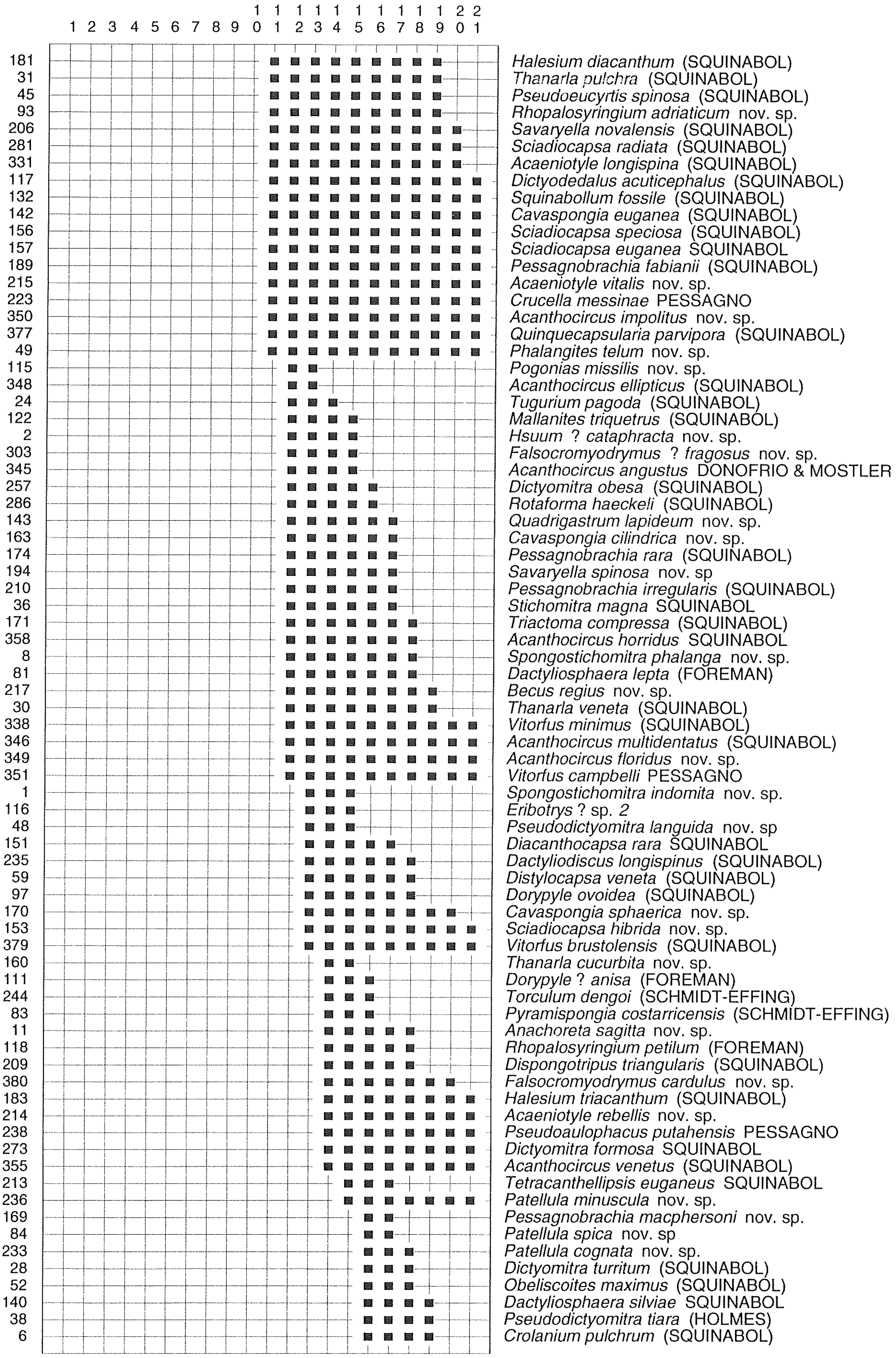


Fig. 9a.- Mid-Cretaceous radiolarian range chart based on Unitary Associations (continued).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
87																■	■	■	■			*Pogonias ? hirsutus* (SQUINABOL)
85																■	■	■	■	■		*Pogonias incallidus* nov. sp.
182																■	■	■	■	■	■	*Halesium amissum* (SQUINABOL)
218																■	■	■	■	■	■	*Pyramispongia glascockensis* PESSAGNO
229																■	■	■	■	■	■	*Crucella irwini* PESSAGNO
329																■	■	■	■	■	■	*Cavaspongia contracta* nov. sp.
342																■	■	■	■	■	■	*Pseudoacanthosphaera superba* (SQUINABOL)
172																	■	■				*Cavaspongia helice* nov. sp.
185																	■	■				*Quadrigastrum oculus* nov. sp.
202																	■	■				*Cavaspongia californiaensis* PESSAGNO
150																	■	■	■			*Diacanthocapsa euganea* SQUINABOL
363																	■	■	■			*Guttacapsa biacuta* (SQUINABOL)
365																	■	■	■			*Rhopalosyringium elegans* (SQUINABOL)
91																	■	■	■			*Guttacapsa gutta* (SQUINABOL)
63																	■	■	■	■		*Dictyomitra crebrisulcata* (SQUINABOL)
199																	■	■	■	■	■	*Savaryella stella* nov. sp.
232																	■	■	■	■	■	*Quadrigastrum insulsum* nov. sp.
234																	■	■	■	■	■	*Patellula helios* (SQUINABOL)
361																	■	■	■	■	■	*Diacanthocapsa ovoidea* DUMITRICA
362																	■	■	■	■	■	*Hemicryptocapsa prepolyhedra* DUMITRICA
152																		■	■			*Diacanthocapsa matsumotoi* (TAKETANI)
155																		■	■			*Sciadiocapsa pertica* nov. sp.
47																		■	■			*Dictyomitra crassispina* (SQUINABOL)
372																		■	■	■		*Distylocapsa nova* SQUINABOL
44																		■	■	■		*Pseudoeucyrtis pulchra* (SQUINABOL)
188																		■	■	■	■	*Triactoma hexeris* nov. sp.
321																		■	■	■	■	*Patellula verteroensis* (PESSAGNO)
352																		■	■	■	■	*Falsocromyodrymus noxiosus* nov. sp.
356																		■	■	■	■	*Acanthocircus bestiarius* nov. sp.
368																		■	■	■	■	*Diacanthocapsa antiqua* (SQUINABOL)
369																		■	■	■	■	*Paronaella communis* (SQUINABOL)
370																		■	■	■	■	*Stichomitra stocki* (CAMPBELL & CLARK)
96																		■	■	■	■	*Quinquecapsularia grandiloqua* nov. sp.
98																			■	■	■	*Diacanthocapsa brevithorax* DUMITRICA
103																				■	■	*Pseudotheocampe tina* (FOREMAN)
106																				■	■	*Rhopalosyringium scissum* nov. sp.
120																				■	■	*Dictyodedalus hesperis* nov. sp.
125																				■	■	*Hemicryptocapsa polyhedra* DUMITRICA
14																				■	■	*Eostichomitra bonum* (KOZLOVA)
158																				■	■	*Sciadiocapsa monticelloensis* (PESSAGNO)
164																				■	■	*Cavaspongia antelopensis* PESSAGNO
167																				■	■	*Alievium superbum* (SQUINABOL)
179																				■	■	*Paronaella solanoensis* PESSAGNO
180																				■	■	*Paronaella californiaensis* PESSAGNO
186																				■	■	*Tetracanthellipsis gregalis* nov. sp.
187																				■	■	*Cavaspongia tricornis* nov. sp.
190																				■	■	*Pessagnobrachia clavata* (SQUINABOL)
221																				■	■	*Crucella cachensis* PESSAGNO
222																				■	■	*Triactoma parva* (SQUINABOL)
283																				■	■	*Sciadiocapsa multiradiata* nom. nov.
287																				■	■	*Falsocromyodrymus ? nebulosus* nov. sp.
290																				■	■	*Ultranapora cretacea* (SQUINABOL)
293																				■	■	*Ultranapora dendroacanthos* (SQUINABOL)
299																				■	■	*Rhopalosyringium hispidum* nov. sp.
325																				■	■	*Patellula heroica* nov. sp.
327																				■	■	*Pseudoacanthosphaera spinosissima* (SQUINABOL)
340																				■	■	*Acanthocircus hueyi* (PESSAGNO)
341																				■	■	*Acanthocircus euganeus* (SQUINABOL)
347																				■	■	*Acanthocircus tympanum* nov. sp.
354																				■	■	*Acanthocircus nanus* nov. sp.
374																				■	■	*Protoxiphotractus machinosus* nov. sp.
375																				■	■	*Quinquecapsularia panacea* nov. sp.
382																				■	■	*Patellula ecliptica* nov. sp.
42																				■	■	*Dictyomitra undata* SQUINABOL
46																				■	■	*Phalangites hastatus* nov. sp.
50																				■	■	*Distylocapsa squama* nov. sp.
108																					■	*Rhopalosyringium radiosum* nov. sp.
113																					■	*Afens liriodes* RIEDEL & SANFILIPPO
144																					■	*Paronaella pseudoaulophacoides* nov. sp.
312																					■	*Paronaella acuta* nov. sp.
336																					■	*Protoxiphotractus ventosus* nov. sp.
337																					■	*Vitorfus morini* EMPSON-MORIN
353																					■	*Acanthocircus subquadratus* (DONOFRIO & MOSTLER)
376																					■	*Dictyodedalus cretaceus* (TAKETANI)
43																					■	*Dictyomitra multicostata* ZITTEL

Fig. 9a.- Mid-Cretaceous radiolarian range chart based on Unitary Associations (continued).

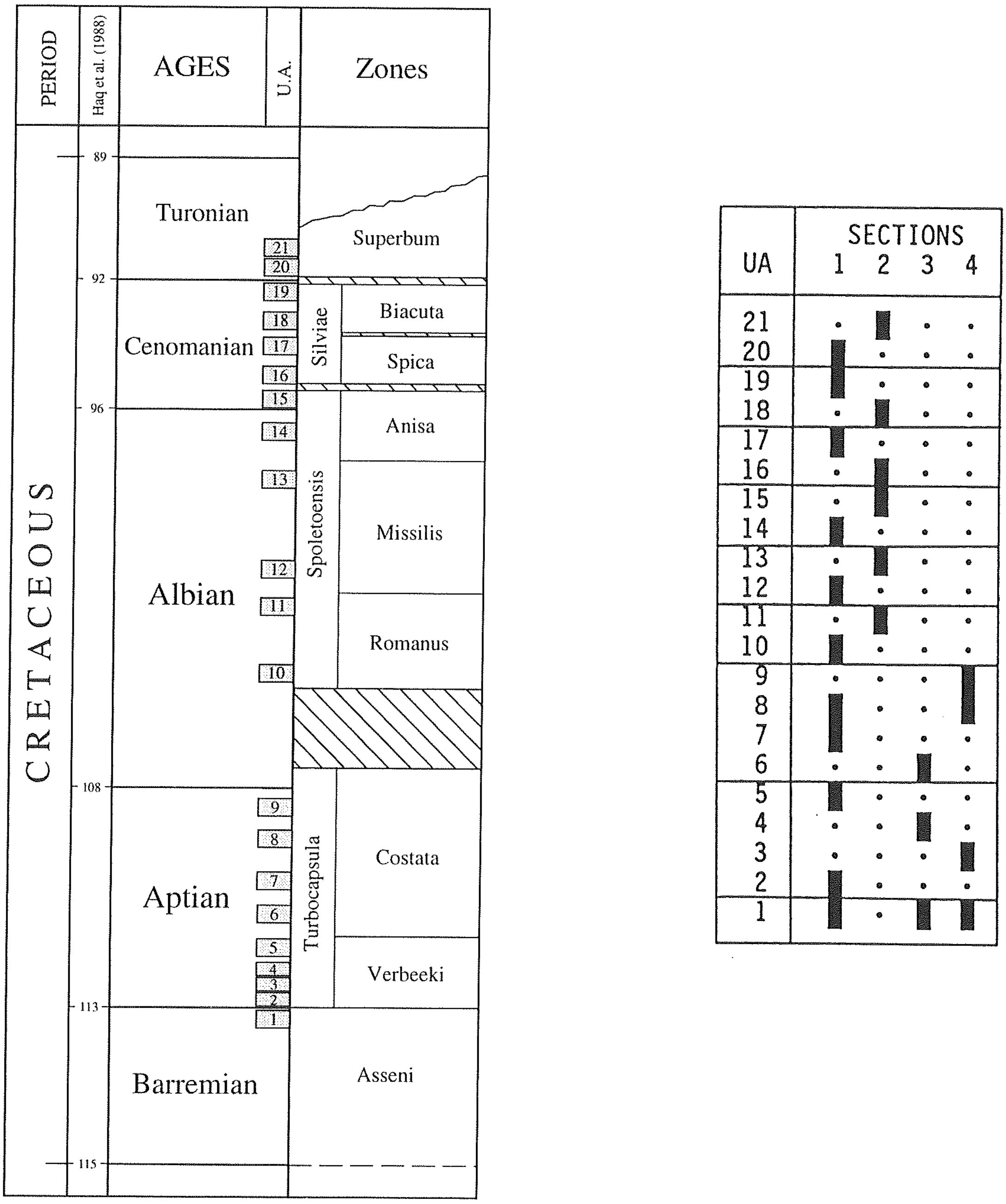


Fig. 9b.- Reproducibility table (right). Black rectangles represent Unitary Associations, strictly identified in the sections studied. The proposed zones are correlated to standard chronostratigraphic stages (time scale from Haq *et al.* 1988). Chronostratigraphic position of Unitary Associations is indicated with dotted fields (left). The calibration is based on co-occurrent planktonic foraminifera and calcareous nannofossils (fig. 11). Oblique hatched fields indicate uncertain position of zonal boundaries.

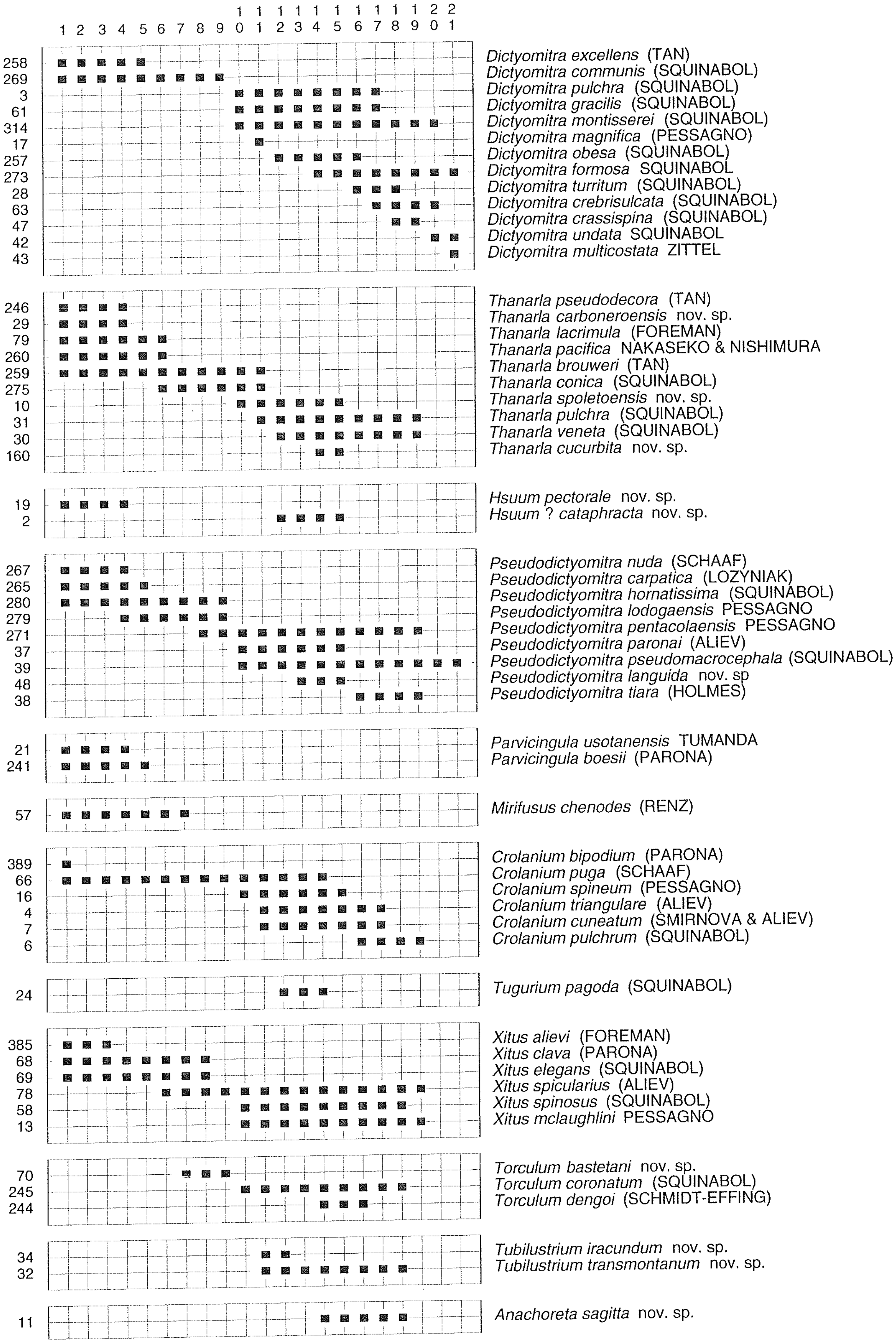


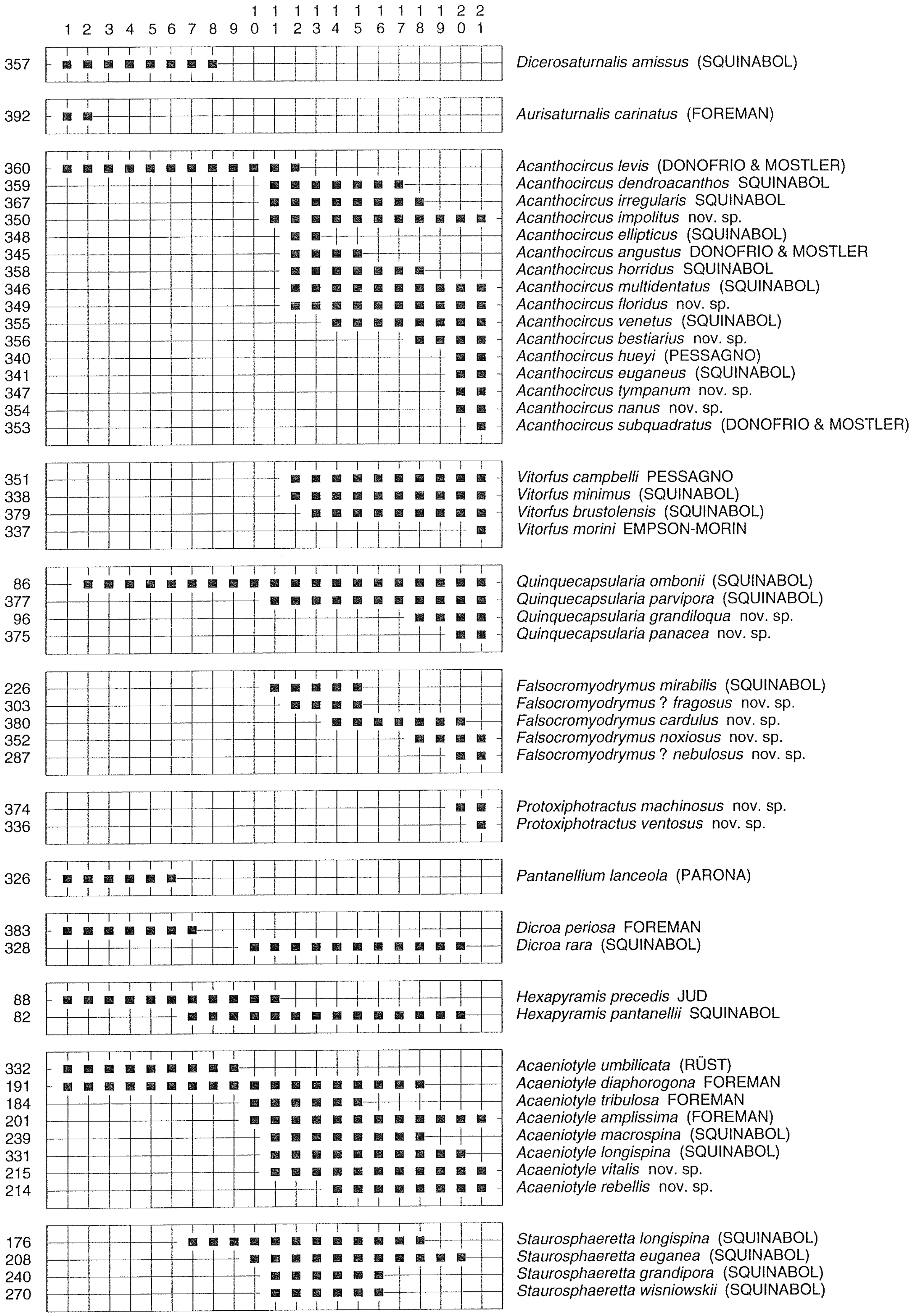
Fig. 10a.- Mid-Cretaceous range chart for the suborder Nassellariina.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
313	■	■	■	■	■	■	■	■	■	■	■											*Stichomitra japonica* (NAKASEKO & NISHIMURA)
305	■	■	■	■	■	■	■	■	■	■	■	■	■	■								*Stichomitra mediocris* (TAN)
300				■	■	■	■	■	■	■												*Stichomitra simplex* (SMIRNOVA & ALIEV)
35					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Stichomitra communis* SQUINABOL
92										■	■	■	■	■								*Stichomitra navalis* nov. sp.
9										■	■	■	■	■	■							*Stichomitra tosaensis* NAKASEKO & NISHIMURA
36												■	■	■	■	■	■					*Stichomitra magna* SQUINABOL
370																		■	■	■	■	*Stichomitra stocki* (CAMPBELL & CLARK)
14																				■	■	*Eostichomitra bonum* (KOZLOVA)
62								■	■	■	■	■	■	■	■	■	■					*Spongostichomitra elatica* (ALIEV)
8												■	■	■	■	■	■	■				*Spongostichomitra phalanga* nov. sp.
1													■	■	■							*Spongostichomitra indomita* nov. sp.
242							■	■	■	■	■	■	■									*Phalangites perspicuus* (SQUINABOL)
15										■	■	■	■	■	■							*Phalangites calamus* nov. sp.
49											■	■	■	■	■	■	■	■	■	■	■	*Phalangites telum* nov. sp.
46																				■	■	*Phalangites hastatus* nov. sp.
308				■	■	■	■	■														*Trimulus parmatus* nov. sp.
110								■	■	■	■	■	■	■								*Trimulus fossilis* (SQUINABOL)
307				■	■	■	■	■	■	■	■	■										*Rhopalosyringium fossile* (SQUINABOL)
101										■	■	■	■	■	■	■	■	■	■			*Rhopalosyringium mosquense* (SMIRNOVA & ALIEV)
64										■	■	■	■	■	■	■	■	■	■	■	■	*Rhopalosyringium euganeum* (SQUINABOL)
109											■	■										*Rhopalosyringium solivagum* nov. sp.
102											■	■	■									*Rhopalosyringium perforaculum* nov. sp.
93											■	■	■	■	■	■	■	■	■			*Rhopalosyringium adriaticum* nov. sp.
118														■	■	■	■	■				*Rhopalosyringium petilum* (FOREMAN)
365																	■	■	■			*Rhopalosyringium elegans* (SQUINABOL)
106																				■	■	*Rhopalosyringium scissum* nov. sp.
299																				■	■	*Rhopalosyringium hispidum* nov. sp.
108																					■	*Rhopalosyringium radiosum* nov. sp.
103																				■	■	*Pseudotheocampe tina* (FOREMAN)
100										■	■	■	■	■	■	■						*Pogonias prodromus* nov. sp.
114											■	■	■	■	■	■						*Pogonias harpago* nov. sp.
115												■	■									*Pogonias missilis* nov. sp.
87																■	■	■	■			*Pogonias ? hirsutus* (SQUINABOL)
85																■	■	■	■	■		*Pogonias incallidus* nov. sp.
391	■	■	■	■																		*Podobursa typica* (RÜST)
76	■	■	■	■																		*Podobursa tytthopora* (FOREMAN)
18	■	■	■	■																		*Pseudoeucyrtis apochrypha* nov. sp.
27	■	■	■	■	■	■	■	■	■													*Pseudoeucyrtis hanni* (TAN)
74	■	■	■	■	■	■	■	■	■													*Pseudoeucyrtis ? columbaria* (RENZ)
45											■	■	■	■	■	■	■	■	■			*Pseudoeucyrtis spinosa* (SQUINABOL)
44																		■	■	■		*Pseudoeucyrtis pulchra* (SQUINABOL)
41											■	■	■	■	■	■	■	■				*Distylocapsa micropora* (SQUINABOL)
59													■	■	■	■	■	■				*Distylocapsa veneta* (SQUINABOL)
372																		■	■	■		*Distylocapsa nova* SQUINABOL
50																				■	■	*Distylocapsa squama* nov. sp.
51	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					*Obeliscoites vinassai* (SQUINABOL)
54	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			*Obeliscoites perspicuus* (SQUINABOL)
53										■	■	■	■	■	■	■						*Obeliscoites giganteus* (ALIEV)
56										■	■	■	■	■	■	■	■	■				*Obeliscoites turris* (SQUINABOL)
52																■	■	■				*Obeliscoites maximus* (SQUINABOL)
133	■	■	■	■	■																	*Hiscocapsa uterculus* (PARONA)
253	■	■	■	■	■	■	■	■	■													*Hiscocapsa grutterinki* (TAN)
261	■	■	■	■	■	■	■	■	■	■												*Hiscocapsa asseni* (TAN)
128			■	■	■	■	■	■	■													*Hiscocapsa verbeeki* (TAN)

Fig. 10a.- Mid-Cretaceous range chart for the suborder Nassellariina (continued).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
132											■	■	■	■	■	■	■	■	■	■	■	*Squinabollum fossile* (SQUINABOL)
99										■	■	■	■	■								*Dorypyle communis* (SQUINABOL)
134											■	■	■									*Dorypyle elliptica* SQUINABOL
97													■	■	■	■	■	■				*Dorypyle ovoidea* (SQUINABOL)
111														■	■	■						*Dorypyle ? anisa* (FOREMAN)
264	■	■	■	■	■	■	■	■														*Trisyringium capellinii* VINASSA
129										■	■	■	■	■	■							*Trisyringium echitonicum* (ALIEV)
126	■	■	■	■																		*Cryptamphorella crepida* nov. sp.
127	■	■	■	■	■	■	■															*Cryptamphorella gilkeyi* (DUMITRICA)
255	■	■	■	■	■	■	■															*Cryptamphorella clivosa* (ALIEV)
254	■	■	■	■	■	■																*Holocryptocapsa hindei* TAN
249				■	■	■																*Holocryptocapsa fallax* (TAN)
362																	■	■	■	■	■	*Hemicryptocapsa prepolyhedra* DUMITRICA
125																				■	■	*Hemicryptocapsa polyhedra* DUMITRICA
311				■	■	■	■	■	■													*Diacanthocapsa betica* nov. sp.
90									■	■	■	■	■	■	■	■	■					*Diacanthocapsa fossilis* (SQUINABOL)
151													■	■	■	■	■					*Diacanthocapsa rara* SQUINABOL
150																	■	■	■			*Diacanthocapsa euganea* SQUINABOL
361																	■	■	■	■	■	*Diacanthocapsa ovoidea* DUMITRICA
152																		■	■			*Diacanthocapsa matsumotoi* (TAKETANI)
368																		■	■	■	■	*Diacanthocapsa antiqua* (SQUINABOL)
98																			■	■	■	*Diacanthocapsa brevithorax* DUMITRICA
247		■	■	■	■	■	■	■	■													*Turbocapsula fugitiva* nov. sp.
248			■	■	■	■	■	■														*Turbocapsula giennensis* nov. sp.
80						■	■	■	■													*Turbocapsula costata* (WU)
363																	■	■	■			*Guttacapsa biacuta* (SQUINABOL)
91																	■	■	■			*Guttacapsa gutta* (SQUINABOL)
393	■	■	■	■	■	■	■	■	■													*Sciadiocapsa patera* nov. sp.
154											■	■	■									*Sciadiocapsa elegans* (SQUINABOL)
281											■	■	■	■	■	■	■	■	■	■		*Sciadiocapsa radiata* (SQUINABOL)
156											■	■	■	■	■	■	■	■	■	■	■	*Sciadiocapsa speciosa* (SQUINABOL)
157											■	■	■	■	■	■	■	■	■	■	■	*Sciadiocapsa euganea* SQUINABOL
153													■	■	■	■	■	■	■	■	■	*Sciadiocapsa hibrida* nov. sp.
155																		■	■			*Sciadiocapsa pertica* nov. sp.
158																				■	■	*Sciadiocapsa monticelloensis* (PESSAGNO)
283																				■	■	*Sciadiocapsa multiradiata* nom. nov.
117											■	■	■	■	■	■	■	■	■	■	■	*Dictyodedalus acuticephalus* (SQUINABOL)
120																				■	■	*Dictyodedalus hesperis* nov. sp.
376																					■	*Dictyodedalus cretaceus* (TAKETANI)
285											■	■	■									*Rotaforma volatilis* nov. sp.
288											■	■	■	■	■	■	■	■				*Rotaforma mirabilis* PESSAGNO
286												■	■	■	■	■						*Rotaforma haeckeli* (SQUINABOL)
294	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			*Ultranapora praespinifera* PESSAGNO
292		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						*Ultranapora crassispina* (SQUINABOL)
291											■	■	■	■	■							*Ultranapora durhami* PESSAGNO
290																				■	■	*Ultranapora cretacea* (SQUINABOL)
293																				■	■	*Ultranapora dendroacanthos* (SQUINABOL)
295											■											*Saitoum ? mercuriale* nov. sp.
113																					■	*Afens liriodes* RIEDEL & SANFILIPPO
77											■	■	■	■								*Eribotrys ? sp. 1*
116													■	■	■							*Eribotrys ? sp. 2*

Fig. 10a.- Mid-Cretaceous range chart for the suborder Nassellariina (continued).



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
357	*Dicerosaturnalis amissus* (SQUINABOL)	■	■	■	■	■	■	■	■													
392	*Aurisaturnalis carinatus* (FOREMAN)	■	■																			
360	*Acanthocircus levis* (DONOFRIO & MOSTLER)	■	■	■	■	■	■	■	■	■	■	■	■									
359	*Acanthocircus dendroacanthos* SQUINABOL											■	■	■	■	■	■	■				
367	*Acanthocircus irregularis* SQUINABOL											■	■	■	■	■	■	■	■			
350	*Acanthocircus impolitus* nov. sp.											■	■	■	■	■	■	■	■	■	■	■
348	*Acanthocircus ellipticus* (SQUINABOL)												■	■								
345	*Acanthocircus angustus* DONOFRIO & MOSTLER												■	■	■	■						
358	*Acanthocircus horridus* SQUINABOL												■	■	■	■	■	■	■			
346	*Acanthocircus multidentatus* (SQUINABOL)												■	■	■	■	■	■	■	■	■	■
349	*Acanthocircus floridus* nov. sp.												■	■	■	■	■	■	■	■	■	■
355	*Acanthocircus venetus* (SQUINABOL)														■	■	■	■	■	■	■	■
356	*Acanthocircus bestiarius* nov. sp.																		■	■	■	■
340	*Acanthocircus hueyi* (PESSAGNO)																				■	■
341	*Acanthocircus euganeus* (SQUINABOL)																				■	■
347	*Acanthocircus tympanum* nov. sp.																				■	■
354	*Acanthocircus nanus* nov. sp.																				■	■
353	*Acanthocircus subquadratus* (DONOFRIO & MOSTLER)																					■
351	*Vitorfus campbelli* PESSAGNO												■	■	■	■	■	■	■	■	■	■
338	*Vitorfus minimus* (SQUINABOL)												■	■	■	■	■	■	■	■	■	■
379	*Vitorfus brustolensis* (SQUINABOL)													■	■	■	■	■	■	■	■	■
337	*Vitorfus morini* EMPSON-MORIN																					■
86	*Quinquecapsularia ombonii* (SQUINABOL)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
377	*Quinquecapsularia parvipora* (SQUINABOL)											■	■	■	■	■	■	■	■	■	■	■
96	*Quinquecapsularia grandiloqua* nov. sp.																		■	■	■	■
375	*Quinquecapsularia panacea* nov. sp.																				■	■
226	*Falsocromyodrymus mirabilis* (SQUINABOL)											■	■	■	■	■						
303	*Falsocromyodrymus ? fragosus* nov. sp.												■	■	■	■						
380	*Falsocromyodrymus cardulus* nov. sp.														■	■	■	■	■	■	■	
352	*Falsocromyodrymus noxiosus* nov. sp.																		■	■	■	■
287	*Falsocromyodrymus ? nebulosus* nov. sp.																				■	■
374	*Protoxiphotractus machinosus* nov. sp.																				■	■
336	*Protoxiphotractus ventosus* nov. sp.																					■
326	*Pantanellium lanceola* (PARONA)	■	■	■	■	■	■															
383	*Dicroa periosa* FOREMAN	■	■	■	■	■	■	■														
328	*Dicroa rara* (SQUINABOL)										■	■	■	■	■	■	■	■	■	■	■	
88	*Hexapyramis precedis* JUD	■	■	■	■	■	■	■	■	■	■	■										
82	*Hexapyramis pantanellii* SQUINABOL							■	■	■	■	■	■	■	■	■	■	■	■	■	■	
332	*Acaeniotyle umbilicata* (RÜST)	■	■	■	■	■	■	■	■	■												
191	*Acaeniotyle diaphorogona* FOREMAN	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
184	*Acaeniotyle tribulosa* FOREMAN										■	■	■	■	■	■						
201	*Acaeniotyle amplissima* (FOREMAN)										■	■	■	■	■	■	■	■	■	■	■	■
239	*Acaeniotyle macrospina* (SQUINABOL)											■	■	■	■	■	■	■	■			
331	*Acaeniotyle longispina* (SQUINABOL)											■	■	■	■	■	■	■	■	■	■	
215	*Acaeniotyle vitalis* nov. sp.											■	■	■	■	■	■	■	■	■	■	■
214	*Acaeniotyle rebellis* nov. sp.														■	■	■	■	■	■	■	■
176	*Staurosphaeretta longispina* (SQUINABOL)							■	■	■	■	■	■	■	■	■	■	■	■			
208	*Staurosphaeretta euganea* (SQUINABOL)										■	■	■	■	■	■	■	■	■	■	■	
240	*Staurosphaeretta grandipora* (SQUINABOL)											■	■	■	■	■	■					
270	*Staurosphaeretta wisniowskii* (SQUINABOL)											■	■	■	■	■	■					

Fig. 10b.- Mid-Cretaceous range chart for the suborder Spumellariina based on Unitary Associations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
213															■	■	■					*Tetracanthellipsis euganeus* SQUINABOL
186																				■	■	*Tetracanthellipsis gregalis* nov. sp.
95											■	■	■	■	■	■						*Pseudoacanthosphaera galeata* nov. sp.
168											■	■	■	■	■	■	■					*Pseudoacanthosphaera magnifica* (SQUINABOL)
342																■	■	■	■	■	■	*Pseudoacanthosphaera superba* (SQUINABOL)
327																				■	■	*Pseudoacanthosphaera spinosissima* (SQUINABOL)
297	■	■	■	■	■	■	■															*Triactoma hybum* FOREMAN
175							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Triactoma cellulosa* FOREMAN
192											■	■	■	■	■	■	■	■				*Triactoma paronai* (SQUINABOL)
171												■	■	■	■	■	■	■				*Triactoma compressa* (SQUINABOL)
188																		■	■	■	■	*Triactoma hexeris* nov. sp.
222																				■	■	*Triactoma parva* (SQUINABOL)
83														■	■	■						*Pyramispongia costarricensis* (SCHMIDT-EFFING)
218																■	■	■	■	■	■	*Pyramispongia glascockensis* PESSAGNO
386	■																					*Cyclastrum infundibuliforme* RÜST
252	■	■	■	■	■	■	■	■	■													*Cyclastrum satoi* (TUMANDA)
142											■	■	■	■	■	■	■	■	■	■	■	*Cavaspongia euganea* (SQUINABOL)
163												■	■	■	■	■	■					*Cavaspongia cilindrica* nov. sp.
170													■	■	■	■	■	■	■	■		*Cavaspongia sphaerica* nov. sp.
329																■	■	■	■	■	■	*Cavaspongia contracta* nov. sp.
172																	■	■				*Cavaspongia helice* nov. sp.
202																	■	■				*Cavaspongia californiaensis* PESSAGNO
164																				■	■	*Cavaspongia antelopensis* PESSAGNO
187																				■	■	*Cavaspongia tricornis* nov. sp.
304	■	■	■	■																		*Becus helenae* (SCHAAF)
320	■	■	■	■	■	■	■	■	■	■												*Becus gemmatus* WU
166							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	*Becus horridus* (SQUINABOL)
217												■	■	■	■	■	■	■	■			*Becus regius* nov. sp.
230										■	■	■	■	■	■							*Pseudoaulophacus sculptus* (SQUINABOL)
238														■	■	■	■	■	■	■	■	*Pseudoaulophacus putahensis* PESSAGNO
167																				■	■	*Alievium superbum* (SQUINABOL)
322											■	■	■	■	■							*Dispongotripus acutispinus* SQUINABOL
209														■	■	■	■	■				*Dispongotripus triangularis* (SQUINABOL)
236															■	■	■	■	■	■	■	*Patellula minuscula* nov. sp.
84																■	■					*Patellula spica* nov. sp
233																■	■	■				*Patellula cognata* nov. sp.
234																	■	■	■	■	■	*Patellula helios* (SQUINABOL)
321																		■	■	■	■	*Patellula verteroensis* (PESSAGNO)
325																				■	■	*Patellula heroica* nov. sp.
382																				■	■	*Patellula ecliptica* nov. sp.
138	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					*Dactyliodiscus lenticulatus* (JUD)
146										■	■	■	■	■	■	■						*Dactyliodiscus cayeuxi* SQUINABOL
207											■	■	■	■	■							*Dactyliodiscus rubus* nov. sp.
235													■	■	■	■	■	■				*Dactyliodiscus longispinus* (SQUINABOL)
149	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					*Godia concava* (LI & WU)
141	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				*Godia coronata* (TUMANDA)
148							■	■	■													*Godia decora* (LI & WU)
147											■	■										*Godia pelta* nov. sp.

Fig. 10b.- Mid-Cretaceous range chart for the suborder Spumellariina (continued).

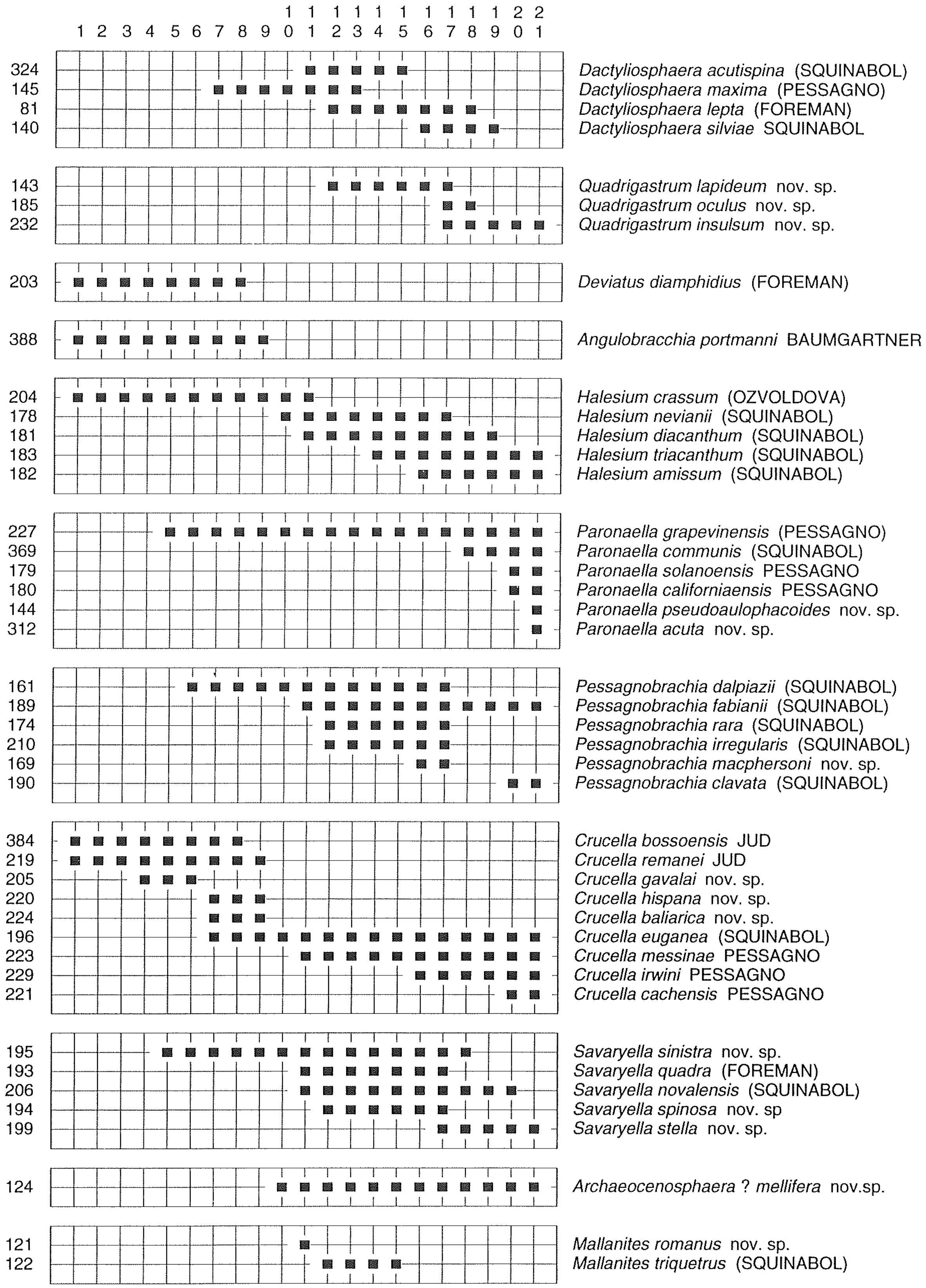


Fig. 10b.- Mid-Cretaceous range chart for the suborder Spumellariina (continued).

III.4. RATES OF FAUNAL TURNOVER

A bivariate scatter diagram (fig. 10c) has been constructed to emphasize the major faunal turnovers which occurred during the Mid-Cretaceous. This diagram shows the cumulated number of species that appear and disappear in each one unitary association (U.A. 1 to U.A. 21). Unitary associations are represented by black squares. The scatter diagram clearly shows alternate periods of high diversification rate (e. i. U.A. 9-13, U.A. 19-20) followed by high extinction rates (U.A. 7-9, U.A. 14-15 and 18-19). To analyze the significance of these turnovers rates a simplified stratigraphic log has been drawn, in which we have indicated the chronostratigraphic position of each unitary association and the major oceanic anoxic events (OAE 1A, OAE 1B, OAE 1C and OAE 2). If now, we analyze simultaneously the cumulated UA's plot and the stratigraphic log, a correlation between anoxic episodes and high extinction rates can be observed; also a correlation has been established between periods of well-oxygenated conditions and rates of high diversification. These sharp faunal turnovers could reflect the ecological response of the biota to global climatic changes which occurred during Mid-Cretaceous times. The variation of the sediment's colour from black-grey-green to red-brown reflects a change to a more vigorous deep-water circulation and more oxygenated mass of water (Premoli-Silva *et al.*, 1989). These changes could represent better environmental conditions favourable to high diversification rate after periods of ecological stress (see Guex 1992, 1993 for a discussion of the influence of stress on faunal changes). More detailed investigations to understand the relation between these radiolarian faunal turnover and the environment is under study.

III.5. CHRONOSTRATIGRAPHY AND CORRELATIONS

Integrated micro- and macrofossil zonations applied in this study

Our material was collected under optimal conditions for integrating biostratigraphic scales based on different fossil groups, essentially planktonic foraminifera and calcareous nannofossils. Planktonic foraminifera have been studied repeatedly in the type localities. The calibration of nannofossil and radiolarian zones to classical stages had to be made via planktonic foraminifera. Furthermore, planktonic foraminifera were the most abundant microfossils found together with radiolarian residues. A preliminary calibration of the different zonal schemes based on ammonites, planktonic foraminifera, calcareous nannofossils and radiolarians is presented in this section (Fig. 11).

The correlation of the calcareous nannofossil zones with the classical stages and ammonite standard zones is given in Fig. 11. The lower Cretaceous (Barremian-Albian) Tethyan ammonite zones used here are those defined by Hoedemaker, Company *et al.* (1993). This scheme has recently been adopted by the Lower Cretaceous Cephalopod Team of IGCP-Project 262 (Tethyan Cretaceous Correlation). The Cenomanian-Turonian standard zones used in this chapter were defined by Hancock (1984, 1991) and Kennedy (1984) (see the "Copenhagen recommendations" proposed by Birkelund *et al.*, 1984).

The proposed radiolarian zones based on Unitary Associations have principally been correlated with planktonic foraminifera partially following the zonal scheme proposed by Caron (1985) with some noticeable modifications. The foraminiferal zones are based on the first and/or last occurrences of the marker species, some of which represent well established phyletic lineages. Caron's zonal scheme is mainly based on the results of Van Hinte (1976), Sigal (1977), Robaszynski & Caron (1979), Sigal (1979), Robaszynski *et al.* (1980), Rebollo (1980), Wonders (1980), González-Donoso *et al.* (1982), Caron (1985), Marks (1984a,b), Leckie (1985), Robaszynski *et al.* (1990), Magniez-Jannin (1991), Aguado (1993, 1994), Aguado *et al.* (1992) and Grosheny *et al.* (1992). The correlation of this foraminiferal zonation with standard stages was established by means of ammonoids by Moullade (1966), Longoria (1974), Sigal (1977, 1986), Rat *et al.* (1979), Robaszynski (1984), Cobban (1985), Reyment & Bengston (1986); Robaszynski *et al.* (1990), Delamette & Kennedy (1991) and Aguado *et al.* (1992). All these schemes are essentially based on integrated biostratigraphic studies of macro and microfaunas from particularly well suited sections.

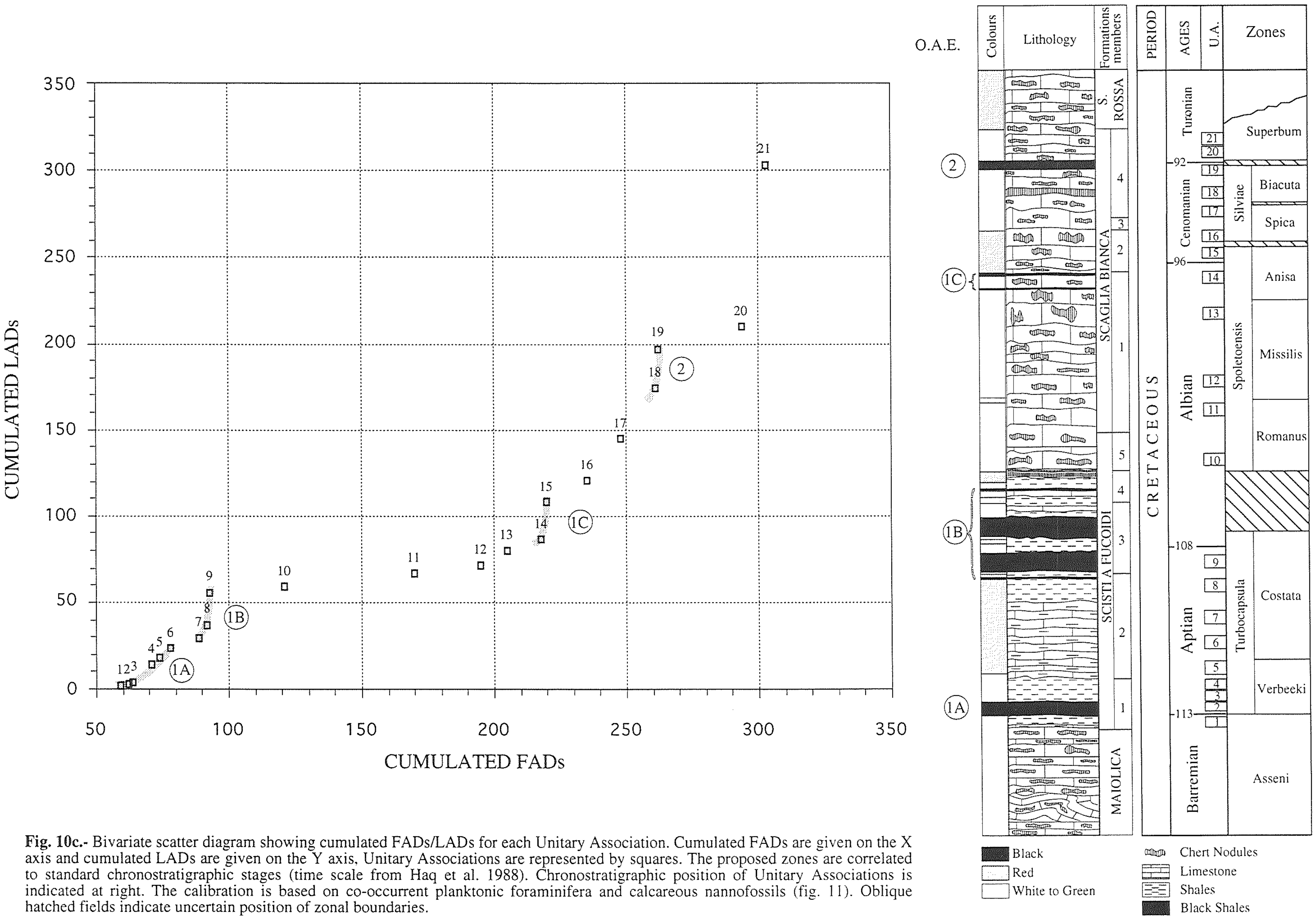


Fig. 10c.- Bivariate scatter diagram showing cumulated FADs/LADs for each Unitary Association. Cumulated FADs are given on the X axis and cumulated LADs are given on the Y axis, Unitary Associations are represented by squares. The proposed zones are correlated to standard chronostratigraphic stages (time scale from Haq et al. 1988). Chronostratigraphic position of Unitary Associations is indicated at right. The calibration is based on co-occurrent planktonic foraminifera and calcareous nannofossils (fig. 11). Oblique hatched fields indicate uncertain position of zonal boundaries.

The nannofossil zonal scheme is that proposed by Aguado (1993, 1994) which has been used for the Betic Cordillera and seems to be valid for the western Mediterranean regions. Aguado's zonation was established following the integrated study of calcareous nannofossils, planktonic foraminifera and the ammonite fauna. This scheme introduces additional modifications to previously proposed nannofossil zonations, but is more or less comparable to those of Sissingh (1977), Verbeek (1977) and Roth (1983).

Radiolarian Correlations

Initial biostratigraphic studies of Mid-Cretaceous radiolarians in land sections first began during the 1960's (Aliev, 1965, 1969a,b; Pessagno 1971a, 1972, 1973a) and a few years later the first zonal schemes appeared (Dumitrica, 1975, Pessagno 1976, 1977c). Simultaneously, the development of the Deep Sea Drilling Project (DSDP) provided new information on radiolarian stratigraphy and triggered the development of new zonal schemes (Moore, 1973; Riedel & Sanfilippo, 1974; Renz, 1974; Foreman, 1973b, 1975, 1978b; Schaaf, 1981). In general all these schemes are more or less tied to chronostratigraphy by means of other fossil groups, essentially calcareous nannofossils. A very detailed compilation of Cretaceous radiolarian studies published before 1985 was done by Sanfilippo & Riedel (1985). This review provides a global synthesis with precise indication of the localities, ages and additional comments on taxonomy.

Although various zonations for the Cretaceous were proposed by different authors in the past decade, no zonal schemes of Mid-Cretaceous radiolarians have been proposed for the Mediterranean regions. The more significant schemes of Mid-Cretaceous zonation are compiled and correlated in figure 12.

Pacific Ocean

The first attempt to establish a zonation based on radiolarians for the Cretaceous sediments from the Pacific Ocean was proposed by Moore (1973). The radiolarian assemblages studied by Moore present noticeable similarities with that from the Mediterranean region. However, Moore's zonal definitions were too broad to allow a precise comparison between the two regions.

Foreman (1973b, 1975) established a zonation for the Cretaceous sediments recovered at different DSDP sites in the Pacific Ocean. These radiolarian faunas are identical to those from western Mediterranean region. Foreman (1975) compiled a first range-chart which served as principal reference for subsequent studies during the last two decades.

Some years later, Schaaf (1981) provided stratigraphic information on radiolarian faunas from the Valanginian-early Cenomanian interval of Mid-Pacific Ocean (DSDP, Leg 62). This author applies the zonal scheme proposed by Foreman (1975) with slight modification for the Hauterivian-Aptian interval. Schaaf's scheme served as a starting point for subsequent zonations.

Indian Ocean

Renz (1974) established a first zonation for samples from the Indian Ocean. This early work recognized two major assemblages for the Valanginian-early Albian interval. The radiolarian fauna presented by Renz shows slight similarities with Mediterranean fauna, but the endemic character of some of the illustrated taxa is an important factor that must be taken into consideration.

More recently, Baumgartner (1992) illustrated radiolarian faunas from off north-western Australia (Argo Basin). These assemblages are characterized by the paucity of Tethyan fauna and by a strong circumantarctic endemism which makes comparison with the Tethyan realm difficult.

Atlantic Ocean

Radiolarian fauna from the North Atlantic Ocean sediment were studied recently by Thurow (1988) who applied Schaaf's (1985) zonation without modification. Thurow's correlation of the late Aptian-Cenomanian interval is practically meaningless because the datums used to define the zonal boundaries of the successive Albian-early Cenomanian zones (i.e. the same as Schaaf's, 1985; see Fig. 12) are observed to be simultaneous at the base of the middle Albian in the western Mediterranean regions (base of the Spoletoensis zone). Only a composite range chart was presented by Thurow for the Cenomanian-Maastrichtian interval. Otherwise, the radiolarian fauna illustrated by Thurow shows many similarities with the fauna studied in the present work.

Composite zonations

The first composite zonation was proposed by Riedel & Sanfilippo (1974). It was based mainly on the study of Cretaceous samples from different DSDP cores (predominantly from the northwestern Pacific, but also from the Caribbean, nortwestern Atlantic and Indian Ocean). This zonation served as a basic reference for subsequent research during later years.

In the mid-1980's, two composite zonations were proposed simultaneously: Sanfilippo & Riedel (1985) and Schaaf (1985). Both zonal schemes were established by means of probabilistic or semiprobabilistic methods (see Baumgartner 1984a and Guex 1991 for a critical discussion of these procedures).

Sanfilippo & Riedel (1985) based their new zonation on Cretaceous radiolarians from different DSDP Sites (loc. cit., p. 582), two land-based sections in Japan from Taketani (1982) and an unpublished section from northern Italy. That zonation is comparable to the ones proposed by Foreman (1975) and Schaaf (1981) and it can be more or less correlated with our zonation of the western Mediterranean region.

The zonal scheme proposed by Schaaf (1985) was constructed by means of a combination of Davaud's (1978, 1982) deterministic algorithm and of Hay's (1972) probabilistic method. This mixed methodology is known as "sequential analysis". It is well known that Hay's probabilistic method produces range charts characterized by an extremely truncated representation of the relative ranges of the species (Guex 1991). Schaaf's database consisted in 111 selected radiolarian species recorded from 30 DSDP Sites. In his semiprobabilistic synthesis (loc. cit., Fig. 11), 56 observed coexistences of species were omitted and 6 observed superpositions were reversed (see Guex, 1991, p. 190-191 for details). In other words, several marker species observed to co-occur in the original samples were placed in an apparent chronological sequence and several species observed in a particular sequence were placed in the wrong stratigraphic order in Schaaf's synthesis. In short, the range chart obtained by Schaaf gives a extremely truncated picture of the total species range. For this reason all correlation with Schaaf's zonation is very complex.

Pacific Coast of the United States

Radiolarian research on the Pacific Coast of the United States began with the works of Campbell & Clark (1944), but unfortunately biostratigraphic outlines were not proposed. The first attempt to utilise radiolarians in the development of a zonation for the Late Cretaceous was by Pessagno (1976). Stratigraphic information on radiolarian faunas from the Cretaceous of California Coast Ranges were presented by Pessagno in a series of articles published between 1969-1977. In all these papers partial radiolarian range charts were given comprising practically all the Cretaceous.

The zonation proposed by Pessagno (1976 and 1977c), largely based in these previous works, is somewhat difficult to compare with the Mediterranean region due to certain discrepancies in first occurrences of species. It is not yet possible to make a comprehensive correlation between the zonation proposed here for the western Mediterranean regions and those proposed by Pessagno. Nevertheless an attempt of correlation is presented in Fig.

12. In spite of these contradictions, the radiolarian fauna seems to have great similarities with that of the western Mediterranean regions and shows little influence of Boreal provincialism as occurred during the Jurassic. The Pessagno zonation was integrated with biostratigraphic data on megafossils (Buchias) for the early Cretaceous and on planktonic foraminifera for the middle-Late Cretaceous.

Central America

Central America radiolarian faunas are known from the works of Schmidt-Effing (1980) and Origlia-Devos (1984). Great similarities are observed between these and the western Mediterranean faunas but unfortunately no attempt at correlation was possible because biostratigraphic schemes were not given by these authors.

Japan

The first zonation of Late Jurassic-middle Cretaceous radiolarians in Japan was proposed by Nakaseko & Nishimura (1981). Taketani (1982) presented a detailed study of the radiolarian faunas from the Late Cretaceous of S. Hokkaido. Although the faunal composition is quite similar to that in the western Mediterranean, zonal correlation is very difficult to establish, due to major discrepancies in first or last occurrences of datum (Fig. 12). Some years later Tumanda (1989) described radiolarians from the Early-middle Cretaceous of N. Hokkaido. This zonation slightly modified the zonation of Nakaseko & Nishimura (1981). In general, Cretaceous radiolarian faunas from Japan are more or less similar to coeval assemblages from western Mediterranean regions.

Carpathians

The radiolarian faunas from the Carpathians are known from the earliest works of Dumitrica (1970, 1975). This author recognized two assemblages for the latest Cenomanian-earliest Turonian interval. These radiolarian assemblages show great similarities within coeval associations in the western Mediterranean area.

Caucasus

Aliev (1965, 1967) initiated the studies of Early and middle Cretaceous radiolarians from the eastern part of the Greater Caucasus, but precise biostratigraphic scales were not available. Recently Vishnevskaya (1993) proposed a zonation for the Late Jurassic-Late Cretaceous interval in the Caucasus region. Although the assemblages proposed by Vishnevskaya for the middle Cretaceous are somewhat broad in their definitions, these may be more or less correlated with the zonation presented in this work. Furthermore, these radiolarian assemblages show great resemblance with the western Mediterranean faunas.

Russian Pacific Rim

Vishnevskaya (1993) proposed a first zonal scheme for the Cretaceous of the eastern Russia. That zonation only distinguishes two zones for the middle Cretaceous. The faunal assemblages recorded from Russian Pacific Rim are more or less comparable with the western Mediterranean faunas, although determinate taxa seem to be latitudinally controlled, showing a boreal influence.

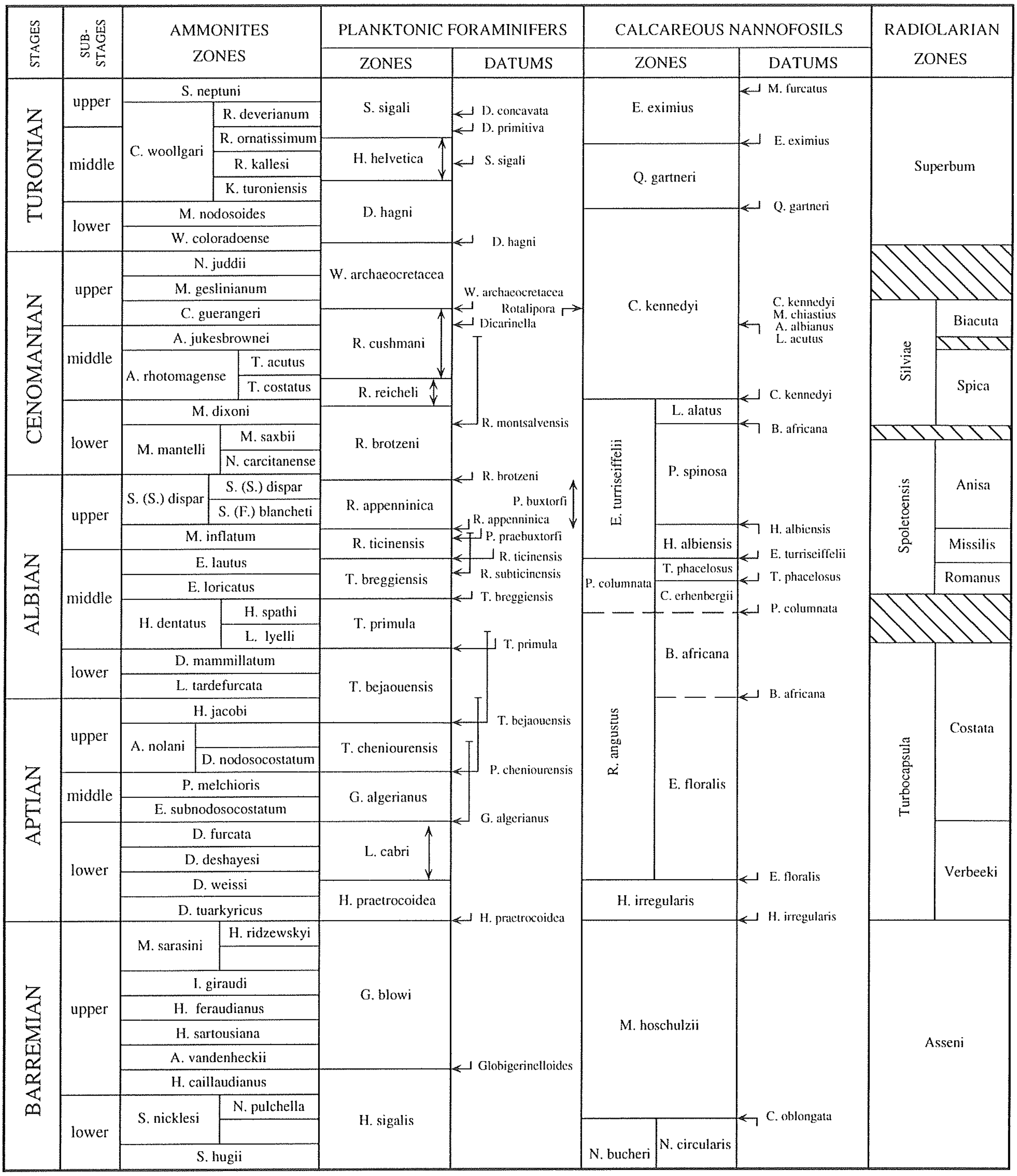


Fig. 11.- Chart showing the tentative correlation of the standard Tethyan ammonite, calcareous plankton and radiolarian zonations (see text for explanations). Oblique hatched fields indicate uncertain position of zonal boundaries.

Fig. 12.- Correlation zones with previously published zonal schemes. Oblique hatched field and dashed lines indicate uncertain position of zonal boundaries. Undulating lines represent unrecognized or undefined boundaries. Arrows show discrepancies of first or /and last occurrences of selected marker taxa between previous data and the biochronological scale proposed here (see fig. 9a). Correlation with chronostratigraphic stages same as in fig. 9b.

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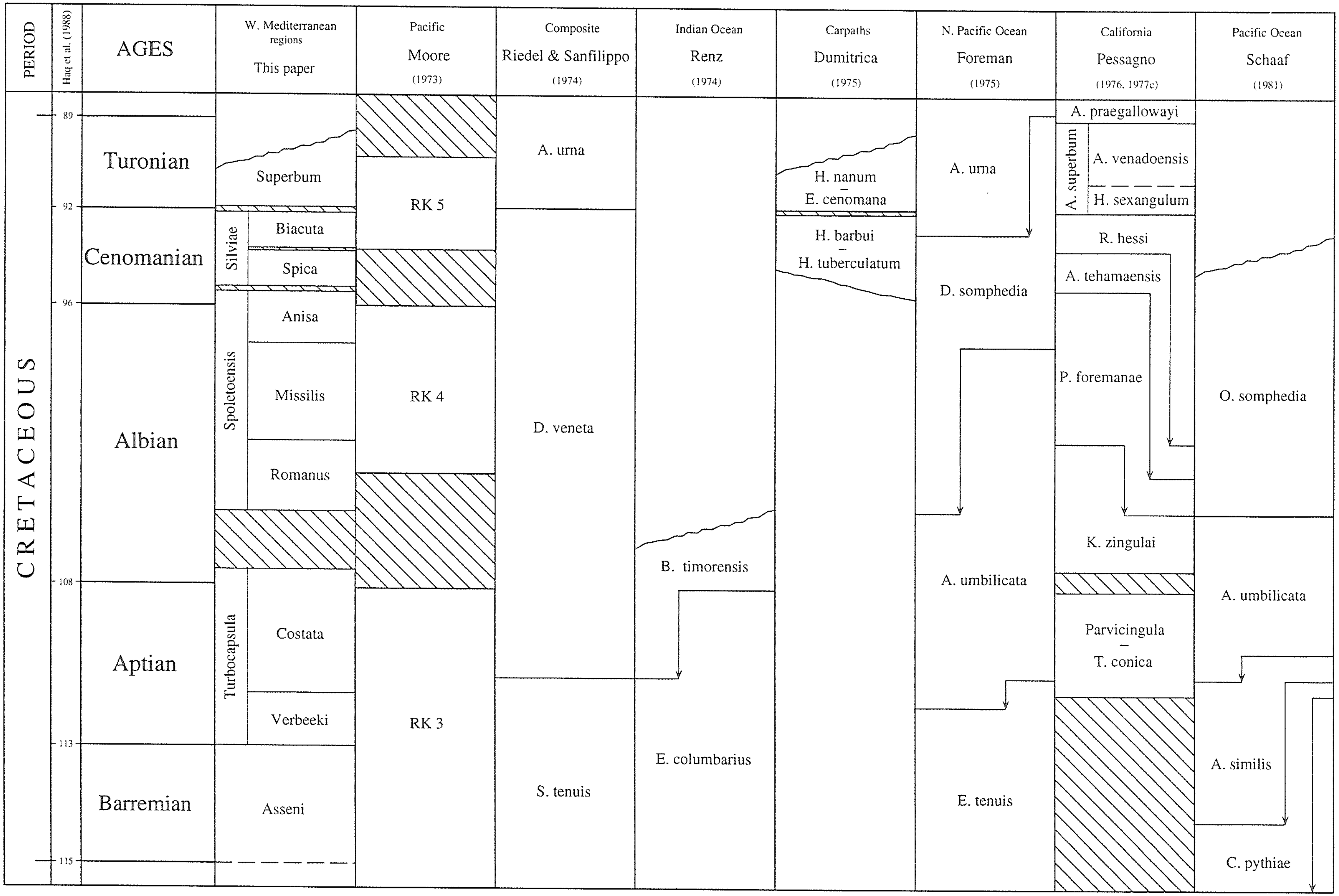
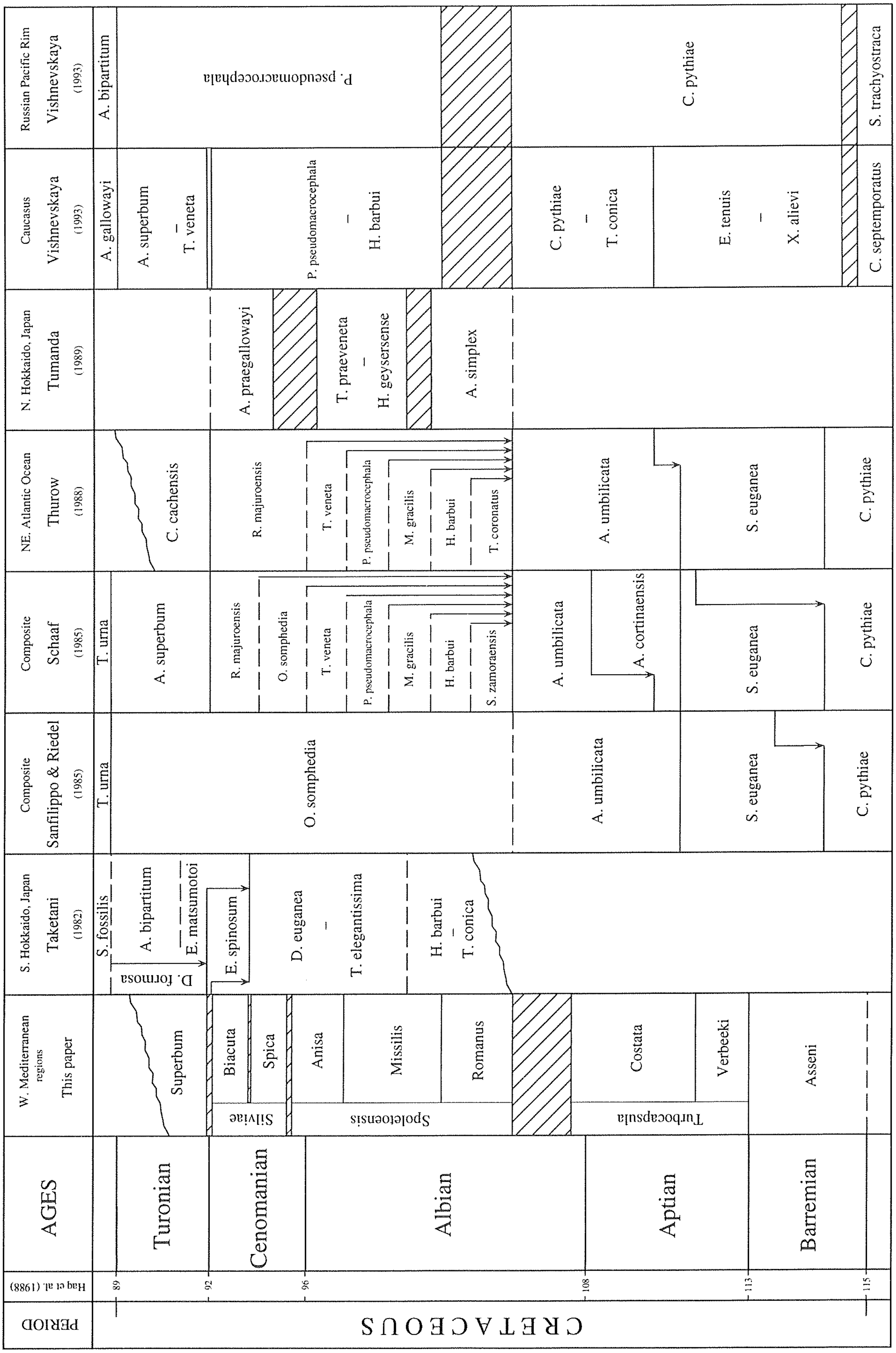

PERIOD
Haq et al. (1988)
AGES
W. Mediterranean regions
This paper
Pacific
Moore
(1973)
Composite
Riedel & Sanfilippo
(1974)
Indian Ocean
Renz
(1974)
Carpaths
Dumitrica
(1975)
N. Pacific Ocean
Foreman
(1975)
California
Pessagno
(1976, 1977c)
Pacific Ocean
Schaaf
(1981)
CRETACEOUS
89
92
96
108
113
115
Turonian
Cenomanian
Albian
Aptian
Barremian
Superbum
Silviae
Biacuta
Spica
Spoletoensis
Anisa
Missilis
Romanus
Turbocapsula
Costata
Verbeeki
Asseni
RK 5
RK 4
RK 3
A. urna
D. veneta
S. tenuis
B. timorensis
E. columbarius
H. nanum
–
E. cenomana
H. barbui
–
H. tuberculatum
A. urna
D. somphedia
A. umbilicata
E. tenuis
A. praegallowayi
A. superbum
A. venadoensis
H. sexangulum
R. hessi
A. tehamaensis
P. foremanae
K. zingulai
Parvicingula
–
T. conica
O. somphedia
A. umbilicata
A. similis
C. pythiae


PERIOD
CRETACEOUS
Haq et al. (1988)
89
92
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Turonian
Cenomanian
Albian
Aptian
Barremian
W. Mediterranean regions
This paper
Superbum
Silviae
Biacuta
Spica
Spoletoensis
Anisa
Missilis
Romanus
Turbocapsula
Costata
Verbeeki
Asseni
S. Hokkaido, Japan
Taketani
(1982)
S. fossilis
D. formosa
A. bipartitum
E. matsumotoi
E. spinosum
D. euganea
–
T. elegantissima
H. barbui
–
T. conica
Composite
Sanfilippo & Riedel
(1985)
T. urna
O. somphedia
A. umbilicata
S. euganea
C. pythiae
Composite
Schaaf
(1985)
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A. superbum
R. majuroensis
O. somphedia
T. veneta
P. pseudomacrocephala
M. gracilis
H. barbui
S. zamoraensis
A. umbilicata
A. cortinaensis
S. euganea
C. pythiae
NE. Atlantic Ocean
Thurow
(1988)
C. cachensis
R. majuroensis
T. veneta
P. pseudomacrocephala
M. gracilis
H. barbui
T. coronatus
A. umbilicata
S. euganea
C. pythiae
N. Hokkaido, Japan
Tumanda
(1989)
A. praegallowayi
T. praeveneta
–
H. geysersense
A. simplex
Caucasus
Vishnevskaya
(1993)
A. gallowayi
A. superbum
–
T. veneta
P. pseudomacrocephala
–
H. barbui
C. pythiae
–
T. conica
E. tenuis
–
X. alievi
C. septemporatus
Russian Pacific Rim
Vishnevskaya
(1993)
A. bipartitum
P. pseudomacrocephala
C. pythiae
S. trachyostraca

IV. PALEONTOLOGY

IV. 1. INTRODUCTION

This chapter is concerned with the description of the radiolarian faunas used in the biochronological synthesis. However, it is virtually impossible to ensure the completion of such a description, because of the diversity of forms belonging to over twenty families and almost seventy genera of Radiolaria in the middle Cretaceous of the Mediterranean regions.

Apart from helping in identification and recognition of the appropriate form of organisms, systematics establishes a hierarchical order for these organisms. As a concept of the theory of evolution, this hierarchy corresponds to monophyletic criteria, i.e., the group of species making up a particular taxon must have common ancestors. As described by Eldredge & Novacek (1985) these monophyletic taxa are the branches of the tree of life and their identification is the aim of systematic palaeontology. Systematics, therefore, provides us with the primary data for any evolutionary study.

Haeckel's classic systematics was based on the central position of the species as the fundamental taxonomic unit. The definition of species was based on purely morphological criteria, exclusively using the typological method, which often reduced systematic problems to mere cataloguing mechanisms rather than questions of biological importance. This had an enormous influence on later work and is the cause of the confusion in nomenclature that still persist.

The systematic palaeontology carried out in this study summarises my interpretation of the middle Cretaceous radiolarian fauna of the Mediterranean region. It is a compromise between my own interpretation and the present state of ideas on the palaeontology of Mesozoic Radiolaria.

IV.1.1. HISTORICAL REVIEW

Although the forms most frequently found in recent or Tertiary sediments were known from early in the 19th century, the study of Mesozoic Radiolaria only began towards the end of the century. Zittel (1876) described the first Cretaceous genera and species from northern Germany. The study of Mediterranean Mesozoic Radiolaria began some years later with Pantanelli (1880) who first described some species from Tuscany (Italy). Soon after, Rüst (1885, 1889) and Parona (1890, 1892) described and illustrated numerous Neocomian species from different Alpine locations in Italy, Switzerland and Austria.

From our present point of view, the chronostratigraphic and biostratigraphic location of these authors' material was imprecise, and they grouped together very different morphologies in the same genus as an indirect consequence of Haeckelian taxonomy, almost always with a very limited sense of intraspecific variability. Likewise, species definitions are based on very few specimens, most commonly with only one specimen figured, and in some cases with no illustration at all. If we consider the minute size of these organisms, together with the scarce technical possibilities for graphic representation at that time, the illustrations presented in these studies are good but sorely deficient by today's standards. Another problem concerning size, is the difficulty of conservation in museums and institutions which has led to the disappearance or destruction of most of these collections, making it practically impossible to view and/or revise type-material.

An additional and more serious systematic problem was the premature assignation by Rüst (1885, 1889) of Mesozoic and Palaeozoic species to different nominal genera created in Haeckel's (1881) famous "Prodromus". The fact that this treatise contained no nominal species when these nominal genera were described implies that Rüst's species (op. cit.) constituted the type-species for numerous Cenozoic genera. This occurred years before Haeckel (1887) designated the Cenozoic species that were to be included in the different genera as previously defined by him. In short, many of these genera are used indifferently for Mesozoic or Cenozoic species. This state of affairs became yet more complicated this century with the appearance of the *Treatise of Invertebrate Palaeontology* part D, Protista 3, by Campbell (1954), which represents a resystematisation of Haeckel's work. The result of this process was nomenclatory confusion which still persists and has characterised a great deal of the literature on Mesozoic Radiolaria.

At the beginning of the XXth century, Italian authors such as Neviani (1900), Vinassa (1899, 1900, 1901) continued the description begun by previous authors (in some cases even using the same material) of Mediterranean Late Jurassic and Neocomian species and restricted the morphological spectrum of species. By not using general taxonomic criteria for a particular group, an ever greater number of characteristics were found able to determine a nominal species. Consequently the number of species grew, together with their recognised nominal varieties.

Squinabol is the most important figure of the beginning of this century. He described over a hundred of the species presented in Chapter Four of this study in his three excellent monographic studies (1903b, 1904, 1914) of middle Cretaceous Radiolaria from the Venetian Alps. The quality of Squinabol's illustrations, the relative precision of the locations studied and a remarkable conception of intraspecific variability distinguish him from the other authors of his time. The only drawback to his work (then customary in micropaleontology) is the almost total absence of biostratigraphy, the only references being to the colour of the silex nodules. This datum can be relatively useful, as four members can be clearly distinguished in "Scaglia Bianca" on the basis of the colour of the silex nodules (see Chapter on Stratigraphy), and this provides an approximate idea of the provenance of the specimens. Actually, a taxonomic revision of Squinabol's original collection is in study.

The study of fossil Radiolaria underwent a dormant period between the beginning of the First World War and the second half of the century. The only relevant work undertaken at this time were the studies by Tan (1927) on the Early Cretaceous in the Moluccas Archipelago and Heitzer (1930) on the Late Jurassic in the Carpathians.

The main aim of paleontological work on Cretaceous Radiolaria over the last three decades has been the biostratigraphical. By using some of the types described earlier together with the description of numerous new nominal species more or less systematically sampled Radiolaria sequences have been detailed. Using these, it has thus been possible for the first time to determine zones or assemblages for different stages or sub-stages, and to begin the development of a zonation based exclusively on Radiolaria. The different zonations proposed for the middle Cretaceous are schematically summarised in my chapter on biochronology (III.4 Correlations). My opinion on all these historical antecedents is made clear throughout the chapter on palaeontology and is especially illustrated on the synonym lists.

IV.1.2 CHARACTERISTICS OF THE MATERIAL STUDIED AND METHODOLOGY

The material prepared and studied includes over eight hundred samples from different, minutely sampled profiles (see chapter on biochronology). Preservation of the Radiolaria fauna in these samples was better than initially expected during preselection at the outcrop. Almost all the samples were appropriate for study, but the relatively short time available for this research meant that detailed analysis of every one was not possible. A selection was therefore made of the most interesting samples from both the paleontological and biostratigraphic points of view. Twenty-nine samples were chosen that represented a significant chronological spectrum of the interval to be studied. In addition, these samples were highly diverse and contained abundant Radiolaria fauna on which it was possible to carry out a very detailed paleontological study that will constitute the basis for future research in this area. My intention, then, was to make an exhaustive study of particular samples and make an inventory of the different Radiolaria species in order to establish an exact biochronological scale of the largest possible faunal spectrum of Radiolaria in the Mediterranean middle Cretaceous.

The number of specimens isolated from all the samples collected was approximately two hundred thousand in all, not including other groups of less abundant microfossils such as planktonic Foraminifera, benthic Foraminifera and sponge spicules. Specimens were chosen from the different pickings of the samples and the material studied consists of over twelve thousand Radiolaria photographed by electron microscope. Rock samples, residues and SEM negatives are stored in the author's collection.

The material collected by myself was compared with numerous samples collected by Dr. Coccioni in the Italian sections at Fiume Bosso and Poggio le Guaine from marly layers of Marne a Fucoidi and Scaglia Bianca. I have also been able to observe numerous samples of the Italian Neocomian that have not been used directly in this study, belonging to several collections in the *Institut de Géologie et Paléontologie* in the University of Lausanne.

Radiolaria were isolated from different lithologies, particularly limestones with silex nodules (the preferentially sampled lithology) and, to a lesser extent, cherts, marls and shales. Preservation was generally very good around the siliceous nodules, revealing a faunal spectrum very close to what may have been the original biocenosis. The opposite is true of the other lithologies, where there is preferential preservation of specimens of the Nassellariina suborder. Most of the samples chosen to establish the biochronology were from limestones with silex nodules.

The laboratory methods used in processing the samples followed the classical methods of Dumitrica (1970), Pessagno & Newport (1972), Pessagno (1977a,c), Baumgartner *et al.* (1981) and De Wever (1982), where complete descriptions of the procedures can be found.

IV.1.3 SIGNIFICANCE OF THE TAXONOMIC UNITS USED

In attempting to explain the manner in which I have used the different taxonomic categories, I do not intend that the concept of these categories should apply to any other group of fossils. My intention is simply to specify my own nomenclature in the absence of a universally accepted one.

Species

A large body of literature is concerned with the classic problem of the species in palaeontology. Analysis of this literature leads to a conclusion which is rather clear and generally accepted by most palaeontologists: fossil species are defined and recognised on the basis of morphological criteria. However, the degree to which the concept of morphospecies approximates that of biological species depends on the system used to chose these distinguishing morphological features, together with paleoecological, paleobiogeographic and biostratigraphic aspects.

The study of numerous specimens from the same bed at a precise location allows us to determine which characteristics are common to the individuals presumably belonging to an original population, and which others vary in a continuum in the same population (it must be pointed out that a particular stratigraphic layer can correspond to several populations of the same species which are indistinguishable from each other in a relatively short geological interval). Observation of more ancient or more modern populations in other layers at the same or nearby locations (always in the same paleogeographic context) leads to the establishment of distinguishing characteristics between populations in temporal succession. Similar patterns of morphological change in the fossil record ultimately lead to the integration of the populations into species.

When defining species, I have chosen only those characteristics common to a group of specimens that allow them to be distinguished from other forms in the same levels, and from other more ancient and more recent forms. Those characteristics that vary in a continuum in the specific spectrum or those that appear to be constant in a group of species and can be used to define taxa of higher rank were not taken into account. Thus, I have been able to establish morphospecies in a spatio-temporal framework. Although these morphospecies present rather clear boundaries, they usually show high intraspecific variability.

Genus

According to Tintant (1984), classification of species into genera can be undertaken using two different procedures. On the one hand, purely morphological criteria can be applied, resulting in groups that are more or less easy to use but probably artificial, leading to the creation of morphological genera. This often occurs with Radiolaria, where discontinuous recurrence of similar morphological characteristics between lineages that are only distantly related leads to numerous phenomena of heterochronous homoeomorphy and prevents the distinction of clear generic differences. On the other hand, groupings can be established on a phylogenetic basis, using the evolutionary history of the lineages involved. Nonetheless, the concepts of both "morphologic genus" and "phyletic genus" can be made compatible to a certain degree. Furthermore, the relationship between different species presumably belonging to the same genus can be inferred by the presence of certain common morphological features, independently of the temporal relations between them.

Obviously only a few morphological characteristics can be used if we are to avoid abuse of the monotypic genus. In this study, therefore, those species linked by kinship in my interpretation (i.e. those which form part of the same phylogenetic line) have been brought together under the same genus. In this way there are very few morphological characteristics common to the species composing a genus, while other characteristics can differ from one species to another.

Family

Those genera linked by supposed kinship relations and by the presence of certain common morphological characteristics have been included in the same family. To a certain extent, this represents the grouping of the most similar morphological types mentioned above in a higher taxonomic category. I have followed a broadly conceived monophyletic criterion in distinguishing these types and have therefore included in the same family all the genera whose common ancestor is a single genus.

Superfamily

Both the families and superfamilies considered in this study originate and/or terminate outside the middle Cretaceous. Moreover, very few studies have established regroupings of families, there being a fundamental lacuna in the existing literature. I have only regrouped those families belonging to the Nassellariina suborder, following a criterion similar to that used for families, some of which are based on preceding models. The opposite is true with the families of the Spumellariina suborder, where it was impossible to analyze the ontogenetic development of the skeleton and structure of microsphere, which is the criterion that must be used (Dumitrica, 1988, 1989) in the definitions of these taxonomic units, together with the lack of studies dealing with this problem. I therefore only indicate groupings at family level in this suborder and only at superfamily level when possible following previous work.

IV.1.4 OBSERVATIONS ON THE DESCRIPTIVE METHOD USED

I have followed the customary method for the systematic study where the characteristics of each species are described. The binomial nomenclature is given first, beneath which I indicate the code arbitrarily assigned to each species in the data base (chapter III.2.). The synonymy of the species is next. The aim here is not only to provide a historic record of the species, but also to give a schematic version of my own interpretation. Accordingly, in the list of synonyms I include all the illustrated specimens that I consider belonging to that species, independent of their original generic or specific assignation. In addition, I give the reference, preceded by the word *non* in the left margin, of those specimens that I consider not to belong to the species to which they have formerly been assigned. If the reference is preceded by the word *pars*, this means that I only attribute part of the illustrated specimens to the species. Finally, a question mark to the left of the reference indicates doubt as regards whether the specimen (or specimens) belongs to the species.

The type-specimen of the species follows. In many cases the holotype or lectotype has been previously designated and it is mentioned merely for the sake of completion. However, apart from the formal nomenclatorial requirement, by designating the type in the case of syntypically designated species my intention is to determine a characteristic morphology of the species despite what that involves.

In the section on material, I account for the number of specimens that have been photographed and measured. This does not indicate the number observed and separated in the picking, but rather gives an exact idea of the amount of material available for a detailed study of variability.

In the section concerning description I first indicate the structural features of the shell and then the ornamental elements. As far as possible, I have attempted to eliminate from the description the characteristics common to all the species of a genus which are indicated in the diagnosis of the genus. I have omitted individual characteristics that are of no interest in the global conception of the species.

In the section measurements are given the dimensions of most important parameters that seems to be useful for biometrical studies. These measurements are exclusively based on the photographed material.

In the last section I provide a more elaborated discussion designed to clarify my concept of the species and also of possible phylogenetic relationships. There is also a comparison with the most morpho-phylogenetically similar species, attention being drawn to the most significant differences.

Finally, between the families I have intercalated phylogenetic schemes for genera and species as deduced from the detailed analysis of some of the fauna studied. These proposed schemes are necessarily partial and provisional. Occasionally these phylogenetic trees can present gaps caused by the restricted paleogeographic domain under consideration. Nonetheless, they are a necessary element in view of the paucity of studies dealing with this subject.

IV. 2. SYSTEMATIC PALEONTOLOGY

The present subchapter is divided into two parts. The first one concerns the taxonomy of the nassellarians. This group has been studied from both phylogenetic and biochronologic points of view and all taxa are described in detail. The second part concerns the spumellarians which were mainly used as a biochronological tool. The taxonomic discussion of this group is therefore restricted to the synonymies and remarks on the different taxa.

SUBORDER **NASSELLARIINA** EHRENBERG, 1875

SUPERFAMILY **ARCHAEODICTYOMITRACEAE** PESSAGNO, 1976

In a chronological order, this superfamily includes the following subordinated taxa: Bagotidae PESSAGNO & WHALEN, 1982; Canutidae PESSAGNO & WHALEN, 1982; Hsuidae PESSAGNO & WHALEN, 1982 and Archaeodictyomitridae PESSAGNO, 1976.

FAMILY **ARCHAEODICTYOMITRIDAE** PESSAGNO, 1976

Type genus: *Archaeodictyomitra* PESSAGNO (subjective synonym of *Dictyomitra* ZITTEL, 1876).

GENUS **DICTYOMITRA** ZITTEL, 1876

Synonyms: *Diplostrobus* SQUINABOL, 1903b; *Archaeodictyomitra* PESSAGNO, 1976; *Mita* PESSAGNO, 1977c; *Zifondium* PESSAGNO, 1977c.

Type species: *Dictyomitra multicostata* ZITTEL, 1876, subsequent designation of Campbell (1954).

Diagnosis: Multi-segmented forms with test elongate, cylindrical, conical to spindle-shaped, with well developed vertically aligned costae. Cephalis small rounded to conical imperforate, costate to non-costate, with or without apical horn. Post-thoracic chambers have costae continuous over the length of the test. Between adjacent costae, single or multiple (more commonly one) parallel rows of aligned pores. Weak to well-developed constrictions, occurring at joints or not. Lateral outlines of the test straight to lobate at segmental division level. Chambers generally gradually increasing in height and width distally. All chambers except cephalis, thorax and final post-abdominal chamber separated by septa with large central circular aperture. Final post-abdominal chambers commonly with aperture. Costal projections on final post-abdominal chamber more or less developed.

Remarks: I prefer to give a large sense to the genus *Dictyomitra* ZITTEL, so I have synonymized different genera, originally included in the family *Archaeodictyomitridae* PESSAGNO, being as certain distinctive parameters have evolved discontinuously. For example, the continuous character of variability between the morphologies *communis* and *vulgaris* annul the capacity to discriminate, the lobate outline and the degree of development of strictures that were originally defined to separate *Archaeodictyomitra* from *Dictyomitra*.

Range: Middle Jurassic to Late Cretaceous.

Dictyomitra excellens (TAN, 1927)

Pl. 1, figs. 1-2

Species code 258

1927 *Lithomitra excellens* spec. nov. TAN, p. 56, pl. 11, fig. 85.
1927 *Lithostrobus dignus* spec. nov. TAN, p. 54, pl. 11, fig. 79.
1973 *Lithomitra excellens* (TAN SIN HOK). - MOORE, p. 827, pl. 4, figs. 3, 4.
1974 *Dictyomitra excellens* (TAN SIN HOK). - RENZ, p. 791, pl. 8, figs. 7, 8; pl. 11, fig. 35.
1975 *Dictyomitra apiarium* (RÜST). - FOREMAN, p. 613, pl. 2G, figs. 7, 8.
pars 1979 *Dictyomitra apiarum* (RÜST). - NAKASEKO *et al.*, p. 21, pl. 3, fig. 3, non fig. 4.
1981 *Archaeodictyomitra apiara* (RÜST).- SCHAAF, p. 432, pl. 18, figs. 2a-b.
pars 1982 *Archaeodictyomitra apiara* (RÜST). - OKAMURA & UTO, pl. 2, figs. 1, 2; non pl. 5, fig, 2 (= *D. apiarium*).
pars 1983 *Archaeodictyomitra apiara* (RÜST). - ORIGLIA-DEVOS, p. 132, pl. 16, fig. 5; non fig. 6.
1983 *Archaeodictyomitra* sp. *A*. ORIGLIA-DEVOS, p. 142, pl. 17, figs. 1 ?, 2.
1984b *Archaeodictyomitra excellens* (TAN SIN HOK). - BAUMGARTNER, p. 758, pl. 2, figs. 7, 8.
1984 *Archaeodictyomitra apiara* (RÜST). - NAKASEKO & NISHIMURA, p. 145, pl. 6, fig. 1; pl. 15, fig. 7, non pl. 6, figs. 2, 3, 4 and pl. 15, figs. 2, 6.
pars 1984 *Archaeodictyomitra apiarium* (RÜST). - SCHAAF, p. 92-93, text-figs. 2, 4a-b; non text-figs. H (= specimen of Rüst, 1885, pl. 39 [14], fig. 8), 1, 3a-b and 5a-b (= *D. apiarium*).
1986b *Archaeodictyomitra apiarium* (RÜST). - SUYARI, pl. 2, fig. 9.
1989 *Archaeodictyomitra apiara* (RÜST). - KATO & IWATA, pl. 2, fig. 4.
1989 *Archaeodictyomitra* sp. KATO & IWATA, pl. 4, fig. 3.
1989 *Archaeodictyomitra excellens* (TAN SIN HOK). - TUMANDA, p. 36, pl. 3, fig. 7; pl. 10, fig. 3.
1990 *Archaeodictyomitra excellens* (TAN SIN HOK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 10.
1991 *Archaeodictyomitra excellens* (TAN). - AGUADO *et al.*, text-fig. 7. 4.
1992 *Archaeodictyomitra excellens* (TAN SIN HOK). - STEIGER, p. 88, pl. 25, figs. 10, 11.
1992 *Archaeodictyomitra apiara* (RÜST). - TAKETANI & KANIE, text-fig. 3. 9.
? 1993 *Archaeodictyomitra apiara* (RÜST). - WU, p. 123, pl. 2, fig. 16.
1994 *Archaeodictyomitra excellens* (TAN). - JUD, p. 63, pl. 3, figs. 15-16.

Holotype: Illustrated by Tan (1927), pl. 11, fig. 85. This specimen has been reported from the Early Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 5 specimens.

Description: Test elongate cylindrical. Proximal part dome-shaped followed by a slender cylinder, often slightly constricted in the middle part (character which disappears on terminal forms). Costate throughout, costae converging apically, wedging out near junctions of the thorax and the first post-abdominal chambers where constrictions are lacking; fourteen to seventeen delicate costae in lateral view. Costal projections may develop (pl. 1, fig. 1). Test terminating in a stout final chamber. It seems probable that this arrangement represents the beginning of the costal projections.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	258	270	291	265
Maximum width of test	95	89	90	80

Remarks: Moore (1973) was the first author who included this species in synonymy, however originally, Tan (1927) considered this form as variety of *Lithostrobus dignus* TAN, not cited in previous works. In order to stabilize the nomenclature I accept the proposed choice.

Many authors have included this species under the synonymy of *Lithocampe apiarium* RÜST. Like Baumgartner (1984b), the separation of these species seems useful because the stratigraphic range of *Dictyomitra excellens* is restricted to the Berriasian-base of the late Aptian. Furthermore, the morphological differences in shape and size, between both morphotypes, support the separation into two different species, but with a clear phylogenetic connection between both.

Dictyomitra communis (SQUINABOL, 1904)

Pl. 1, figs. 3-11
Species code 269

1904 *Lithostrobus communis* n. sp. SQUINABOL, p. 228, pl. 9, fig. 7.
1927 *Stichomitra pseudoscalaris* spec. nov. TAN, p. 56, pl. 11, fig. 84.
1961a *Dictyomitra margarita* sp. n. ALIEV, p. 55, pl. 1, figs. 3, 4.
1965 *Dictyomitra orginala* ALIEV. - ALIEV, p. 50, pl. 9, fig. 3.
1965 *Dictyomitra ordinaria* ALIEV. - ALIEV, p. 51, pl. 9, fig. 4.
1965 *Dictyomitra ordinaria* var. *elongata* ALIEV. - ALIEV, p. 52, pl. 9, fig. 5.
1965 *Dictyomitra margarita* ALIEV. - ALIEV, p. 40, pl. 7, figs. 1, 2 (= specimen of Aliev, 1961a, pl. 1, figs. 3, 4).
pars 1965 *Dictyomitra mutabila* ALIEV. - ALIEV, p. 53, pl. 9, fig. 6; non figs. 7-8.
pars 1965 *Lithocampe lipmanae* sp. n. ALIEV, p. 64, pl. 12, fig. 1-3; figs. 4-6 ?; non fig. 7 (= *T. conica* ?).
1965 *Lithocampe lipmanae* sp. n. *varians* var. n. ALIEV, p. 65, pl. 12, fig. 8.
1969 *Dictyomitra* aff. *striata* LIPMAN. - LOZYNIAK, p. 38, pl. 2, figs. 7-9.
1973b *Dictyomitra* sp. FOREMAN, pl. 10, figs. 6, 8.
pars 1973 *Dictyomitra margarita* ALIEV. - MOORE. p. 829, pl. 13, fig. 6; non fig. 5.
pars ? 1974 *Dictyomitra pseudoscalaris* (TAN SIN HOK). - RENZ, p. 791, pl. 11, fig. 34; pl. 8, fig. 6; non fig. 5 (= *P. pentacolaensis* ?).
non 1975 *Dictyomitra* cf. *pseudoscalaris* TAN SIN HOK. - DUMITRICA, pl. 2, fig. 15 in text. (= *D. multicostata* ?).
1975 *Dictyomitra* sp. *C*. FOREMAN, p. 615, pl. 2G, figs. 15-17.
1977 *Dictyomitra margarita* ALIEV. - MUZAVOR, p. 96, pl. 6, fig. 9.
1977c *Archaeodictyomitra vulgaris* n. sp. PESSAGNO, p. 44, pl. 6, fig. 15.
? 1981 *Dictyomitra formosa* SQUINABOL. - DE WEVER, (in DE WEVER & THIEBAULT), p. 587, pl. 2, fig. 1.
pars 1981 *Archaeodictyomitra sliteri* PESSAGNO. - NAKASEKO & NISHIMURA, p. 146, pl. 6, fig. 9; non pl. 15, fig. 4 (= *D. montisserei*).
1981 *Stichocapsa decora* RÜST. - NAKASEKO & NISHIMURA, p.162, pl. 11, fig. 8; non pl. 17, fig. 9 (= *T. pseudodecora*).
1981 *Archaeodictyomitra* sp. cf. *A. puga* n. sp. SCHAAF, pl. 4, figs. 3, 4.
1981 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - SCHAAF, p. 432, pl. 4, fig. 5; pl. 21, figs. 13a-b.
? 1981 *Stichocapsa decora* RÜST. - SCHAAF, p. 439, pl. 27, figs. 13a-b.
1982 *Archaeodictyomitra* sp. or *Dictyomitra* sp. OKAMURA & UTO, pl. 6, fig. 1.
1982 *Pseudodictyomitra leptocostata* sp. nov. WU & LI, p. 68, pl. 1, figs. 18, 19.
1983 *Dictyomitra momentaria* ALIEV. - ORIGLIA-DEVOS, p. 156, pl. 17, fig. 28.
1983 *Dictyomitra torquata* gr. FOREMAN. - ORIGLIA-DEVOS, p. 158, pl. 17, fig. 26.

1983 ? *Stichocapsa* (?) *rutteni* TAN SIN HOK. - ORIGLIA-DEVOS, p. 154, pl. 17, fig. 29.
1984 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - YAO, pl. 4, figs. 9.
1986 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - OKAMURA & MATSUGI, p. 124, pl. 2, fig. 2.
1986 *Archaeodictyomitra* cf. *pseudoscalaris* (TAN SIN HOK). - OKAMURA & MATSUGI, p. 124, pl. 2, fig. 4.
pars 1986 *Archaeodictyomitra* sp. OKAMURA & MATSUGI, pl. 1, fig. 13; non fig. 7 and pl. 2, figs. 1, 5, 6 (= *T. brouweri*).
non 1986a *Archaeodictyomitra* cf. *pseudoscalaris* (TAN SIN HOK). - SUYARI, pl. 9, fig. 10-11 (= *D. multicostata*).
1986b *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - SUYARI, pl. 2, figs. 3, 4.
1986b *Archaeodictyomitra* ? spp. SUYARI, pl. 2, figs. 5-8.
1986 *Archaeodictyomitra* cf. *pseudoscalaris* (TAN SIN HOK). - TERAOKA & KURIMOTO, pl. 2, fig. 23.
1986 *Archaeodictyomitra* (?) sp. TERAOKA & KURIMOTO, pl. 2, fig. 19.
1986 *Zifondium* (?) *mirabundum* sp. nov. WU, p. 357, pl. 2, figs. 19, 20.
1986 *Zifondium obesum* sp. nov. WU, p. 357, pl. 2, fig. 21.
1986 *Zifondium plenum* sp. nov. WU, p. 357, pl. 3, fig. 12.
1988 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - THUROW, p. 398, pl. 7, fig. 14.
1988 *Archaeodictyomitra* sp. cf. *A. puga* SCHAAF. - THUROW, p. 398, pl. 6 , fig. 18; pl. 7, fig. 15.
1988 *Archaeodictyomitra vulgaris* PESSAGNO. - THUROW, p. 398, pl. 6, fig. 19.
1988 *Archaeodictyomitra* sp. cf. *A. vulgaris* PESSAGNO. - THUROW, p. 398, pl. 7, fig. 13.
1989 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - TUMANDA, p. 36, pl. 3, fig. 12.
1989 *Dictyomitra duodecimcostata* (SQUINABOL). - TUMANDA, p. 36, pl. 3, fig. 5.
non 1990 *Archaeodictyomitra vulgaris* PESSAGNO. - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 4 (= *T. brouweri*).
1990 *Pseudodictyomitra pseudoscalaris* (TAN SIN HOK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, figs. 8, 9.
1992 *Archaeodictyomitra* spp. (slender group) BAUMGARTNER, p. 318, pl. 3, figs. 12, 13, 17-19.
1992 *Archaeodictyomitra pseudoscalaris* (TAN SIN HOK). - OZVOLDOVA & PETERCAKOVA, pl. 4, figs. 1, 7.
non 1992 *Archaeodictyomitra vulgaris* PESSAGNO. - STEIGER, p 88, pl. 26, fig. 1 (= *T. brouweri* ?).
non 1992 *Archaeodictyomitra vulgaris* PESSAGNO. - TAKETANI & KANIE, text-fig. 3. 11 (= *D. montisserei*).
1993 *Archaeodictyomitra vulgaris* PESSAGNO. - TAKAHASHI & LING, p. 97, pl. 2, fig. 3; pl. 3, fig. 3.
1994 *Dictyomitra pseudoscalaris* TAN sensu SCHAAF. - JUD, p. 75, pl. 9, figs. 6-7.

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 9, fig. 7, may be considered as valid type. This specimen has been reported at the locality of Teòlo, in the Colli Euganei, southern Venetian Alps, N Italy.

Photographed material: 257 specimens.

Description: Test conical, moderately to strongly lobulate and characterized by a great variability of the outline. Cephalis sharply pointed apically. Test costate throughout, with well developed constrictions. Six to eight post-abdominal chambers, which increase more rapidly in width than height as added. Costae converging apically, wedging out near junctions of the thorax and the first post-abdominal chambers where constrictions are lacking. Ten to twelve massive costae in lateral view. Costal projection rarely develop. A single transverse row of large circular pores occurs at each stricture, showing up a more lobulate outline.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	235	316	427	287
Maximum width of test	108	154	203	140

Remarks: The study material (more than 250 specimens), shows populations with a considerable variability. There are adequate criterion to recognize the existence of an intraspecific polymorphism for this species. Two apparently morphologically different groups, but in a continuum, show a gradual passage from slightly lobate slender forms with few chambers (pl. 1, figs. 3, 4), to forms with well pronounced constrictions, generally larger in size and composed of more segments (pl. 1, figs. 9-11). This fact has led to the accumulation of an extensive list of synonyms, in base to slightly variation on ornamental feature, possible only to distinguish if we consider the species at the population level. This character is quite variable into the same population, as well as through successive populations.

Comparisons: This species differs from other forms of *Dictyomitra* by having massive costae, a more conical test and chambers lobate in outline. It seems most likely that in early Albian times, *D. communis* gave rise to a double lineage of *Dictyomitra*, characterised by *D. montisserei* and *D. gracilis*. These two lineages, independent since the Albian, show the highest diversification rate during the Cenomanian-early Turonian.

Dictyomitra gracilis (SQUINABOL, 1903b)

Pl. 1, figs. 12-25
Species code 61

	1903b	*Sethoconus gracilis* n. sp. SQUINABOL, p. 131, pl. 10, fig. 13.
pars	1973	*Cyrtocapsa turritica* ALIEV. - MOORE, p. 828, pl. 10, fig. 3; non figs. 1-2 (= *D. pulchra*).
	1977c	*Archaeodictyomitra simplex* n. sp. PESSAGNO, p. 43, pl. 6 figs. 1, 24, 28; pl. 12, fig. 12.
	1981	*Archaeodictyomitra vulgaris* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 585, pl. 1, fig. 14.
pars	1981	*Mita magnifica* PESSAGNO. - SCHAAF, p. 435, pl. 24, figs. 3a-b, 13a-b; non pl. 6, fig. 10 (= *D. brouweri* ?).
	1982	*Mita gracilis* (SQUINABOL). - TAKETANI, p. 60, pl. 5, figs. 2a-b; pl. 12, fig. 3.
pars	1982	*Mitra regina* (CAMPBELL and CLARK). - TAKETANI, p. 60, pl. 5, figs. 3a, b; non pl. 12, fig. 2.
	1983	*Archaeodictyomitra lacrimula* (FOREMAN).- ORIGLIA-DEVOS, p. 134, pl. 16, figs. 7, 8.
pars	1984	*Mita gracilis* (SQUINABOL). - SCHAAF, p. 110-111, text-figs. H (= holotype refigured), 1, 3, 4a-b (= specimen of Schaaf, 1981, pl. 24, figs. 13a-b), 5a-c; non text-fig. 2 (= specimen of Schaaf, 1981, pl. 6, fig. 10).
non	1986	*Mita gracilis* (SQUIN.). - KHUNT *et al.*, pl. 7, fig o (= *D. crassispina*).
	1988	*Mita gracilis* (SQUINABOL). - THUROW, p. 402, pl. 3, fig. 2.
?	1988	*Archaeodictyomitra simplex* PESSAGNO. - TUMANDA, p. 36, pl. 8, fig. 2.
?	1993	*Mita* sp. *A*. BAK, p. 190, pl. 3, fig. 5.
non	1993	*Mita* sp. cf. *M. gracilis* THUROW. - TAKAHASHI & LING, p. 97, pl. 3, fig. 6.

Holotype: Nominal species with specified type. Only one specimen was included in the nominal series illustrated by Squinabol (1903b) on pl. 10, fig. 13. This specimen was reported from the locality of Teòlo (Colli Euganei, southern Venetian Alps, N Italy).

Photographed material: 101 specimens.

Description: Test conical, spindle shaped to globose distally. Cephalis sharply pointed apically with an acute horn. Normally with weakly marked constrictions. Costae on early post-abdominal chambers gradually fade out towards the apical direction. Fourteen to twenty delicate costae visible in lateral view, extending longitudinally throughout the test; distally costae become convergent. Single rows of pores between costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	280	416	492	358
Maximum width of test	120	160	183	133

Remarks: Morphological analysis on modification of the outline based on over 150 specimens, demonstrates the strong variability of shape and size of the test. This species illustrates the gradual transition between conical to inflated-globose forms.

Comparisons: *D. gracilis* differs from its ancestor *D. communis* by having a more elongated shape without strong constrictions, and by more densely-spaced slender costae.

Dictyomitra obesa (SQUINABOL, 1903b)

Pl. 2, figs. 1-6
Species code 257

1903b *Artophormis obesa* n. sp. SQUINABOL, p. 137, pl. 10, fig. 1.

Holotype: The single specimen illustrated by Squinabol (1903b) in pl. 10, fig. 1, from the locality of Teòlo (Colli Euganei, southern Venetian Alps, N Italy) maybe considered a valid holotype.

Photographed material: 10 specimens.

Description: Test spindle shaped to globose. Cephalis conical to rounded apically. Only one important constriction is well marked; this is located between the first two post-abdominal chambers. In this area the inflexion point of the shape changes noticeably, giving the test an asymmetrical appearance. Twelve to fifteen delicate costae visible in lateral view. Single row of small pores between costae. Distal projections well developed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	260	303	353	230
Maximum width of test	130	163	173	140

Remarks: Undoubtedly, these forms are closely related to *D. gracilis; D. obesa* evolved from the latter through a progressive decrease of size. In younger populations of *D. obesa*, a progressive inflation of the cephalic portion of the test is observed; this becomes completely rounded and hidden in terminal forms.

Dictyomitra turritum (SQUINABOL, 1904)

Pl. 2, figs. 7-11
Species code 28

	1904	*Eucyrtidium turritum* n. sp. SQUINABOL, p. 234, pl. 10, fig. 9.
non	1973	*Dictyomitra* ? cf. *Eucyrtidium turritum* SQUINABOL. - MOORE, p. 830, pl. 10, figs. 4-6.
non	1993	*Dictyomitra*? sp. cf. *Eucyrtidium turritum* MOORE. - TAKAHASHI & LING, p. 97, pl. 3, fig. 5 (= *O. turris* ?).

Holotype: The only specimen illustrated by Squinabol (1904) on pl. 10, fig. 9, coming from the Teòlo section (Colli Euganei in the southern Venetian Alps, N Italy) may be considered a valid holotype.

Photographed material: 6 specimens.

Description: Test conical proximally, becoming cylindrical in shape distally. Cephalis small, rounded to sharply pointed, sometimes with small apical horn. Externally test with or without weakly developed constrictions, frequently only one is presented distally on the cylindrical part. An important stricture is located where the inflexion point changes; this is accompanied by a deep elongated ring of pores. Costae converging apically, extend longitudinally throughout the test, but more pronounced in the conical portion; about fourteen to seventeen costae visible in lateral view. Distally, the costae become weaker and in some specimens, costae disappear on the final segments. A single longitudinal row of pores is present between adjacent costae. Costal projections slightly developed.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	450	303	353	230
Maximum width of test	170	163	173	140

Remarks: The appearance of a significant deep stricture, important from a geometrical point of view (true division between proximal conical part and cylindrical distal one), allows me to propose the possible evolution from *D. gracilis* to *D. turritum* and finally to *D. crebrisulcata*. This possible phylogenetic lineage seems justified considering that some specimens of *D. gracilis* have a weak inflexion (more or less pronounced but without a stricture) on the outline of the test. It is likely that *D. turritum* gave rise to *D. crebrisulcata* in early Cenomanian times through the loss of the stricture accompanied by a general narrowing of the test (Fig. 13).

Comparisons: *D. turritum* differs from other species of *Dictyomitra* by having a conical proximal and cylindrical distal portion, separated by a relatively deep stricture.

Dictyomitra crebrisulcata (SQUINABOL, 1904)

Pl. 2, figs. 12-17
Species code 63

1904 *Dictyomitra crebrisulcata* n. sp. SQUINABOL, p.231, pl. 10, fig. 1

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 10, fig. 1, from the locality of Teòlo (Colli Euganei in the southern Venetian Alps, N Italy) may be considered as valid type.

Photographed material: 9 specimens.

Description: Test elongated, slender, for the most part cylindrical. Cephalis small, rounded to sharply pointed. Test outline smooth or rarely with weak constrictions. Densely-spaced slim costae converge apically and extend longitudinally throughout the test; about sixteen to eighteen costae visible in lateral view. A single longitudinal row of small pores is present between adjacent costae.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	375	522	608	425
Maximum width of test	90	101	113	92

Remarks: During the Cenomanian *D. crebrisulcata* co-occurs with *D. turritum* in the material studied. Although the amount of available specimens is not too numerous, transitional forms have not been found. Therefore, these two morphotypes are assigned to two different species.

Comparisons: *D. crebrisulcata* differs from *D. turritum* by having more numerous costae and more elongated slender test, and by lacking a constriction. The costae are more developed distally.

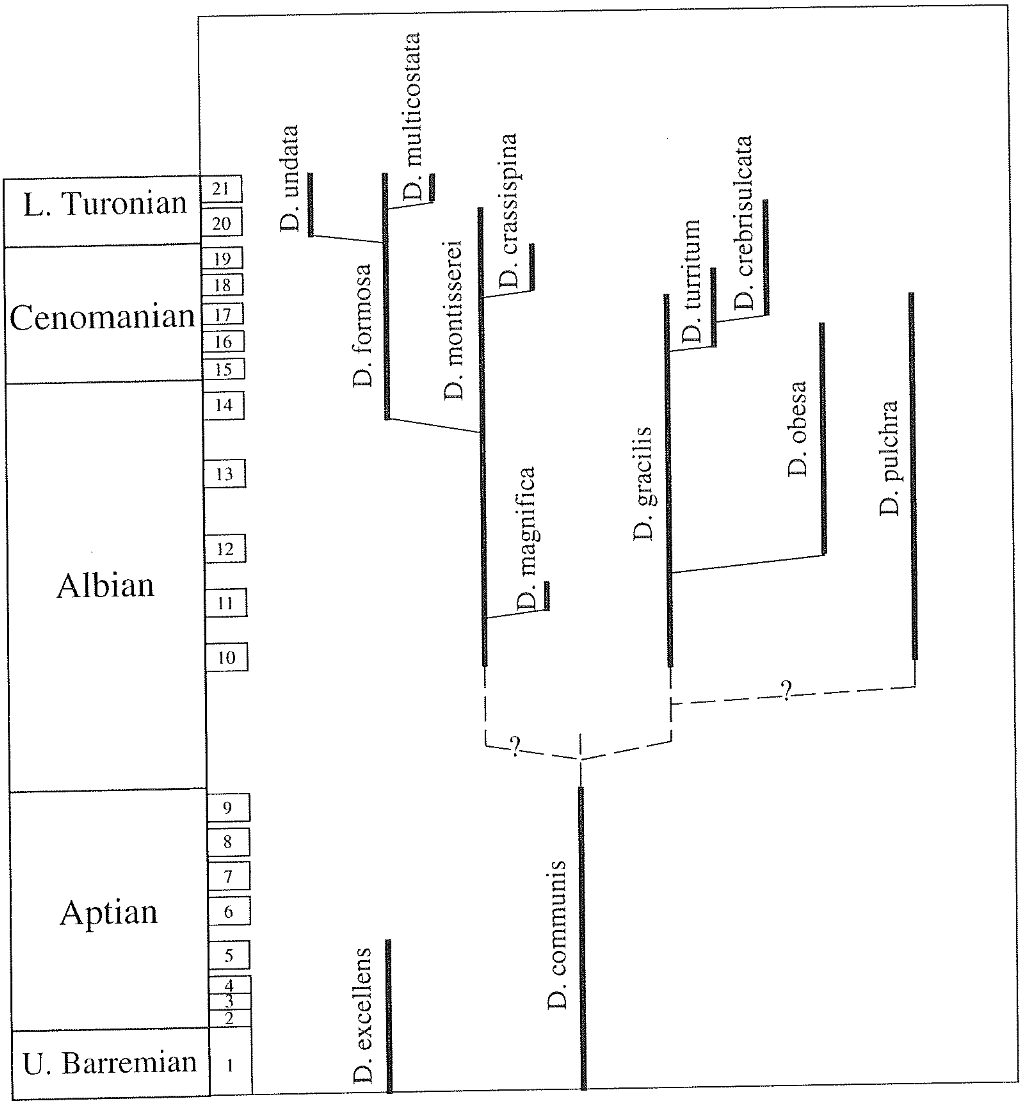

Fig. 13.- Stratigraphic range and possible phyletic relationships of the species of *Dictyomitra.*

Dictyomitra pulchra (SQUINABOL, 1903b)

Pl. 2, figs. 18-24
Species code 3

	1903b	*Sethoconus pulcher* n. sp. SQUINABOL, p. 131, pl. 8, fig. 31.
pars	1973	*Cyrtocapsa turritica* ALIEV. - MOORE, p. 828, pl. 10, figs. 1, 2; non fig. 3 (= *D. gracilis*).
	1988	*Mita* sp. C. THUROW, p. 402, pl. 3, fig. 4.

Holotype: Specified type, illustrated by Squinabol (1903b) on pl. 8, fig. 31, reported from the locality of Teòlo (Colli Euganei in the southern Venetian Alps, N Italy).

Photographed material: 30 specimens.

Description: Large and thick test, costate throughout. Cephalis relatively large, sharply pointed. Twelve to sixteen massive, longitudinal parallel costae in lateral view that strongly converge apically. Test without constrictions, cylindrical outline. A single longitudinal row of rectangular pores between adjacent costae; transverse bars connect adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	612	758	840	653
Maximum width of test	358	233	273	200

Remarks: This form differs from the other species of *Dictyomitra* by having a much larger size. Its origin is not yet clear. This morphology probably evolved in middle Albian time from the *D. communis* - *D. gracilis* lineage. Because *D. pulchra* first appears in the critical interval (early Albian) where radiolarians are very scarce or missing, the possible connection still remains doubtful.

Dictyomitra montisserei (SQUINABOL, 1903b)

Pl. 3, figs. 1-29
Species code 314

1903b *Stichophormis Montis Serei* n. sp. SQUINABOL, p. 137, pl. 8, fig. 38.
1903b *Stichophormis costata* n. sp. SQUINABOL, p. 136, pl. 8, fig. 41.
1904 *Lithocampe euganea* n. sp. SQUINABOL, p. 235, pl. 10, fig, 11.
1904 *Stichocorys pulchra* n. sp. SQUINABOL, p. 229, pl. 9, fig. 9.
1965 *Dictyomitra ornata* ALIEV.- ALIEV, p. 53, pl. 9, figs. 9, 10; pl. 15, fig. 1 ?.
1965 *Lithocampe chalilovi* sp. n. ALIEV, p. 66, pl. 12, figs. 10-13.
1972 *Dictyomitra costata* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 3.
1972 *Dictyomitra crassispina* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 4.
pars 1975 *Dictyomitra* sp. *A*. FOREMAN, p. 615. pl. 1G, fig. 7; pl. 2G, figs. 18, 20 ?; non fig. 19.
1977c *Archaeodictyomitra sliteri* n. sp. PESSAGNO, p. 43, pl. 6, figs. 3, 4, 22, 23, 27.
1977c *Archaeodictyomitra* sp. *A*. PESSAGNO, p. 44, pl. 6, fig. 10.
1977c *Zifondium lassenensis* n. sp. PESSAGNO, p. 47, pl. 7, figs. 4, 20, 22.
1977c *Zifondium* sp. *A*. PESSAGNO, p. 47, pl. 7, fig. 9.
pars 1979 *Dictyomitra squinaboli* (PESSAGNO). - NAKASEKO *et al.* , p.22, pl. 6, figs 6, 10; non fig. 7 (= *T. brouweri* ?).
1980 *Archaeodictyomitra* sp. *A*. OKAMURA, pl. 21, fig. 3.
1980 *Archaeodictyomitra simplex* PESSAGNO. - SCHMIDT-EFFING, p. 246, text-fig. 25.
1981 *Archaeodictyomitra sliteri* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 585, pl. 1, fig. 19.
1981 *Archaeodictyomitra simplex* PESSAGNO. - NAKASEKO & NISHIMURA, p. 146, pl. 6, fig. 8; pl. 15, fig. 3.
pars 1981 *Archaeodictyomitra sliteri* PESSAGNO. - NAKASEKO & NISHIMURA, p. 146, pl. 15, fig. 4; non pl. 6, fig. 9. (= *D. communis*).
1982 *Archaeodictyomitra* sp. *A*. TAKETANI, p. 58, pl. 4, figs. 5a-b.
1982 *Dictyomitra* sp. *A*. TAKETANI, p. 59, pl. 4, figs. 7a-b.
1983 *Archaeodictyomitra squinaboli* PESSAGNO. - ORIGLIA-DEVOS, p. 136, pl. 16, figs. 13, 14.
1983 *Archaeodictyomitra* sp. cf. *squinaboli* PESSAGNO. - ORIGLIA-DEVOS, p. 137, pl. 16, figs. 11, 12.
1983 *Archaeodictyomitra vulgaris* PESSAGNO. - ORIGLIA-DEVOS, p. 138, pl. 16, fig. 19.
1984 *Pseudodictyomitra sagitafera* (ALIEV). - SCHAAF, p. 162-163, text-figs. 1a-b.
1986a *Archaeodictyomitra simplex* PESSAGNO. - SUYARI, pl. 2, fig. 6; pl. 7, fig. 12; pl. 19, fig. 9 ?.
1986a *Archaeodictyomitra* cf. *simplex* PESSAGNO. - SUYARI, pl. 4, fig. 12.
1986a *Archaeodictyomitra sliteri* PESSAGNO. - SUYARI, pl. 2, fig. 7; pl. 4, fig. 13 ?.
1986a *Archaeodictyomitra* aff. *sliteri* PESSAGNO. - SUYARI, pl. 2, fig. 8.
pars 1986a *Archaeodictyomitra vulgaris* PESSAGNO. - SUYARI, pl. 2, fig. 5; pl. 19, fig. 10 ? ; non pl. 4, fig. 14 and pl. 11, fig. 5 ? (= *D. multicostata*).

? 1988 *Archaeodictyomitra lacrimula* (FOREMAN). - THUROW, p. 397, pl. 3, fig. 8.
1988 *Archaeodictyomitra simplex* PESSAGNO. - THUROW, p. 398, pl. 3, fig. 9.
1988 *Archaeodictyomitra* sp. *A*. THUROW, p. 398, pl. 3, fig. 10.
1988 *Archaeodictyomitra simplex* PESSAGNO. - TUMANDA & SASHIDA, text-fig. 4. 6.
1988 *Archaeodictyomitra sliteri* PESSAGNO. - TUMANDA & SASHIDA, text-fig. 4. 7.
1989 *Archaeodictyomitra sliteri* PESSAGNO. - TUMANDA, p. 36, pl. 7, fig. 2 (= specimen figured in Tumanda & Sashida, 1988, text-fig. 4. 7).
pars ? 1989 *Archaeodictyomitra vulgaris* PESSAGNO. - TUMANDA, p. 36, pl. 7, fig. 1; non fig. 4 (= *D. multicostata*).
1989 *Dictyomitra densicostata* PESSAGNO. - TUMANDA, p. 36, pl. 9, fig. 5.
1991 *Archaeodictyomitra sliteri* PESSAGNO. - MARCUCCI *et al.*, text-figs. 3. n, o.
1992 *Archaeodictyomitra* cf. *A. sliteri* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. m.
non 1992 *Archaeodictyomitra sliteri* PESSAGNO. - STEIGER, p. 88, pl. 26, fig. 2.
1992 *Archaeodictyomitra vulgaris* PESSAGNO. - TAKETANI & KANIE, text-fig. 3. 11.
1993 *Archaeodictyomitra sliteri* PESSAGNO. - BAK, p. 187, pl. 2, fig. 12.
1993 *Archaeodictyomitra vulgaris* PESSAGNO. - BAK, p. 187, pl. 2, fig. 13.
1993 *Dictyomitra multicostata* ZITTEL. - BAK, p. 188, pl. 2, fig. 14.
non 1994 *Archaeodictyomitra chalilovi* (ALIEV). - JUD, p. 63, pl. 3, figs. 12-14.

Holotype: It may be considered as valid type, the specimen illustrated by Squinabol (1903b) on pl. 8, fig. 38, coming from the locality of Teòlo (Colli Euganei, southern Venetian Alps, N Italy).

Photographed material: 138 specimens.

Description: Test slender, moderately elongated to slightly lobate; gradually becoming conical to cylindrical toward distal part. Cephalis small and sharply pointed. Test costate throughout, with constrictions weak to well developed. Post-abdominal chambers increasing more rapidly in height than width as added; wide variability. Costae converging apically, some costae wedging out near junctions of the thorax and first post-abdominal chamber; ten to twelve costae in lateral view. Costal projections form a cylindrical terminal tube. In adult specimens, a single transverse row of large circular pores occurs at each stricture. The high development of the costal projections presented at the distal part could play an important role in the growth of the final chambers as the adult stage was achieved.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	315	398	567	292
Maximum width of test	95	113	158	92

Remarks: The abundance and good preservation of the collected material, allowed me a serious study of population variability for this taxon. Thereby, it seems clear that for the most part, the nominal species described and illustrated thus far have been established on the basis of certain more or less pronounced differences in ornamentation. This fact is evident following an analysis of the available material, and leads to the conclusion that ornamentation is not an adequate criterion to establish separate groups. A gradual transition from slender forms almost without strictures (pl. 3, fig. 15) to forms with well marked external segmental divisions (pl. 3, fig. 18) has been observed. The latter specimens have generally a longer test. Successive populations show a gradual increase of size and segmentation through time.

Comparisons: *D. pulchra* differs from its probable ancestor *D. communis* by having more numerous and closely-spaced costae. The test is also more elongated and almost cylindrical. The costae are parallel and narrower.

Dictyomitra magnifica (PESSAGNO, 1977c)

Pl. 4, fig. 1
Species code 17

1977c *Mita magnifica* n. sp. PESSAGNO, p. 44, pl. 6, figs. 2, 5, 11, 13, 17; pl. 7, fig. 24; pl. 12, fig. 11.
pars ? 1979 *Archaeodictyomitra* sp. NAKASEKO et al., pl. 6, fig. 8, non fig. 9 (= *D montisserei*)
pars ? 1981 *Mita magnifica* PESSAGNO. - NAKASEKO & NISHIMURA, p. 155, pl. 6, fig. 12; non fig. 11; non pl. 15, fig. 8.
non 1981 *Mita magnifica* PESSAGNO. - SCHAAF, p. 435, pl. 24, figs. 3a-b and 13a-b (= *D. gracilis*); pl. 6, fig. 10 (= *D. brouweri* ?).
non 1986a *Mita magnifica* PESSAGNO. - SUYARI, pl. 5, fig. 12.

Holotype: Designated by Pessagno (1977c). It is the specimen figured on pl. 6, fig. 2; from NSF 884 (middle-late Albian) Great Valley sequence, northern California.

Photographed material: 2 specimens.

Description: Test conical to spindle shaped with seven to ten chambers. Cephalis sharply pointed apically. Test normally without or slightly marked constrictions. Costae converging apically, extending longitudinally throughout; about ten to twelve costae visible in lateral view. Double rows of pores distally between costae. Cylindrical terminal tube.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	480	470	490	441
Maximum width of test	150	140	154	115

Remarks: This species is poorly represented in my samples. In some well preserved specimens, the costal projections on the final post-abdominal segment becomes an open cylindrical terminal tube. This species is restricted to the middle Albian. Its evolved from *D. montisserei* by increasing the number of rows of pores between adjacent longitudinally costae (frequently adding a second row).

Comparisons: *D. magnifica* differs from all other species of *Dictyomitra* in the middle Cretaceous by possessing a double rows of pores between costae distally, where these may become discontinuous.

Dictyomitra crassispina (SQUINABOL, 1903b)

Pl. 4, figs. 2-7
Species code 47

1903b *Diplostrobus crassispina* n. sp. SQUINABOL, p. 140, pl. 8, fig. 37.
non 1968 *Dictyomitra* cf. *crassispina* (SQUINABOL). - FOREMAN, p. 67, pl. 7, figs. 7a-b.
non 1972 *Dictyomitra crassispina* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 4 (= *D. montisserei*).
non 1973 *Dictyomitra* cf. *D. crassispina* (SQUINABOL). - MOORE, p. 829, pl. 9, fig. 6 (= *P. pentacolaensis*).
non 1978b *Dictyomitra* sp. cf. *Diplostrobus crassispina* SQUINABOL. - FOREMAN, p. 747, pl. 4, fig. 7.
1986 *Mita gracilis* (SQUIN.). - KHUNT *et al.*, pl. 7, fig o.
? 1989 *Archaeodictyomitra simplex* PESSAGNO. - TUMANDA, p. 36, pl. 8, fig. 2.

Holotype: The single specimen illustrated and described by Squinabol (1903b) on pl. 8, fig. 37, may be considered as valid type. This specimen has been reported from the Scaglia Formation at the locality of Teòlo in the Colli Euganei, southern Venetian Alps, N Italy.

Photographed material: 13 specimens.

Description: Test as with genus, spindle-shaped, possessing seven to sixteen chambers. Cephalis small, sharply pointed with short apical horn. Externally test without or with weakly developed constrictions. Post-abdominal chambers increasing more rapidly in height than width. Costae extend longitudinally throughout the test converging apically and distally; about twelve to fourteen costae visible in lateral view. A single longitudinal row of pores between adjacent costae. Long slender conical terminal tube.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	437	504	533	483
Maximum width of test	86	101	104	96

Remarks: With some specimens there appear to be one or two slight constrictions between distal post-abdominal chambers but generally this feature is not apparent. It would be reasonable to assume that this morphological character is probably due to a different ontogenetic stage.

This species is restricted to the middle-late Cenomanian, evolving apparently, from the end members of *D. montisserei* by progressive changes in the outline shape (constriction disappears, trend to more slender spindle-shape) accompanied by a general decrease of size.

Dictyomitra formosa SQUINABOL, 1904

Pl. 4, figs. 8-12
Species code 273

	1904	*Dictyomitra formosa* n. sp. SQUINABOL, p. 232, pl. 10, fig. 4.
pars	1963	*Dictyomitra* (*Dictyomitra*) *multicostata* ZITTEL. - PESSAGNO, p. 206, pl. 4, figs. 1, 3 ; pl. 5, fig. 7; non fig. 3 ; non pl. 1, figs 9, 10.
	1972	*Dictyomitra* sp. *A*. PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 12.
	1973b	*Dictyomitra torquata* FOREMAN. - FOREMAN, pl. 15, fig. 9-11.
non	1973	*Dictyomitra formosa* SQUINABOL. - MOORE, p. 829, pl. 1, figs. 1-4.
	1973	*Dictyomitra sagitafera* ALIEV. - MOORE, p. 829, pl. 8, fig. 9.
	1973	*Dictyomitra veneta* (SQUINABOL). - MOORE, p. 829, pl. 9, fig. 7.
pars	1974	*Dictyomitra torquata* FOREMAN. - RIEDEL & SANFILIPPO, p. 778, pl. 5, figs. 1, 2 and 4 ?; non pl. 5, fig. 3 and pl. 14, fig. 2.
pars	1975	*Dictyomitra duodecimcostata* (SQUINABOL). - FOREMAN, p. 614, pl. 7, fig. 8; pl. 1G, fig. 5 ?; non fig. 6 (= *P. tiara* ?).
	1976	*Dictyomitra formosa* SQUINABOL. - PESSAGNO, p. 51, pl. 8, fig. 10-12.
	1978	*Dictyomitra duodecimcostata duodecimcostata* (SQUINABOL). - FOREMAN, p. 746, pl. 4, figs. 8-9.
pars	1979	*Dictyomitra duodecimcostata* (SQUINABOL). - NAKASEKO *et al.*, p. 22, pl. 8, fig. 16; non fig. 15.
	1979	*Dictyomitra formosa* SQUINABOL. - NAKASEKO *et al.*, p. 22, pl. 8, fig. 17.
non	1981	*Dictyomitra formosa* SQUINABOL. - DE WEVER, (in DE WEVER & THIEBAULT), p. 587, pl. 2, fig. 1 (= *D. communis* ?).
	1981	*Dictyomitra formosa* SQUINABOL. - NAKASEKO & NISHIMURA, p. 150, pl. 8, figs. 7, 8; pl. 16, figs. 4, 11.
non	1981	*Pseudodictyomitra formosa* (SQUINABOL). - SCHAAF, p. 436, pl. 3, fig. 9.
	1982	*Dictyomitra formosa* SQUINABOL. - OKAMURA *et al.* pl. 17, fig. 5.
	1982	*Dictyomitra formosa* SQUINABOL. - TAKETANI, p. 58, pl. 4, figs. 6a-b; pl. 11, fig. 13.

1983 *Dictyomitra formosa* (SQUINABOL). - ORIGLIA-DEVOS, p. 156, pl. 17, fig. 27.
1984 *Dictyomitra formosa* SQUINABOL. - YAO, pl. 5, fig. 22, 23 ?.
1986a *Dictyomitra duodecimcostata* (SQUINABOL). - SUYARI, pl. 8, figs. 1-6; pl. 10, figs. 1, 2; pl. 11, figs. 1, 9; pl. 12, fig. 10 ?; pl. 14, figs. 1, 2, 10, 11; pl. 15, figs. 1-3; pl. 16, figs. 7, 8.
1986 *Dictyomitra formosa* (SQUINABOL). - TERAOKA & KURIMOTO, pl. 7, figs. 6, 7.
? 1986 *Dictyomitra* cf. *formosa* (SQUINABOL). - TERAOKA & KURIMOTO, pl. 7, fig. 8.
1986 *Dictyomitra koslovae* FOREMAN. - TERAOKA & KURIMOTO, pl. 7, figs. 3, 4.
1986 *Dictyomitra* cf. *koslovae* FOREMAN. - TERAOKA & KURIMOTO, pl. 7, fig. 5.
1988 *Dictyomitra* cf. *D. formosa* SQUINABOL. - THUROW, p. 400, pl. 1, fig. 23.
1988 *Dictyomitra formosa* SQUINABOL. - THUROW, p. 400, pl. 1, fig. 25.
non 1988 *P. formosa* VISHNEVSKAYA, pl. 11, fig. 9.
non 1992 *Dictyomitra* cf. *D. formosa* SQUINABOL. - MARCUCCI & GARDIN, text-fig. 4. g.
1992 *Dictyomitra* sp. *A.* NAKASEKO & NISHIMURA. - MARCUCCI & GARDIN, text-fig. 4. h.
? 1994 *Dictyomitra duodecimcostata* (SQUINABOL). - OKAMOTO *et al.*, fig. 4. D, H.
1994 *Dictyomitra* sp. aff. *D. formosa* SQUINABOL. - OKAMOTO *et al.*, fig. 4. G.
1994 *D. formosa* SQUINABOL. - WAKITA & BAMBANG, figs. 5.1-3; figs. 6.1-3.

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 10, fig. 4, may be considered as valid type. This specimen has been reported from Teòlo (Colli Euganei in the southern Venetian Alps, N Italy).

Photographed material: 11 specimens.

Description: Test conical, moderately to markedly lobulate in outline. Cephalis sharply pointed apically. Test costate throughout with well developed deep constrictions. Normally six post-abdominal chambers that increase regularly both in width and height as added. The first post-abdominal segment can be inflated, producing a kind of ledge neck. Costae converging apically where constrictions are lacking. Ten to twelve massive costae in lateral view. Development of costal projections.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	260	268	300	247
Maximum width of test	120	125	147	107

Remarks: *D. formosa* seems to have evolved directly from *D. montisserei* achieving a ribbed outline by development of deep strictures. Transitional forms (in general between the smallest specimens) have been observed in the latest Albian.

Comparisons: *D. formosa* differs from *D. multicostata* by having deep strictures between post-abdominal chambers, more massive costae and a more markedly lobate outline.

Dictyomitra undata SQUINABOL, 1904

Pl. 4, figs. 13-16
Species code 42

1904 *Dictyomitra undata* n. sp. SQUINABOL, p. 231, pl. 10, fig. 2.
1986a *Archaeodictyomitra* sp. *A.* SUYARI, pl. 4, fig. 10.
1986a *Dictyomitra* aff. *koslovae* FOREMAN. - SUYARI, pl. 20 , figs. 5-6 ?, 7, 8.
1986a *Thanarla* cf. *praeveneta* PESSAGNO. - SUYARI, pl. 4, fig. 11.
1994 *Archaeodictyomitra* sp. cf. *A. apiarum* (RÜST). - WAKITA & BAMBANG, fig. 4.11; fig. 5.9.

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 10, fig. 2, may be considered as valid type. This specimen has been reported from the Teòlo section, Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 5 specimens.

Description: Test wide, cylindrical. Cephalis subrounded to pointed apically. Short forms with a proximal part dome-shaped inflated, followed by a slender cylindrical part, strangled at the central portion. Occasionally exhibits slight constrictions. Costate throughout, costae disappearing in an apical direction; eleven to fourteen moderately sharp costae in lateral view, someone are discontinuous. Possible development of costal projection. A stricture present on the last chamber seems to have been formed by the outgrow of the costal projection.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	215	243	277	220
Maximum width of test	87	123	127	120

Remarks: This species is distinguished from *D. excellens* in the pronounced change in contour at the middle part of the test. Furthermore, stratigraphic ranges of these two species are not superposed. It seems probable that these forms evolve from *D. formosa* through the progressively loss of lobulate contour and by acquiring a more inflated proximal part, giving rise to the particular dome-shaped area.

Dictyomitra multicostata ZITTEL, 1876

Pl. 4, figs. 17-19
Species code 43

1876 *Dictyomitra multicostata* ZITTEL, p. 81, pl. 2, figs, 2-4.
1892 *Dictyomitra multicostata* ZITTEL. - RÜST, p. 109, pl. 16, fig. 3.
1900 *Dictyomitra multicostata* ZITTEL. - HOLMES, p. 701 , pl. 38, fig. 3.
1944 *Dictyomitra (Dictyomitroma) multicostata* ZITTEL. - CAMPBELL & CLARK, p. 39, pl. 8, figs. 22-24 ?, 29 ?, 35, ?, 42.
pars 1947 *Dictyomitra multicostata* ZITTEL. - NAUSS, p. 341, pl. 48, fig. 3; non fig. 8.
1956 *Dictyomitra* (*D.*) cf. *D.* (*D.*) multicostata ZITTEL. - BOLIN, p. 295, pl. 39, fig. 19.
non 1963 *Dictyomitra (Dictyomitra) multicostata* ZITTEL. - PESSAGNO, p. 206, pl. 1, figs. 9, 10; pl. 4, figs. 1 and 3 (= *D. formosa*); pl. 5, fig. 3; fig. 7 (= *D. formosa*).
1968 *Dictyomitra lamellicostata* sp. nov. FOREMAN, p. 65, pl. 7, figs. 8a-b.
1968 *Dictyomitra multicostata* ZITTEL. - FOREMAN, pl. 7, figs. 4a-b.
1968 *Dictyomitra* cf. *multicostata* ZITTEL. - FOREMAN, p. 63, pl. 7, figs. 9a-b.
non 1968 *Dictyomitra* aff. *multicostata* ZITTEL. - ZHAMOIDA *et al.*, pl. 3, fig. 3.
non 1971 *Dictyomitra* sp. cf. *D. multicostata* ZITTEL. - FOREMAN, pl. 5, fig. 16 (= *P. lodogaensis* ?).
1971 *Dictyomitra* sp. FOREMAN, p. 1677, pl. 3, fig. 6.
non 1972 *Dictyomitra multicostata* ZITTEL. - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 8, figs. 9, 10.
pars ? 1972 *Dictyomitra striata* LIPMAN. - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 8 , fig. 13; non fig. 12.
non 1972 *Dictyomitra* ex. gr. *multicostata* ZITTEL. - ZHAMOIDA, p. 118, pl. 16, fig. 6; pl. 18, figs. 6, 7.
? 1975 *Dictyomitra* cf. *pseudoscalaris* TAN SIN HOK. - DUMITRICA, text-fig. 2. 15.
1976 *Dictyomitra multicostata* ZITTEL. - PESSAGNO, p. 52, pl. 14, figs. 4-9.
1981 *Dictyomitra multicostata* ZITTEL. - NAKASEKO & NISHIMURA, p. 151, pl. 8, fig. 1; pl. 16, fig. 1.
1982 *Archaeodictyomitra squinaboli* PESSAGNO. - OKAMURA *et al.*, pl. 17, figs. 1, 8.
1982 *Dictyomitra multicostata* ZITTEL. - OKAMURA *et al.*, pl. 17, fig. 3.
1986 *Dictyomitra multicostata* ZITTEL. - KHUNT *et al.*, pl. 7, fig. v.
1986a *Archaeodictyomitra* cf. *pseudoscalaris* (TAN SIN HOK). - SUYARI, pl. 9, figs. 10, 11.

pars	1986a	*Archaeodictyomitra vulgaris* PESSAGNO. - SUYARI, pl. 4, fig. 14 ; pl. 11, fig. 5 ?; non pl. 2, fig. 5 and pl. 19, fig. 10 ? (= *D. montisserei*).
	1986a	*Dictyomitra multicostata* ZITTEL. - SUYARI, pl. 8, figs. 7 ?, 8; pl. 10, fig. 13; pl. 12, fig. 9 ?; pl. 14, fig. 12; pl. 16, fig. 4; pl. 18, figs. 10-11 ?; pl. 21, fig. 4.
	1986a	*Dictyomitra napaensis* PESSAGNO. - SUYARI, pl. 5, fig. 4.
	1986	*Dictyomitra* cf. *multicostata* ZITTEL. - THUROW & KHUNT, text-fig. 9. 10.
?	1989	*Dictyomitra* gr. *doudecimcostata* (SQUINABOL). - GORKA, p. 342, pl. 13, figs. 10-12.
?	1989	*Dictyomitra* gr. *multicostata* ZITTEL. - GORKA, p. 342, pl. 13, figs. 9, 13.
	1989	*Dictyomitra multicostata* ZITTEL. - IWATA & TAJIKA, pl. 2, fig. 5.
pars	1989	*Archaeodictyomitra vulgaris* PESSAGNO. - TUMANDA, p. 36, pl. 7, fig. 4; non fig. 1 (= *D. montisserei* ?).
non	1991	*Dictyomitra* gr. *multicostata* ZITTEL. - GORKA, p. 44, pl. 2, fig. 5 (= *P. lodogaensis*).
	1991	*Dictyomitra multicostata* ZITTEL. - LING, p. 320, pl. 2, figs. 4-5; pl. 3, fig. 5 ?.
non	1993	*Dictyomitra multicostata* ZITTEL. - BAK, p. 188, pl. 2, fig. 14 (= *D. montisserei*).
	1994	*D. multicostata* ZITTEL. - WAKITA & BAMBANG, figs. 7.3-5.

Lectotype: In order to stabilise the chaotic taxonomic status of this nominal species a lectotype was designated by Pessagno (1976). It is the specimen shown on pl. 2, fig. 2, among the Zittel's original illustrations. This lectotype was reported from Upper Cretaceous (Maastrichtian ?) of Vordorf (Germany). Only a minor revision was made by Foreman (1968) on material from Oberg bei Peine (one sample from the Campanian strata), near Zittel's type locality. The specimen figured by Foreman in pl. 7, figs. 4a-b corresponds very well with Zittel's original description.

Photographed material: 7 specimens.

Description: Test slender spindle shaped, conical proximally; more or less lobulate in outline. Cephalis sharply pointed apically. Test costate throughout, with slight constrictions. Six to eight post-abdominal chambers rapidly increasing in length distally. Costae converging apically, wedging out near junctions of the thorax and the first post-abdominal chambers, where constrictions are absent. Nine to ten sharp widely spaced costae in lateral view. Costal projections developed on distalmost chamber.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	218	273	287	267
Maximum width of test	89	118	120	117

Remarks: *D. multicostata* seems to have evolved directly from *D. formosa* in early Turonian time by acquiring a more spindle-shaped test accompanied by a decrease on the degree of the development of strictures.

GENUS **THANARLA** PESSAGNO, 1977c

Type species: *Phormocyrtis veneta* SQUINABOL, 1903b, by original designation.

Diagnosis: Multi-segmented forms possessing relatively wide conical, campanulate, spindle-shaped or globose test with well developed longitudinal costae. Low number of chambers. Cephalis lacking horn. Test with or without constrictions which, when present, do not occur at segmental divisions. No multilobate contour. Pores are disposed in single or double rows between adjacent costae. In general the contour shows an abrupt change between proximal and distal chambers (at different position depending on species). Frequently, a conical proximal portion abruptly contrasts to a broadly inflated distal one. Closely spaced lamellar feet are co-linear with costae, the progressive development of these could obstruct nearly the whole terminal area. The final post-abdominal chamber with or without aperture.

Remarks: Classically there seems to be some accord on the origin of this group from earliest Archaeodictyomitra (Pessagno, 1977c), depending exclusively on morphological affinity between some particular forms of both groups. Early Cretaceous faunas examined from the same localities studied herein (Jud material's), show a very possible connection to specimens having morphologies attributable to the genus *Hsuum* in late Berriasian times, at least for a lineage (*T. pacifica-T. carboneroensis*) and not from *Dictyomitra*, such has been proposed by earliest workers. More data are required to clarify the possible phylogenetic relationship among these groups.

Comparisons: According to Pessagno (1977c), this species differs from *Dictyomitra* by having blade-like terminal feet rather than costal projections on its final post-abdominal chamber. An other particular character, always present among the nominal species, is the abrupt change in contour between proximal and distal parts of the test. From a geometrical point of view, two dissimilar parts could be differentiated: a slight, conical and even relatively small proximal part and a conical, cylindrical or even globose distal one in which the segments are much broader.

Range: Berriasian to latest Cenomanian.

Thanarla pacifica NAKASEKO & NISHIMURA, 1981

Pl. 4, figs. 20-24
Species code 260

pars 1974 *Lithocampe elegantissima* CITA. - RIEDEL & SANFILIPPO, p. 779, pl. 13, figs. 2, 3; non fig. 4 and pl. 6, figs. 8-10 (= *T. pulchra*).
1975 *Lithocampe elegantissima* CITA. - FOREMAN, p. 616, pl. 2G, figs. 3, 4.
1977 *Lithocampe elegantissima* CITA. - MUZAVOR, p. 100, pl. 8, fig. 1.
1979 *Lithocampe elegantissima* FOREMAN. - NAKASEKO *et al.*, p. 23, pl. 4, fig. 2.
1981 *Thanarla pacifica* n. sp. NAKASEKO & NISHIMURA, p. 163, pl. 7, figs. 3 a-b, 6 (= specimen of Nakaseko *et al.*, 1979, pl. 4, fig. 2), 9; pl. 15, fig. 14.
1981 *Thanarla pulchra* (SQUINABOL). - SCHAAF, p. 439, pl. 4, fig. 10, pl. 19, figs. 7a-b.
? 1982 *Eucyrtidium* (?) *ptyctum* RIEDEL & SANFILIPPO. - OKAMURA & UTO, pl. 6, fig. 18.
? 1982 *Thanarla* cf. *pulchra* (SQUINABOL). - OKAMURA & UTO, pl. 5, fig. 6.
1983 *Eucyrtidium ptyctum* RIEDEL et SANFILIPPO. - ORIGLIA-DEVOS, p. 159, pl. 17, figs. 23, 24.
1984b *Thanarla pulchra* (SQUINABOL). - BAUMGARTNER, p. 788, pl. 9, fig. 15.
pars 1984 *Thanarla pulchra* (SQUINABOL). - SCHAAF, p. 132-133, text-figs. 1, 5a-b, 7a-b; non text-fig. H (= *T. pulchra*, holotype refigured), 2, 3, 4a-b and 6 (= *T. brouweri*).
1984 *Thanarla* sp. aff. *T. pulchra* (SQUINABOL). - YAO, pl. 4, fig. 10.
1986 *Thanarla pulchra* (SQUINABOL). - OKAMURA & MATSUGI, p. 124, pl. 2, figs. 14, 15.
pars 1986b *Thanarla pulchra* (SQUINABOL). - SUYARI, pl. 2, fig. 1; non fig. 2 (= *T. brouweri*).
? 1988 *Thanarla pulchra* (SQINABOL). - THUROW, p. 407, pl. 7, fig. 9.
? 1988 *Thanarla elegantissima* VISHNEVSKAYA, pl. 6, fig. 4.
1989 *Thanarla* cf. *pulchra* (SQUINABOL). - IWATA & TAJIKA, pl. 4, fig. 3.
1989 *Thanarla pulchra* (SQUINABOL). - TUMANDA, p. 40, pl. 3, fig. 17.
1990 *Thanarla pulchra* (SQUINABOL). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 3.
1992 *Thanarla pulchra* (SQUINABOL). - TAKETANI & KANIE, text-fig. 5. 11, 12.
pars ? 1994 *Thanarla elegantissima* (CITA) sensu SANFILIPPO & RIEDEL. - JUD, p. 113, pl. 23, fig. 3, non fig. 4.
1994 *Thanarla pulchra* (SQUINABOL) sensu SANFILIPPO & RIEDEL. - JUD, p. 114 , pl. 23, figs. 6-7.

Lectotype: In the absence of holotype, I designate as lectotype the specimen from the type-series illustrated by Nakaseko & Nishimura (1981) on pl. 7, fig. 6; this specimen has been reported from MITK-1509, type-locality of the *Eucyrtis tenuis* assemblage of these authors, possible Hauterivian in age (Shimanto Group, SW Japan).

Photographed material: 24 specimens.

Description: Test campanulate. Proximal part short, narrow, conical; distal part rounded to cylindrical. Costate throughout; first three conical segments properly costate, converging apically. A deep stricture is situated in the area where the outline abruptly changes. Distal part apparently constituted only by one post-abdominal chamber without constrictions. This segment presents a cylindroid outline, more wide than high. Diametrically this cylinder is wider in the middle than in the bounded parallel planes. In consequence the contour is like a barrel with slightly bulging sides. Seven to eight widely spaced massive costae in lateral view. Final post-abdominal chamber with aperture. Terminal lamellar feet well developed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	191	201	213	180
Maximum width of test	142	149	160	133

Remarks: Early Cretaceous specimens, erroneously assigned to *T. pulchra,* could represent weaker constricted variants of *T. pacifica*. However, the large amount of specimens studied here demonstrates this as a continuous variation. The stratigraphic record shows a strongly morphological convergence between *T. pacifica* and *T. pulchra*, although such resemblance must be regarded as a phenomenon of heterochronous homoeomorphy.

Comparisons: *T. pacifica* is distinguished from *T. pulchra* by its conspicuous stricture and by having a more bulging last post-abdominal chamber. *T. pacifica* has similar ornamentation on the post-abdominal segment but costae are more widely spaced.

Thanarla carboneroensis nov. sp.

Pl. 4, figs. 25-29
Species code 29

Holotype: Specimen 9736 (pl. 4, fig. 25). This specimen coming from locality no. Ca1-9.70, late Barremian of Carbonero Formation, Betic Cordillera (Valdepeñas, Province of Jaén, S. Spain).

Derivatio nominis: Named for the type-locality of the Carbonero Formation where this species has been reported.

Photographed material: 21 specimens.

Description: Test campanulate costate throughout. Proximal part very short, conical, narrow apically and composed of three small segments costate throughout, weakly constricted. A deep and important stricture is situated in the area where the outline changes, using as major division between proximal and distal part. Rounded to cylindrical distal part, formed by a single segment with very thick costae, widely spaced. Double rows of rounded pores situated in deep grooves between adjacent costae. This segment is cylindrical in outline with slightly bulging sides. Constrictions are apparently lacking. Seven to eight widely spaced massive costae in lateral view. Little nodes can be present along the costae of the last chamber. Final post-abdominal chamber with aperture and terminal lamellar feet where costae are developing.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	300	300	342	267
Maximum width of test	217	211	225	200

Remarks: *T. carboneroensis* differs from all other congeneric species by early acquisition of double rows of pores in post-abdominal segment. This character is almost exclusively represented in the Betic specimens (only very few specimens have been found in Italian sections). *T. carboneroensis* is tentatively regarded as an offshoot from *T. pacifica* during Barremian time as far is known at present. Further research on Early Cretaceous *Thanarla* is required to explain how and when, the deep grooves are acquired, so leading to better support for proposed phylogenetic relationships.

Comparisons: Compared with its potential ancestor *T. pacifica*, which occurs in the same interval (Barremian-early Aptian), *T. carboneroensis* is more inflated in width, with more massive costae and has a double row of pores located in the grooves, between adjacent costae at latter segments.

Thanarla brouweri (TAN, 1927)

Pl. 5, figs. 1-12
Species code 259

1927 *Eucyrtidium Brouweri* spec. nov. typ. TAN, p. 58, pl. 11, figs. 89a-b.
1927 *Eucyrtidium Brouweri* spec. nov. var. α TAN, p. 59, pl. 11, fig. 93.
non 1927 *Eucyrtidium Brouweri* spec. nov. var. β TAN, p. 59, pl. 11, fig. 92 (= *T. conica*).
1927 *Eucyrtidium Brouweri* spec. nov. var. δ TAN, p. 58, pl. 11, fig. 90.
1927 *Eucyrtidium Brouweri* spec. nov. var. γ TAN, p. 57, pl. 11, fig. 91.
1965 *Cornutanna conica* sp. n. ALIEV, p. 34, pl. 6, fig. 1.
1965 *Dictyomitra momentaria* ALIEV. - ALIEV, p. 54, pl. 10, fig. 1.
1965 *Lithocampe strelkovi* sp. n. ALIEV, p. 66, pl. 12, fig. 9; pl. 15, fig. 7 ?.
1969 *Cornutanna* aff. *conica* ALIEV. - LOZYNIAK, p. 35, pl. 2, figs. 1, 2.
1969 *Dictyomitra* sp. *I.* LOZYNIAK, pl. 2, fig. 10.
pars 1971 *Dictyomitra* sp. cf. *Eucyrtidium brouweri* TAN SIN HOK. - FOREMAN, p. 1682, pl. 5, fig. 15; non fig. 14 (= *T. conica*).
1973b *Dictyomitra* sp. FOREMAN, pl. 10, fig. 7.
pars 1973 *Cornutanna conica* ALIEV. - MOORE, p. 830, pl. 14, fig. 1; non fig. 2 (= *T. lacrimula*).
1973 *Dictyomitra* sp. cf. *Eucyrtidium brouweri* TAN SIN HOK. - MOORE, p. 830, pl. 14, figs. 7-9.
1974 *Sethamphora pulchra* SQUINABOL. - RIEDEL & SANFILIPPO, pl. 13, fig. 5.
1974 *Dictyomitra brouweri* var. α (TAN SIN HOK). - RENZ, p. 790, pl. 8, figs. 14-16; pl. 11, fig. 26.
1974 *Dictyomitra brouweri* var. γ (TAN SIN HOK). - RENZ, p. 790, pl. 8, figs. 9-13; pl. 11, fig. 27.
1977c *Thanarla conica* (ALIEV). - PESSAGNO, p. 45, pl. 7, figs. 1, 13, 15.
1977c *Thanarla* sp. aff. *T. conica* (ALIEV). - PESSAGNO, p. 46, pl. 7, figs. 8, 14.
1979 *Dictyomitra* sp. NAKASEKO *et al.*, pl. 6, fig. 5.
1980 *Thanarla conica* (ALIEV). - OKAMURA, pl. 20, fig. 8.
1981 *Archaeodictyomitra lacrimula* (FOREMAN). - DE WEVER (in DE WEVER & THIEBAULT), p. 585, pl. 1, fig. 6.
1981 *Thanarla praeveneta* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 593, pl. 1, fig. 7.
1981 *Thanarla broweri* (TAN SIN HOK). - NAKASEKO & NISHIMURA, p. 162, pl. 6, fig. 14; pl. 7, figs. 1, 2; pl. 15, fig. 13.
1981 *Archaeodictyomitra brouweri* var. α (TAN SIN HOK). - SCHAAF, p. 432, pl. 19, figs. 3a-b.
1981 *Archaeodictyomitra vulgaris* PESSAGNO. - SCHAAF, p. 432, pl. 4, fig. 2.
1981 *Archaeodictyomitra* sp. SCHAAF, pl. 4, fig. 1.
1982 *Thanarla-Archaeodictyomitra* groups. OKAMURA & UTO, pl. 1, figs. 1-24; pl. 8, figs. 4a-b, 5a-b.
1982 *Thanarla conica* (ALIEV). - TAKETANI, p. 59, pl. 4, figs. 11a-c.
1982 *Thanarla* aff. *conica* (ALIEV). - WU & LI, p. 68, pl. 1, fig. 17.
1983 *Archaeodictyomitra patricki* KOCHER. - ORIGLIA-DEVOS, p. 134, pl. 16, figs. 9, 10.
1983 *Archaeodictyomitra* sp. cf. *vulgaris* PESSAGNO. - ORIGLIA-DEVOS, p. 139, pl. 16, figs. 20, 21.
1983 *Archaeodictyomitra* sp. *1.* ORIGLIA-DEVOS, p. 139, pl. 16, fig. 22.
1983 *Archaeodictyomitra* sp. 2. ORIGLIA-DEVOS, p. 140, pl. 16, fig. 23.
1983 *Thanarla conica* (ALIEV). - ORIGLIA-DEVOS, p. 143, pl. 17, figs. 4, 5.
pars 1983 *Thanarla pulchra* (SQUINABOL). - ORIGLIA-DEVOS, p. 145, pl. 17, fig. 9; non fig. 8 (= *Thanarla* sp.).

pars 1984 *Thanarla pulchra* (SQUINABOL). - SCHAAF, p. 132-133, text-figs. 2, 3, 4a-b, 6; non text-figs. H (= *T. pulchra* , holotype refigured), 1, 5a-b and 7a-b (= *T. pacifica*).
1984 *Archaeodictyomitra brouweri* (TAN SIN HOK). - YAO, pl. 4, figs. 7-8.
pars 1984 *Archaeodictyomitra* sp. aff. *A. praeveneta* (PESSAGNO). - YAO, pl. 5, fig. 7; non fig. 8 (= *T. veneta* ?).
1984 *Archaeodictyomitra* sp. cf. *A. vulgaris* PESSAGNO. - YAO, pl. 4, fig. 6.
1984 *Thanarla conica* (ALIEV). - YAO, pl. 4, fig. 11.
1985 *Archaeodictyomitra brouqeri* var. α (TAN SIN HOK). - LI & WU, pl. 2, fig. 7.
1986 *Thanarla conica* (ALIEV). - AITA & OKADA, pl. 1, fig. 12.
1986 *Archaeodictyomitra vulgaris* PESSAGNO. - OKAMURA & MATSUGI, p. 124, pl. 2, figs. 7, 8, 12.
pars 1986 *Archaeodictyomitra* sp. OKAMURA & MATSUGI, pl. 2, figs. 1, 5, 6; pl. 1, fig. 7; non fig. 13 (= *D. communis*).
1986 *Thanarla conica* (ALIEV). - OKAMURA & MATSUGI, p. 124, pl. 2, figs. 3, 9.
1986a *Thanarla conica* (ALIEV). - SUYARI, pl. 7, fig. 11.
1986a *Thanarla* aff. *conica* (ALIEV). - SUYARI, pl. 2, fig. 10.
pars 1986a *Thanarla praeveneta* PESSAGNO. - SUYARI, pl. 7, figs. 9, 10; non pl. 1, figs. 5-8 (= *T. veneta*).
1986a *Thanarla* aff. *praeveneta* PESSAGNO. - SUYARI, pl. 1, fig. 12.
1986a *Thenarla conica* (ALIEV). - SUYARI, pl. 1, fig. 11.
1986b *Thanarla conica* (ALIEV). - SUYARI, pl. 2, fig. 10.
pars 1986b *Thanarla pulchra* (SQUINABOL). - SUYARI, pl. 2, fig. 2; non fig. 1 (= *T. pacifica*).
1986b *Thanarla* sp. SUYARI, pl. 4, fig. 4.
1986 *Archaeodictyomitra brouweri* (TAN SIN HOK). - TERAOKA & KURIMOTO, pl. 1, figs. 12-14; pl. 2, figs. 5-9.
pars 1986 *Archaeodictyomitra* sp. TERAOKA & KURIMOTO, pl. 1, figs. 16-19; non figs 15, 21, 22.
1986 *Thanarla* cf. *conica* (ALIEV). - TERAOKA & KURIMOTO, pl. 1, figs. 6-10.
1988 *Archaeodictyomitra* (?) sp. B. THUROW, p. 398, pl. 7, fig. 10.
1988 *Thanarla conica* (ALIEV). - THUROW, p. 406, pl. 6, fig. 20; pl. 7, figs. 5, 11.
1988 *Thanarla* (?) sp. *A*. aff. *T. conica* (ALIEV). - THUROW, p. 406, pl. 7, figs. 7, 8.
1988 *Thanarla* sp. *B*. aff. *T. conica* (ALIEV). - THUROW, p. 406, pl. 7, fig. 12.
1988 *Thanarla* sp. *C*. THUROW, p. 407, pl. 4, fig. 12; pl. 7, fig. 6 ?.
non 1989 *Thanarla conica* (ALIEV). - GORKA & GEROCH, p. 190, pl. 2, fig. 2 (= *T. pulchra*).
1989 *Thanarla conica* (ALIEV). - KATO & IWATA, pl. 2, figs. 1, 2; pl. 4, fig. 7.
1989 *Thanarla conica* (ALIEV). - TUMANDA, p. 40, pl. 3, fig. 16; pl. 10, fig. 10.
1990 *Archaeodictyomitra vulgaris* PESSAGNO. - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 4.
1990 *Thanarla conica* (ALIEV). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 1.
1990 *Thanarla elegantissima* (CITA). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 2.
1990 *Thanarla conica* (ALIEV). - OZVOLDOVA, p. 143, pl. 4, fig. 2.
1990 *Thanarla* aff. conica (ALIEV). - OZVOLDOVA, p. 144, pl. 4, figs. 3, 4, 6.
1990 *Thanarla* sp. A. OZVOLDOVA, p. 144, pl. 4, fig. 1.
1990 *Thanarla* sp. B. OZVOLDOVA, p. 144, pl. 4, fig. 5.
1992 *Archaeodictyomitra brouweri* alpha (TAN SIN HOK). - BAUMGARTNER, p. 318, pl. 3, figs. 14, 15.
1992 *Archaeodictyomitra brouweri* s. l. (TAN SIN HOK). - BAUMGARTNER, p. 318, pl. 3, figs. 9, 10.
1992 *Archaeodictyomitra brouweri* typica (TAN SIN HOK). - BAUMGARTNER, p. 318, pl. 3, fig. 11.
1992 *Thanarla conica* (ALIEV). - OZVOLDOVA & PETERCAKOVA, pl. 4, figs. 8, 10.
? 1992 *Archaeodictyomitra vulgaris* PESSAGNO. - STEIGER, p 88, pl. 26, fig. 1.
1992 *Thanarla conica* (ALIEV). - STEIGER, p. 89, pl. 26, figs. 3-6.
1992 *Thanarla* sp. STEIGER, pl. 26, fig. 8.
1993 *Thanarla* sp. cf. *T. conica* (ALIEV). - BAK, p. 190, pl. 3, fig. 2.

Lectotype: This species was described syntypically by Tan (1927). In order to stabilize the taxonomy and provide the basis for a standardized concept of this species, a lectotype has been selected. I designate the smallest form of the only two specimens labelled as typicus, among the numerous specimens originally included into the type-series. The type-specimen was illustrated by Tan (op. cit.) on pl. 11, fig. 89a; it comes from the Early Cretaceous (without more precision) of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 237 specimens.

Description: Test conical, campanulate, slightly constricted. Costate throughout; well developed longitudinal costae converging apically. Distally too weakly lobate contour. Pores are situated in single rows between adjacent costae. Variable number of costae, eight to fourteen visible in lateral view. Closely spaced lamellar feet are collinear with costae. In youngest specimens progressive development of feet can partially obstruct the terminal part. An aperture is always presents.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	189	228	300	180
Maximum width of test	126	140	167	113

Remarks: *T. brouweri* may be one of the most illustrated species in recent years among the Cretaceous Radiolaria. It shows a wide range of variation which sometimes difficult to express verbally because these changes are only restricted to weak variations on the angle of the conical outline. *T. brouweri* constitutes an early stock for this group, giving rise to different lineages of *Thanarla* through the Cretaceous.

Thanarla lacrimula (FOREMAN, 1973b)

Pl. 5, figs. 13-16
Species code 79

1973b *Dictyomitra* (?) *lacrimula* new species FOREMAN, p. 263, pl. 10, fig. 11.
? 1973b *Dictyomitra* sp. FOREMAN, pl. 6, fig. 2.
pars 1973 *Cornutanna conica* ALIEV. - MOORE, p. 830, pl. 14, fig. 2; non fig. 1 (= *T. brouweri*).
1975 *Dictyomitra* (?) *lacrimula* FOREMAN. - FOREMAN, p. 614, pl. 2G, figs. 5, 6; pl. 6, fig. 1.
1979 *Dictyomitra* (?) *lacrimula* FOREMAN. - NAKASEKO *et al.*, p. 22, pl. 4, fig. 1.
non 1981 *Archaeodictyomitra lacrimula* (FOREMAN). - DE WEVER (in DE WEVER & THIEBAULT), p. 585, pl. 1, fig. 6 (= *T. brouweri*).
1981 *Archaeodictyomitra lacrimula* (FOREMAN). - NAKASEKO & NISHIMURA, p. 146, pl. 6, figs. 5, 6; pl. 15, fig. 10.
1981 *Archaeodictyomitra lacrimula* (FOREMAN). - SCHAAF, p. 432, pl. 22, figs. 3a-b.
1982 *Archaeodictyomitra lacrimula* (FOREMAN). - OKAMURA & UTO, pl. 7, fig. 4.
non 1983 *Archaeodictyomitra lacrimula* (FOREMAN).- ORIGLIA-DEVOS, p. 134, pl. 16, figs. 7, 8 (= *D. gracilis*).
1985 *Archaeodictyomitra lacrimula* SANFILIPPO & RIEDEL, p. 598, text-figs. 7. 3a-b, 7. 3c (= specimen of Okamura & Uto, 1982, pl. 7, fig. 4).
1986 *Archaeodictyomitra lacrimura* (FOREMAN). - OKAMURA & MATSUGI, p. 123, pl. 1, figs. 1, 2.
non 1988 *Archaeodictyomitra lacrimula* (FOREMAN). - THUROW, p. 397, pl. 3, fig. 8 (= *D. montisserei*).
1989 *Archaeodictyomitra* cf. *lacrimula* (FOREMAN). - TERAOKA & KURIMOTO, pl. 4, fig. 2.
1989 *Archaeodictyomitra lacrimula* (FOREMAN). - TUMANDA, p. 36, pl. 3, fig. 19.
1990 *Archaeodictyomitra lacrimula* (FOREMAN). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 10.
1991 *Archaeodictyomitra lacrimula* (FOREMAN). - AGUADO *et al.*, text-fig. 7. 1.
1992 *Archaeodictyomitra lacrimula* (FOREMAN). - TAKETANI & KANIE, text-fig. 3. 10.
1993 *Archaeodictyomitra lacrimula* (FOREMAN). - AGUADO *et al.*, pl. 3, fig. 6.
1994 *Archaeodictyomitra lacrimula* (FOREMAN). - JUD, p. 63, pl. 3, fig. 17; pl. 4, fig. 1.

Holotype: The specimen illustrated on pl. 10, fig. 11 is designated as type by Foreman (1973b). It is reported from the *Acaeniotyle tribulosa* zone of Foreman (early Hauterivian, cf. Foreman op. cit.) and presumably belongs to level 194-5-CC (Leg 20, NW Pacific Ocean). The fossil assemblage from this level seems to be younger, suggesting its range as Barremian.

Photographed material: 25 specimens.

Description: Test amphiconical, with an abrupt change in contour between the approximately equal upper and lower conical parts. Test costate throughout with well developed longitudinal costae converging apical and distally.

Segments are not expressed externally (no lobate outline). Pores are situated in single rows between adjacent costae; nine to eleven costae in lateral view. Lamellar feet obstructing in whole the terminal part. Test showing distally a very narrow aperture.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	277	272	293	253
Maximum width of test	112	128	138	120

Remarks: The particular morphology of the test suggests that the potential ancestor may have had a tendency to the biconical growth at mature stages. This character can be also remarked with some specimens of *T. brouweri*.

Comparisons: *A. lacrimula* differs from the other congeneric species in having a well defined inverted conical terminal segment.

Thanarla pseudodecora (TAN, 1927)

Pl. 5, figs. 17-22
Species code 246

1927 *Stichocapsa pseudodecora* spec. nov. TAN, p. 72, pl. 16, fig. 137.
1981 *Stichocapsa decora* RÜST. - NAKASEKO & NISHIMURA, p. 162, pl. 17, fig. 9; non pl. 11, fig. 8 (= *D. communis*).
1981 *Stichocapsa* sp. cf. *S. decora* RÜST. - SCHAAF, p. 439, pl. 27, figs. 12a-b.
non 1981 *Stichocapsa pseudodecora* TAN SIN HOK. - SCHAAF, p. 439, pl. 27, figs. 7a-b.
1988 *Mita* (?) sp. E. THUROW, p. 402, pl. 6, fig. 22.

Holotype: The specimen figured by Tan (1927). on pl. 16, fig. 137, may be considered as valid holotype. This specimen comes from the Early Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 14 specimens.

Description: Test small, spindle-shaped, with four or five chambers. An abrupt change in contour is located more or less towards the distal part, where the last chamber becomes globose. Test with well developed aligned costae throughout, converging apically. Pores are situated in single rows between adjacent costae; eight to nine costae visible in lateral view. An inflexion on the growth direction of the last post-abdominal chamber affects seriously the shelf-outline, bringing about a convergence of the costae downwards (some costae can be discontinuous). Progressive growth of lamellar feet close in the terminal part. Only a small aperture appears distally.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	205	206	247	173
Maximum width of test	111	119	140	75

Remarks: This species shows through its range, a strong decrease of test size. This change affects principally the proximal segments, which become more rapidly smaller than the last one. The distal chamber remains apparently without considerable changes.

T. pseudodecora seems to have evolved from *T. lacrimula* by a transformation of the original conical distal part, leading to a globose stage. Accompanying this change, the originally amphiconical test becomes lobate by a weak development of constrictions at inter-segmental levels.

Thanarla conica (SQUINABOL, 1903b)

Pl. 5, figs. 23-27

Species code 275

	1903b	*Carpocanistrum conicum* n. sp. SQUINABOL, p. 128, pl. 8, fig. 36.
	1927	*Eucyrtidium Brouweri* spec. nov. var. β TAN, p. 59, pl. 11, fig. 92.
pars ?	1965	*Lithocampe lipmanae* sp. n. ALIEV, p. 64, pl. 12, fig. 7 ?; non fig. 1-3 (= *D. communis*); non figs. 4-6.
pars	1971	*Dictyomitra* sp. cf. *Eucyrtidium brouweri* TAN SIN HOK. - FOREMAN, p. 1682, pl. 5, fig. 14; non fig. 15 (= *T. brouweri*).
pars	1973	*Dictyomitra* sp. *B*. MOORE, p. 830, pl. 14, fig. 6; non fig. 5 (= *T. brouweri* ?).
	1977c	*Mita* sp. *B* PESSAGNO, p. 45, pl. 7, fig. 6.
	1978b	*Hsuum* spp. FOREMAN, p. 747, pl. 2, fig. 7.
	1983	*Mita* sp. *B*. ORIGLIA-DEVOS, p. 142, pl. 17, fig. 3.
pars	1986a	*Archaeodictyomitra squinaboli* PESSAGNO. - SUYARI, pl. 2, fig. 3; non figs 1, 2, 4; non pl. 4, figs 3, 4 (= *Dictyomitra* sp.); non pl. 7, figs. 1-8; non pl. 10, figs. 3, 4, non pl. 11, figs. 6, 7; non pl. 13, figs. 3, 4; non pl. 15, fig. 7; non pl. 17, figs. 1-4.
	1988	*Mita* sp. *A*. THUROW, p. 402, pl. 3, fig. 1.
?	1988	*Archaeodictyomitra squinaboli* PESSAGNO. - TUMANDA & SASHIDA, text-fig. 4. 4.
?	1989	*Archaeodictyomitra squinaboli* PESSAGNO. - TUMANDA, p. 36, pl. 7, fig. 3 (= specimen figured in Tumanda & Sashida, 1988, text-fig. 4. 4).

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 36 may be considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 15 specimens.

Description: Test as with the genus, very small, almost cylindrical, initial chambers dome-shaped. Very small cephalis somewhat rounded apically. Costate throughout; well developed parallel costae converging and wedging out apically. Pores are situated in single rows between adjacent costae; eight to nine relatively wide costae in lateral view. Possesses sharp blade-like terminal feet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	148	178	208	108
Maximum width of test	69	86	92	67

Remarks: The few available specimens (fifteen) from the middle Aptian-middle Albian indicate that the morphology of *T. conica* ranges does not change significantly throughout its range. This species seems to have evolved from *T. brouweri*, by successive increase in width of the proximal segments, rising rapidly to a cylindrical stage. We have to be careful with this name, which does not correspond to the classical *Cornutanna conica* ALIEV, herein synonymized in *T. brouweri*.

Comparisons: Test shape and size conform to those of *Thanarla*. Distinguished from all other congeneric species by having a cylindrical test and smaller size.

Thanarla pulchra (SQUINABOL, 1904)

Pl. 5, figs. 28-33
Species code 31

1904 *Sethamphora pulchra* n. sp. SQUINABOL, p. 213, pl. 5, fig. 8.
1964 *Lithocape elegantissima* n. sp. CITA, p. 148, pl. 12, figs. 2, 3.
pars 1973 *Sethamphora pulchra* SQUINABOL. - MOORE, p. 826, pl. 3, figs. 4, 5; non fig. 6 (*T. pacifica* ?).
pars 1974 *Lithocampe elegantissima* CITA. - RIEDEL & SANFILIPPO, p. 779, pl. 6, figs. 8-10; pl. 13, fig. 4 (= specimen of Riedel & Sanfilippo, 1974, pl. 6, fig. 9); non figs. 2, 3 (= *T. pacifica*).
non 1974 *Sethamphora pulchra* SQUINABOL. - RIEDEL & SANFILIPPO, pl. 13, fig. 5 (= *T. brouweri*).
1975 *Dictyomitra pulchra* (SQUINABOL). - DUMITRICA, text-fig. 2. 7.
1976 *Lithocampe* (?) *elegantissima* CITA. - PESSAGNO, p. 55, pl. 3, fig. 6.
non 1977 *Lithocampe elegantissima* CITA. - MUZAVOR, p. 100, pl. 8, fig. 1 (= *T. pacifica* ?).
1977c *Thanarla elegantissima* (CITA). - PESSAGNO, p. 46, pl. 7, fig. 10 (= specimen of Pessagno, 1976, p. 55, pl. 3, fig. 6).
1977c *Thanarla pulchra* (SQUINABOL). - PESSAGNO, p. 46, pl. 7, figs. 7, 21, 26.
1979 *Lithocampe elegantissima* CITA. - NAKASEKO *et al.*, p. 23, pl. 7, fig. 1.
1980 *Thanarla elegantissima* (CITA), - OKAMURA, pl. 21, fig. 1.
1980 *Thanarla elegantissima* (CITA). - SCHMIDT-EFFING, p. 246, text-figs. 2, 21, 22.
1981 *Thanarla pulchra* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 163, pl. 7, figs. 4, 5, 7, 8; pl. 15, figs. 11, 12.
non 1981 *Thanarla pulchra* (SQUINABOL). - SCHAAF, p. 439, pl. 4, fig. 10 and pl. 19, figs. 7a-b (= *T. pacifica*).
non 1982 *Thanarla* cf. *pulchra* (SQUINABOL). - OKAMURA & UTO, pl. 5, fig. 6 (= *T. pacifica* ?).
1982 *Thanarla elegantissima* (CITA). - TAKETANI, p. 59, pl. 4, fig. 12; pl. 11, figs. 17, 18.
1982 *Thanarla pulchra* (SQUINABOL). - TAKETANI, p. 59, pl. 11, fig. 19.
1983 *Thanarla elegantissima* (CITA). - ORIGLIA-DEVOS, p. 144, pl. 17, figs. 6, 7.
non 1983 *Thanarla pulchra* (SQUINABOL). - ORIGLIA-DEVOS, p. 145, pl. 17, fig. 8 (= *Thanarla* sp.); fig. 9 (= *T. brouweri*).
1984 *Thanarla elegantissima* (CITA). - SCHAAF, p. 162-163, text-figs. 11a-b.
non 1984b *Thanarla pulchra* (SQUINABOL). - BAUMGARTNER, p. 788, pl. 9, fig. 15 (= *T. pacifica*)
pars 1984 *Thanarla pulchra* (SQUINABOL). - SCHAAF, p. 132-133, text-fig. H (= holotype refigured); non text-figs. 1 (= specimen of Schaaf, 1981, pl. 4, fig. 10), 5a-b (= specimen of Schaaf, 1981, pl. 19, fig. 7a-b) and 7a-b (= *T. pacifica*); non text-figs. 2, 3, 4a-b and 6 (= *T. brouweri*).
1985 *Thanarla elegantissima* SANFILIPPO & RIEDEL, p. 600, text-figs. 8. 1a (= specimen of Riedel and Sanfilippo, 1974, pl. 6, fig. 9), 1b-c, 1d (= specimen of Pessagno, 1977b, pl. 7, fig. 10), 1e.
pars 1985 *Thanarla pulchra* SANFILIPPO & RIEDEL, p. 600, text-figs. 8. 2a-c, 2d (= specimen of Pessagno, 1977b, pl. 7, fig. 7); non text-fig. 8. 2e (= specimen of Okamura and Uto, 1982, pl. 1, fig. 12).
non 1986 *Thanarla pulchra* (SQUINABOL). - OKAMURA & MATSUGI, p. 124, pl. 2, figs. 14, 15 (= *T. pacifica*).
1986a *Thanarla elegantissima* (CITA). - SUYARI, pl. 1, figs. 1-4.
non 1986b *Thanarla pulchra* (SQUINABOL). - SUYARI, pl. 2, fig. 1 (= *T. pacifica*), 2 (= *T. brouweri*).
1988 *Thanarla elegantissima* (CITA). - THUROW, p. 407, pl. 4, fig. 11.
non 1988 *Thanarla pulchra* (SQINABOL). - THUROW, p. 407, pl. 7, fig. 9 (= T. pacifica ?).
non 1988 *Thanarla elegantissima* VISHNEVSKAYA, pl. 6, fig. 4 (= *T. pacifica* ?).
1989 *Thanarla conica* (ALIEV). - GORKA & GEROCH, p. 190, pl. 2, fig. 2.
non 1989 *Thanarla* cf. *pulchra* (SQUINABOL). - IWATA & TAJIKA, pl. 4, fig. 3 (= *T. pacifica*)
1989 *Thanarla elegantissima* (CITA). - KATO & IWATA, pl. 8, fig. 1.
1989 *Thanarla pulchra* (SQUINABOL). - KATO & IWATA, pl. 8, fig. 2.
non 1989 *Thanarla pulchra* (SQUINABOL). - TUMANDA, p. 40, pl. 3, fig. 17 (= *T. pacifica*).
non 1990 *Thanarla elegantissima* (CITA). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 2 (= *T. brouweri*).
non 1990 *Thanarla pulchra* (SQUINABOL). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 3 (= *T. pacifica*).
1991 *Thanarla elegantissima* (CITA). - MARCUCCI *et al.*, text-figs. 3. a-b.
1991 *Thanarla pulchra* (SQUINABOL). - MARCUCCI *et al.* text-fig. 3. c.
1992 *Thanarla* cf. *elegantissima* (CITA). - TAKETANI & KANIE, text-fig. 5. 9.
non 1992 *Thanarla pulchra* (SQUINABOL). - TAKETANI & KANIE, text-figs. 5. 11, 12 (= *T. pacifica*).
1993 *Thanarla pulchra* (SQUINABOL). - BAK, p. 189, pl. 3, fig. 1.
1993 *Thanarla elegantissima* (CITA). - TAKAHASHI & LING, p. 98, pl. 1, fig. 9; pl. 3, fig. 11.
1993 *Thanarla pulchra* (SQUINABOL). - TAKAHASHI & LING, p. 98, pl. 1, fig. 10 ?; pl. 3, fig. 12.

non 1994 *Thanarla elegantissima* (CITA) sensu SANFILIPPO & RIEDEL. - JUD, p. 113, pl. 23, figs. 3 (= *T. pacifica* ?), 4.

non 1994 *Thanarla pulchra* (SQUINABOL) sensu SANFILIPPO & RIEDEL. - JUD, p. 114 , pl. 23, figs. 6-7 (= *T. pacifica*).

Holotype: The single specimen figured by Squinabol (1904) on pl. 5, fig. 8, may be considered as valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy). The original figure of the holotype has been reproduced by Schaaf (1984).

Photographed material: 24 specimens.

Description: Test conical to campanulate. The short proximal part is sharply pointed; this is followed by larger, more cylindrical part. A slight stricture can appear at the intersection between both parts. Costate throughout; first three conical segments sharply costate, converging apically. The distal part apparently constituted of only one post-abdominal chamber without constrictions. This segment presents a more or less cylindrical contour, that is greater in width than height. Nine to ten widely spaced pronounced costae observed in lateral view. Final post-abdominal chamber with large aperture surrounded by well developed terminal lamellar feet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	178	224	240	207
Maximum width of test	112	144	173	129

Remarks: Variable degree of development of the principal stricture gives rise to a wide range of variation in test-outline. The results is a continuum of morphologies, well represented by two extreme morphotypes: *T. pulchra* and *T. elegantissima*. Since its creation by Cita (1964), unfortunately, this taxon has been a nomenclatorial mistake. A double reason exists to explain it: 1) *T. elegantissima* should be regarded as an extreme morphotype in a continuum with *T. pulchra* (remember that both type-specimens have been reported from the same time interval, middle-late Albian, and coming from nearby localities); and 2) the occurrence of similar morphologies (*T. pacifica*, heterochronical homoemorphous with *T. pulchra*) at levels stratigraphically older, but unconnected, have complicated this problem. The result is a long complex list of synonyms (see above).

A biometrical method on test shape has been proposed by Sanfilippo & Riedel (1985). It tried to quantify numerically the differences between the continuum (herein considered) *pulchra-elegantissima*. This procedure is based on measurement of the degree of distension of the last segments. This parameter seems to have no discriminatory value from a systematic point of view, because it only allows the separation of those specimens situated in the opposite direction of the faunal spectrum, but not all the other intermediate forms.

Comparisons: This species differs from *T. pacifica*, in having a more cylindrical post-abdominal segment with parallel vertical sides in a longitudinal section, and in lacking conspicuous strictures (I must admit that this character could be difficult to recognize in poorly preserved assemblages). On the other hand, these species have no phylogenetic connection (cf. fig. 14). *T. pulchra* appears to be stratigraphically restricted to the middle Albian-latest Cenomanian, whereas *T. pacifica* becomes extinct in the middle Aptian.

Thanarla veneta (SQUINABOL, 1903b)

Pl. 6, figs. 1-4
Species code 30

1903b *Phormocyrtis veneta* n. sp. SQUINABOL, p. 134, pl. 9, fig. 30.
1972 *Dictyomitra veneta* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 2.
1973b *Dictyomitra veneta* (SQUINABOL). - FOREMAN, p. 264, pl. 14, fig. 11.

non 1973 *Dictyomitra veneta* (SQUINABOL). - MOORE, p. 829, pl. 9, fig. 7 (= *D. formosa*).
1974 *Dictyomitra veneta* (SQUINABOL). - RIEDEL & SANFILIPPO, p. 778, pl. 5, figs. 5, 6.
1975 *Dictyomitra veneta* (SQUINABOL). - DUMITRICA, pl. 2, text-fig. 17.
1975 *Dictyomitra veneta* (SQUINABOL). - FOREMAN, p. 614, pl. 1G, fig. 4.
1976 *Phormocyrtis* (?) *veneta* SQUINABOL. - PESSAGNO, p. 55, pl. 3, fig. 10.
pars 1977c *Thanarla praeveneta* n. sp. PESSAGNO, p. 46, pl. 7, figs. 16, 18, 23, 27; non fig. 11 (= *T. brouweri* ?).
1977c *Thanarla veneta* (SQUINABOL). - PESSAGNO, p. 46, pl. 7, figs. 5, 12, 17, 19, 25; pl. 12, fig. 8.
1979 *Dictyomitra veneta* (SQUINABOL). - NAKASEKO *et al.*, p. 22, pl. 6, fig. 11.
1980 *Thanarla veneta* (SQUINABOL). - OKAMURA, pl. 21, fig. 4.
1980 *Thanarla veneta* (SQUINABOL). - SCHMIDT-EFFING, p. 247, text-figs. 3, 23.
1981 *Thanarla veneta* (SQUINABOL). - DE WEVER (in DE WEVER & THIEBAULT), p. 593, pl. 1, fig. 8.
1981 *Thanarla veneta* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 164, pl. 6, figs. 13, 15; pl. 15, fig. 15.
? 1981 *Thanarla* sp. aff. *T. praeveneta* PESSAGNO. - NAKASEKO & NISHIMURA, p. 163, pl. 6, fig. 16; pl. 15. fig. 9.
1982 *Thanarla veneta* (SQUINABOL). - TAKETANI, p. 60, pl. 5, figs. 1a-c; pl. 11, figs. 20, 21.
1983 *Thanarla veneta* (SQUINABOL). - ORIGLIA-DEVOS, p. 146, pl. 17, figs. 10-11.
1984 *Thanarla veneta* (SQUINABOL). - SCHAAF, p. 162-163, text-figs. 3a-b.
1984 *Archaeodictyomitra veneta* (SQUINABOL). - YAO, pl. 5, figs. 9, 10.
1985 *Thanarla veneta* SANFILIPPO & RIEDEL, p. 602, text-figs. 8. 3a-f.
pars 1986a *Thanarla praeveneta* PESSAGNO. - SUYARI, pl. 1, figs. 5-8; non pl. 7, figs. 9, 10 (= *T. brouweri*).
non 1986a *Thanarla* cf. *praeveneta* PESSAGNO. - SUYARI, pl. 4, fig. 11 (= *D. undata*).
1986a *Thanarla veneta* (SQUINABOL). - SUYARI, pl. 1, figs. 9, 10; pl. 15, fig. 4.
1988 *Thanarla veneta* (SQUINABOL). - THUROW, p. 407, pl. 4, figs. 13, 14.
non 1988 *Thanarla* (?) sp. aff. *T. veneta* (SQUINABOL). - THUROW, p. , pl. 1, figs. 15, 27.
1988 *Thanarla praeveneta* PESSAGNO. - TUMANDA & SASHIDA, text-fig. 4. 5.
non 1988 *Thanarla ? praeveneta* VISHNEVSKAYA, pl. 4, fig. 7 (= *Dictyomitra* sp.).
non 1988 *Thanarla praeveneta* VISHNEVSKAYA, pl. 11, fig. 10.
1989 *Thanarla veneta* (SQUINABOL). - KATO & IWATA, pl. 8, fig. 3.
1989 *Thanarla praeveneta* PESSAGNO. - TUMANDA, p. 40, pl. 8, fig. 1 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 5).
non 1992 *Thanarla praeveneta* PESSAGNO. - STEIGER, p. 89, pl. 26, fig. 7.
non 1992 *Thanarla praeveneta* PESSAGNO. - TAKETANI & KANIE, text-fig. 5. 10.
1993 *Thanarla veneta* (SQUINABOL). - BAK, p. 189, pl. 3, fig. 3.
1993 *Thanarla* sp. cf. *T. veneta* (SQUINABOL). - BAK, p. 190, pl. 3, fig. 4.
pars 1993 *Thanarla praeveneta* PESSAGNO. - TAKAHASHI & LING, p. 98, pl. 1, figs. 11-12; pl. 3, fig. 15, non figs. 13-14.
1993 *Thanarla veneta* (SQUINABOL). - TAKAHASHI & LING, p. 98, pl. 1, fig. 13; pl. 3, fig. 16.
1993 *Thanarla praeveneta* PESSAGNO. - VISHNEVSKAYA, pl. 4, fig. 7.
1993 *Thanarla veneta* (SQUINABOL). - VISHNEVSKAYA, pl. 4, figs. 5-6.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 30, may be considered the holotype. This holotype has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 20 specimens.

Description: Test conical-campanulate, relatively elongated. Composed of four slender segments with a typical change of test-outline, located between the annular third segment and the long truncated-conical fourth segment. Costate throughout, with at least two major constrictions. Costae converging apically and widely spaced on post-abdominal chambers (nine to ten costae in lateral view separated by a single row of circular pores). Final post-abdominal chamber with aperture. Normally with terminal lamellar feet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	184	203	210	195
Maximum width of test	99	112	123	95

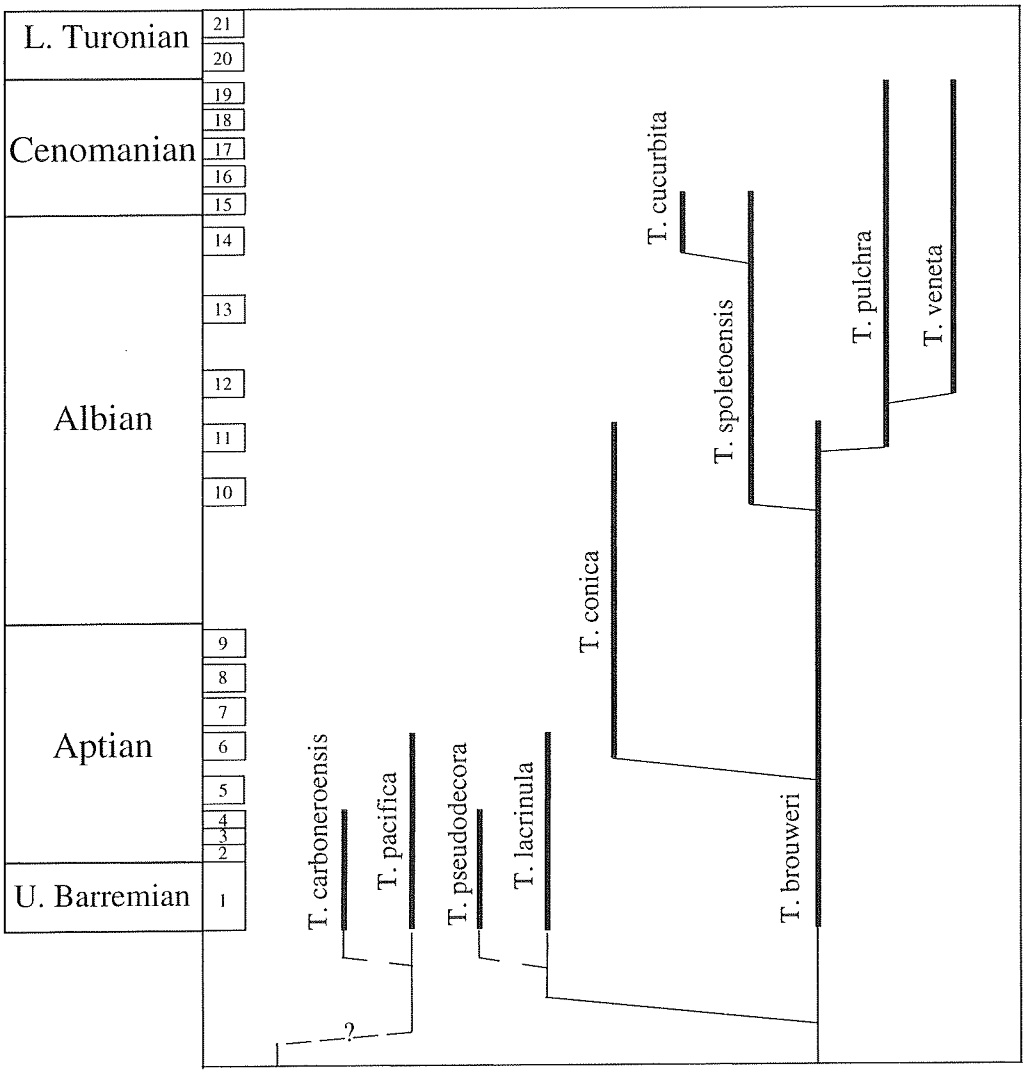

Fig. 14.- Stratigraphic range and possible phyletic relationships of the species of *Thanarla*.

Remarks: The test shows a broad range of variability in the stage of development of the proximal lobe. *T. praeveneta* Pessagno (1977c), is to be regarded as an extreme morphotype among the variable faunal spectrum presented by *T. veneta*, ranging from weakly lobate to a well inflated two-lobed test. This is no more than the expression of a strong variability occurring in the lineage between *brouweri-pulchra-veneta* during the middle-late Albian interval.

Comparisons: In general, *Thanarla veneta* is invariably distinguished from all middle-late Albian-Cenomanian congeneric species by its annular third chamber and two-lobed test shape. A form with generally similar outline, but with more segments separated by external constrictions is figured by Moore (1973). This form has been reported from younger strata and seems to be related to Late Cretaceous dictyomitrids.

Thanarla spoletoensis nov. sp.

Pl. 6, figs. 5-12
Species code 10

1988 *Mita* sp. *B*. THUROW, p. 402, pl. 3, fig. 3.

Holotype: Specimen 4 (pl. 6, fig. 7). The type-specimen comes from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Named in honour of Spoleto, a wonderful medieval town in the heart of the Umbria-Marche Apennines.

Photographed material: 33 specimens.

Description: Test spindle-shaped, inflated to globose. Proximal part sharply pointed apically. Costate throughout length of test; costae converging apically and distally. A weak constriction is visible on the plane where post-abdominal chambers are rapidly increasing in diameter. At this point some costae are bifurcating. Post-abdominal chambers inflated with fifteen to twenty-six sharp costae, separated by single rows of circular pores. The inversely conical distal part increases rapidly ending in a false short tube, resulting from joining of terminal feet-costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	458	410	458	343
Maximum width of test	242	239	333	208

Remarks: The characteristic inflated spindle-shaped forms represented by *T. spoletoensis* and its direct descendent *T. cucurbita*, could be regarded, in a first approach, as an apparent criterion to assign these two species to a new nominal genus. But, in order to attempt a clear nomenclature, I have preferred not to split this group. Following a detailed analysis of the recollected fauna, the existence of a close spatial-temporal relationship between this lineage and *Thanarla* is unequivocal. Furthermore, the tests show similar ontogenetic development.

Thanarla cucurbita nov. sp.

Pl. 6, figs. 13-15
Species code 160

Holotype: Specimen 12178 (pl. 6, fig. 15); it comes from locality no. Ap2-12, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *cucurbita* -ae (f), meaning pumpkin.

Photographed material: 3 specimens.

Description: Test globose. A ridicule minute conical part is opposed to an enormous globose distal one. A weakly marked constriction is situated at the base of the apex formed by the initial segments (probably three). Costate throughout, costae converging at apex and appendage. Twelve to fourteen slight costae, separated by a double or triple row of circular pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	379	376	383	367
Maximum width of test	284	260	284	236

Remarks: *T. cucurbita* is obviously closely allied to the stratigraphically older *T. spoletoensis*. It is, however, distinguished from the latter in being finely costate and in having a more inflated post-abdominal chamber with a double inter-costal row of pores.

This species represents the end of an evolutionary lineage initiated from *T. brouweri*. In this line, the process of morphological transformation from an open conical form to a nearly closed subspherical test, is accompanied by a progressive reduction in size of the apical segments. These morphologic changes appear to have occurred rapidly (Fig. 14).

FAMILY **HSUIDAE** PESSAGNO & WHALEN, 1982

Type genus: *Hsuum* PESSAGNO, 1977b.

Genus **HSUUM** PESSAGNO, 1977b

Synonyms: *Semihsuum* PESSAGNO, BLOME & HULL, in PESSAGNO *et al.*, 1993.

Type species: *Hsuum cuestaensis* PESSAGNO, 1977b, by original designation.

Diagnosis: Test multi-segmented, conical to cylindroid-shaped, without strictures. Cephalis conical to rounded, with or without small horn. Cephalis weakly perforate. Thorax trapezoidal in outline with sparse irregularly dispersed pores. Abdomen and post-abdominal chambers with relatively massive, continuous costae. Some costal elements are occasionally bifurcated or staggered. Frequently, irregular branches link adjoining costae (connecting bars) and obscure the pore frames. Occasionally test with small protuberances at junction between connected costae. Variable number of pores irregularly arranged between costae. Slight development of costal projection. Test seems to grow via costal secretion. Distally costae fade and can rapidly disappear. An aperture is located distally.

Remarks: This genus is well represented in the Jurassic but very few species are present through the early Cretaceous. *Hsuum* appears to be a possible evolutionary offshoot from *Parahsuum* YAO, 1982 (cf. Takemura, 1986). Apparently *Hsuum* leaves no other generic descendants during the Late Jurassic and early Cretaceous and becomes extinct at early Aptian times.

Comparisons: *Hsuum* differs from *Dictyomitra* in lacking strictures and by having a test with several rows of pores between costae, and by possessing primary rather than relict pores. *Hsuum* is distinguished from *Transhsuum* TAKEMURA, 1986 by the possession of distinct longitudinal continuous costae on its test surface. It further differs from *Parahsuum* by having more than one row of pores between adjacent costae.

Range: Early Jurassic to early Aptian; late Albian ?.

Hsuum pectorale nov. sp.

Pl. 6, figs. 21-23
Species code 19

Holotype: Specimen 7956 (pl. 6, fig. 23); this specimen comes from locality no. Cal-22.30, early Aptian of Cortijo Carbonero (Valdepeñas de Jaén, Betic Cordillera, S. Spain).

Derivatio nominis: Latin substantive *pectorale* -is (n), meaning cuirass.

Photographed material: 16 specimens.

Description: Test multi-segmented, conical, lacking strictures. Cephalis conical with small horn sharply-pointed apically and sparse irregularly dispersed pores. Thorax trapezoidal in outline with sparse irregularly dispersed pores. Abdomen and post-abdominal chambers with a very complicated framework of massive, staggered costae, with irregular connecting bars that link adjoining costae. Small protuberances appear at junctions between costae. number of rows of pores between costae is indeterminable because the complex surface ornamentation obscures the pore-pattern beneath. Slight development of costal projections.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	270	255	270	240
Maximum width of test	130	125	130	117

Remarks: The lower stratigraphic limit of *H. pectorale* is not known (probably situated in the Hauterivian or early Barremian, cf. Jud's material). The upper limit is located at the early Aptian and corresponds to the extinction of the last species unquestionably assignable to the genus *Hsuum*. However, rare specimens morphologically close to *Hsuum* have been found, ranging through the middle-late Albian but without stratigraphic connection with *H pectorale*, the latest species representative of this group.

Comparisons: *H. pectorale* differs from all other congeneric species by having a more irregular and complicated ornamental features throughout the test.

Hsuum ? cataphracta nov. sp.

Pl. 6, figs. 16-20
Species code 2

Holotype: Specimen 888 (pl. 6, fig. 19); it comes from locality no. Gc-1027.10, middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *cataphracta*, -ae, (f), meaning military armour for men or horses.

Photographed material: 6 specimens.

Description: Test multi-segmented, conical to cylindrical distally, lacking strictures. Apical part rounded and weakly perforate lacking an apical horn. Proximal part dome-shaped. Thorax and abdomen trapezoidal in outline with sparse irregularly dispersed pores and with costae faintly developed. Post-abdominal chambers with delicate, continuous subparallel costae without connecting bars. Usually two or three rows of small pores appear between costae. Some costae are disconnected towards the distal part, they remain relict between continuous costae. Test without costal projections. Distally, costae become more delicate, fade simultaneously and rapidly disappear. An aperture is located distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	375	353	388	317
Maximum width of test	175	181	204	167

Remarks: The generic assignment of this species is questionable because its stratigraphic range is isolated from the latest species of *Hsuum* (see range chart). More data are required to clarify if there is a phylogenetic relationship between *H.* ? *cataphracta* and *H. pectorale* from the early Aptian.

Comparisons: *Hsuum* ? *cataphracta* differs from all others congeneric species by having a dome-shaped outline proximally, by lacking an apical horn, and by having finer ornamentation.

SUPERFAMILY **AMPHIPYNDACACEAE** RIEDEL, 1967a

Approximately in chronological order, this superfamily includes the subordinated families: Canoptidae PESSAGNO & WHALEN, 1982; Pseudodictyomitridae PESSAGNO, 1977c; Parvicingulidae PESSAGNO, 1977b; Xitidae PESSAGNO, 1977c and Amphipyndacidae RIEDEL, 1967a.

FAMILY **PSEUDODICTYOMITRIDAE** PESSAGNO, 1977c

Type genus: Pseudodictyomitra PESSAGNO, 1977c.

GENUS **PSEUDODICTYOMITRA** PESSAGNO, 1977c

Synonyms: *Shana* WU & PESSAGNO in WU, 1993.

Type species: *Pseudodictyomitra pentacolaensis* PESSAGNO, 1977c, by original designation.

Diagnosis: Test elongate, conical, lobate and multi-segmented. Cephalis and thorax imperforate smooth or with incipient development of costae. Cephalis usually conical lacking apical horn, but in younger species could be somewhat rounded with a weakly developed horn. Thorax and abdomen trapezoidal in outline. In general post-abdominal chambers expand more rapidly in width than height as added. Generally two rings of primary pores are situated in strictures, separating adjacent chambers from the abdomen to the last post-abdominal chamber. Abdomen and post-abdominal chambers costate. This ornamentation is interrupted at segmental level, because the costae do not cross the strictures between chambers. Variable number of discrete pores longitudinally aligned could be occurring at grooves between costae. Final post-abdominal chamber with aperture. Absence of costal projections.

Remarks: Although the name given to this genus by Pessagno (1977c) might suggest a certain phylogenetic relationship with *Dictyomitra*, there is no evolutionary connection between the two multi-segmented genera, and both constitute individualised lineages as Pessagno has correctly indicated. A possible origin for this group could be found in some bizarre multi-segmented Callovian forms assigned to the genus "*Dictyomitrella*" that have more affinities to morphologies typical of the Parvicingulidae than to Archaeodictyomitridae. The evolution of *Pseudodictyomitra* from Archaeodictyomitridae has not been confirmed. *Pseudodictyomitra* as an independent lineage can be traced to the Middle Jurassic. The oldest forms were found in the *Stylocapsa* (?) *spiralis* zone of Matsuoka and Yao, 1986 (*Pseudodictyomitra* (?) sp. D in Matsuoka & Yao, 1985), which is assigned to the late Callovian-early Oxfordian (Matsuoka, 1992). A possible ancestor was illustrated by Yamamoto *et al.* (1985, *Dictyomitrella* (?) sp., p. 34, pl. 4, fig. 2). The earliest forms of *Pseudodictyomitra* show more affinities with "*Dictyomitrella*" and in this way with Parvicingulidae than with Archaeodictyomitridae.

Comparisons: *Pseudodictyomitra* differs from *Dictyomitra* by having discontinuous costae which do not traverse the strictures and by having double rings of primary pores in the strictures. Some species of *Pseudodictyomitra*, however, posses only one ring of pores, which are sustained throughout the entire test (ex. *P. nuda* Schaaf or *P. languida* nov. sp.).

Range: Late Jurassic (Callovian ?-Oxfordian) to Turonian.

Pseudodictyomitra carpatica (LOZYNIAK, 1969)

Pl. 7, figs. 1-5
Species code 265

	1969	*Dictyomitra carpatica* sp. n. LOZYNIAK, p. 38, pl. 2, fig. 12; figs 11 and 13 ?.
pars ?	1973b	*Dictyomitra carpatica* (?) LOZYNIAK. - FOREMAN, p. 263, pl. 10, figs. 1-3; pl. 16, fig. 5 ? (= *D. hornatissima* ?).
	1973b	*Dictyomitra leptoconica* new species FOREMAN, p. 264, pl. 10, fig. 4; pl. 16, fig. 6.
pars	1975	*Dictyomitra carpatica* (?) LOZYNIAK. - FOREMAN, p. 614, pl. 2G, fig. 14; non figs 11-13 (= *P. hornatissima* ?); pl. 7, fig. 7; non fig. 6 (= *P. hornatissima* ?).
	1977c	*Pseudodictyomitra* sp. *A*. PESSAGNO, p. 52, pl. 8, fig. 2.
	1977c	*Pseudodictyomitra* sp. *C*. PESSAGNO, p. 52, pl. 8, fig. 6.
non	1979	? *Dictyomitra carpatica* LOZYNIAK. - NAKASEKO *et al.*, p. 21, pl. 3, fig. 9 (= *C. puga*).
	1980	*Pseudodictyomitra pentacolensis* PESSAGNO. - SCHMIDT-EFFING, p. 247, text-fig. 28.
non	1981	*Pseudodictyomitra carpatica* (LOZYNIAK). - DE WEVER (in DE WEVER & THIEBAULT), p. 590, pl. 2, fig. 2 (= *P. hornatissima*).
	1981	*Pseudodictyomitra carpatica* (LOZYNIAK). - NAKASEKO & NISHIMURA, p.158, pl. 9, figs. 6, 11.
	1981	*Pseudodictyomitra* sp. cf. *P. lanceloti* SCHAAF. - NAKASEKO & NISHIMURA, p. 159, pl. 9, fig. 10.
	1981	*Pseudodictyomitra leptoconica* (FOREMAN). - NAKASEKO & NISHIMURA, p. 159, pl. 9, fig. 7.
pars	1981	*Pseudodictyomitra carpatica* (LOZYNIAK). - SCHAAF, p. 436, ; pl. 3, fig. 2; non figs. 1a-c (= *P. tiara*) and pl. 20, figs. 4a-b (= *P. paronai* ?).
	1981	*Pseudodictyomitra lodogaensis* PESSAGNO. - SCHAAF, p. 437, pl. 3, fig. 5.
pars ?	1982	*Archeodictyomitra carpatica* (LOZYNIAC). - OKAMURA & UTO, pl. 2, figs. 4-5 ?; non figs. 3, 10 (= *P. nuda*).
non	1982	*Pseudodictyomitra carpatica* (LOZYNIAC). - OKAMURA & UTO, pl. 8, figs. 7a-b.
	1982	*Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - WU & LI, p. 69, pl. 1, fig. 20.
	1983	*Pseudodictyomitra carpathica* (LOZYNIAK). - ORIGLIA-DEVOS, p. 175, pl. 20, fig. 11.
	1983	*Pseudodictyomitra leptoconica* (FOREMAN). - ORIGLIA-DEVOS, p. 176, pl. 20, fig. 10.
	1983	? *Pseudodictyomitra* sp. *A*. ORIGLIA-DEVOS, p. 180, pl. 20, fig. 23.
	1984b	*Pseudodictyomitra carpatica* (LOZNIAK). - BAUMGARTNER, p. 782, pl. 8, fig. 1.
pars	1984	*Pseudodictyomitra carpatica* (LOZYNYAK). - SCHAAF, p. 94-95, text-figs. 1 (= specimen of Schaaf, 1981, pl. 3, fig. 2), non text-figs. 2a-b (= specimen of Schaaf, 1981, pl. 3, figs. 1b-c) and 3a-b (= specimen of Schaaf, 1981, pl. 20, figs. 4a-b).
	1984	*Pseudodictyomitra carpatica* (LOZYNIAK). - YAO, pl. 4, fig. 14.
	1984	*Pseudodictyomitra* sp. cf. *P. leptoconica* (FOREMAN), - YAO, pl. 4, fig. 18.
	1986	*Pseudodictyomitra carpatica* (LOZYNIAK). - AITA & OKADA, pl. 1, figs. 13, 14; pl. 7, fig. 10.

non 1986 *Pseudodictyomitra carpatica* (LOZYNIAK). - OKAMURA & MATSUGI, p. 123, pl. 1, fig. 3 (= *P. hornatissima*).
non 1986a *Pseudodictyomitra carpatica* (LOZYNIAK). - SUYARI, pl. 6, fig. 1 (= *P. tiara*).
1986b *Pseudodictyomitra carpatica* (LOZYNIAK). - SUYARI, pl. 1, figs. 1, 2 ?, 3, 4.
non 1986 *Pseudodictyomitra carpatica* (LOZYNIAK). - TERAOKA & KURIMOTO, pl. 4, fig. 9 (= *P. paronai*).
? 1986 *Pseudodictyomitra* cf. *carpatica* (LOZYNIAK). - TERAOKA & KURIMOTO, pl. 3, fig. 4.
non 1988 *Pseudodictyomitra carpatica* (LOZYNIAK). - THUROW, p. 404, pl. 6, fig. 12 (= *P. hornatissima*).
non 1988 *Pseudodictyomitra carpatica* VISHNEVSKAYA, pl. 11, fig. 8 (= *P. tiara* ?).
1989 *Pseudodictyomitra carpatica* LOZYNIAK. - IWATA & TAJIKA, pl. 4, fig. 12.
non 1989 *Pseudodictyomitra carpatica* (LOZYNIAK). - TUMANDA, p. 38, pl. 3, fig. 8.
1989 *Pseudodictyomitra leptoconica* (FOREMAN). - TUMANDA, p. 38, pl. 3, figs. 10, 11 ?.
1989 *Pseudodictyomitra lilyae* (TAN SIN HOK). - TUMANDA, p. 38, pl. 3, fig. 15.
1990 *Pseudodictyomitra carpatica* (LOZYNYAK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 5.
1990 *Pseudodictyomitra leptoconica* (FOREMAN). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 7.
1990 *Pseudodictyomitra lilyae* (TAN SIN HOK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 6.
non 1991 *Pseudodictyomitra carpatica* (LOZYNIAK). - AGUADO *et al.*, text-fig. 7. 2 (= *P. hornatissima*).
non 1991 *Pseudodictyomitra carpatica* (LOZYNIAK). - MARCUCCI *et al.*, text-fig. 3. k (= *P. tiara*).
1992 *Pseudodictyomitra carpatica* LOZYNJAK. - OZVOLDOVA & PETERCAKOVA, pl. 4, fig. 13.
1992 *Pseudodictyomitra* cf. *lilyae* (TAN SIN HOK). - OZVOLDOVA & PETERCAKOVA p. 316, pl. 4, fig. 3.
1992 *Pseudodictyomitra carpatica* (LOZNYAK). - STEIGER, p. 87, pl. 25, figs. 1-3, 7.
1992 *Pseudodictyomitra carpatica* (LOZYNYAK). - TAKETANI & KANIE, text-fig. 4. 12.
1993 *Pseudodictyomitra carpatica* (LOZYNIAK). - AGUADO *et al.*, pl. 3, fig. 11.
non 1993 *Pseudodictyomitra* aff. *leptoconica* FOREMAN. - AGUADO *et al.*, pl. 3, fig. 1 (= *P. hornatissima*).
1993 *Shana lii* n. sp. WU, p. 126, pl.. 3, fig. 19.
1993 *Shana xialuensis* n. sp. WU, p. 126, pl. 4, fig. 14.
1994 *Pseudodictyomitra carpatica* (LOZYNIAK). - JUD, p. 97, pl. 18, figs. 3-5.
non 1994 *P. carpatica* (LOZYNYAK). - WAKITA & BAMBANG, fig. 4.1 (= *P. tiara*).
non 1994 *P. leptoconica* (FOREMAN). - WAKITA & BAMBANG, fig. 4.3.

Lectotype: For twenty years of modern research, this species has been frequently cited and figured in the literature, but no lectotype has been established (I recall that the type-series was described by Lozyniak in 1969 without a precise type). In absence of the holotype, and in spite of the poor quality of the pictures, I designate as lectotype among the syntypes illustrated by Lozyniak, the complete specimen with more packed costae figured on pl. 2, fig. 12 (the other two specimens are doubtfully assigned to this species taking into account the original description), coming from the Neocomian of Svalyavskaya series, located in the Pieniny zone of the Ukrainian Carpathians. Nevertheless, if the Lozyniak's syntypes are still available, further revisory works should be necessary in the interest of stability of nomenclature.

Photographed material: 128 specimens.

Description: Test elongated conical. Cephalis conical, weakly rounded apically. Proximal part smooth, without constrictions. Multi-segmented form with seven to nine post-abdominal chambers, which increase regularly in width to the distal part. Post-abdominal chambers with eight to twelve massive costae visible in lateral view. Individual costae with pyramidal form. Pores do not appear between costae, where only a longitudinal smooth groove is presented. Distally the ornamentation fades out and the final post-abdominal chamber could be more weakly costate.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	190	265	273	247
Maximum width of test	86	126	130	115

Remarks: The material studied (128 specimens) allows me to recognize moderate variability in some morphological characters through successive populations. In this way, this species presents a wide range of variation in the number of costae per segment, and in changes on the triangular section of the costae. Classically a pair of morphospecies (*P. carpatica* and *P. leptoconica*) has been separated exclusively on the basis of the density of costae. The continuum expressed in the faunal spectrum between both extreme morphotypes makes it difficult to establish a real division between the two, and is not useful for biostratigraphy, because these differences are only attributable to a marked intraspecific variability.

Comparisons: *P. carpatica* differs from its immediately allied *P. hornatissima* in having well defined triangular costae and by having more closely spaced costae per segment, that increase in number gradually towards the distal part.

Pseudodictyomitra hornatissima (SQUINABOL, 1904)

Pl. 7, figs. 6-17
Species code 280

	1904	*Dictyomitra hornatissima* n. sp. SQUINABOL, p. 230, pl. 9, fig. 12.
?	1927	*Dictyomitra Lilyae* spec. nov. TAN, p. 55, pl. 10, fig. 83.
pars ?	1973b	*Dictyomitra carpatica* (?) LOZYNIAK. - FOREMAN, p. 263, pl. 16, fig. 5, non pl. 10, figs. 1-3 (= *D. carpatica*).
	1974	*Dictyomitra lilyae* TAN SIN HOK. - RIEDEL & SANFILIPPO, p. 778, pl. 4, figs. 7, 8-9 ?; pl. 12, fig. 13.
pars ?	1975	*Dictyomitra carpatica* (?) LOZYNIAK. - FOREMAN, p. 614, pl. 2G, figs 11-13 ?; non fig. 14 (= *P. carpatica*); pl. 7, fig. 6 ? (= specimen in pl. 2G, fig. 11); non fig. 7 (= *P. carpatica*).
	1981	*Pseudodictyomitra carpatica* (LOZYNIAK). - DE WEVER (in DE WEVER & THIEBAULT), p. 590, pl. 2, fig. 2
	1981	*Pseudodictyomitra lilyae* (TAN SIN HOK). - NAKASEKO & NISHIMURA, p. 159, pl. 9, fig. 12.
	1981	*Pseudodictyomitra lanceloti* n. sp. SCHAAF, p. 436, pl. 18, figs. 9a-b.
	1981	*Pseudodictyomitra* (?) *lilyae* (TAN SIN HOK). - DE WEVER (in DE WEVER & THIEBAULT), p. 591, pl. 1, figs. 1-4.
	1981	*Pseudodictyomitra lilyae* (TAN SIN HOK). - SCHAAF, p. 437, pl. 3, fig. 8; pl. 18, figs. 5 a-b.
	1982	*Pseudodictyomitra pachicostata* sp. nov. WU & LI, p. 69, pl. 2, figs. 3, 4.
	1983	*Pseudodictyomitra lilyae* (TAN SIN HOK). - ORIGLIA-DEVOS, p. 177, pl. 20, figs. 8, 9.
pars	1984	*Pseudodictyomitra lilyae* (TAN SIN HOK). - SCHAAF, p. 118-119, text-figs. H (= specimen of Tan, 1927, pl. 10, fig. 83, redrawn), 1 (= specimen of Schaaf, 1981, pl. 3, fig. 8), 2a-b, 3, 4a-b, 6a-b (= specimen of Schaaf, 1981, pl. 18, figs. 5a-b), 7a-b; non text-figs. 5a-b.
	1986	*Pseudodictyomitra carpatica* (LOZYNIAK). - OKAMURA & MATSUGI, p. 123, pl. 1, fig. 3.
	1986	*Pseudodictyomitra* sp. OKAMURA & MATSUGI, pl. 1, fig. 11.
	1986	*Pseudodictyomitra* sp. (LOZYNIAK). - TERAOKA & KURIMOTO, pl. 3, fig. 5.
	1986	*Pseudodictyomitra rigida* sp. nov. WU, p. 358, pl. 2, figs. 15, 22.
	1988	*Pseudodictyomitra carpatica* (LOZYNIAK). - THUROW, p. 404, pl. 6, fig. 12.
	1988	*Pseudodictyomitra lilyae* (TAN SIN HOK). - THUROW, p. 405, pl. 6, figs. 13, 14, 17.
?	1988	*Pseudodictyomitra* sp. transitional form between *P. leptoconica* (LOZYNIAK) and *P. lilyae* (TAN SIN HOK). - THUROW, pl. 6, fig. 16.
non	1989	*Pseudodictyomitra lilyae* (TAN SIN HOK). - TUMANDA, p. 38, pl. 3, fig. 15 (= *P. carpatica*).
non	1990	*Pseudodictyomitra lilyae* (TAN SIN HOK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 6 (= *P. carpatica*).
	1991	*Pseudodictyomitra carpatica* (LOZYNIAK). - AGUADO *et al.*, text-fig. 7. 2.
non	1992	*Pseudodictyomitra* cf. *lilyae* (TAN SIN HOK). - OZVOLDOVA & PETERCAKOVA, p. 316, pl. 4, fig. 3 (= *P. carpatica*).
?	1992	*Pseudodictyomitra lilyae* (TAN SIN HOK). - TAKETANI & KANIE, text-fig. 4. 15.
	1992	*Pseudodictyomitra* cf. *pentacolaensis* PESSAGNO. - TAKETANI & KANIE, text-fig. 5. 2.
	1993	*Pseudodictyomitra* aff. *leptoconica* FOREMAN. - AGUADO *et al.*, pl. 3, fig. 1.
	1994	*Pseudodictyomitra lanceloti* SCHAAF. - JUD, p. 98, pl. 18, fig. 6.
	1994	*Pseudodictyomitra* sp. aff. *P. lanceloti* SCHAAF. - JUD, p. 98, pl. 18, fig. 7.
	1994	*Pseudodictyomitra leptoconica* (FOREMAN). - JUD, p. 98, pl. 18, fig. 8.
	1994	*Pseudodictyomitra lyliae* (TAH). - JUD, p. 99, pl. 18, figs. 9-11.

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 9, fig. 12, may be regarded as the valid holotype. This specimen comes from the Teòlo section in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 179 specimens.

Description: Test broadly conical. Cephalis conical and weakly rounded apically. Proximal part without ornamentation, externally constrictions are lacking. Multi-segmented form with five to seven post-abdominal chambers, which increase more rapidly in height than width as added to the distal part. Post-abdominal chambers with six to eight very thick lengthwise costae visible in lateral view. Individual costae with triangular to rectangular section. Pores do not appear between costae where a deep broad groove is visible. In some specimens the height of the last post-abdominal segment can be twice that of the initial ones, simultaneously the ornamentation may fade away.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	325	191	253	145
Maximum width of test	155	102	126	93

Remarks: In the assemblage studied (175 specimens) this species shows a wide range of variation on the ornamental characters, which is more evident among the younger populations. After an initial stage with few vigorous costae, the ontogeny leads to progressive fading out in the ornamental features. Then suddenly the costae can disappear distally with the last segments become smooth, with only weak protuberances as a slight trace of the costae. Thus, for example, *P. lilyae* and *P. lanceloti* are not more that illustrative extremes in the range of variability manifested by this species. Throughout the succession there is a steady reduction in the number of costae per segment accompanied by an increase of the size and width of the groove between adjacent costae.

Comparisons: This species differs from the closely allied *P. carpatica* by having fewer costae on post-abdominal segments, furthermore these costae are more massive and longer. *P. hornatissima* also has a much wider groove between adjacent costae than other representatives of the genus.

Pseudodictyomitra nuda (SCHAAF, 1981)

Pl. 6, figs. 24-27

Species code 267

	1981	*Archaeodictyomitra nuda* n. sp. SCHAAF, p. 432, pl. 3, fig. 6.
pars ?	1982	*Archaeodictyomitra carpatica* (LOZYNIAC). - OKAMURA & UTO, pl. 2, fig. 10; non figs. 3-5.
	1983	*Pseudodictyomitra nuda* (SCHAAF). - ORIGLIA-DEVOS, p. 178, pl. 20, fig. 16
	1986b	*Pseudodictyomitra nuda* (SCHAAF). - SUYARI, pl. 1, fig. 8.
	1988	*Pseudodictyomitra leptoconica* Group (FOREMAN). - THUROW, p. 405, pl. 6, fig. 11.
	1989	*Dictyomitra* sp. TUMANDA, pl. 6, fig. 3.
?	1993	*Shana* (?) *nuda* (SCHAAF). - WU, p. 126, pl. 2, fig. 17.
	1994	*Pseudodictyomitra nuda* SCHAAF. - JUD, p. 99, pl. 18, figs. 12-13.

Lectotype: Although the holotype was designated by Schaaf (1981), curiously this has never been properly illustrated (Schaaf's reference seems to be a specimen mounted in a preparation for transmitted light). The single SEM figure presented (pl. 3, fig. 6 in Schaaf) was originally considered as paratype. In the absence of the figures corresponding to the holotype, I propose the designation of the single syntype illustrate by Schaaf (op. cit.) as lectotype of this nominal species.

Photographed material: 25 specimens.

Description: Test as with genus, small conical. Cephalis slightly rounded apically, imperforate with or without apical horn. Proximal part smooth, without constrictions. Multi-segmented form with six to eight post-abdominal chambers, which increase regularly in the distal direction. Post-abdominal chambers with variable number of costae (nine to fourteen visible laterally) which are irregularly developed, somewhat bifurcated and relatively massive medially. In some specimens segmental ornamentation fades simultaneously and rapidly disappears distally. Pores are not observed between costae, only a narrow longitudinal groove is presented.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	180	199	265	155
Maximum width of test	92	107	113	100

Remarks: The relative absence of ornamentation (weakly pronounced costae) suggests as possible ancestor, some early Cretaceous (Valanginian-Hauterivian) forms of *P. hornatissima*, as these progressively lose the costate stage, and simultaneously decrease the number of segments. However, since this evolutionary change takes place in strata not studied in this work, more new data are required to prove a phylogenetic connection.

Comparisons: *P. nuda* differs from all the other congeneric species in having a weakly ornamented test.

Pseudodictyomitra lodogaensis PESSAGNO, 1977c

Pl. 7, figs. 18-21
Species code 279

?	1971	*Dictyomitra* sp. cf. *D. multicostata* ZITTEL. - FOREMAN, pl. 5, fig. 16.
	1977c	*Pseudodictyomitra lodogaensis* n. sp. PESSAGNO, p. 50, pl. 8, figs. 4, 21, 28.
	1981	*Pseudodictyomitra lodogaenisis* PESSAGNO. - NAKASEKO & NISHIMURA, p. 159, pl. 9, fig. 5.
non	1981	*Pseudodictyomitra lodogaensis* PESSAGNO. - SCHAAF, p. 437, pl. 3, fig. 5 (*P. carpatica*).
non	1983	*Pseudodictyomitra* (?) *lodogaensis* PESSAGNO. - ORIGLIA-DEVOS, p. 178, pl. 20, figs. 14, 15.
non	1984	*Pseudodictyomitra lodogaensis* PESSAGNO. - YAO, pl. 5, fig. 14 (= *P. pentacolaensis*).
	1984	*Zifondium* (?) sp. YAO, pl. 4, fig. 5.
non	1988	*Pseudodictyomitra lodogaensis* PESSAGNO. - THUROW, p. 405, pl. 3, fig 12 (= *P. paronai*).
	1988	*Pseudodictyomitra vestalensis* PESSAGNO. - THUROW, p. 405, pl. 3, fig. 15.
?	1989	*Dictyomitra* sp. TUMANDA, pl. 8, fig. 7.
	1991	*Dictyomitra* gr. *multicostata* ZITTEL. - GORKA, p. 44, pl. 2, fig. 5.
	1991	*Dictyomitra striata* LIPMAN. - GORKA, p. 44, pl. 2, fig. 1.
	1992	*Pseudodictyomitra lodogaensis* PESSAGNO. - TAKETANI & KANIE, text-fig. 5. 1.

Holotype: Specimen designated by Pessagno (1977c) on pl. 8, figs. 4, 21, 28. The holotype has been reported from the locality NSF 884 (early-middle Albian) Great Valley sequence, northern California.

Photographed material: 20 specimens.

Description: Test elongate conical. Cephalis conical to weakly rounded, without a horn but thickened apically. Proximal part smooth, without constrictions. Multi-segmented form with seven to nine post-abdominal chambers. Segments increase rapidly in size throughout. Usually individual segments tend to be widest distally; with some specimens (pl. 7, fig. 8) last segments decrease in width, and the test becomes somewhat cylindrical distally. Two rings of primary pores are situated in strictures at joints, separating adjacent chambers from the abdomen to the last post-abdominal chamber; sixteen to twenty massive and elongated costae, visible in lateral view. A single row of four or five small pores appears longitudinally between adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	330	280	325	200
Maximum width of test	110	105	120	93

Remarks: The range of variability in both *P. lodogaensis* and *P. pentacolaensis* partially overlap, but *P. lodogaensis* distinctly includes robust forms with densely packed costae which are separated by narrower strictures.

A phylogenetic link is suggested from *P. nuda* (early Aptian) to *P. lodogaensis* by a rapid increase in the number of chambers and restoration of the ornamental characters. In this way, a marked costate stage will prevail in new larger forms.

Pseudodictyomitra pentacolaensis PESSAGNO, 1977c

Pl. 7, figs. 29-32
Species code 271

	1973	*Dictyomitra* sp. cf. *D. andersoni* (CAMPBELL and CLARK). - MOORE, p. 829, pl. 9, fig. 5.
	1973	*Dictyomitra* cf. *D. crassispina* (SQUINABOL). - MOORE, p. 829, pl. 9, fig. 6
pars	1973	*Dictyomitra* ? cf. *Eucyrtidium turritum* SQUINABOL. - MOORE, p. 830, pl. 10, fig. 4, 5 ?; non fig. 6.
pars ?	1974	*Dictyomitra pseudoscalaris* (TAN SIN HOK). - RENZ, p. 791, pl. 8, fig. 5 ?; non fig. 6 and pl. 11, fig. 34 (= *D. communis* ?)
?	1975	*Dictyomitra* sp. DUMITRICA, text-fig. 2. 8.
pars ?	1975	*Dictyomitra* sp. *B*. FOREMAN, p. 615, pl. 2G, fig. 10; non fig. 9 (= *P. paronai* ?).
	1977c	*Pseudodictyomitra pentacolaensis* n. sp. PESSAGNO, p. 50, pl. 8, figs. 3, 17, 23; pl. 12, fig. 10 ?.
	1977c	*Pseudodictyomitra vestalensis* n. sp. PESSAGNO, p. 51, pl. 8, figs. 7, 18, 24; pl. 12, fig. 9.
	1977c	*Pseudodictyomitra* sp. *D*. PESSAGNO, p. 52, pl. 8, fig. 13.
non	1980	*Pseudodictyomitra pentacolensis* PESSAGNO. - SCHMIDT-EFFING, p. 247, text-fig. 28 (= *P. carpatica*).
	1982	*Dictyomitra urakawensis* n. sp. TAKETANI, p. 59, pl. 4, figs. 8a-b; pl. 11, fig. 16.
	1983	*Pseudodictyomitra pentacolaensis* PESSAGNO. - ORIGLIA-DEVOS, p. 179, pl. 20, figs. 17, 18.
	1984	*Dictyomitra* sp. *B*. TAKETANI. - SCHAAF, p. 162-163, text-figs. 2a-b.
	1984	*Pseudodictyomitra lodogaensis* PESSAGNO. - YAO, pl. 5, fig. 14.
	1986a	*Dictyomitra* sp. *A*. SUYARI, pl. 2, fig. 11.
?	1986a	*Dictyomitra* sp. *C*. SUYARI, pl. 5, figs. 2, 3.
?	1986a	*Dictyomitra* sp. *D*. SUYARI, pl. 5, fig. 1.
	1986a	*Pseudodictyomitra* sp. *B*. SUYARI, pl. 4, fig. 7.
non	1988	*Pseudodictyomitra pentacolaensis* PESSAGNO. - THUROW, p. 405, pl. 3, fig. 17 (= *P. paronai*).
	1988	*Dictyomitra urakawaensis* TAKETANI. - TUMANDA & SASHIDA, text-fig. 4. 10.
pars	1989	*Dictyomitra urakawensis* TAKETANI. - TUMANDA, p. 37, pl. 8, fig 4 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 10), non fig. 5 (= *P. languida* ?)
non	1992	*Pseudodictyomitra* cf. *pentacolaensis* PESSAGNO. - TAKETANI & KANIE, text-fig. 5. 2 (= *P. hornatissima*).

Holotype: Holotype designated by Pessagno (1977c) on pl. 8, figs. 3, 17, 23. This specimen is from locality NSF 860 (late Albian) Great Valley sequence, northern California.

Photographed material: 49 specimens.

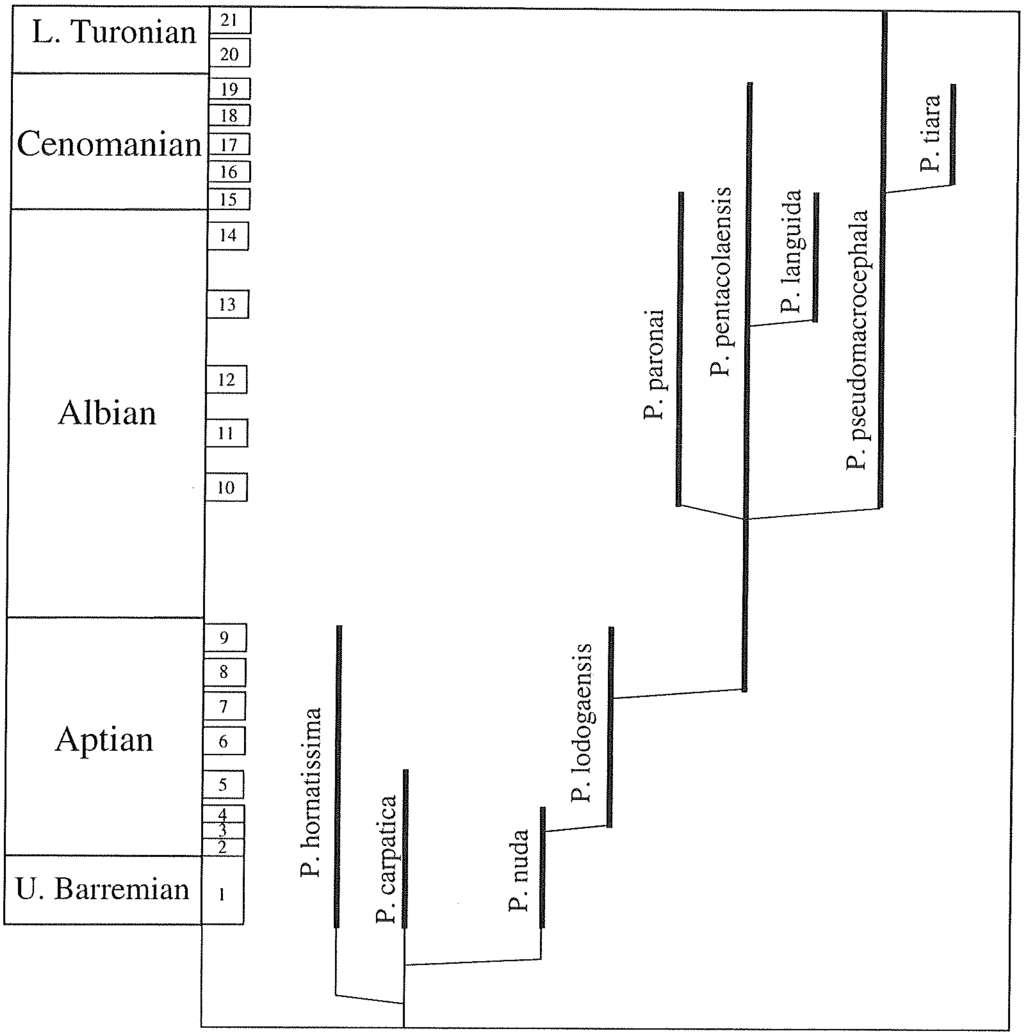

Fig. 15.- Stratigraphic range and possible phyletic relationships of species of *Pseudodictyomitridae.*

Description: Test elongated conical. Cephalis smooth conical, without horn but thickened apically. Proximal part smooth, without constrictions. A single ring of primary pores between thorax and abdomen; abdomen occasionally can be weakly costate. Double rings of primary pores are situated in strictures at joints separating adjacent post-abdominal chambers. Multi-segmented form with nine to fifteen post-abdominal chambers which rapidly increase in height and slowly in width distally. Post-abdominal chambers with twelve to fourteen elongated spaced costae visible in lateral view. In some specimens a single row with two or three small pores is situated in the groove between adjacent costae, although usually these grooves are covered with a layer of microgranular silica. Only the pores located at the base of each strictures appear better marked, causing the stricture to seem like a triple ring of primary pores at joints (pl. 7, fig. 22). This pore frame character could be obscured by accretion of test material in later ontogenetic stages.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	210	395	490	300
Maximum width of test	120	106	127	93

Remarks: *P. pentacolaensis* ranges through the late Aptian-late Cenomanian, and shows during this long period a wide range of variation in density of costae, as well as in the numbers and width of its post-abdominal chambers. This species seems to have evolved from *P. lodogaensis*.

Comparisons: *P. pentacolaensis* differs from its closely allied *P. paronai* by having more lengthy post-abdominal chambers that increase rapidly in height distally.

Pseudodictyomitra paronai (ALIEV, 1965)

Pl. 7, figs. 22-28
Species code 37

	1965	*Stichomitra paronai* sp. n. ALIEV, p. 59, pl. 11, figs. 1-3; pl. 15, fig. 4 ?.
pars ?	1973	*Dictyomitra* ? cf. *Eucyrtidium turritum* SQUINABOL. - MOORE, p. 830, pl. 10, fig. 5 ?; non figs. 4, 6.
pars ?	1975	*Dictyomitra* sp. *B*. FOREMAN, p. 615, pl. 2G, fig. 9; non fig. 10 (= *P. pentacolaensis* ?).
	1977c	*Pseudodictyomitra* sp. *B*. PESSAGNO, p. 52, pl. 9, fig. 3.
pars ?	1981	*Pseudodictyomitra carpatica* (LOZYNIAK). - SCHAAF, p. 436, pl. 20, figs. 4a-b ?; non pl. 3, figs. 1a-c (= *P. tiara*), 2 (= *P. carpatica*).
	1982	*Pseudodictyomitra* sp. *B*. TAKETANI, p. 62, pl. 12, fig. 10.
pars ?	1984	*Pseudodictyomitra carpatica* (LOZYNYAK). - SCHAAF, p. 94-95, text-figs. 3a-b (= specimen of Schaaf, 1981, pl. 20, figs. 4a-b), non text-figs. 1 (= *P. carpatica*) and 2a-b (= *P. tiara*).
	1984	*Dictyomitra* (?) sp. YAO, pl. 5, fig. 24.
	1986	*Pseudodictyomitra carpatica* (LOZYNIAK). - TERAOKA & KURIMOTO, pl. 4, fig. 9.
	1988	*Pseudodictyomitra lodogaensis* PESSAGNO. - THUROW, p. 405, pl. 3, fig 12.
	1988	*Pseudodictyomitra pentacolaensis* PESSAGNO. - THUROW, p. 405, pl. 3, fig. 17.
	1988	*Pseudodictyomitra* sp. cf. *P. pseudomacrocephala* (SQUINABOL). - THUROW, p. 405, pl. 3, fig. 11.
	1989	*Pseudodictyomitra* sp. KATO & IWATA, pl. 8, fig. 7.
?	1993	*Pseudodictyomitra* sp. B. BAK, p. 192, pl. 3, fig. 9.

Lectotype: Although a holotype was designated by Aliev (1965), he did not indicate which specimen was selected for the nominal species. In absence of references about the correct type-specimen, I propose to designate as lectotype the longest specimen illustrated among the type-series by Aliev (1965) on pl. 11, fig. 1. These fauna have been reported from the Albian sediments of the NE Azerbaidzhan, unfortunately with no more details.

Photographed material: 45 specimens.

Description: Test elongate, slender, conical. Cephalis smooth, sharply pointed apically, with weakly developed horn. Proximal part smooth, without constrictions. Abdomen faintly costate. Multi-segmented form with nine to eighteen post-abdominal chambers. Rings of primary pores are situated in strictures at joints separating adjacent segments. The first three rings of primary pores occur in single rings at strictures; the first one separating thorax from abdomen, the second one between abdomen and first post-abdominal segment. All but initial two post-abdominal chambers separated by two rings of primary pores situated at strictures. Post-abdominal chambers slowly increasing in width and height distally. Post-abdominal chambers with twelve to thirteen elongated spaced costae visible in lateral view. A row of three small pores is arranged linearly in the groove between adjacent costae.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	755	416	600	342
Maximum width of test	190	124	138	104

Remarks: Through the middle-late Albian *P. paronai* co-occurs with *P. pseudomacrocephala* constituting two different lineages. Both evolved from the common ancestor *P. pentacolaensis*, presumably in middle Albian time. They occur in a relatively short time interval and there are many differing transitional forms between the two lineages.

Comparisons: Ranges of variability of *P. paronai* and *P. pseudomacrocephala* only slightly overlap at the beginning, but *P. paronai* distinctly includes elongated forms with three pores between adjacent costae, during all its range.

Pseudodictyomitra languida nov. sp.

Pl. 8, figs. 1-4
Species code 48

pars ? 1989 *Dictyomitra urakawensis* TAKETANI. - TUMANDA, p. 37, pl. 8, fig 5 ?, non fig. 4 (= *P. pentacolaensis*)
1994 Nassellaria, gen. and sp. indet. WAKITA & BAMBANG, fig. 6.6.

Holotype: Specimen 2668 (pl. 8, fig. 2). The holotype comes from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *languidus* -a -um, meaning languid, listless.

Photographed material: 4 specimens.

Description: Test elongate, slender conical to cylindrical distally. Cephalis imperforate conical, sharply pointed apically. Proximal part smooth, without constrictions. Abdomen weakly costate. Multi-segmented form with eighteen to twenty post-abdominal chambers. Single rings of primary pores occur at strictures between adjacent chambers, only sporadically double rings appear distally. Post-abdominal segments increase gradually in size throughout, but near middle part of the test growth becomes constant; the test attains a larger adult size. Post-abdominal chambers with fifteen to nineteen closely packed fine costae visible in lateral view. A row of four pores aligned between adjacent costae.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	529	550	600	479
Maximum width of test	100	103	117	92

Remarks: *P. languida* displays single rows of pores between chambers throughout its ontogenetic development. This feature seems to represent the end of an evolutionary lineage, which began in the Aptian from strongly costate and relatively inflated morphologies with an accelerated increase of width (*P. lodogaensis*). This population rapidly acquires a longer, slender test by growing moderately slow in width but irregularly in height (*P. pentacolaensis*). The lineage concludes in late Albian time with elongated forms (*P. languida*) of larger size, displaying relatively constant growth and very high density of costae. This process could explain the entire resorption of one ring (the upper) of primary pores by the immediate lower segment. In other *Pseudodictyomitra* the same mechanism could have been employed, allowing the segments to attain a greater height, although the ring is very weakly resorpted by the new segment.

Comparisons: *P. languida* differs from other congeneric species by having more numerous, densely packed, finer costae and by having one ring of pores in strictures between adjacent segments. This species evolved from *T. pentacolaensis*, and left no descendants.

Pseudodictyomitra pseudomacrocephala (SQUINABOL, 1903b)

Pl. 8, figs. 5-8
Species code 39

1903b *Dictyomitra pseudomacrocephala* n. sp. SQUINABOL, p. 139, pl. 10, fig. 2.
? 1904 *Dictyomitra macrocephala* n. sp. SQUINABOL, p. 230, pl. 9, fig. 10.
? 1965 *Dictyomitra sagitafera* ALIEV. - ALIEV, p. 55, pl. 10, figs. 2-4; pl. 15, fig. 2.
1969b *Dictyomitza malleola* ALIEV. - PESSAGNO, p. 610, pl. 5, fig. A.
1972 *Dictyomitra pseudomacrocephala* SQUINABOL. - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 5.
1973b *Dictyomitra* sp. FOREMAN, p. 264, pl. 14, fig. 16.
1973 *Dictyomitra macrocephala* SQUINABOL. - MOORE, p. 829, pl. 9, figs. 8, 9.
1974 *Dictyomitra macrocephala* SQUINABOL. - RIEDEL & SANFILIPPO, p. 778, pl. 4, figs. 10, 11; pl. 14, fig. 11.
1975 *Dictyomitra pseudomacrocephala* SQUINABOL. - DUMITRICA, text-fig. 2. 19.
1975 *Dictyomitra pseudomacrocephala* SQUINABOL. - FOREMAN, p. 614, pl. 7, fig. 10.
1975 *Dictyomitra dnistrensis* sp. n. LOZYNIAK, p. 52, pl. 2, figs. 3-7.
1975 *Dictyomitra sagitatta* sp. n. LOZYNIAK, p. 52, pl. 2, figs. 8-9.
1976 *Dictyomitra* (?) *pseudomacrocephala* SQUINABOL. - PESSAGNO, p. 53, pl. 3, figs. 2, 3.
1977c *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - PESSAGNO, p. 51, pl. 8, figs. 10, 11 (= specimens of Pessagno, 1976, pl. 3, figs. 2, 3).
1977 *Dictyomitza malleola* ALIEV. - SALAJ & SAMUEL, pl. 46, figs. 2-4.
1979 *Dictyomitra* (?) *pseudomacrocephala* SQUINABOL. - NAKASEKO *et al.*, p. 22, pl. 6, figs. 13-15.
1979 *Dictyomitra* (?) cf. *pseudomacrocephala* SQUINABOL. - NAKASEKO *et al.*, p. 22, pl. 6, fig. 12.
1980 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - OKAMURA, pl. 21, fig. 6.
1980 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - SCHMIDT-EFFING, p. 247, fig. 8 in text.
1981 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - DE WEVER (in DE WEVER & THIEBAULT), p. 592, pl. 1, fig. 5.
pars 1981 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 159, pl. 9, figs. 1-4; pl. 16, figs. 5, 7, 8; non fig. 6.
pars 1981 *Pseudodictyomitra* sp. *A*. NAKASEKO & NISHIMURA, p. 160, pl. 9, fig. 9; non pl. 16, fig. 12 .
1981 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - SCHAAF, p. 437, pl. 24, figs. 1a-b.
1982 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - TAKETANI, p. 61, pl. 5, figs. 4a-b; pl. 12, figs. 7, 8.
non 1982 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - WU & LI, p. 69, pl. 1, fig. 20 (= *P. carpatica*).
1983 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - ORIGLIA-DEVOS, p. 179, pl. 20, figs. 19, 20.
1984 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - SCHAAF, p. 130-131, text-figs. H (= holotype refigured), 1-5, 6a-c.
1984 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - YAO, pl. 5, figs. 11, 12, 16.
1985 *Pseudodictyomitra pseudomacrocephala* SANFILIPPO & RIEDEL p. 608, text-figs. 10. 1a, 1b (= specimen of Pessagno, 1977b, pl. 8, fig. 10), 1c-e.
1986 *Pseudodictyomitra pseudomacrocephala* (SQUIN.). - KUHNT *et al.*, pl. 7, fig. t.
pars 1986a *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - SUYARI, pl. 3, figs. 7, 11; pl. 4, fig. 1; pl. 11, fig. 3; pl. 16, fig. 11 ?; pl. 6, fig. 12; non figs. 9, 10 (= *P. tiara*).
1986 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - TERAOKA & KURIMOTO, pl. 4, figs. 10, 11.
1986 *Pseudodictyomitra pseudomacrocephala* (SQUIN.). - THUROW & KUHNT, text-fig. 9. 11.
1988 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - THUROW, p. 405, pl. 1, fig. 13; pl. 3, fig. 16.

non 1988 *Pseudodictyomitra* sp. cf. *P. pseudomacrocephala* (SQUINABOL). - THUROW, p. 405, pl. 3, fig. 11 (= *P. paronai*).

1988 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - TUMANDA & SASHIDA, text-fig. 4. 9.

1988 *Pseudodictyomitra pseudomacrocephala* VISHNEVSKAYA, pl. 4, fig. 8.

1989 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). KATO & IWATA, pl. 8, fig. 6.

1989 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - TUMANDA, p. 39, pl. 8, fig. 3 (= specimen figured in Tumanda & Sashida, 1988, text-fig. 4. 9).

1991 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 3.

1991 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - MARCUCCI *et al.*, text-fig. 3. h

1993 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - BAK, p. 191, pl. 3, figs. 6-7.

1993 *Pseudodictyomitra* sp. A. BAK, p. 192, pl. 3, fig. 8.

1993 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - TAKAHASHI & LING, p. 98, pl. 2, figs. 13-14; pl. 3, fig. 9.

1993 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL). - VISHNEVSKAYA, pl. 4, fig. 10 (= specimen of Vishnevskaya, 1988, pl. 4, fig. 8).

Holotype: The single specimen illustrated by Squinabol (1903b) on pl. 10, fig. 2, may be considered as valid holotype. This was reported from the Scaglia Bianca formation at the Teòlo series, in the Colli Euganei (southern Venetian Alps, N Italy). The original illustration of Squinabol's holotype has been refigured recently by Schaaf (1984).

Photographed material: 79 specimens.

Description: Test elongate conical, cylindrical distally. Cephalis smooth with a weakly developed horn. The initial four or five segments are enclosed in a greatly thickened wall masking externally the segmental divisions (this character only visible under transmitted light); the proximal part resembles an arrowhead in outline. This initial part is smooth, but slightly costate at the lower part, frequently two single rings of primary pores can be observed. The base of the proximal portion is followed by a single ring of primary pores.

The test is multi-segmented with eight to eleven post-abdominal chambers. Double rings of primary rounded pores occur in strictures between adjacent post-abdominal chambers. Width and height of post-abdominal chambers increase very slightly and in about equal degree as chambers are added. Seven to nine elongated massive spaced costae visible in lateral view. One deep circular pore occupying the groove between two adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	460	418	458	388
Maximum width of test	190	157	192	139

Remarks: *P. pseudomacrocephala* differs from all other species of *Pseudodictyomitra* by having an arrowhead typical outline on the early portion of its test. Among earliest specimens of this species this character shows a considerable range of variation ranging from conical contour to arrowhead-like.

Pseudodictyomitra tiara (HOLMES, 1900)

Pl. 8, figs. 9-11

Species code 38

1900 *Dictyomitra tiara* sp. nov. HOLMES, p. 701, pl. 38, fig. 4.

? 1972 *Dictyomitra tiara* HOLMES. - PETRUSHEVSKAYA & KOZLOVA, p. 550, pl. 2, fig. 8.

1975 *Dictyomitra tiara* HOLMES. - DUMITRICA, text-fig. 2. 9.

pars ? 1975 *Dictyomitra duodecimcostata* (SQUINABOL). - FOREMAN, p. 614, pl. 1G, fig. 6; non pl. 1G, fig. 5 and pl. 7, fig. 8 (= *D. formosa*).

1979 *Dictyomitra* (?) sp. *B.* NAKASEKO *et al.*, p. 22, pl. 6, fig. 21.

pars 1981 *Pseudodictyomitra carpatica* (LOZYNIAK). - SCHAAF, p. 436, pl. 3, figs. 1a-c; non pl. 3, fig. 2 (= *P. carpatica*) and pl. 20, figs. 4a-b (= *P. paronai* ?).

1982 *Pseudodictyomitra nakasekoi* n. sp. TAKETANI, p. 60, pl. 12, figs. 4-6.

1982 *Pseudodictyomitra* sp. *A.* TAKETANI, p. 61, pl. 12, fig. 9.

pars 1984 *Pseudodictyomitra carpatica* (LOZYNYAK). - SCHAAF, p. 94-95, text-figs. 2a-b (= specimen of Schaaf, 1981, pl. 3, figs. 1b-c), non text-figs. 1 (= *P. carpatica*) and 3a-b (= *P. paronai* ?).

1986a *Pseudodictyomitra carpatica* (LOZYNIAK). - SUYARI, pl. 6, fig. 1.

1986a *Pseudodictyomitra nakasekoi* TAKETANI. - SUYARI, pl. 6, figs. 2-4; non pl. 13, fig. 1;

1986a *Pseudodictyomitra* aff. *nakasekoi* TAKETANI. - SUYARI, pl. 15, fig. 9.

1986a *Pseudodictyomitra* cf. *nakasekoi* TAKETANI. - SUYARI, pl. 16, fig. 12.

1986a *Pseudodictyomitra* sp. *E.* SUYARI, pl. 6, figs. 5-8; pl. 16, figs. 9, 10.

1986a *Pseudodictyomitra* sp. *E.* var. SUYARI, pl. 15, figs. 10, 11 ?.

1986 *Pseudodictyomitra nakasekoi* TAKETANI. - KUHNT *et al.*, pl. 7, fig. s.

1988 *Pseudodictyomitra nakasekoi* TAKETANI. - TUMANDA & SASHIDA, text-fig. 4. 13.

? 1988 *Pseudodictyomitra carpatica* VISHNEVSKAYA, pl. 11, fig. 8.

1989 *Pseudodictyomitra nakasekoi* TAKETANI. - TUMANDA, p. 39, pl. 9, fig. 3 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 13).

1991 *Pseudodictyomitra carpatica* (LOZYNIAK). - MARCUCCI *et al.*, text-fig. 3. k.

1994 *P. carpatica* (LOZYNYAK). - WAKITA & BAMBANG, fig. 4.1.

Holotype: The single specimen illustrated by Holmes (1900) on pl. 38, fig. 4, may be considered as valid holotype. The nominal species has been reported from the Late Turonian of the upper Chalk at Coulsdon (Surrey, England).

Photographed material: 48 specimens.

Description: Test conical. Cephalis smoothly conical, rounded apically. Thorax, abdomen and first post-abdominal chamber trapezoidal in outline, smooth or occasionally with a single ring of small circular pores separating abdomen from the first post-abdominal segment. Costae are lacking in this portion of the test. After the initial smooth stage, a single ring of circular pores appears at each intersegmental division. This is followed by six or seven very closely packed nodose costae forming a false ring of elliptical nodes. With further rapid increase in test size, costae become more numerous and are disconnected towards the distal part.

The test is multi-segmented with seven to eight post-abdominal chambers. Double rings of large primary rounded pores occur in strictures at segmental division between post-abdominal chambers, which gradually increase in width distally. The height of post-abdominal chambers is more or less uniform throughout. Nine to eleven elongate very narrowly-spaced costae visible in lateral view . Only one very large circular pore occupies in whole the deep groove between two adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	405	306	333	275
Maximum width of test	180	161	167	150

Remarks: This species is undoubtedly closely allied to *P. pseudomacrocephala*. A phylogenetic transformation could occur by a rapid contraction of the inflated proximal part with a simultaneous decrease in size during early Cenomanian times.

Comparisons: *P. tiara* differs from *P. pseudomacrocephala*, and all other species of *Pseudodictyomitra* in that the groove between adjacent costae is occupied in whole by a big pore and by having a false ring of nodes proximally.

FAMILY **PARVICINGULIDAE** Pessagno, 1977b.

Type genus: *Parvicingula* PESSAGNO, 1977b.

GENUS **PARVICINGULA** PESSAGNO, 1977b.

Synonyms: *Praeparvicingula* PESSAGNO, BLOME & HULL, in PESSAGNO *et al.* 1993.

Type species: *Parvicingula santabarbarensis* PESSAGNO, 1977b, by original designation.

Diagnosis: Test multi-segmented, elongate, conical to cylindrical or spindle-shaped. Cephalis conical to subspherical, poreless or sparsely perforate with or without apical horn. Thorax and abdomen frequently trapezoidal, with irregular pores. Test with numerous closely spaced post-abdominal chambers, trapezoidal or rectangular in outline.

The thick walled test consists of a double lattice layer of pore frames. Pores of inner layer irregular in size, circular to elliptical in shape, disposed in well defined pore frames. Outer layer confined mostly to pores connected and adjacent to circumferential nodose ridges. The outer layer is built upon the inner layer of pore frames. Externally, each post-abdominal chamber has three rows of offset pores: two outer rows sloping steeply to either inner side of successive circumferential ridges. Outer layer may be variably developed; early forms may have a weakly developed outer layer, whereas later forms tend to have a strongly developed outer layer, normally with a much more complex ornamentation externally.

Test with abdomen and post-abdominal chambers constricted, but separated externally by closely spaced circumferential ridges which are continuous internally with platform-like septal divisions. Test without external strictures, because the contractions of the test do not occur at joints between two successive chambers. Final post-abdominal chamber sometimes with tubular neck lacking nodes or bars, and with small terminal aperture antapically.

Remarks: *Parvicingula* is interpreted in the sense of Baumgartner (1984b), who included under this genus forms with or without weakly developed apical horn, which otherwise fit Pessagno's original definition. Pessagno (1977c) fixes the extinction datum of this genus and the family Parvicingulidae at the top of the Valanginian, corresponding very closely to that of Buchia in the southern Boreal province of the north eastern Pacific region. Nevertheless, results of this study indicate that the final appearance of *Parvicingula* clearly takes place in the latest early Aptian, at least for the Mediterranean Tethyan regions.

Range: Middle Toarcian to early-middle Aptian.

Parvicingula boesii (PARONA, 1890)

Pl. 8, fig. 16
Species code 241

1890 *Dictyomitra Boesii* n. f. PARONA, p. 170, pl. 6, fig. 9.
1898 *Lithocampe fasciata* n. sp. RÜST, p. 63, pl. 18, fig. 3.
1898 *Stichocapsa fasciata* n. sp. RÜST, p. 65, pl. 18, fig. 6.
pars 1973b *Amphipyndax* (?) spp. FOREMAN, p. 263, pl. 9, figs. 3, 4; non fig. 5.
pars 1973 *Lithocampe ananassa* RÜST. - MOORE, p. 828, pl. 4, fig. 9; non figs. 7 ?, 8 (= *P. usotanensis*).
1974 *Dictyomitra boesii* PARONA. - RIEDEL & SANFILIPPO, p. 778, pl. 4, figs. 5 ?, 6.
1975 *Dictyomitra boesii* PARONA. - FOREMAN, p. 613, pl. 2H, figs. 10, 11; pl. 7, fig. 9.
1977c *Parvicingula boesii* (PARONA). - PESSAGNO, p. 48, pl. 8, fig. 5.
1977c *Parvicingula citae* n. sp. PESSAGNO, p. 48, pl. 8, fig. 19.
1978b *Mirifusus boesii* (PARONA). - FOREMAN, p. 746, pl. 2, fig. 6.

1979 *Parvicingula boesii* (PARONA). - NAKASEKO *et al.*, p. 23, pl. 3, figs. 1, 2.
non 1980 *parvicingula boesii* group (PARONA). - BAUMGARTNER *et al.*, p. 58, pl. 5, fig. 15; pl. 6, fig. 8.
1980 *Parvicingula boesii* (PARONA). - OKAMURA, pl. 20, figs. 3, 9.
1981 *Parvicingula boesii* (PARONA). - NAKASEKO & NISHIMURA, p. 156, pl. 8, fig. 13 (= specimen of Nakaseko *et al.*, 1979, pl. 3, fig. 1); pl. 17, fig. 6.
non 1981 *Parvicingula boesii* (PARONA). - SCHAAF, p. 436, pl. 3, figs. 13a-b and pl. 18, figs. 6a-b (= *P. usotanensis*); pl. 4, fig. 13 (= *X. clava*).
1982 *Parvicingula boesii* (PARONA). - OKAMURA & UTO, pl. 3, fig. 5, 6, 7, 9, 10.
1982 *Parvicingula boesii* (PARONA). - WU & LI, p. 68, pl. 2, figs. 1, 2.
non 1983 *Parvicingula boesii* gr. (PARONA). - ORIGLIA-DEVOS, p. 171, pl. 20, figs. 1, 2.
1984 *Parvicingula* sp. cf. *P. boesii* (PARONA). - YAO, pl. 4, fig. 15.
1986 *Ristola boesii* (PARONA). - AITA & OKADA, pl. 2, fig. 2, 3.
? 1986 *Parvicingula boesii* (PARONA). - LI, pl. 3, fig. 22.
1986 *Parvicingula boesii* (PARONA). - OKAMURA & MATSUGI, p. 123, pl. 1, fig. 5.
1986b *Parvicingula boesii* (PARONA). - SUYARI, pl. 3, fig. 1.
1988 *Parvicingula boesii* (PARONA). - THUROW, p. 403, pl. 6, fig. 9.
non 1988 *Parvicingula* cf. *citae* VISHNEVSKAYA, pl. 6, fig. 8.
pars ? 1989 *Ristola boesii* (PARONA). - IWATA & TAJIKA, pl. 4, fig. 4; non pl. 5, fig. 6.
1989 *Ristola boesii* (PARONA). - KATO & IWATA, pl. 1, fig. 4; pl. 4, fig. 6.
1989 *Parvicingula boesii* (PARONA). - TUMANDA, p. 38, pl. 4, figs. 1, 2.
1990 *Ristola boessi* (PARONA).- O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 12.
1992 *Parvicingula boesii* (PARONA). - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 12.
1992 *Parvicingula boesii* (PARONA). - STEIGER, p. 86, pl. 23, figs. 1-3, 4 ?, 5-7.
? 1992 *Parvicingula sphaerica* n. sp. STEIGER, p. 86, pl. 24, figs. 1, 2.
1992 *Parvicingula boesii* (PARONA). - TAKETANI & KANIE, text-fig. 4. 8-9.
non 1993 *Parvicingula* ex gr. *boesii* (PARONA). - VISHNEVSKAYA, pl. 6, figs. 7-8.
1993 *Ristola boesii* (PARONA). - WU, p. 125, pl. 3, fig. 14.
1994 *Parvicingula boesii* gr. (PARONA). - JUD, p. 91, pl. 16, figs. 1-2.

Holotype: The specimen illustrated by Parona (1890) on pl. 6, fig. 9 may be considered as valid holotype. The exact provenance of this specimen is unknown. Only an undetermined Neocomian age may be presumed. The holotype seems to be reported from the Maiolica Formation at the Monte Sangiano, near the locality of Cittiglio, Province of Varese (southern Alps, N Italy). Recently, Jud (1994) has illustrated topotypical material from the Neocomian of Cava Rusconi. The faunal assemblage shows great similarity with that of Parona, thus it suggests a possible early Cretaceous age for Parona's Radiolaria.

Photographed material: 4 specimens.

Description: Test multi-segmented, large, notably spindle-shaped, usually with seven to eight post-abdominal chambers and terminal neck-like tubular extension. Cephalis smooth subspherical without or slightly developed apical horn. Thorax sparsely perforate, trapezoidal in outline. Abdomen and first post-abdominal chamber trapezoidal with irregular small staggered pores in rough rings. Remaining post-abdominal chambers subtrapezoidal, each one with three rows of pores.

Test wall as with genus. Three rows of very regular hexagonally offset pores per chamber; the middle pore (inner row) is depressed and usually smaller and the two outer rows partly cut into either transverse ridges. Outer layer composed of a delicate set of diagonal and vertical bars which may connects nodes between successive circumferential ridges. Distalmost chamber bears a short and narrow tubular extension with closely spaced pores; pores occur in horizontal rows lacking nodes or bars. Frequently, the test becomes narrower and can be closed antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	214	253	279	267
Maximum width of test	110	131	147	135

Remarks: *P. boesii* together with *P. usotanensis* are the last representatives of the genus *Parvicingula* at latest early Aptian time. After a detailed morphologic study of Aptian-Albian multicyrtids, there seems to be no direct descendent evolving from either taxa. On the other hand, *P. boesii* and *P. usotanensis* could belong to the same phyletic lineage, where probably *P. usotanensis* evolved from *P. boesii* in late Valanginian time, by acquiring a smaller size and a more compressed shape, simultaneously the ornamental characters become more noticeable.

Comparisons: *P. boesii* differs from other Cretaceous species of *Parvicingula* by having a slender spindle-shaped test and pronounced circumferential ridges with very regularly arranged nodes connected by vertical or diagonal faint bars between adjacent ridges.

Parvicingula usotanensis TUMANDA, 1989

Pl. 8, figs. 12-15
Species code 21

pars 1973 *Lithocampe ananassa* RÜST. - MOORE, p. 828, pl. 4, figs. 7 ?, 8; non fig. 9 (= *P. boesii*).
pars 1981 *Parvicingula boesii* (PARONA). - SCHAAF, p. 436, pl. 3, figs. 13a-b; pl. 18, figs. 6a-b; non pl. 4, fig. 13 (= *X. clava*).
1982 *Parviciugula* sp. OKAMURA & UTO, pl. 2, fig. 16.
1982 Unnamed *nassellariinid D.* WU & LI, pl. 2, fig. 17.
1986b *Parvicingula* sp. SUYARI, pl. 3, fig. 2.
1989 *Archicapsa* (?) sp. KATO & IWATA, pl. 1, fig. 8.
1989 *Parvicingula usotanensis* n. sp. TUMANDA, p. 30, pl. 4, fig. 4; pl. 10, figs. 11a-b.
1989 *Parvicingula hamatonbetsensis* n. sp. TUMANDA, p. 30, pl. 4, fig. 3; pl. 10, fig. 7.
1994 *Parvicingula usotanensis* TUMANDA. - JUD, p. 92, pl. 16, fig. 8.

Holotype: Specimen described and illustrated by Tumanda (1989) on pl. 4, fig. 4. The holotype comes from the late Valanginian-Hauterivian? of the Usotan section (Esashi mountain area, northern Hokkaido, Japan).

Photographed material: 11 specimens.

Description: *Parvicingula* of small size with test relatively broad and markedly spindle-shaped. Cephalis small, hemispherical, sparsely perforate and lacking apical horn. Thorax relatively small, trapezoidal in outline, with irregularly arranged small pores. Abdomen and post-abdominal chambers subtrapezoidal in outline, conspicuously ornamented, with three rows of subcircular to elliptical pores per chamber in an irregular hexagonal arrangement. Test with a typical large depression (sutural pore), appearing upon the second and third post-abdominal chambers.

Test wall as with genus. Circumferential ridges at segmental division bear small nodes or faint spines connected between nodes of circumferential adjacent ridges by massive diagonal bars, which form irregular triangular frames enclosing three or four elliptical pores. Last chambers much narrower. Terminal chamber bears narrow tubular neck with closely spaced pores, but without nodes, spines or bars. Test with small aperture, but occasionally closed antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	246	267	293	240
Maximum width of test	146	177	189	167

Remarks: The presence of a large, depressed sutural pore upon initial post-abdominal chambers, a feature hitherto unknown among Parvicingula, is very common. This character seems to appear by earlier acquisition of a small size test, highly compressed in shape.

Comparisons: *P. usotanensis* is distinguished from its probably closely related *P. boesii* (1) by having a narrower and smaller distal part, (2) by having more complex ornamented outer layer irregularly arranged and (3) in having and less prominent circumferential ridges. This species also attains a much smaller size than other representatives of the genus.

GENUS **MIRIFUSUS** PESSAGNO, 1977b.

Type species: *Mirifusus guadalupensis* PESSAGNO, 1977b, by original designation.

Remarks: *Mirifusus* is interpreted in the sense of Baumgartner (1984b), including under this genus forms having usually a double lattice layer of pore frames and with or without spines at nodes, which otherwise fit Pessagno's (1977b) description. Furthermore, the cephalis may develop an apical horn.

Range: Middle Jurassic (Bajocian) to the base of late Aptian.

Mirifusus chenodes (RENZ, 1974)

Pl. 8, figs. 17-19
Species code 57

1974 *Lithocampe chenodes* n. sp. RENZ, p. 793, pl. 7, fig. 30; pl. 12, figs. 14a-d.
pars 1974 *Lithocampe chenodes* RENZ. - RIEDEL & SANFILIPPO, p. 779, pl. 13, fig. 1; pl. 6, figs. 6, 7 ?; non fig. 5.
non 1975 *Lithocampe chenodes* RENZ. - FOREMAN, p. 616, pl. 2K, fig. 6 (= *P. apochrypha*).
1981 *Lithocampe chenodes* group RENZ. - SCHAAF, p. 435, pl. 5, fig. 2; pl. 25, figs. 5a-b, 7.
1983 *Lithocampe chenodes* RENZ. - ORIGLIA-DEVOS, p. 163, pl. 18, figs. 8, 9.
1984b *Mirifusus chenodes* (RENZ). - BAUMGARTNER, p. 770, pl. 5, figs. 9, 15.
1984 *Mirifusus chenodes* (RENZ). - SCHAAF, p. 98-99, text-figs. H (= holotype refigured), 1 (= specimen of Schaaf, 1981, pl. 5, fig. 2), 2 (= specimen of Schaaf, 1981, pl. 25, fig. 7), 3a-b (= specimen of Schaaf, 1981, pl. 25, figs. 5a-b), 4a-b.
1986 *Mirifusus kezheni* sp. nov. LI, p. 313, pl. 2, figs. 18, 19.
1986 *Lithocampe chenodes* RENZ. - LI, pl. 3, fig. 20.
1989 *Lithocampe chenodes* RENZ. - KATO & IWATA, pl. 1, fig. 3.
1989 *Mirifusus chenodes* (RENZ). - TUMANDA, p. 38, pl. 1, fig. 15.
1992 *Mirifusus chenodes* (RENZ). - BAUMGARTNER, p. 321, pl. 7, figs. 6, 7.
1992 *Mirifusus chenodes* (RENZ). - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 3
1992 *Mirifusus chenodes* (RENZ). - TAKETANI & KANIE, text-fig. 4. 1, 2.
1994 *Mirifusus chenodes* (RENZ). - JUD, p. 84, pl. 12, fig. 16; pl. 13, fig. 1.

Holotype: The holotype was designated and illustrated by Renz (1973) on pl. 12, fig. 14c, and recently has been refigured by Schaaf (1984). This specimen has been reported from Leg 27, site 261-12, CC, in the Argo Abyssal Plain (eastern Indian Ocean).

Photographed material: 12 specimens.

Description: Multi-segmented form, fusiform test as with the genus, usually composed of fifteen to eighteen post-abdominal chambers. Cephalis hemispherical sparsely perforate, with stout apical horn. Thorax, abdomen and first six to eight post-abdominal chambers constitute together a narrow conical portion of the test. Thorax and abdomen trapezoidal in outline, imperforate to sparsely perforate.

Test wall as with genus. Post-abdominal chambers in the initial portion with an inner layer of three to four rows of pores per chamber in an irregular arrangement, outer layer weakly developed and appears only distally. Following chambers (eight to ten) form an inflated median fusiform portion of the test. Inner layer with four or five rows of pores in hexagonal arrangement. Outer layer consisting of very irregular, branched diagonal bars extending over each segment and joining at nodes. Stout spines may arise from nodes. Test may terminate in an open cylindrical tube, thick walled, apparently without septal division.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	150	539	629	458
Maximum width of test	113	279	292	258

Remarks: *M. chenodes* is the last species of *Mirifusus* that becomes extinct in the Cretaceous (earliest late Aptian). This generic lineage began in the middle Jurassic and gave rise to many species through the upper Jurassic and early Cretaceous (Neocomian). From the Barremian on, *M. chenodes* is the only remaining representative of the genus *Mirifusus*.

Comparisons: *M. chenodes* is notably distinguished from all other congeneric species by having more numerous pores per segment, together with a generally smaller size of the entire test.

GENUS **CROLANIUM** PESSAGNO, 1977c

Type species: *Crolanium triquetrum* PESSAGNO, 1977c, by original designation. In this work, this species is regarded as a synonym of *Stichocampe triangularis* ALIEV, 1968.

Diagnosis: Test multi-segmented, elongate, conical to tetrahedral, with or without strictures. Test circular to triangular in cross section towards the distal part. Cephalis imperforate conical, weakly to well developed apical horn. Thorax very sparsely perforate or imperforate. Abdomen and post-abdominal chambers weakly to moderately well constricted. Test composed for two latticed layers of pore frames: inner layer with aligned rows of circular pores, outer layer composed of numerous large circular pores with rays and nodes, often with small spines at vertices of the nodes; outer layer built upon inner layer of pores. Terminal segment outgrowing at vertices of the triangular section, distally three terminal extensions may develop. Final post-abdominal chamber with an aperture.

Remarks: Classically *Crolanium* was included together with *Xitus* in the Xitidae, but some morphological features allow me to suggest parvicingulids as the most likely origin. Consequently, this implies exclusion from the Xitidae. Provisionally, *Crolanium* is included into the Parvicingulidae. The justification in a future time of a new subfamily that will include the genera *Crolanium* and the new monospecific *Torculum* seems to be reasonable.

The first morphological changes that occurred in this group led away from the conical shape of *Parvicingula* and *C. puga* (only earliest specimens) to a test with a more triangular transverse section and finally to tetrahedral-shaped test at its most typical. This modification occurs in the adult stages of ontogeny. The second and superposed change occurred in the Albian. The nodose ridge was transmuted by diffusion of the nodes upon the constricted areas between nodose ridges. The outer layer became progressively denser and covered the entire test. Concomitantly, the test became larger distally. Finally, a spinose to tubercular stage was imposed on final chambers.

Comparisons: *Crolanium* seems very closely related to the genus *Parvicingula* in the development of circumferential ridges (most noticeable in early specimens of *Crolanium*), but differs from *Parvicingula* in the development of a tetrahedral-shaped test, and by having a densely porous outer layer that is strongly developed in later forms.

Range: Late Valanginian to latest Cenomanian.

Crolanium puga (SCHAAF, 1981)

Pl. 8, figs. 22-28

Species code 66

1972 *Dictyomitra* (?) sp. DUMITRICA, pl. 4, figs. 4, 7.

pars ? 1975 *Dictyomitra* spp. FOREMAN, p. 615, pl. 2H, fig. 2; non pl. 1H, fig. 2 (= *C. triangulare* ?); non pl. 1H, fig. 3 (= *T. pagoda*).

1979 ? *Dictyomitra carpatica* LOZYNIAK. - NAKASEKO *et al.*, p. 21, pl. 3, fig. 9.

1980 *Zifondium* cf. *lassenensis* PESSAGNO. - SCHMIDT-EFFING, p. 247, text-fig. 29.

1981 *Parvicingula* sp. aff. *P. cosmoconica* (FOREMAN). - NAKASEKO & NISHIMURA, p. 157, pl. 8, fig. 17; pl. 17, fig. 2 ?.

1981 *Pseudodictyomitra puga* (SCHAAF). - NAKASEKO & NISHIMURA, p. 160, pl. 9, fig. 8 (= specimen of Nakaseko *et al.*, 1979, pl. 3, fig. 9).

1981 *Archaeodictyomitra puga* n. sp. SCHAAF, p. 432, pl. 3, fig. 7; pl. 21, figs. 11a-b

non 1981 *Archaeodictyomitra* sp. cf. *A. puga* n. sp. SCHAAF, pl. 4, figs. 3, 4 (= *D. communis*).

? 1981 *Parvicingula hsui* PESSAGNO. - SCHAAF, p. 436, pl. 3, fig. 4.

1982 *Pseudodictymita* sp. OKAMURA & UTO, pl. 5, fig. 1.

? 1982 Unnamed *nassellariinid F.* WU & LI, pl. 2, fig. 19.

1984 *Archaeodictyomitra puga* SCHAAF. - SCHAAF, p. 156-157, text-fig. 1 (= specimen of Schaaf, 1981, pl. 3, fig. 7).

? 1984 *Parvicingula hsui* PESSAGNO. - SCHAAF, p. 156-157, text-fig. 2 (= specimen of Schaaf, 1981, pl. 3, fig. 4).

1986 *Pseudodictyomdtra* cf. *depressa* BAUMGARTNER. - OKAMURA & MATSUGI, p. 123, pl. 1, fig. 6.

1986b *Pseudodictyomitra depressa* BAUMGARTNER. - SUYARI, pl. 1, fig. 7.

1986b *Pseudodictyomitra puga* (SCHAAF). - SUYARI, pl. 1, figs. 5, 6, 9 ?.

1988 *Archaeodictyomitra puga* SCHAAF. - THUROW, p. 398, pl. 6, fig. 15.

non 1988 *Archaeodictyomitra* sp. cf. *A. puga* SCHAAF. - THUROW, p. 398, pl. 6 , fig. 18; pl. 7, fig. 15 (= *D. communis*).

? 1989 *Pseudodictyomitra carpatica* (LOZYNIAK). - TUMANDA, p. 38, pl. 3, fig. 8.

1989 *Pseudodictyomitra puga* (SCHAAF). - TUMANDA, p. 39, pl. 3, fig. 6.

1989 *Pseudodictyomitra* sp. *C.* TUMANDA, pl. 6, fig. 1.

1990 *Archaeodictyomitra puga* SCHAAF. - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 2, fig. 7.

1990 *Archaeodictyomitra puga* SCHAAF. - OZVOLDOVA, p. 140, pl. 3, figs. 8, 9; pl. 4, fig. 7.

1992 *Pseudodictyomitra puga* (SCHAAF). - TAKETANI & KANIE, text-fig. 5. 3

1994 *Wrangellium* (?) *puga* (SCHAAF). - JUD, p. 117, pl. 24, figs. 2-3.

Holotype: Holotype designated by Schaaf (1981, pl. 21, figs. 11a-b). The specimen has been reported from the late Barremian in leg 62, DSDP, at site 463-89-1 (Mid-Pacific Mountains).

Photographed material: 61 specimens.

Description: Test multi-segmented conical to tetrahedral, many specimens tend to be triangular in cross section on the two latest segments. Test without strictures. Test composed of seven to eight well ornamented post-abdominal chambers. Chambers separated externally by spaced ridges which are coplanar with segmental division. Cephalis smooth, conical, somewhat rounded, lacking apical horn. Thorax conical, very sparsely perforate without ornamentation. Abdomen and post-abdominal chambers subtrapezoidal in axial section, width and height increasing very slightly in about equal degree.

Test composed of two well ornamented lattice layers of pore frames: inner layer of small circular pore frames disposed in well aligned rows; outer layer much thicker, better developed and is often dense enough to partially obscure the inner meshwork. Outer layer composed of a ring of elliptical to longitudinal sharp nodes (ten to twelve visible in lateral view) which are closely disposed vertically around each ridge. Adjacent nodes separated by a single, small depression. Each depression with a circular pore situated on both edges of the ridges bounding chambers. A second complex system of external meshwork is located in the groove at intrasegmental division; this consists of staggered ovoid pores.

In specimens with a triangular cross section, test material weakly outgrowing at the vertices on the last post-abdominal segment. Final chamber always with large circular central aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	300	252	280	217
Maximum width of test	160	148	173	127

Remarks: This species shows a wide range of variation of contour in test cross section (circular to triangular). *C. puga* appears to be a transitional species between the genus *Parvicingula* and the genus *Crolanium*. Both genera have circumferential ridges at chamber joints and are similar in ornamentation. However, due to the appearance of new structural parameters on the test beginning in the late Valanginian (cf. Jud's material), *C. puga* acquires a tetrahedral shape. At the present time, this is the fundamental reason to include this species in the genus *Crolanium*.

Crolanium bipodium (PARONA, 1890)

Pl. 8, figs. 20-21
Species code 389

1890 *Lithochytris bipodium* n. f. PARONA, p. 167, pl. 5, fig. 16.
1975 *Dictyomitra* (?) sp. FOREMAN, p. 615, pl. 2H, fig. 4.
1981 *Crolanium pythiae* n. sp. SCHAAF, p. 432, pl. 20, figs. 5a-c
? 1981 *Stichomitra asymbatos* FOREMAN. - SCHAAF, p. 439, pl. 22, figs. 6a-b.
1984 *Crolanium pythiae* SCHAAF. - SCHAAF, p. 158-159, text-figs. 1, 2, 3a-b.
1985 *Crolanium pythiae* SANFILIPPO & RIEDEL, p. 616, text-figs. 13. 1a-e.
1988 *Crolanium pythiae* SCHAAF. - THUROW, p. 399, pl. 6, fig. 23.
? 1988 *Crolanium* aff. *pythiae* VISHNEVSKAYA, pl. 5, fig. 5-6.
1991 *Crolanium pythiae* SCHAAF. - AGUADO *et al.*, text-fig. 7. 7.
1993 *Crolanium pythiae* SCHAAF. - AGUADO *et al.*, pl. 3, fig. 4.
1993 *Crolanium pythiae* SCHAAF. - VISHNEVSKAYA, pl. 3, figs. 6 (= specimen of Vishnevskaya, 1988, pl. 5, fig. 5), 7.
1994 *Crolanium pythiae* SCHAAF. - JUD, p. 69, pl. 6, figs. 1-2.

Holotype: Nominal species based on a single specimen described and figured by Parona (1890, pl. 5, fig. 16). This specimen was reported from the Maiolica Formation (Neocomian, without more precision) at the Monte Sangiano, near the locality of Cittiglio, Province of Varese (southern Alps, N Italy).

Photographed material: 7 specimens.

Description: Test elongate, conical to tetrahedral distally, with eight to nine weakly constricted post-abdominal chambers. Test without strictures. Cephalis smooth conical, somewhat rounded, with short massive apical horn. Thorax conical, very sparsely perforate without ornamentation. Abdomen and post-abdominal chambers trapezoidal in outline with slightly bulging sides.

Test composed of two well ornamented lattice layers: inner layer of pore frames large, open and circular, disposed in well aligned horizontal rows; outer layer much thicker and better developed, composed of small tubercular nodes situated on the narrow circumferential ridge midway in each chamber. On the last post-abdominal segment, test outgrowing at the vertices of the triangular base; distally three massive, terminal tubular extensions may appear. Final chamber always with circular central aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	336	327	333	320
Maximum width of test	128	141	145	137

Remarks: This species appears to be the earliest evolutionary offshoot from *C. puga*, and to have left no descendants are recognized. It is emphasized that in the early Cretaceous, *C. bipodium* is the first form to develop a multisegmented morphology with three tubular extensions on the distalmost chamber. This same pattern occurs in an earlier form, *C. cuneatum*, but lacks a direct connection from *C. bipodium*. Both "three-footed" morphologies seem to have a common ancestor in *C. puga*, which has a basic triangular cross section in the terminal chamber. These repeated offshoots may be explained as a simple phenomenon of homoeomorphy.

Comparisons: *C. bipodium* differs from *C. puga* in having three terminal tubular extensions, outer layer quite developed and less marked circumferential ridges.

Crolanium spineum (PESSAGNO, 1977c)

Pl. 9, figs. 1-6

Species code 16

1977c *Xitus spineus* n. sp. PESSAGNO, p. 56, pl. 10, figs. 3, 12, 16, 20; pl. 12, fig. 13.

Holotype: Holotype designated by Pessagno (1977c, pl. 10, figs. 3, 12, 16, 20); from locality NSF 854 early or middle Albian Great Valley sequence, northern California.

Photographed material: 42 specimens.

Description: Test slender, subconical to spindle-shaped. Test with thirteen to sixteen weakly constricted post-abdominal chambers, with strictures. Cephalis hemispherical and imperforate with long tapering apical horn (pl. 9, fig. 3). Thorax and abdomen trapezoidal in outline, very sparsely perforate. Post-abdominal chambers cylindrical in outline; initial post-abdominal chambers increasing rapidly in width and slowly in height as added. Remaining final chambers (two to six) gradually narrowing in width distally. On smallest specimens a weakly triangular section may develop. At maturity, the test tends to be spindle-shaped.

Test composed for two lattice layers of pore frames: inner layer has small, circular pores (five or six rows per chamber); outer layer composed of numerous large circular to elliptical pores with small nodes arranged in a double system of circumferential ridges. The first ridge appears midway in each chamber, and the second one, less wide, occurs at joints between adjacent chambers. Test frequently possessing very small nodes bearing short spines. In longest specimens the distalmost chambers consists only of inner layer of meshwork. Test may be closed distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	410	699	946	525
Maximum width of test	150	166	200	150

Remarks: This species was originally included in the nominal series of *Xitus*. However one of the diagnostic characters for the nominal genus was the absence of spinose ridges (cf. Pessagno, 1977c, p. 55). This feature is always present on *C. spineum*. It would appear that *C. spineum* evolved from *C. puga*, through the same kind of morphological transformation, as occurred in the test of *C. bipodium* (important development on outer layer with the occurrence of spinose ridges). In *C. spineum,* as in its ancestor, the triangular cross section is not well developed, nor is there a tubular extension. The latter is conspicuously developed in its direct descendant *C. cuneatum*. In general an important increase in size takes place in this lineage.

Comparisons: *C. spineus* differs from representatives of the genus *Xitus* in having a larger, more slender test with narrow spinose ridges.

Crolanium cuneatum (SMIRNOVA & ALIEV) in ALIEV & SMIRNOVA, 1969

Pl. 9, figs. 7-14
Species code 7

1969 *Stichocampe cuneatus* sp. n. SMIRNOVA & ALIEV (in ALIEV & SMIRNOVA), p. 69, pl. 2, figs. 5, 5a.
pars 1973 *Stichomitra rüsti* ALIEV. - MOORE, p. 828, pl. 7, fig. 7; non figs. 8 and 9 (= *S. communis* ?).
1988 *Xitus* (?) sp. THUROW, p. 408, pl. 3, figs. 20a-b.
? 1989 *Stichocampe cuneatus* SMIRNOVA & ALIEV. - GORKA & GEROCH, p. 191, pl. 3, fig. 4.

Holotype: The specimen described and illustrated by Smirnova & Aliev (in Aliev & Smirnova, 1969) on pl. 2, figs. 5-5a (lateral and antapical views respectively). The holotype has been reported from the Albian strata of Vladimir region (central area of the Russian platform).

Photographed material: 51 specimens.

Description: Test multi-segmented, elongate, conical to tetrahedral, thick-walled. Test with strictures and triangular in transverse section distally. Cephalis hemispherical and imperforate with short apical horn. Thorax, abdomen and remaining chambers trapezoidal in outline and weakly constricted. First four or five post-abdominal chambers gradually increasing in width and height in about equal degree; successive post-abdominal chambers strongly increasing in width.

Test composed of two lattice layers of pore frames: inner layer consisting of very small, circular pores, almost always obscured by the external ornamentation; outer layer composed of numerous, regularly aligned (five or seven rows per chamber) large, circular to elliptical pores; pores lacking nodes, but having few short spines at the middle part of each segments (slightly wider).

Terminal chamber grows outward at vertices of the triangular base, forming three long flaring terminal tubular extensions. The terminal tubes are composed of a single thick layer of meshwork with large, circular pores. Aperture has not been observed on distalmost chamber.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	504	755	730	600
Maximum width of test	182	307	410	240

Remarks: *C. cuneatum* is undoubtedly closely allied to *C. spineum*. Both species are quite similar in ornamental features but differ in that tubular extensions are present on *C. cuneatum*. On both species a very narrow range of morphologic variability exists, but their faunal spectra were never superposed. No transitional forms have been observed in the abundant material studied. It seems probable that *C. cuneatum* evolved from *C. spineum* and left no evolutionary descents.

Comparisons: This species differs radically from all other congeneric species by having a large tetrahedral test with three well developed, terminal tubular extensions and a thicker outer lattice layer of well arranged pores.

Crolanium triangulare (ALIEV, 1968)

Pl. 10, figs. 1-7

Species code 4

	1968	*Stichocampe triangularis* sp. n. ALIEV, p. 28, pl. 1, figs. 3, 4.
pars ?	1975	*Dictyomitra* spp. FOREMAN, p. 615, pl. 1H, fig. 2; non pl. 2H, fig. 2; non pl. 1H, fig. 3 (= *T. pagoda*).
	1977c	*Crolanium triquetrum* n. sp. PESSAGNO, p. 54, pl. 9, figs. 1, 2, 9, 19, 24, 28; pl. 12, fig. 14.
non	1983	*Crolanium triquetrum* PESSAGNO. - ORIGLIA-DEVOS, p. 210, pl. 25, fig. 1 (= *T. coronatum*).
	1988	*Crolanium* sp. cf. *C. triquetrum* PESSAGNO. - THUROW, p. 399, pl. 3, fig. 14.

Holotype: The single specimen figured by Aliev (1968) on pl. 1, fig. 3-4 (lateral and antapical views respectively). The holotype has been reported from the middle Albian of Konakhkend (south-eastern Caucasus, NE Azerbaidzhan).

Photographed material: 38 specimens.

Description: Test as with genus. Test large conical (proximal part) to authentic tetrahedral-shaped (distal part) multi-segmented test usually having eight to eleven closely spaced post-abdominal chambers which are separated by tuberculate circumferential ridges. Test without visible strictures externally. Cephalis conical and imperforate with or without a weakly developed horn. Thorax and abdomen trapezoidal in outline, imperforate (thorax sometimes sparsely perforate). First post-abdominal chambers subtrapezoidal in outline, width and height increasing slightly and in about equal degree. Succeeding post-abdominal chambers triangular in cross section. Distal chambers very strongly increasing in width and very slightly in height.

Test composed of two lattice layers of pore frames: inner layer composed of small open pores, subcircular to elliptical in shape and poorly developed proximally, but in the two last post-abdominal chambers four or five rows of large circular pores are visible; outer layer quite ornamented, composed of numerous small tubercles interconnected by massive radiating rays which often bifurcate.

Test strongly enlarged at the vertices on the last five or six post-abdominal segments, distally attaining a large triangular cross section. Three terminal weakly developed laminar extensions, occur externally at the intersection between the three vertical plane faces of the tetrahedron (pl. 10, fig. 4). Test with a central circular aperture on final post-abdominal chamber.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	492	367	433	280
Maximum width of test	216	229	287	170

Comparisons: *C. triangulare* bears a striking resemblance to *C. puga*, from which it seems to have evolved. It is distinguished from the latter by its well developed tetrahedral shape comprising almost a half of the test. There is a progressive trend in stratigraphically younger specimens of *C. triangulare* toward increased thickness of the triangular distal chambers.

Crolanium pulchrum (SQUINABOL, 1903b)

Pl. 10, figs. 8-14

Species code 6

1903b	*Dictyomitra pulchra* n. sp. SQUINABOL, p. 140, pl. 10, fig. 8.
1986	*Xitus* (?) sp. *A*. KUHNT *et al.*, pl. 7, fig. r.

? 1993 *Stichomitra* gr. *asymbatos* FOREMAN. - BAK, p. 194, pl. 3, fig. 14.

Holotype: The nominal species is based on a single specimen, figured by Squinabol (1903b) on pl. 10, fig. 8. This specimen was reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 33 specimens.

Description: Test multi-segmented, large, predominantly conical in shape; usually having eight to nine post-abdominal chambers separated by massive nodose circumferential ridges. Post-abdominal chambers constricted between ridges. Cephalis and thorax small, conical; cephalis smooth with a massive tapering apical horn, thorax sparsely perforate lacking ornamental features. Abdomen and post-abdominal chambers subtrapezoidal in outline. Post-abdominal chambers increase rapidly in width and gradually in height as added, distalmost chamber strongly increasing in width and usually quite large. Externally, ridges indicate separation of chambers.

Test consisting in two layers of irregular pore frames. Inner layer lacks nodes and has at least four rows of large circular pores per chamber; outer layer much thicker and best developed on circumferential ridges where one row of massive nodes is interconnected by massive rays. These rays fade to the inner layer and rapidly disappear at the groove. Test strongly widening in the two distalmost post-abdominal segments. Some specimens develop a weak subtriangular cross section on the distal chamber (pl. 10, fig. 14). Test has a central circular aperture visible antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	215	462	558	338
Maximum width of test	140	274	325	242

Remarks: The morphological convergence shown in the test shape between smallest specimens of *C. pulchrum* and *Torculum dengoi* makes it difficult to establish systematic differences between solitary specimens of different populations. In fact, the Parvicingulidae and Xitidae form lineages that could be only distantly related and the phenomenon of homoeomorphy may be restricted to a single feature, such as the ornamentation at ridges, or of the whole test. Nevertheless, in mature specimens of *C. pulchrum*, the stout ornamentation and tetrahedral shape of the distalmost chamber are undoubtedly criteria of distinction. In addition, the initial conical portion bearing a tapering apical horn is more slender with *C. pulchrum* than with *T. dengoi*.

Comparisons: *C. pulchrum* is distinguished by the massive nodes occurring at ridges. It also attains a much larger size in distalmost chambers that other representatives of the genus.

GENUS **TUGURIUM** NOV. GEN.

Derivatio nominis: Latin substantive *tugurium* -ii (n), meaning a kind of primitive cabin.

Type species: *Lithostrobus pagoda* SQUINABOL, 1904.

Description: Large conical to subcylindrically shaped, thick-walled test. Multi-segmented, with numerous quite widely-spaced cylindrical post-abdominal chambers separated by single, narrow nodose circumferential ridges situated at segmental divisions. Test without strictures. Cephalis and thorax usually conical and imperforate. Test consisting on a double lattice layer of regular pores. Pores of inner layer very regular in size, circular in shape, appearing in large, well-defined sets of aligned pore frames. Outer layer confined exclusively to connected nodes on circumferential ridges. Externally, inner meshwork always visible on segments, because the weak development on

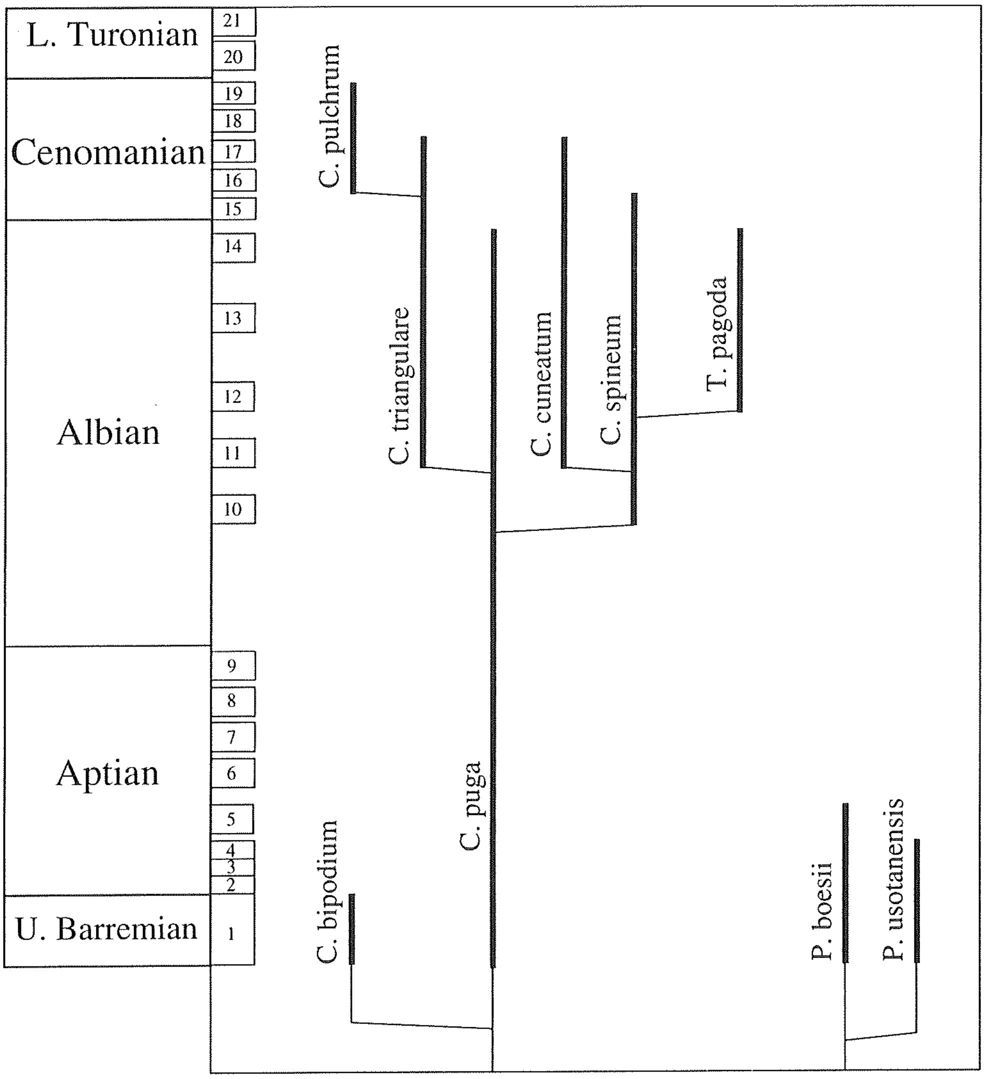

Fig. 16.- Stratigraphic range and possible phyletic relationships of species of *Parvicingula*, *Crolanium* and *Tugurium*.

the outer layer is built only upon a very narrow fringe of the inner layer. Distalmost segment with a large circular aperture.

Remarks: Introduction of a new generic name is justified by the presence of post-abdominal chambers having four or more large rows of circular pores, a feature hitherto not known among Cretaceous conical parvicingulids. This new genus is monospecific but its restricted range makes it a useful marker for the middle-late Albian.

A direct phylogenetic relation with *Parvicingula* is impossible, because the last representatives of *Parvicingula* occur in early Aptian.

Range: Middle-late Albian, as far as known.

Tugurium pagoda (SQUINABOL, 1904)

Pl. 10, figs. 15-21
Species code 24

	1904	*Lithostrobus pagoda* n. sp. SQUINABOL, p. 229, pl. 9, fig. 8
pars	1975	*Dictyomitra* spp. FOREMAN, p. 615, pl. 1H, fig. 3; non fig. 2 (= *C. triangularis* ?); non pl. 2H, fig. 2 (= *C. puga* ?).
	1981	*Lithostrobus punctulatus* PESSAGNO. - SCHAAF, p. 435, pl. 21, figs. 5a-b.

Holotype: The holotype is the single specimen illustrated by Squinabol (1904) on pl. 9, fig. 8. This specimen was reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 19 specimens.

Description: Test as with genus. Test very large, conical to subcylindrical in shape, with seven to ten very widely spaced post-abdominal chambers, separated by single and narrow nodose circumferential ridges. Ridges are continuous with planiform partitions at segmental divisions. Cephalis and thorax conical. Cephalis imperforate with weakly developed apical horn; thorax imperforate to sparsely perforate. Abdomen and first post-abdominal chambers trapezoidal in outline, remaining post-abdominal chambers subcylindrical.

Test composed of two lattice layers of pore frames; inner layer of pores large, very regular in size, circular in shape, and appearing in large sets of four or five well-defined rows of pores per chamber. Outer layer weakly developed and almost exclusively confined to hemispherical nodes on the circumferential ridges. Distalmost segment with large circular aperture. A short terminal tube composed of a single layer of meshwork is occasionally present.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	196	414	515	308
Maximum width of test	90	155	169	142

Remarks: Squinabol's holotype is smaller in size and shows only one segment with four pores below the first ring of nodes.

Comparisons: *T. pagoda* differs from other Cretaceous Parvicingulidae in having larger cylindrical post-abdominal chambers with distinctive sets of pore frames disposed in four or five circumferential rows per chamber.

FAMILY **XITIDAE** PESSAGNO, 1977c

Type genus: *Xitus* PESSAGNO, 1977c.

GENUS **XITUS** PESSAGNO, 1977c

Synonyms: *Novixitus* PESSAGNO, 1977c; *Pseudoxitus* WU & PESSAGNO in WU, 1993.

Type species: *Xitus plenus* PESSAGNO, 1977c, by original designation. This species is considered in this work as a synonym of *Dictyomitra spicularia* ALIEV, 1965.

Diagnosis: Test multi-segmented, elongate, conical, with strictures. Cephalis conical, with apical horn. Thorax imperforate or sparsely perforate. Abdomen perforate with polygonal pore frames. Post-abdominal chambers trapezohedral in outline, sometimes constricted.

Ornamentation consists of two layers of meshwork. Inner layer consists of uniform small polygonal to circular pore frames. Commonly, outer layer composed of tubercles interconnected by numerous bars, disposed indistinctly on constrictions and ridges. Tubercles in each row staggered with respect to tubercles in flanking rows. Outer layer built upon inner layer by means of small bars; often the growth can become dense enough to obscure the inner meshwork throughout the test, except on distalmost chambers, where the external ornamentation may gradually fade and rapidly disappear.

Post-abdominal segments separated by planiform divisions, each one having a central aperture (only visible in broken specimens or under transmitted light), where a contraction of the test is variably developed, depending on the species. Test with a large circular aperture antapically.

Remarks: In the specific description, references has been made to only the outer layer, because frequently the ornamentation on the outer layer is dense enough to obscure entirely the inner meshwork, which in this work is considered to have little systematic value at specific level.

Comparisons: Although certain species assignable to this genus are quite comparable to some Albian specimens of *Crolanium*, *Xitus* is, however, distinguished from *Crolanium* by having staggered rows of large tubercles, lacking spinose ridges, and being circular in cross section. On the other hand, although both genera were originally included in the same family, each genus should be considered as a separate phyletic lineage. No origin for *Xitus* has been proposed and it remains unknown.

Range: Middle Jurassic to latest Cenomanian.

Xitus clava (PARONA, 1890)

Pl. 11, figs. 1-8
Species code 68

1890 *Cannobotrys clava* n. f. PARONA, p. 163, pl. 5, fig. 2.
1898 *Lithocampe botryoides* n. sp. RÜST, p. 61, pl. 17, fig. 10.
? 1904 *Lithostrobus incrassatus* n. sp. SQUINABOL, p. 228, pl. 9, fig. 6.
1961a *Dictyomitra clivosa* sp. n. ALIEV, p. 54, pl. 1, figs 1, 2.
1965 *Dictyomitra clivosa* ALIEV. - ALIEV, p. 38, pl. 6, figs. 7, 8 (= specimens of Aliev, 1961a, pl. 1, figs. 1, 2); pl. 14, fig. 3.
1973b *Dictyomitra* sp. cf. *D. spicularia* ALIEV. - FOREMAN, p. 264, pl. 9, figs. 8, 9.
1973b *Dictyomitra* sp. FOREMAN, pl. 9, fig. 7.
1973 *Dictyomitra* sp. *C*. MOORE, p. 830, pl. 14, figs. 3, 4.
pars 1975 *Dictyomitra* spp. FOREMAN, p. 615, pl. 2H, figs. 6, 7; non fig. 5; non pl. 1H, fig. 4, fig. 5 (= *X. elegans* ?).
1979 *Dictyomitra* sp. cf. *D. spicularia* ALIEV. - NAKASEKO *et al.*, p. 22, pl. 3, fig. 5.
1981 *Novixitus mclaughlini* PESSAGNO. - DE WEVER, (in DE WEVER & THIEBAULT), p. 589, pl. 2, fig. 3.
1981 *Xitus* (?) sp. *A*. NAKASEKO & NISHIMURA, p. 164, pl. 10, figs. 5 (= specimen of Nakaseko *et al.*, 1979, pl. 3, fig. 5), 8.
pars 1981 *Parvicingula boesii* (PARONA). - SCHAAF, p. 436, pl. 4, fig. 13; non pl. 3, figs. 13a-b and pl. 18, figs. 6a-b (= *P. usotanensis*).
1981 *Xitus spicularius* (ALIEV). - SCHAAF, p. 440, pl. 4, fig. 11; pl. 5, figs. 12a-b; pl. 19, figs. 2a-b.
pars 1982 *Novixitus* sp. OKAMURA & UTO, pl. 2, fig. 8; non figs. 7, 9.
1982 *Xitus* sp. OKAMURA & UTO, pl. 5, figs. 4, 5.
1982 *Novixitus normalis* sp. nov. WU & LI, p. 69, pl. 2, fig. 5.
1982 *Xitus transversus* sp. nov. WU & LI, p. 69, pl. 2, figs. 7, 8 ?.

1984b *Xitus* sp. cf. *X. spicularius* (ALIEV). - BAUMGARTNER, p. 792, pl. 10, figs. 16, 17.
pars 1984 *Xitus spicularius* (ALIEV). - SCHAAF, p. 140-141, text-figs. 1 (= specimen of Schaaf, 1981, pl. 4, fig. 11), 2a-b and 3a-b; non text-fig. H (= *X. spicularius*, holotype refigured).
1984 *Xitus spicularius* (ALIEV). - YAO, pl. 4, fig. 17.
1986b *Novixitus mclaughlini* PESSAGNO. - SUYARI, pl. 3, fig. 7.
1986b *Xitus spicularius* ALIEV. - SUYARI, pl. 3, fig. 3.
1986 *Xitus decorus* sp. nov. WU, p. 358, pl. 3, figs. 1, 9, 20, 24.
1986 *Xitus naxiaensis* sp. nov. WU, p. 359, pl. 3, figs. 5, 11, 13, 22, 26.
1986 *Xitus triangularis* sp. nov. WU, p. 359, pl. 3, figs. 8, 18, 21, 25.
1988 *Xitus alievi* (FOREMAN). - THUROW, p. 408, pl. 7, fig. 2.
pars 1988 *Xitus spicularius* (ALIEV). - THUROW, p. 408, pl. 7, fig. 1; non pl. 3, fig. 19 (= *X. spicularius*).
pars ? 1989 *Novixitus weyli* SCHMIDT-EFFING. - KATO & IWATA, pl. 3, fig. 3; non pl. 8, fig. 9 (= *X. mclaughlini*).
1989 *Xitus* (?) sp. KATO & IWATA, pl. 3, fig. 2.
? 1989 *Novixitus* sp. *A*. TUMANDA, pl. 6, fig. 5.
1990 *Xitus spicularius* (ALIEV). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 6; pl. 2, fig. 11.
1990 *Xitus spicularius* (ALIEV). - OZVOLDOVA, p. 144, pl. 3, figs. 5-7.
1992 *Xitus* spp. BAUMGARTNER, p. 326, pl. 13, figs. 11, 12, 13?.
1992 *Xitus spicularius* (ALIEV). - OZVOLDOVA & PETERCAKOVA, pl. 4, figs. 4, 6.
1992 *Xitus spicularius* (ALIEV). - STEIGER, p. 89, pl. 26, figs. 9-11.
1992 *Xitus spicularius* (ALIEV). - TAKETANI & KANIE, text-fig. 5. 14.
1993 *Xitus robustus* n. sp. WU, p. 127, pl. 4, fig. 10.
1994 *Xitus* sp. aff. *X. spicularius* (ALIEV). - JUD, p. 119, pl. 24, fig. 11.

Holotype: Nominal species based only on a single specimen described and figured by Parona (1890, pl. 5, fig. 2). The holotype seems to be reported from the Maiolica Formation (Neocomian age, without more precision) at Monte Sangiano, near the locality of Cittiglio, Province of Varese (southern Alps, N Italy).

Photographed material: 102 specimens.

Description: Test as with genus, usually with four or five post-abdominal chambers. Test broadly conical, well constricted. Cephalis conical to hemispherical and smooth, with weakly developed apical horn. Thorax sparsely perforate, subtrapezoidal in outline. Post-abdominal chambers gradually increasing in height, strongly increasing in width. Outer layer composed of a double system of massive tubercular rings, occurring upon ridges and constrictions. The size of the tubercles in the ridges are always larger than those of the adjacent constrictions. A beautiful complex of connected bars is developed between tubercles on the same ridge and with tubercles of adjacent constrictions.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	244	235	253	193
Maximum width of test	146	164	193	143

Remarks: The concept of the type for this species has been strongly altered in recent years. This fact is probably due to the reillustration by Schaaf (1984) of an original picture of the holotype of *X. spicularius*, to which he assigned also particular small specimens with broadly conical test assignable undoubtedly to *X. clava*, recorded in the Aptian. This fact led likely to numerous mistakes of identification by different authors, because Aliev's holotype is clearly more elongate with a large number of chambers. In addition, it was reported from the Albian.

Comparisons: *X. clava* differs from the certainly closely related *X. spicularius* in having a broad conical test with a long tapering horn, and in having a smaller number of post-abdominal chambers but each one provided with quite large tubercles.

Xitus elegans (SQUINABOL, 1903b)

Pl. 11, figs. 9-14
Species code 69

	1903b	*Lithostrobus elegans* n. sp. SQUINABOL, p. 138, pl. 9, fig. 22.
	1974	*Eucyrtidium vermiculatum* n. sp. RENZ, p. 792, pl. 8, figs. 17-19; pl. 11, fig. 22.
pars ?	1975	*Dictyomitra* spp. FOREMAN, p. 615, pl. 1H, fig. 5, non fig. 4; non pl. 2H, fig. 5; non figs. 6 and 7 (= *X. clava*).
	1981	*Xitus vermiculatus* (RENZ). - SCHAAF, p. 441, pl. 19, figs. 6a-b.
	1981	*Xitus* sp. cf. *X. spicularius* (ALIEV). - SCHAAF, p. 441, pl. 4, fig. 12.
?	1981	*Xitus* sp. indet. SCHAAF, pl. 21, figs. 10a-b.
	1982	*Novixitus tuberculatus* sp. nov. WU & LI, p. 69, pl. 2, fig. 6.
	1988	*Parvicingula* (?) sp. THUROW, p. 403, pl. 6, fig. 10.
	1989	*Pseudodictyomitra* sp. A. TUMANDA, pl. 8, fig. 10.
	1994	*Novixitus* (?) *daneliani* n. sp. JUD, p. 85, pl. 13, fig. 6.
	1994	*Novixitus* (?) *tuberculatus* WU. - JUD, p. 86, pl. 13, figs. 7-9.

Holotype: The description of the nominal species seems to be based on a single specimen figured by Squinabol (1903b, pl. 9, fig. 22). This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 62 specimens.

Description: Test as with genus, usually with five to six well-separated post-abdominal chambers. Test conical and quite constricted. Cephalis conical imperforate, with weakly developed apical horn. Thorax and abdomen trapezoidal in outline and imperforate or sparsely perforate. Successive post-abdominal chambers increasing more in height than width. Outer layer composed of circular or elliptical pores, bars and tubercles, all arranged in a double setting of circumferential rings. A first ring of pointed tubercles occurs at ridges; a second, narrower and less massive one is located at constrictions having very small nodes. Both different rings are connected by a complex framework of delicate transverse rays.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	280	203	230	185
Maximum width of test	151	113	118	105

Comparisons: *X. elegans* differs from *X. clava* by having a pointed tubercular ring at ridges, flanked on each constriction by a single ring of very small circular to elliptical tubercles. A possible phylogenetic origin is proposed (fig. 17) from *X. clava* by a progressive gain of a double set of different-sized tubercles and narrowing of the test.

Xitus alievi (FOREMAN, 1973b)

Pl. 11, figs. 15-16
Species code 385

	1973b	*Dictyomitra alievi* new species FOREMAN, p. 263, pl. 9, fig. 10; pl. 16, fig. 4.
	1975	*Dictyomitra alievi* FOREMAN. - FOREMAN, p. 613, pl. 2H, figs. 8, 9; pl. 7, fig. 2.
pars	1981	*Xitus alievi* (FOREMAN). - SCHAAF, p. 440, pl. 5, figs. 4a-b; pl. 19, figs. 8a-b; non figs. 1a-b.
?	1982	*Xitus* sp. OKAMURA & UTO, pl. 2, fig. 6.
non	1983	*Xitus alievi* (FOREMAN). - ORIGLIA-DEVOS, p. 215, pl. 25, fig. 16 (= *X. spicularius* ?).

non 1983 *Xitus* sp. cf. *alievi* (FOREMAN). - ORIGLIA-DEVOS, pl. 25, fig. 15.
pars 1984 *Xitus alievi* (FOREMAN). - SCHAAF, p. 88-89, text-figs. H (= holotype refigured), 1a-b (= specimen of Schaaf, 1981, pl. 5, figs. 4a-b), 2, 4, 5; non text-figs. 3a-b.
1986 *Parvicingula cosmoconica* (FOREMAN). - OKAMURA & MATSUGI, p. 124, pl. 2, fig. 13.
non 1988 *Xitus alievi* (FOREMAN). - THUROW, p. 408, pl. 7, fig. 2 (= *X. clava*).
non 1988 *Xitus* sp. cf. *Xitus alievi* (FOREMAN). - THUROW, p. 408, pl. 7, fig. 3.
non 1988 *Parvicingula* cf. *alievi* VISHNEVSKAYA, pl. 6, fig. 5.
non 1989 *Xitus* cf. *alievi* (FOREMAN). - KATO & IWATA, pl. 4, fig. 4.
1989 *Xitus alievi* (FOREMAN). - TUMANDA, p. 40, pl. 4, fig. 12.
1989 *Xitus spicularius* (ALIEV). - TUMANDA, p. 40, pl. 4, fig. 6.
1992 *Parvicingula* cf. *dhimenaensis* BAUMGARTNER. - OZVOLDOVA & PETERCAKOVA, pl. 4, fig. 2.
1992 *Xitus alievi* (FOREMAN). - TAKETANI & KANIE, text-fig. 5. 15.
1993 *Xitus alievi* (FOREMAN). - WU, p. 127, pl. 4, fig. 1.
1994 *Xitus* (?) *alievi* (FOREMAN). - JUD, p. 117, pl. 24, fig. 4.

Holotype: Holotype designated by Foreman (1973b, pl. 9, fig. 10). This specimen has been reported from the Valanginian-early Hauterivian (*Sethocapsa trachyostraca* assemblage of Foreman) of DSDP Leg 20 at site 196 (north-west Pacific Ocean).

Photographed material: 4 specimens.

Description: Test as with genus, usually with nine to eleven post-abdominal chambers. Test elongate conical and relatively constricted. Cephalis conical, imperforate, sharply pointed apically and seemingly lacking an apical horn. Thorax and abdomen subtrapezoidal in outline; thorax very sparsely perforate. Abdomen weakly perforate, faintly ornamented with initial development of the pore frames of the inner lattice layer. Post-abdominal chambers trapezoidal in outline; width and height increasing slightly and in about equal degree, distalmost chamber slightly decreasing in width and usually developing a terminal tube, narrower distally (in unbroken specimens). Externally, test composed of a lattice layer (outer layer) having numerous, relatively sharp tubercles and irregular small pores. Tubercles are arranged exclusively on circumferential ridges and are connected through flanking constrictions by slightly massive rays, tubercles not occurring at constrictions.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	375	298	340	257
Maximum width of test	170	140	150	130

Comparisons: *X. alievi* differs from all other congeneric species by displaying tubercles only at ridges, interconnected by means of diagonal bars between adjacent circumferential ridges.

Xitus spicularius (ALIEV, 1965)

Pl. 11, figs. 17-31
Species code 78

1965 *Dictyomitra spicularia* ALIEV. - ALIEV, p. 39, pl. 6, fig. 9; pl. 14, fig. 4 ?.
non 1973b *Dictyomitra* sp. cf. *D. spicularia* ALIEV. - FOREMAN, p. 264, pl. 9, figs. 8, 9 (= *X. clava*).
1975 *Stichomitra asymbatos* FOREMAN. - DUMITRICA, text-fig. 2. 13.
1977c *Xitus antelopensis* n. sp. PESSAGNO, p. 55, pl. 9, figs. 10, 20, 25; pl. 12, fig. 16.
1977c *Xitus plenus* n. sp. PESSAGNO, p. 55, pl. 9, figs. 15, 21, 22, 26; pl. 12, fig. 15.
1977c *Xitus spicularius* (ALIEV). - PESSAGNO, p. 56, pl. 9, fig. 7; pl. 10, fig. 5.
non 1979 *Dictyomitra* sp. cf. *D. spicularia* ALIEV. - NAKASEKO *et al.*, p. 22, pl. 3, fig. 5 (= *X. clava*).

1980 *Xitus spicularius* PESSAGNO. - SCHMIDT-EFFING, text-fig. 31.

? 1981 *Eucyrtis* sp. NAKASEKO & NISHIMURA, p. 152, pl. 11, fig. 4; pl. 17, fig. 1.

non 1981 *Xitus plenus* PESSAGNO. - NAKASEKO & NISHIMURA, p. 164, pl. 10, figs. 3a-b; pl. 16, fig. 13 (= *X. mclaughlini* ?).

non 1981 *Xitus spicularius* (ALIEV). - SCHAAF, p. 440, pl. 4, fig. 11; pl. 5, figs. 12a-b; pl. 19, figs. 2a-b (= *X. clava*).

non 1981 *Xitus* sp. cf. *X. spicularius* (ALIEV). - SCHAAF, p. 441, pl. 4, fig. 12 (= *X. elegans*).

? 1983 *Xitus alievi* (FOREMAN). - ORIGLIA-DEVOS, p. 215, pl. 25, fig. 16.

1983 *Xitus plenus* PESSAGNO. - ORIGLIA-DEVOS, p. 215, pl. 25, figs. 12, 13.

1983 *Xitus spicularius* (ALIEV). - ORIGLIA-DEVOS, p. 217, pl. 25, fig. 17.

non 1984b *Xitus* sp. cf. *X. spicularius* (ALIEV). - BAUMGARTNER, p. 792, pl. 10, figs. 16, 17 (= *X. clava*).

pars 1984 *Xitus spicularius* (ALIEV). - SCHAAF, p. 140-141, text-fig. H (= holotype refigured); non text-figs. 1 (= specimen of Schaaf, 1981, pl. 4, fig. 11), 2a-b and 3a-b (= *X. clava*).

non 1984 *Xitus spicularius* (ALIEV). - YAO, pl. 4, fig. 17 (= *X. clava*).

pars 1986a *Xitus spicularius* (ALIEV). - SUYARI, pl. 3, fig. 13; non pl. 5, fig. 13 (= *X. mclaughlini*).

non 1986b *Xitus spicularius* ALIEV. - SUYARI, pl. 3, fig. 3 (= *X. clava*)

? 1986 *Xitus* cf. *spicularius* (ALIEV). - TERAOKA & KURIMOTO, pl. 6, fig. 5.

1988 *Xitus plenus* PESSAGNO. - THUROW, p. 408, pl. 3, fig. 22.

pars 1988 *Xitus spicularius* (ALIEV). - THUROW, p. 408, pl. 3, fig. 19; non pl. 7, fig. 1 (= *X. clava*).

1988 *Novixitys bjlobgeski* sp. nov. VISHNEVSKAYA, p. 14, pl. 4, figs. 3, 4-5 ?.

pars ? 1988 *Xitys spicularius* VISHNEVSKAYA, pl. 11, fig. 5; non pl. 6, fig. 7.

non 1989 *Xitus antelopensis* PESSAGNO. - GORKA, p. 345, pl. 13, fig. 7.

non 1989 *Xitus spicularius* (ALIEV). - GORKA, p. 346, pl. 13, figs. 6, 8.

non 1989 *Xitus spicularius* (ALIEV). - TUMANDA, p. 40, pl. 4, fig. 6 (= *X. alievi*).

non 1990 *Xitus spicularius* (ALIEV). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 6; pl. 2, fig. 11 (= *X. clava*).

non 1990 *Xitus spicularius* (ALIEV). - OZVOLDOVA, p. 144, pl. 3, figs. 5-7 (= *X. clava*).

non 1992 *Xitus spicularius* (ALIEV). - OZVOLDOVA & PETERCAKOVA, pl. 4, figs. 4, 6 (= *X. clava*).

non 1992 *Xitus spicularius* (ALIEV). - STEIGER, p. 89, pl. 26, figs. 9-11 (= *X. clava*).

non 1992 *Xitus spicularius* (ALIEV). - TAKETANI & KANIE, text-fig. 5. 14 (= *X. clava*).

1993 *Novixitus bjlobgeski* VISHNEVSKAYA. - VISHNEVSKAYA, p. 14, pl. 4, fig. 8 (= specimen of Vishnevskaya, 1988, pl. 4, fig. 3).

non 1994 *Xitus* sp. aff. *X. spicularius* (ALIEV). - JUD, p. 119, pl. 24, fig. 11 (= *X. clava* ?).

Holotype: The specimen reillustrated and specified by Aliev (1965), on pl. 6, fig. 9. The holotype has been reported from the Albian of Konakhkend, (south-eastern Caucasus, NE Azerbaidzhan). This specimen was originally illustrated by this author in an early paper (see reference in Aliev, 1965), which seems not to be available. Nevertheless a reillustration of the original holotype has been recently published (Schaaf, 1981).

Photographed material: 102 specimens.

Description: Test as with genus, usually with five or seven post-abdominal chambers. Test elongate conical to subcylindrical distally; weakly to pronouncedly constricted. Cephalis small, hemispherical and imperforate with long, asymmetrical apical horn. Thorax subtrapezoidal in outline, sparsely perforate. Abdomen slightly globose, covered only by a single lattice layer of circular pore frames, corresponding to the inner layer. Test usually grows spectacularly in width between thorax and abdomen, the latter being almost twice as broad as thorax. Initial post-abdominal chambers increasing slightly in height and moderately rapidly in width as added. Outer layer in post-abdominal chambers having two different tubercular rings: the first one, situated at ridges, with slightly massive tubercles; the second ring weakly marked, with relatively small tubercles and located on the constrictions. All adjacent tubercles are connected by a complex system of delicate transverse bars.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	616	349	392	300
Maximum width of test	200	151	188	121

Remarks: The detailed analysis of the abundant material shows a wide range of variation in the width and the external development of some ornamental characters of the test. Throughout the same population it is possible to find a gradual transition from specimens weakly ornamented to specimens well constricted and frequently having a more densely ornamented outer layer. Pessagno (1977c) introduced two nominal species: *X plenus* (type-species of *Xitus*, herein synonym of *X. spicularius*) and *X. antelopensis* displaying a slight ornamental difference. In fact these morphospecies are morphological end-forms in the constriction-sculpture of the test, without possibility of division in a persistent range of variability for a long period the time during which they remain almost unchanged. It must be emphasized that Aliev's holotype appears to be one of the most extreme forms in this continuum, although it is poorly represented in the collected material.

Comparisons: This species differs from all other congeneric species by its small size, its broad conical test, and by possessing large massive tubercles on its test.

Xitus spinosus (SQUINABOL, 1904)

Pl. 12, figs. 1-13
Species code 58

	1904	*Theocorys spinosa* n. sp. SQUINABOL, p. 222, pl. 8, fig. 9.
	1973b	*Dictyomitra somphedia* new species FOREMAN, p. 264, pl. 14, fig. 18.
	1973b	*Dictyomitra* (?) sp. aff. *Lithostrobus rostovzevi* LIPMAN. - FOREMAN, p. 264, pl. 14, fig. 19.
pars ?	1975	*Dictyomitra somphedia* FOREMAN. - FOREMAN, p. 614, pl. 7, fig. 11; non figs. 12, 13.
	1981	*Eucyrtis carnegiensis* CAMPBELL & CLARK. - NAKASEKO & NISHIMURA, p. 152, pl. 11, figs. 1, 2; pl. 17, fig. 3.
	1982	*Xitus takayanagii* n. sp. TAKETANI, p. 62, pl. 5, figs. 5a-b; pl. 12, fig. 14.
	1983	*Xitus pulcher* PESSAGNO - ORIGLIA-DEVOS, p. 216, pl. 25, fig. 14.
	1983	*Xitus* sp. *A*. ORIGLIA-DEVOS, p. 218, pl. 25, figs. 18, 19 ?.
pars	1984	*Obesacapsula somphedia* (FOREMAN). SCHAAF, p. 138-139, text-figs. H (= specimen of Foreman, 1973b, pl. 14, fig. 18); non figs. 1 and 3 (= specimens of Schaaf, 1981, pl. 4, figs. 8, 9; = *T. iracundum* ?), 2 (= specimen of Schaaf, 1981, pl. 4, fig. 6), 4a-b (= specimen of Schaaf, 1981, pl. 20, fig. 2, = *S. elatica* ?).
pars ?	1985	*Obesacapsula somphedia* SANFILIPPO & RIEDEL, p. 609, text- fig. 10. 4a; non text- figs. 10.4b (= specimen of Schaaf, 1981, pl. 4, fig. 8; = *T. iracundum* ?), 10.4.c (= specimen of Schaaf, 1981, pl. 4, fig. 6).
	1986a	*Stichomitra* sp. SUYARI, pl. 3, fig. 12.
non	1993	*Obesacapsula somphedia* (FOREMAN). - TAKAHASHI & LING, p. 98, pl. 3, fig. 8.

Holotype: The single specimen figured by Squinabol (1904, pl. 8, fig. 9) on which the nominal species was based may be considered as holotype. The type-specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 38 specimens.

Description: Test as with genus, usually with four or five post-abdominal chambers. Test large, elongate, subconical to cylindrical in shape. Test externally without constrictions or weakly constricted. Very small cephalis hemispherical and imperforate with long, robust, tapering and asymmetric apical horn. Frequently, outer latticed layer very strongly developed throughout; it can even cover the cephalis, making sometimes only the long tapering horn visible apically. Thorax and abdomen relatively large. Outer latticed layer of abdomen, thorax and first post-abdominal chambers with irregularly sized and shaped polygonal pore frames. Remaining chambers with outer latticed layer composed of numerous irregular subcircular pore frames and minute spinose tubercles heterogeneously distributed over the test surface. The initial ornamentation is rapidly obscured by a successive outgrowth of the outer meshwork in mature stage.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	405	289	353	207
Maximum width of test	125	143	157	120

Remarks: In many aspects, *X. spinosus* appears as a transitional form between peculiar morphological end-forms, slightly constricted and poorly ornamented, of *X. spicularius* and *Tubilustrium iracundum*. Presence of tuberculation finely arranged in earlier growth stages (see pl. 12, figs. 1-3), which generally becomes strongly spinose when the test attains the mature size (pl. 12, figs. 4-13), justifies generic assignment to *Xitus*.

Comparisons: This species differs from all other congeneric species by having a markedly spiny outer layer and a weakly constricted test.

Xitus mclaughlini PESSAGNO, 1977c

Pl. 12, figs. 14-21
Species code 13

1904 *Dictyomitra elegans* n. sp. SQUINABOL, p. 232, pl. 10, fig. 5.
1972 *Stichocapsa* sp. aff. *L. elegans* SQUINABOL. - PETRUSHEVSKAYA & KOZLOVA, p. 546, pl. 2, fig. 7.
1975 *Stichomitra elegans* (SQUINABOL). - DUMITRICA, text-fig 2. 13.
1977c *Novixitus mclaughlini* n. sp. PESSAGNO, p. 54, pl. 9, fig. 17.
1977c *Novixitus* sp. *A*. PESSAGNO, p. 54, pl. 9, fig. 6.
1977c *Novixitus* sp. *B*. PESSAGNO, p. 54, pl. 9, fig. 14.
1979 *Dictyomitra* (?) sp. *A*. NAKASEKO *et al.*, p. 22, pl. 7, fig. 5.
1979 *Dictyomitra* (?) sp. *C*. NAKASEKO *et al.*, p. 22, pl. 7, fig. 3, 4.
1979 *Dictyomitra* (?) sp. *F*. NAKASEKO *et al.*, p. 22, pl. 7, fig. 7.
1979 *Dictyomitra* (?) sp. *H*. NAKASEKO *et al.*, p. 22, pl. 7, fig. 6.
1980 *Novixitus mclaughlini* PESSAGNO. - OKAMURA, pl. 21, figs. 8, 12.
1980 *Novixitus weyli* n. sp. SCHMIDT-EFFING, p. 252-253, text-fig. 33.
non 1981 *Novixitus mclaughlini* PESSAGNO. - DE WEVER, (in DE WEVER & THIEBAULT), p. 589, pl. 2, fig. 3 (= *X. clava*).
pars 1981 *Novixitus weyli* SCHMIDT-EFFING. - NAKASEKO & NISHIMURA, p. 155, pl. 10, figs. 1, 2; non pl. 16, fig. 10.
? 1981 *Xitus plenus* PESSAGNO. - NAKASEKO & NISHIMURA, p. 164, pl. 10, figs. 3a-b; pl. 16, fig. 13.
1982 *Novixitus weyli* SCHMIDT-EFFING. - TAKETANI, p. 62, pl. 5, figs. 9a-b; pl. 12, fig. 11.
1983 *Novixitus dengoi* SCHMIDT-EFFING. - ORIGLIA-DEVOS, p. 211, pl. 25, fig. 4.
1983 *Novixitus* (?) *maclaughlini* PESSAGNO. - ORIGLIA-DEVOS, p. 211, pl. 25, figs. 2, 3.
? 1983 *Novixitus weylii* SCHMIDT-EFFING. - ORIGLIA-DEVOS, p. 212, pl. 25, fig. 5.
1984 *Novoxitus weyli* SCHMIDT-EFFING. - SCHAAF, p. 162-163, text-figs. 9a-b.
pars 1986a *Novixitus mclaughlini* PESSAGNO. - SUYARI, pl. 3, fig. 10; non pl. 8, figs. 10, 11.
1986a *Novixitus* sp. *B* of PESSAGNO. - SUYARI, pl. 8, fig. 9.
pars 1986a *Xitus spicularius* (ALIEV). - SUYARI, pl. 5, fig. 13; non pl. 3, fig. 13.
non 1986b *Novixitus mclaughlini* PESSAGNO. - SUYARI, pl. 3, fig. 7 (= *X. clava*).
1986 *Novixitus weyli* SCHMIDT-EFFING. - TERAOKA & KURIMOTO, pl. 4, figs. 6, 7.
1988 *Novixitus mclaughlini* PESSAGNO. - THUROW, p. 402, pl. 3, fig. 21.
1988 *Novixitus weyli* SCHMIDT-EFFING. - THUROW, p. 402, pl. 4, fig. 1.
1988 *Novixitus* sp. *C*. THUROW, p. 402, pl. 3, figs. 18a-b.
non 1988 *Novixitys mclaughlini* VISHNEVSKAYA, pl. 11, fig. 6.
pars 1989 *Novixitus weyli* SCHMIDT-EFFING. - KATO & IWATA, pl. 8, fig. 9; non pl. 3, fig. 3 (= *X. clava* ?).
1989 *Novixitus* sp. KATO & IWATA, pl. 8, fig. 10.
1991 *Novixitus mclaughlini* PESSAGNO. - MARCUCCI *et al.*, text-figs. 3. f-g.
1993 *Novixitus maclaughlini* PESSAGNO. - BAK, p. 198, pl. 4, fig. 8.

1993 *Novixitus weyli* SCHMIDT-EFFING. - BAK, p. 199, pl. 4, figs. 9-11.

Holotype: The identical generic approach applied in this work to *Dictyomitra elegans* Squinabol, 1904 and *Lithostrobus elegans* Squinabol, 1903b led the first species to be considered as a homonym of *Lithostrobus elegans* Squinabol, 1903b. Both nominal species have been regrouped here under the genus *Xitus*, Pessagno, 1977c. Consequently, *D. elegans* is a rejected homonym and the oldest synonym must be adopted. Nevertheless, the specimen illustrated by Squinabol (1904, pl. 10, fig. 5) must be accepted as the holotype, according to the articles 60a and 71d of the I.C.Z.N. Squinabol's holotype comes from the Scaglia Formation of the Colli Euganei, near the locality of Teòlo (southern Venetian Alps, N. Italy).

Photographed material: 82 specimens.

Description: Test as with genus, usually with four post-abdominal chambers. Test small, broadly conical and well constricted. Cephalis small, hemispherical without apical horn. Thorax subtrapezoidal, sparsely perforate. A single row of pores between torax and abdomen. Abdomen with an incipient row of very small nodes. First post-abdominal chamber with a ring of enormous tubercles belonging to the outer layer; four or five visible in lateral view, occupying the whole of the chamber. Remaining post-abdominal chambers slightly increasing in height and strongly increasing in width as added.

Outer lattice layer composed of a double system of massive tubercular rings, occurring on ridges and constrictions; tubercles in each ring staggered with respect to tubercles in flanking rings. The size of the tubercles in the ridges is always greater than those of the adjacent constrictions, but substantially smaller with respect to the tubercles in the first post-abdominal chamber. A delicate complex of rays connects tubercles on the same ridge ring and tubercles of adjacent constrictions. Frequently the distalmost chamber has a cylindrical to subcylindrical tubular extension lacking tubercles; extension composed of a single layer of meshwork with small, subcircular pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	240	296	367	254
Maximum width of test	170	172	192	163

Remarks: This species shows a considerable range of variation in the development of the tubercular ring of its initial post-abdominal chamber. Because *X. mclaughlini* presents an inflated ring of large tubercles on the initial portion of the test, a possible phylogenetic origin from *X. spicularius* is suggested.

Comparisons: *Xitus mclaughlini* is distinguished from all other congeneric species in having a wide, single row of very large tubercles on its first post-abdominal chamber.

GENUS **TORCULUM** NOV. GEN.

Derivatio nominis: Latin substantive *torculum* -i (n), meaning millstone.

Type species: *Theoconus coronatus* SQUINABOL, 1904.

Diagnosis: Large, distinct lobulate conical, multi-segmented test, with numerous widely spaced post-abdominal chambers. Test having well marked strictures in post-abdominal chambers. Cephalis and thorax conical, generally imperforate, without apical horn. Abdomen subtrapezoidal, sparsely perforate. Initial post-abdominal chambers subtrapezoidal, width and height increasing in about equal degree. Succeeding post-abdominal chambers trapezoidal restricted to a very thick spongy lattice layer of delicate pores, eventually with tubercles or faint nodes occurring

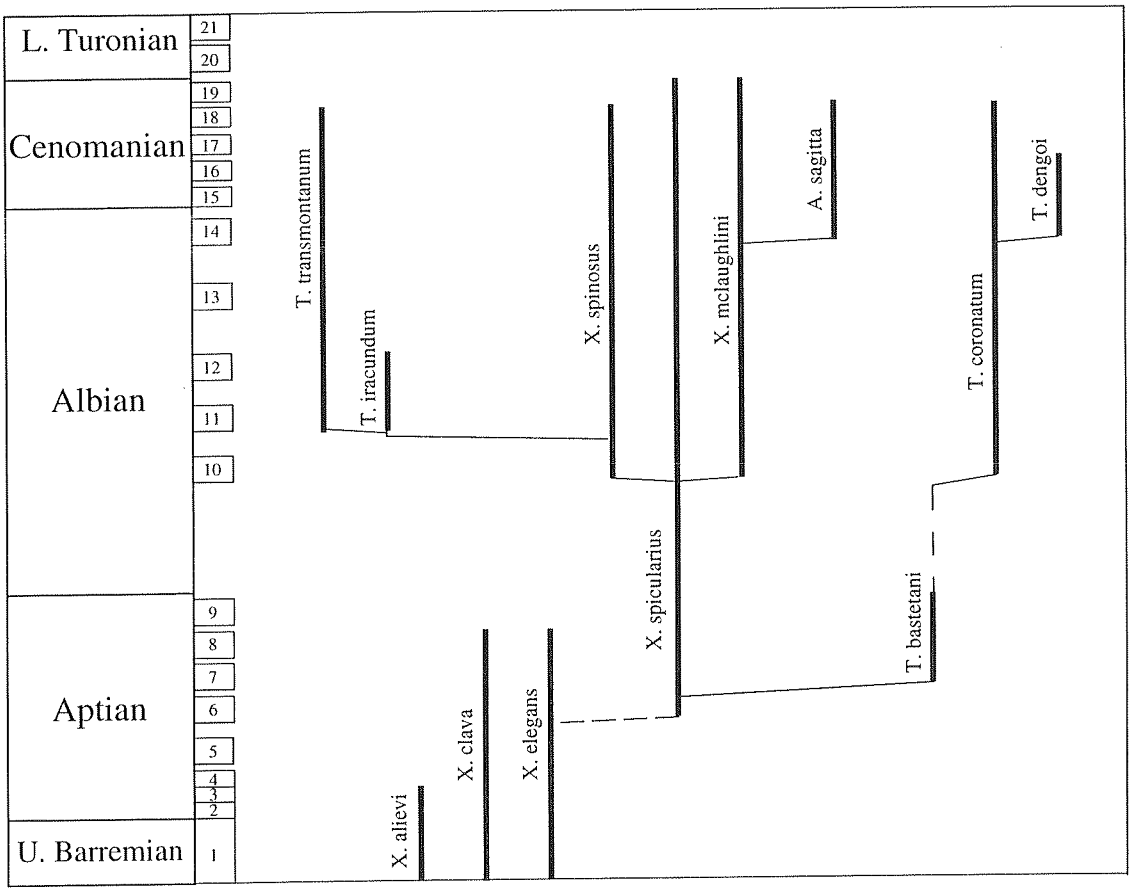

Fig. 17.- Stratigraphic range and possible phyletic relationships of genera and species of the family Xitidae.

irregularly on the initial post-abdominal chambers. A large circular aperture is visible antapically. Occasionally test with a cylindrical terminal tube.

Remarks: The test wall seems to be formed by a single, very thick lattice layer. However, the occurrence of small tubercles (preferentially at ridges) in well constricted specimens, as well as the strong development of the spongy framework, evokes the same growth mechanisms as with *Xitus* (a secondary layer of tubercles and pores building upon the inner layer of small pores). This fact leads to the postulation of the existence of a double (or multiple) set of lattice layers, both closely interconnected, but very difficult to observe, which makes a clear differentiation between layers impossible. From a systematic point of view this character has poor taxonomic value, and therefore the genus is described as if the test wall were composed of a single layer.

The great resemblance in sculpture and development of the lattice layer between some representatives of this genus (like *T. bastetani*) and some Aptian xitids, is quite probably of phylogenetic significance.

Comparisons: *Torculum* differs from *Xitus* by its proportionally wider and more spongy, broadly conical test, the presence of numerous spiny nodes at circumferential ridges, and more constricted test.

Range: Late Aptian to late Cenomanian.

Torculum bastetani nov. sp.

Pl. 12, figs. 22-26
Species code 70

Holotype: Specimen 10606 (pl. 12, fig. 25), from locality no. Pan-1, late Aptian, near Vélez Blanco, Almería (eastern Betic Cordillera, SE Spain).

Derivatio nominis: This species is named after *Bastetani*, Latin name of the old region in the south-east of Spain (actually Baza and Guadix depressions).

Photographed material: 31 specimens.

Description: Test multi-segmented, large conical to cylindrical distally; usually with five or six post-abdominal chambers. Test wall thick, always well constricted and constituted of a lattice layer of polygonal to circular pore frames. Cephalis conical to subspherical, smooth, without apical horn. Thorax and abdomen trapezoidal; thorax sparsely perforate, abdomen slightly perforate, with weak small nodes. First post-abdominal chambers with four or five enlarged tubercles visible in lateral view. Tuberculation progressively fades, and rapidly tends to disappear on distalmost chambers, where exclusively a thick layer of meshwork occurs. Concomitantly, the two last chambers noticeably increase in width. Externally the lattice layer of pore frames on distal chambers occasionally displays linear arrangement; this is particularly evident in the widest portion of test (see pl. 12, figs 24-26).

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	343	321	343	307
Maximum width of test	177	187	210	173

Remarks: *T. bastetani* appears to be transitional between *Xitus* and *Torculum*. Generic attribution to the latter results from the characteristic robust spongy test. This species seems to have evolved from *X. spicularius* by acquiring very massive tubercles concomitantly with a noticeable development of robust spongy-walled test, with marked constrictions. Commonly these changes are associated with a rapid increase in size of the chambers.

Comparisons: *T. bastetani* differs from the closely allied *X. spicularius* by the development of a stoutly tuberculated stage exclusively on the abdomen and first post-abdominal chambers, and in having a wider test distally.

Torculum coronatum (SQUINABOL, 1904)

Pl. 12, figs. 27-28; Pl. 14, figs. 1-29
Species code 245

1904 *Theoconus coronatus* n. sp. SQUINABOL, p. 220, pl. 8, fig. 3.
1961a *Dictyomitra disparlita* sp. n. ALIEV, p. 59, pl. 2, fig. 2.
1961a *Dictyomitra disparlita* sp. n. var. *opstupida* var. n. ALIEV, p. 60, pl. 2, fig. 3.
1965 *Dictyomitra disparlita* ALIEV. - ALIEV, p. 46, pl. 8, fig. 2; pl. 14, fig. 8.
1965 *Dictyomitra disparlita* var. *opstupida* ALIEV. - ALIEV, p. 47, pl. 8, fig. 3; pl. 14, fig. 9.
1967 *Dictyomitra disparlita salabretica* subsp. nov. ALIEV, p. 28, text-figs. z, i.
1976 *Stichomitra* (?) *zamoraensis* n. sp. PESSAGNO, p. 54, pl. 3, figs. 7-9.
1977c *Spongocapsula* (?) *zamoraensis* (PESSAGNO). - PESSAGNO, p. 53, pl. 9, figs, 5, 16.
pars ? 1981 *Amphipyndax tylotus* FOREMAN. - NAKASEKO & NISHIMURA, p. 145, pl. 17, fig. 13; non pl. 12, figs. 11a-b.

	1981	*Novixitus variabilis* n. sp.	NAKASEKO & NISHIMURA, p. 155, pl. 10, figs. 7, 9; pl. 16, fig. 9 ?.
	1981	*Novixitus* (?) sp. *A*.	NAKASEKO & NISHIMURA, p. 156, pl. 10, figs. 10a-b.
	1981	*Spongocapsula* ? *zamoraensis* PESSAGNO.	- SCHAAF, p. 438, pl. 24, figs. 2a-b.
	1982	*Spongocapsula* (?) *zamoraensis* (PESSAGNO).	- TAKETANI, p. 62, pl. 5, figs. 6a-b; pl. 12, figs. 12, 13.
	1983	*Crolanium triquetrum* PESSAGNO.	- ORIGLIA-DEVOS, p. 210, pl. 25, fig. 1.
pars	1983	*Novixitus* sp. *A*.	ORIGLIA-DEVOS, p. 212, pl. 25, figs. 6, 11; non fig. 7.
	1986	*Theoconus coronatus* (SQUIN.).	- KUHNT *et al.*, pl. 7, fig. q.
	1988	*Theoconus coronatus* Group SQUINABOL.	- THUROW, p. 407, pl. 4, fig. 2.
	1988	*Theoconus* sp. *A* cf. *T. coronatus* SQUINABOL.	- THUROW, p. 407, pl. 4, figs. 3, 4.
	1989	*Spongocapsula zamoraensis* (PESSAGNO).	- TUMANDA, p. 40, pl. 7, fig. 14.
	1993	*Spongocapsula* (?) *zamoraensis* (PESSAGNO).	- BAK, p. 193, pl. 3, fig. 10.
non	1994	*Spongocapsula coronata* (SQUINABOL).	- JUD, p. 107, pl. 20, fig. 18 (= *Spongocapsula tripes* JUD, 1994)

Holotype: The holotype may be considered to be the single specimen figured by Squinabol (1904, pl. 8, fig. 3). This specimen has been reported from the red member of the Scaglia Bianca, without precision of locality (Teòlo or Bastia series) in the Colli Euganei in the southern Venetian Alps, N Italy.

Photographed material: 220 specimens.

Description: Test as with genus, usually with five post-abdominal chambers. Cephalis smooth conical, sharply pointed apically, but without apical horn. Thorax small, sparsely perforate, thick walled, not spongy, and trapezoidal in outline. In general, abdomen and first post-abdominal chamber relatively inflated, with a spongy meshwork, densely porous and with numerous randomly disposed, conspicuous nodes (nodes occasionally display a linear arrangement). This nodose inflated neck is present in numerous specimens, but is less evident in constricted forms, where each bulging chamber has a narrow ring of small nodes, emphasising the lobate silhouette of its test. Successive post-abdominal chambers increasing rapidly in width and slowly in height. Distalmost chamber inflated annular to subspherical.

Specimens having very lobate test with deep constrictions may present a long tubular extension on their terminal segment. On the other hand, a narrow and short tubular extension occurs only on weakly constricted specimens.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	460	452	700	355
Maximum width of test	266	238	285	170

Remarks: This species has a wide range of intraspecific variability (see pl. 14). The different development of two features, constrictions and outer ornamentation, simultaneously seems to condition these changes. Different species and varieties described by Aliev (1961a, 1967) are included herein in synonymy with *T. coronatum*. They seem to be distinguishable exclusively by the major or minor intensity of the development of constrictions and the frequency of spiny nodes at ridges. However, the number of available specimens is suitable to demonstrate such a continuous variation in a single population, where these characters appear strongly variable.

T. coronatum ranges through the Albian-Cenomanian and apparently evolved from *T. bastetani*. This hypothesis can nevertheless be questionable because there exists a short gap of information in the fossil record during the early Albian, between the stratigraphic ranges of the two species.

Comparisons: This species differs from *T. bastetani,* which might be its ancestor, by having a very typical initial post-abdominal chamber with a variably inflated nodose neck.

Torculum dengoi (SCHMIDT-EFFING, 1980)

Pl. 15, figs. 1-4

Species code 244

	1980	*Novixitus dengoi* n. sp. SCHMIDT-EFFING, p. 252, text-fig. 30.
non	1983	*Novixitus dengoi* SCHMIDT-EFFING. - ORIGLIA-DEVOS, p. 211, pl. 25, fig. 4 (= *X. mclaughlini*).
	1983	*Novixitus* sp. *1.* ORIGLIA-DEVOS, p. 213, pl. 25, figs. 8, 9.
?	1993	*Novixitus* sp. cf. *N. dengoi* SCHMIDT-EFFING. - BAK, p. 198, pl. 4, fig. 12.

Holotype: The specimen designated by Schmidt-Effing (1980, fig. 30). The holotype has been reported from Capas del Sardinal (presumably early Cenomanian), in the Rio Potrero Grande series, in Santa Elena Peninsula, (NW Costa Rica, Central America)

Photographed material: 6 specimens.

Description: Test broadly conical, well lobulate with four or five post-abdominal chambers. Cephalis conical, rounded apically and without apical horn. Thorax and abdomen sparsely perforate and trapezoidal in outline. Post-abdominal chambers trapezoidal to rectangular in outline; chambers increase gradually in height and strongly in width; distalmost chamber becomes inflated annular, making about a third of the height of the entire test. Outer lattice layer of polygonal pore frames, regularly arranged with thickened walls especially on more distal chambers. Post-abdominal chambers basically ornamented by meshwork of pores. Nodes are lacking or very slightly developed.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	400	328	367	292
Maximum width of test	230	231	263	188

Remarks: This species is closely allied with constricted end-forms in the wide range of variation of *T. coronatum*. Probably the ranges of variability of both species partially overlap, but *T. dengoi* includes very constricted forms with a finer spongy outer layer with nodes lacking or poorly developed.

Comparisons: *T. dengoi* is distinguished from all other congeneric species by possessing (1) post-abdominal chambers very well defined externally, without nodes or tubercles on its outer ornamentation (2) a smaller test and (3) rapidly and strongly increasing width of its terminal chamber.

GENUS **TUBILUSTRIUM** NOV. GEN.

Derivatio nominis: Latin substantive *tubilustrium* -ii (n), meaning in the past the consecration trumpet's day.

Type species: *Tubilustrium transmontanum* nov. sp.

Diagnosis: Test probably has multiple chambers, but these are not clearly divided externally. Test ovate to irregular spindle-shaped. Cephalis small with apical horn. Test wall thick, composed of two or more lattice layers of pore frames. Outer lattice layer built upon and fused to inner lattice layer. Externally, test surface constituted of a meshwork of pore frames of variable size and shape, without any characteristic arrangement and without any other ornamental features. Frequently test distally narrower. Distalmost post-abdominal chamber may develop a terminal tube.

Remarks: Introduction of a new generic name is justified by the presence of an asymmetrical unconstricted test, with a lattice layer of irregular pores, with no ornamental features. Test shape suggests otherwise a probable derivation from *Xitus*.

Comparisons: *Tubilustrium* is distinguished from *Xitus* by having an unconstricted test, by lacking tubercles on its outer latticed layer and by its relatively asymmetrical inflated test.

Range: Middle Albian to late Cenomanian.

Tubilustrium iracundum nov. sp.

Pl. 15, figs. 5-8

Species code 34

pars ? 1981 *Obesacapsula somphedia* (FOREMAN). - SCHAAF, p. 435, pl. 4, figs. 8-9 ?; pl. 20, figs. 1a-b ?; non pl. 4, fig 6; non pl. 20, fig. 2 (= *S. elatica* ?).

pars ? 1984 *Obesacapsula somphedia* (FOREMAN). SCHAAF, p. 138-139, text-figs. 1 and 3 ? (= specimens of Schaaf, 1981, pl. 4, figs. 8, 9), non figs. H (= specimen of Foreman, 1973b, pl. 14, fig. 18; = *X. spinosus*), 2 (= specimen of Schaaf, 1981, pl. 4, fig. 6), 4a-b (= specimen of Schaaf, 1981, pl. 20, fig. 2, = *S. elatica* ?).

Holotype: Specimen 283 (pl. 15, fig. 6), from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *iracundus* -a -um, meaning irritable, irascible.

Photographed material: 9 specimens.

Description: Test large conical, inflated, with a thick, porous spongy wall composed of large, irregular polygonal pore frames throughout. Cephalis small hemispherical and poreless, with a small and slightly asymmetric apical horn, either hidden in the test wall or protruding slightly.

Pores are circular in the outer layer, small on proximal chambers, becoming rapidly larger on distal chambers. Thorax, abdomen and first two or three post-abdominal chambers trapezoidal, gradually increasing in height, strongly increasing in width; remaining post-abdominal chambers slightly reduced in width.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	347	307	347	260
Maximum width of test	197	185	197	177
Length of apical horn	20	18	20	15

Remarks: Specimens assigned to *T. iracundum* could represent wider and less ornamented variants of *X. spinosus*. However, the number of available specimens is not sufficient to demonstrate such a continuous variation.

Comparisons: This species appears to be transitional between *Xitus* and *Tubilustrium*. Generic assignment to the latter results from the characteristic asymmetrical unconstricted test. It must be especially mentioned that both genera co-occur in late Albian-Cenomanian times, but their morphological differentiation is already fully achieved.

Tubilustrium transmontanum nov. sp.

Pl. 15, figs. 9-19
Species code 32

Holotype: Specimen 3280 (pl. 15, fig. 16), locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *transmontani*, (m. pl.), meaning the villages located further over the mountains.

Photographed material: 42 specimens.

Description: Very asymmetric multi-segmented form with prominent hunchbacked silhouette. Test wall thick, composed of at least two (or likely more) lattice layers of polygonal to circular small pore frames, irregularly disposed. Cephalis small, smooth, rounded apically, without apical horn or with a very slightly developed one. Proximal portion of the test narrower and relatively small. Thorax and abdomen trapezoidal; usually a prominent depression occurring in the thoracic-abdominal area. Immediately, successive chambers strongly increasing in width and height, middle portion of the test becomes amorphously inflated. Distally the test decreases rapidly in width and the distalmost chamber becomes strongly compressed. Wide terminal tubular extension, composed of a thick layer of meshwork with small, subcircular pores.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	438	395	483	332
Maximum width of test	213	189	242	143
Length of distal tube	113	83	113	54

Remarks: This species appears to be completely new and is distinguished significantly from all other Cretaceous Nassellariina by its peculiar hunchbacked and asymmetrical test.

GENUS **ANACHORETA** NOV. GEN.

Derivatio nominis: Latin adjective *anachoreta* -ae (m), meaning alone.

Type species: *Anachoreta sagitta* nov. sp.

Diagnosis: Multi-segmented test, slender, pentahedrical. Apical portion of the test (cephalis and thorax) conical. Cephalis small, smooth without apical horn. Remaining chambers (abdomen and post-abdominal chambers) pentagonal in cross section. Closely spaced post-abdominal chambers, with nodose circumferential ridges.

Remarks: Introduction of a new generic name is justified by the presence of abdomen and post-abdominal chambers having pentagonal cross section, a feature hitherto not known among xitids. Test shape and ornamentation otherwise suggest derivation from *Xitus* acquiring a test pentahedrical-shaped. *Anachoreta* is apparently a monospecific taxon ranging from the latest Albian to middle-late Cenomanian times and only the type species has been described. This genus seems to be the last offshoot in the Xitidae before the big extinction occurred at the Cenomanian-Turonian boundary. No other generic descendant is known.

Comparisons: This genus is distinguished from all other Cretaceous multicyrtids by its pentahedrical test.

Range: Latest Albian to middle Cenomanian, as far as known.

Anachoreta sagitta nov. sp.

Pl. 15, figs. 20-26
Species code 11

Holotype: Specimen 5284 (pl. 15, fig. 26), from locality no. Gb-84.40, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *sagitta* - ae, a kind of arrow.

Photographed material: 31 specimens.

Description: Test multicyrtid, slender, pentahedrical, consisting of six to eight post-abdominal chambers, faintly constricted. Apical portion conical. Cephalis small, poreless, conical to rounded, without apical horn. Thorax sparsely perforate, trapezoidal in outline. Abdomen and post-abdominal chambers trapezoidal to rectangular in outline and pentagonal in cross section; width and height increasing very slightly and in about equal degree as added. Each pentahedrical post-abdominal chamber with five bulging vertical edges and with five concave vertical sides (see pl. 15, fig. 20, 26). Test with thick walls. Ornamentation consists of a thick and dense lattice layer of irregular pore frames, which develops nodose circumferential narrow ridges approximately situated at the upper part of each chamber; ridges better developed proximally than distally.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	580	443	580	320
Maximum width of test	205	203	250	165

Remarks: The nodose ridges, a character more pronounced in specimens with a smaller size, may suggest a phylogenetic link from *Xitus*. *Anachoreta* is tentatively regarded as an offshoot of latest *Xitus*, as illustrated by *X. mclaughlini*. Their seemingly common characters are presented exclusively between specimens with small size, where the initial conical shape and the faint ornamentation of the test are comparable to those that occur in *X. mclaughlini*.

FAMILY **AMPHIPYNDACIDAE** RIEDEL, 1967a

Type genus: *Amphipyndax* FOREMAN, 1966.

This suprageneric category includes those multi-segmented forms in which the cephalis, usually having a poreless wall, is divided into chambers by a transverse internal ledge. This family includes the following genera: *Stichomitra* CAYEUX, 1897, *Eostichomitra* EMPSON-MORIN, 1981, *Phalangites* nov. gen. and *Amphipyndax* FOREMAN, 1966.

GENUS **STICHOMITRA** CAYEUX, 1897

Synonyms: *Protostichocapsa* EMPSON-MORIN, 1982; *Vistularia* GORKA, 1989.

Type species: *Stichomitra bertrandi* CAYEUX, 1897 (*Stichomitra compsa* FOREMAN, 1968, posterior subjective synonym); subsequently designated herein. In accordance with the article 69 (recommendation 69b) of the I.C.Z.N., the subsequent designation of Chediya (1959) of *Stichomitra costata* CAYEUX, 1897 (as is indicated in Petrushevskaya & Kozlova (1972) or in Schaaf (1984)) does not constitute a valid designation. Cayeux's description and illustration (op. cit., p. 204, pl. 8, fig. 68), are sufficient to place this species into the genus *Dictyomitra* ZITTEL, 1876. Also, it is not possible to regard as valid the designation indicated in Pessagno (1976) of *Stichomitra jaspidea* RÜST as type species, because this nominal species was not originally included into the type-series. Consequently, I designate as type species the specimen illustrated by Cayeux (1897, pl. 8, fig. 69); giving, in this way, preference to the best described and figured specimen originally included into the nominal genus and assignable to it, after Cayeux's description.

Diagnosis: Multi-segmented forms in which the cephalis, generally with a poreless wall, is structurally divided into two minute portions (sub-chambers) by a transverse internal ledge (branching of the vertical spine, cf. Foreman, 1966). Test elongate conical. Cephalis distinctively tends to be knob-like, sometimes encased in thoracic wall. Cephalis generally without apical horn, seldom slightly developed. Variable number of chambers (five to twelve, occasionally even more). Thick walled test having usually a single hexagonal closely packed layer of pores per chamber. External contour of the test very variable, because strictures between chambers may be poorly to well developed. Test may terminate in an open terminal tube that lacks septal partitions.

Remarks: Numerous nominal species here assigned to *Stichomitra* have been frequently attached to *Amphipyndax* FOREMAN, 1966 in the literature (as example see synonymy of *S. stocki* or *S. mediocris*). However, the nominal genus conspicuously differs from *Amphipyndax* in lacking a secondary layer of test material covering post-abdominal chambers, structurally distinct from underlying layer and forming regularly to irregularly disposed, interconnecting ridges over surface of test. The typical single rows of nodes at circumferential ridges coplanar with segmental division are also absent. In short, the generic designation *Amphipyndax*, as Empson-Morin (1982) remarks, is retained for those forms having two structurally distinct layers of test material. Erroneously at the same time, Empson-Morin believes that the collar pores are situated at the base of the upper cephalic chamber. Nevertheless, the cephalic structure of diverse nominal genera of Amphipyndacidae shows that collar pores and transverse ledge often clearly have the relations illustrated by Foreman (1966, text-fig. 4-9), as has been emphasized also by Sanfilippo & Riedel (1985).

Finally, in spite of these differences in external ornamentation, the close phylogenetic relation that exists between both genera is unquestionable. In this way, the inclusion of *Amphipyndax* in Xitidae by Empson-Morin (1982), and consequently, the nominal species here considered under *Stichomitra* seems not to be justified. Furthermore all the nominal genera here included under Xitidae become extinct at the Cenomanian-Turonian boundary, that is, before the first occurrence of any nominal species of *Amphipyndax*.

Comparisons: *Stichomitra* is easily distinguished from the other Cretaceous multi-segmented forms by its typical pattern of hexagonal close-packed layer of pores per chamber and by a cephalis, frequently dome-shaped, divided into two chambers by a transverse internal ledge. *Stichomitra* is distinguished from *Amphipyndax* in lacking two structurally distinct layers of test material, and furthermore, if circumferential ridges develop, they never occur at segmental divisions.

Range: Late Berriasian to Maastrichtian.

Stichomitra japonica (NAKASEKO & NISHIMURA), in NAKASEKO *et al.*, 1979

Pl. 16, figs. 1-6
Species code 313

pars 1974 *Lithomitra pseudopinguis* TAN SIN HOK. - RENZ, p. 794, pl. 7, figs. 5-6, 7 ?; non pl. 11, fig. 30 (= *S. communis* ?).

1979 *Diabolocampe japonicum* n. sp. NAKASEKO & NISHIMURA (in NAKASEKO *et al.*), p. 21, pl. 7, fig. 8.

1981 *Lithomitra* sp. aff. *L. pseudopinguis* TAN SIN HOK. - NAKASEKO & NISHIMURA, p. 154, pl. 11, figs. 7 (= specimen of Nakaseko *et al.*, 1979, pl. 7, fig. 8), 10.

1983 *Theocorys renzae* SCHAAF. - ORIGLIA-DEVOS, p. 199, pl. 23, fig. 6, 11.

1986a *Theocampe* sp. SUYARI, pl. 3, fig. 9.

Holotype: The single specimen illustrated in Nakaseko *et al.* (1979), on pl. 7, fig. 8, may be considered as the valid holotype, in spite of lacking a description or diagnosis of the species. The holotype has been reported from the late Albian-Cenomanian (*Holocryptocanium barbui - H. geysersensis* assemblage) of the Suzaki Formation (Shimanto belt, SW Japan).

Photographed material: 46 specimens.

Description: Test as with genus. Test small, broadly conical, with four chambers. Cephalis conical to subspherical, tapering apically and poreless. Older specimens slightly smaller in size and developing short apical horn. Post-cephalic chambers subtrapezoidal in outline; strongly increasing in width and slightly in height, final chamber becomes cylindrical. Pores of post-cephalic chambers small, subcircular to polygonal, irregular in size, arranged irregularly or in hexagonal close-packed layers. On the distal cylindrical chamber they may become larger and more irregular in size and arrangement.

Thick walled test, with strictures well developed. There is a tendency to enlarging the pores situated upon the strictures, giving rise to a peculiar system of small robust bars that cross the constrictions vertically. Test with poor development of terminal extension, composed of a weak layer of meshwork with small, subcircular pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	71	155	183	140
Maximum width of test	61	117	125	105
Length of apical horn	-	9	10	7

Remarks: One of the most important radiations occurring during the Mid-Cretaceous seems to have its origin in *S. japonica* (cf. fig. 18), from which evolved the genera *Phalangites*, *Trimulus* and in consequence the lineage *Rhopalosyringium-Prodromus*. A possible phylogenetic link for the nominal species is *S. mediocris*.

In the middle-late Aptian interval, there was observed a changeable population of *S. japonica*. The entire test, especially its three initial chambers, were subject to considerable transformations, rapidly reaching an acutely conical proximal portion typical of *S. simplex*. The peculiar system of small, but robust, bars upon the strictures seems to be a common feature among at least three nominal species here included in *Stichomitra*: *S. japonica*, *S. simplex* and *S. navalis*. Whether or not this group should be assigned to a new distinct genus is a somewhat premature question, but such an alternative would have the merit of faithfully reflecting their intermediate characters between *Stichomitra* and *Rhopalosyringium*. Provisionally, they have been classified with *Stichomitra*.

S. japonica appears to be a transitional species between the genera *Stichomitra* and *Trimulus*. Generic attribution to the former results from the characteristic strictures, always well developed in a test having only a single post-abdominal chamber. This fourth chamber never appears in specimens of *Trimulus*.

Comparisons: This species differs from *S. mediocris* in having well developed strictures and a more sharply pointed apical portion. Ranges of variation of *S. japonica* and its undoubtedly closely allied *Trimulus parmatus* partially overlap. It is relatively easy to distinguish these two species because the latter has only three chambers (with a very small cephalis), no constrictions, an irregular arrangement of pores apically, and bears a large sutural pore between thorax and abdomen.

Stichomitra simplex (SMIRNOVA & ALIEV) in ALIEV & SMIRNOVA, 1969

Pl. 16, figs. 7-12
Species code 300

	1969	*Theocampe simplex* sp. n. SMIRNOVA & ALIEV (in ALIEV & SMIRNOVA), p. 69, pl. 2, figs. 1, 1a.
	1973	? *Eucyrtidium* cf. *E. thiensis* TAN SIN HOK. - MOORE, p. 829, pl. 7, fig. 6.
	1974	*Eucyrtidiun* sp. cf. *E. thiensis* TAN SIN HOK. - RENZ, p. 792, pl. 11, fig. 23.
pars ?	1982	*Stichomitra* sp. OKAMURA & UTO, pl. 2, fig. 15; non pl. 5, fig. 3.
pars	1982	*Stichomitra* sp. *A*. TAKETANI, p. 56, pl. 11, fig. 10; non pl. 3, figs. 11a-b (= *Ph. perspicuus*).
?	1986	*Amphipyndax* sp. *A*. OKAMURA & MATSUGI, pl. 1, fig. 4.

Holotype: The specimen figured by Aliev & Smirnova (1969) on pl. 2, figs. 1,1a (lateral and antapical views respectively) is to be considered as the holotype. This specimen has been reported from the Albian of the Vladimir region (central area of the Russian platform).

Photographed material: 13 specimens.

Description: Multi-segmented test with two portions morphologically well differentiated and conspicuously constricted. The first one, proximal, acutely conical, formed by cephalis, thorax and abdomen. Cephalis conical, sparsely perforate, tapering apically; in youngest specimens a short apical horn may appear. Thorax and abdomen trapezoidal in outline; gradually increasing in height and slightly in width. Pores on post-cephalic chambers small, subcircular, arranged irregularly or quincuncially. Occasionally weak protuberances occur around pores on the abdomen.

The second portion, distal, composed of two globose post-abdominal chambers, strongly increasing in height and width, the terminal chamber reduced in height. Thick walled test with polygonal pores regularly arranged in a hexagonal close-packed layer; pores recessed with blunt nodes or tiny thorns at the corners.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	100	194	225	153
Maximum width of test	62	114	125	95

Remarks: This species ranges through the late Aptian-early Albian. It is quite probable that *S. simplex* evolved from *S. japonica* by means of noticeable modifications of its test, acquiring rapidly an elongate test with two morphologically well differentiated portions, and by adding an additional post-abdominal chamber.

Comparisons: *S. simplex* is distinguished from the otherwise comparable *S. navalis* in lacking lateral spines on the first post-abdominal chamber, and in having one more post-abdominal chamber instead of a terminal tube.

Stichomitra navalis nov. sp.

Pl. 16, figs. 13-17
Species code 92

1973 ? *Eucyrtidium* sp. *A*. MOORE, p. 829, pl. 10, fig. 7.

Holotype: Specimen 132 (pl. 16, fig. 15). This specimen comes from locality. no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *navalis* -e, meaning naval.

Photographed material: 14 specimens.

Description: Test as with genus. Test similar to *S. simplex*, but it has only four chambers and a slender terminal cylindrical tube. Cephalis acutely conical, with long sharply pointed apical horn. Thorax and abdomen narrower than in the ancestor, with small protuberances. The globose first post-abdominal chamber usually has slender lateral spines (four to eight) that extend radially from its medial portion. Lateral spines solid triradiate to circular in cross-section. Test with flaring terminal tube, bearing at least four or more long and robust spines, downwardly directed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	307	303	347	247
Maximum width of test	127	123	132	108
Length of distal tube	87	101	134	87

Remarks: The particular flaring terminal tube and the inflated distalmost chamber, make it not very likely that this species is closely related to the other nominal species here included under *Stichomitra*. However, taking into account the particular test composed of at least four chambers justifies this inclusion. On the other hand it must be emphasized that a very narrow phylogenetic relationship has been established with *S. simplex* and so consequently with *S. japonica*.

S. navalis evolved from *S. simplex*, by later acquisition of lateral spines, coupled with a transformation of the last chamber to a flaring terminal tube.

Comparisons: This form differs from all described species of *Stichomitra* in having an inflated last post-abdominal chamber with usually lateral spines confined to it, and in having a thick flaring terminal tube.

Stichomitra mediocris (TAN, 1927)

Pl. 16, figs. 18-24; Pl. 17, figs. 1-5
Species code 305

1927 *Dictyomitra mediocris* spec. nov. TAN, p. 55, pl. 10, fig. 82.
1969b *Nassellariina* PESSAGNO, pl. 6, fig. B.
1974 *Amphipyndax mediocris* (TAN SIN HOK). - RENZ, p. 788, pl. 5, fig. 7-9; pl. 12, fig. 3.
pars 1973 *Eucyrtis molengraaffi* (TAN SIN HOK). - RENZ, p. 792, pl. 7, figs. 1, 3; non figs. 2, 4 and pl. 11, fig. 32.
1974 *Stichomitra cathara* FOREMAN. - RENZ, p. 797, pl. 11, fig. 17.
pars 1974 *Amphipyndax stocki* (CAMPBELL and CLARK). - RIEDEL & SANFILIPPO, p. 775, pl. 11, fig. 3; non figs. 1, 2 and pl. 15, fig. 11 (= *S. stocki*).
pars 1979 *Amphipyndax stocki* (CAMPBELL & CLARK). - NAKASEKO *et al.*, p. 21, pl. 6, figs. 17-19; non fig. 20 (= *S. magna*).
1979 *Amphipyndax awaensis* n. sp. NAKASEKO & NISHIMURA (in NAKASEKO *et al.*), p. 21, pl. 6, fig. 16.
1981 *Amphipyndax conicus* n. sp. NAKASEKO & NISHIMURA, p. 143, pl. 12, figs. 1, 2; pl. 17, fig. 8.
1981 *Amphipyndax ellipticus* n. sp. NAKASEKO & NISHIMURA, p. 144, pl. 12, figs. 7 (= specimen of Nakaseko *et al.*, 1979, pl. 6, fig. 19), 8a-b .
non 1981 *Amphipyndax mediocris* (TAN SIN HOK). - NAKASEKO & NISHIMURA, p. 144, pl. 12, fig. 6 (= *S. stocki*).
1981 *Amphipyndax mediocris* (TAN SIN HOK). - SCHAAF, p. 431, pl. 3, fig. 11; pl. 22, figs. 7a-b.
1981 *Eucyrtis molengraaffi* (TAN SIN HOK). - SCHAAF, p. 434, pl. 27, figs. 5a-b.
non 1982 *Amphipyndax elliptica* NAKASEKO et NISHIMURA. - OKAMURA *et al.*, p. 97, pl. 18, figs. 7, 7'.

pars 1982 *Amphipyndacid*, gen et. sp. indet. OKAMURA & UTO, pl. 7, fig. 1.; non pl. 2, figs. 11, 12.

1982 Unnamed nassellariinid *E.* WU & LI, pl. 2, fig. 18.

non 1984 *Amphipyndax ellipticus* NAKASEKO & NISHIMURA. - YAO, pl. 5, fig. 26.

1986 *Amphipyndax mediocris* (TAN SIN HOK). - OKAMURA & MATSUGI, pl. 1, fig. 8.

1986a *Amphipyndax conicus* NAKASEKO & NISHIMURA. - SUYARI, pl. 3, fig. 2.

pars 1986a *Amphipyndax ellipticus* NAKASEKO & NISHIMURA. - SUYARI, pl. 3, fig. 4; non pl. 9, fig. 3 and pl. 12, fig. 7 (= *S. stocki*).

pars 1986a *Amphipyndax stocki* (CAMPBELL & CLARK). - SUYARI, pl. 3, fig. 1; non pl. 5, figs. 10, 11; pl. 9, figs. 1, 2; pl. 10, fig. 5; pl. 11, fig. 10; pl. 14, fig. 5; pl. 16, fig. 3; pl. 18, fig. 2; pl. 19, figs. 5, 6 and pl. 12, fig. 5, 6 (= *S. stocki*); non pl. 12, figs. 3, 4.

1986a *Amphipyndax* cf. *stocki* (CAMPBELL & CLARK). - SUYARI, pl. 3, fig. 3.

pars 1988 *Amphipyndax mediocris* (TAN SIN HOK). - THUROW, p. 397, pl. 4, fig. 5; non pl. 1, fig. 7.

1988 *Amphipyndax* (?) sp. THUROW, p. 397, pl. 4, fig. 6.

1988 *Stichomitra livermorensis* (CAMPBELL & CLARK). - TUMANDA & SASHIDA, text-fig. 4. 11.

pars 1988 *Amphipyndax stocki* var *A.* VISHNEVSKAYA, pl. 5, figs. 9 ?, 10; non pl. 12, fig. 14 (= *S. stocki* ?).

1989 *Amphipyndax conicus* NAKASEKO & NISHIMURA. - TUMANDA, p. 35, pl. 7, fig. 10.

1989 *Amphipyndax* sp. *C.* TUMANDA, pl. 8, fig. 8.

1989 *Stichomitra livermorensis* (CAMPBELL & CLARK). - TUMANDA, p. 40, pl. 8, fig. 9 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 11).

1990 *Amphipyndax stocki* (CAMPBELL et CLARK). - OZVOLDOVA, p. 140, pl. 2, fig. 3.

1991 *Amphipyndax mediocris* (TAN SIN HOK). - GORKA, p. 43, pl. 2, figs. 2, 3.

1993 *Amphipyndax stocki* (CAMPBELL et CLARK). - BAK, p. 186, pl. 2, figs. 8-10.

? 1993 *Amphipyndax* sp. *A.* BAK, p. 186, pl. 2, fig. 11.

1993 *Amphipyndax stocki* CAMPBELL and CLARK var *A.* VISHNEVSKAYA. - VISHNEVSKAYA, pl. 3, fig. 10 (= specimen of Vishnevskaya, 1988, pl. 5, fig. 10).

non 1994 *Amphipyndax* (?) *conicus* NAKASEKO and NISHIMURA. - WAKITA & BAMBANG, fig. 6.13 (= *S. stocki*).

Holotype: The single specimen illustrated by Tan (1927, pl. 10, fig. 82), upon which he founded his taxon, may be considered the holotype. This specimen has been reported from the early Cretaceous (unfortunately without more precision) from Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 86 specimens.

Description: Multi-segmented test, conical to cylindrical distally, generally with six to seven chambers. Long hemispherical, knob-like cephalis. Thorax, abdomen and first two post-abdominal chambers subtrapezoidal in outline; remaining chambers cylindrical. A sutural pore may be present on first post-abdominal chambers. Test weakly to not constricted externally. Thick walled test, with subcircular to hexagonal large pores in hexagonal closely packed layers. In older specimens final post-abdominal chamber may become narrowed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	135	202	299	135
Maximum width of test	58	104	125	88

Remarks: Since a large number of specimens has been available from two levels in the late Aptian, the first impression is the wide, continuous morphological variation. A rapid increase in size takes place in the population of *S. mediocris* through this interval, specimens attaining double the size of those from the Barremian strata.

Test shape, size and sutural pore, suggest a direct origin from particular specimens that may be assigned to *Archicorys pulchella* RÜST (1898, pl. 13, fig. 6), in late Valanginian-Hauterivian time. I wish to emphasize that specimens clearly assignable to the latter nominal species have been erroneously cited under *Stichocapsa cribata* HINDE, 1900, (see for example Moore, 1973; Schaaf, 1981, 1984; etc.). Hinde's specimen has a noticeable close spindle-shape quite different from the Neocomian forms frequently assigned to it.

Comparisons: *S. mediocris* is quite comparable to *S. stocki* originally described from Late Cretaceous (Campanian) of California. It is however distinguished from *S. stocki* in having larger pores, fewer rows of pores per chamber, and frequently a large sutural pore on first post-abdominal chambers. Furthermore these species show disconnected stratigraphic ranges (cf. fig. 18). See also comments under *S. stocki*.

Stichomitra communis SQUINABOL, 1903b

Pl. 17, figs. 6-16
Species code 35

1900 *Dictyomitra regularis* PERNER. - HOLMES, p. 702, pl. 38, fig. 10.
? 1900 *Dictyomitra* sp. γ HOLMES, p. 703, pl. 38, fig. 7
1900 *Dictyomitra* sp. ε HOLMES, p. 703, pl. 38, fig. 11
1903b *Dictyomitra euganea* n. sp. SQUINABOL, p. 139, pl. 8, fig. 45.
1903b *Lithocampe obesa* n. sp. SQUINABOL, p. 141, pl. 9, fig. 4.
1903b *Lithocampe veneta* n. sp. SQUINABOL, p. 141, pl. 9, fig. 15.
1903b *Stichomitra communis* n. sp. SQUINABOL, p. 141, pl. 8, fig. 40.
1904 *Dictyomitra aspera* n. sp. SQUINABOL, p. 230, pl. 9, fig. 11.
1904 *Dictyomitra insignis* n. sp. SQUINABOL, p. 233, pl. 10, fig. 6.
1904 *Dictyomitra subtilis* n. sp. SQUINABOL, p. 233, pl. 10, fig. 7
? 1930 *Lithocampe elegans* HINDE. - HEITZER, p. 399, pl. 29, fig. 64a-b.
1961a *Dictyomitra ferosia* sp. n. ALIEV, p. 55, pl. 1, figs. 5-6.
1961a *Dictyomitra ferosia* sp. n. var. *kelevudacica* var. n. ALIEV, p. 56, pl. 1, fig. 7.
1961a *Dictyomitra konachkendiensis* sp. n. ALIEV, p. 57, pl. 1, figs. 8, 9.
1961b *Cyrtocapsa ambiferia* sp. n. ALIEV, p. 66, pl. 1, figs. 4, 5.
1961b *Stichocapsa hemisphaera* sp. n. ALIEV, p. 68, pl. 1, fig. 9.
1965 *Cyrtocapsa ambiferia* ALIEV. - ALIEV, p. 69, pl. 13, figs. 4-5 (= specimens of Aliev, 1961b, pl. 1, figs. 4, 5).
? 1965 *Dictyomitra albiensis* ALIEV. - ALIEV, p. 49, pl. 9, fig. 2; pl. 14, fig. 10.
1965 *Dictyomitra ferosia* ALIEV. - ALIEV, p. 41, pl. 7, fig. 3 (= specimen of Aliev, 1961a, pl. 1, fig. 5).
1965 *Dictyomitra ferosia* var. *kelevudacika* ALIEV. - ALIEV, p. 42, pl. 7, fig. 4 (= specimen of Aliev, 1961a, pl. 1, fig. 7).
1965 *Dictyomitra konachkendensis* ALIEV. - ALIEV, p. 43, pl. 7, figs. 5, 6 (= specimens of Aliev, 1961a, pl. 1, figs. 9, 8); pl. 14, fig. 6.
1965 *Lithocampe rotundata* sp. n. ALIEV, p. 61, pl. 11, fig. 6.
1965 *Stichocapsa hemisphaera* ALIEV. - ALIEV, p. 72, pl. 13, fig. 9 (= specimen of Aliev, 1961b, pl. 1, fig. 9).
1965 *Stichomitra rüsti* sp. n. ALIEV, p. 58, pl. 10, fig. 7.
1967 *Dictyomitra tekschaensis* sp. nov. ALIEV, p. 29, text-fig. k.
pars 1968 *Stichocapsa arca* ALIEV subsp. *varians* subsp. n. ALIEV, p. 31, pl. 1, fig. 9; non fig. 8 (= S. magna ?).
1969 *Dictyomitra ferosia* ALIEV subsp. *angusta* subsp. nov. SMIRNOVA (in ALIEV & SMIRNOVA), p. 71, pl. 2, figs. 2, 2a, 3.
pars ? 1973 *Stichomitra rüsti* ALIEV. - MOORE, p. 828, pl. 7, figs. 8, 9; non fig. 7 (= *C. cuneatum*).
pars ? 1974 *Lithomitra pseudopinguis* TAN SIN HOK. - RENZ, p. 794, pl. 11, fig. 30, non pl. 7, figs. 5-7 (= *S. japonica*).
1975 *Stichomitra* sp. DUMITRICA, text-fig. 2. 21.
pars 1975 *Dictyomitra* spp. cf. *D. tekschaensis* ALIEV. - FOREMAN, p.615, pl. 2H, fig. 1; non pl. 1H, fig. 1.
1978a *Dictyomitra rotundata* (ALIEV). - FOREMAN, p. 841, pl. 1, figs. 1-3.
non 1979 *Stichomitra communis* SQUINABOL. - NAKASEKO *et al.*, p. 24, pl. 7, fig. 10 (= *S. tosaensis* ?).
1980 *Stichomitra* cf. *compsa* FOREMAN. - SCHMIDT-EFFING, p. 251, text-fig. 24.
1981 *Stichomitra* gr. *asymbatos* FOREMAN. - DE WEVER (in DE WEVER & THIEBAULT), p. 593, pl. 1, figs. 9, 18.
? 1981 *Amphipyndax plousios* FOREMAN. - NAKASEKO & NISHIMURA, p. 145, pl. 12, fig. 12.
1981 *Stichomitra communis* SQUINABOL. - NAKASEKO & NISHIMURA, p. 162, pl. 11, fig. 11; pl. 16, fig. 14.
1981 *Stichomitra insignis* SQUINABOL. - NAKASEKO & NISHIMURA, p. 162, pl. 11, fig. 6.
1981 *Parvicingula* ? *tekschaensis* (ALIEV). - SCHAAF, p. 436, pl. 3, fig. 12; pl. 20, figs. 3a-b.

1982 *Stichomitra communis* SQUINABOL. - OKAMURA *et al.*, p. 100, pl. 17, fig. 9.
1982 *Stichomitra communis* SQUINABOL. - TAKETANI, p. 54, pl. 3, fig. 9; pl. 11, fig. 5.
1983 *Stichomitra* sp. cf. *compsa* FOREMAN. - ORIGLIA-DEVOS, p. 165, pl. 18, fig. 11.
1984 *Parvicingula tekschaensis* (ALIEV). - SCHAAF, p. 160-161, text-fig. 5 (= specimen of Schaaf, 1981, pl. 3, fig. 12).
1984 *Stichomitra communis* SQUINABOL. - SCHAAF, p. 162-163, text-figs. 8a-b.
1986 *Stichomitra communis* SQUIN. - KUHNT *et al.*, pl. 7, fig. w
1986a *Stichomitra* aff. *insignis* (SQUINABOL). - SUYARI, pl. 5, fig. 5.
1986a *Stichomitra communis* SQUINABOL. - SUYARI, pl. 11, fig. 8 ?; pl. 15, fig. 12; pl. 17, fig. 9.
1988 *Stichomitra communis* SQUINABOL. - THUROW, p. 406, pl. 4, fig. 10.
1988 *Stichomitra* sp. cf. *S. communis* SQUINABOL. - THUROW, p. 406, pl. 4, fig. 9.
? 1988 *Parvicingula ? tekschaensis* VISHNEVSKAYA, pl. 5, fig. 8.
? 1988 *Stichomitra communis* VISHNEVSKAYA, pl. 4, fig. 6.
1989 *Stichomitra communis* SQUINABOL. - TUMANDA, p. 40, pl. 7, fig. 7.
1989 *Stichomitra* sp. TUMANDA, pl. 8, fig. 6.
1989 *Stichomitra* sp. *E* TUMANDA, pl. 7, fig. 6.
? 1989 *Stichomitra* sp. *F* TUMANDA, pl. 7, fig. 12.
1990 *Stichomitra asymbatos* FOREMAN. - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 11.
1991 *Stichomitra* gr. *asymbatos* FOREMAN. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 4.
1991 *Stichomitra asymbatos* gr. FOREMAN. - MARCUCCI *et al.*, text-fig. 3. e.
1993 *Stichomitra communis* SQUINABOL. - BAK, p. 193, pl. 3, figs. 11-12.
1993 *Stichomitra* sp. cf. *S. communis* SQUINABOL. - BAK, p. 194, pl. 3, fig. 13.
1993 *Stichomitra* sp. *A*. BAK, p. 194, pl. 3, fig. 15.
1994 *S. communis* SQUINABOL. - WAKITA & BAMBANG, fig. 7.8.

Holotype: Nominal species founded on a single specimen, which was described and illustrated by Squinabol (1903b) on pl. 8, fig. 40. The holotype has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 162 specimens.

Description: Test as with genus, usually with eight to eleven post-cephalic chambers. Cephalis conical to subspherical, poreless. Thorax and abdomen well perforate, trapezoidal in outline. Frequently thorax, abdomen and first two post-abdominal chambers separated by deeply marked constrictions (pl. 18, figs. 17, 21, 23). Post-abdominal chambers gradually increasing in height and width as added. Occasionally the two or three distalmost chambers reduced in height and width. Thick walled test, having large pores in hexagonal closely packed layer (four or five rows of pores on each post-abdominal chamber).

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	460	439	517	363
Maximum width of test	172	162	200	138

Remarks: The diverse species and subspecies described by Squinabol or Aliev (see synonymy) clearly show the wide range of variation presented by *S. communis*. This variability is expressed in differences in the number of the chambers and the more or less impressed character of constrictions on its test. A progressive decrease in size has been observed toward younger populations.

Comparisons: By rapid increase of the number of post-abdominal chambers and developing marked constrictions, *S. communis* evolved from *S. mediocris*, which accompanies it through much of its range. *S. communis* later gave rise to *S. magna*, by progressively lengthening of its test concomitantly with loss of external constrictions.

S. communis is easily distinguished from its closely allied *S. magna* by having post-abdominal chambers with bulging lateral sides in outline, which are separated by well marked constrictions.

Stichomitra tosaensis NAKASEKO & NISHIMURA, in NAKASEKO *et al.*, 1979

Pl. 18, figs. 1-8
Species code 9

pars 1974 *Stichomitra asymbatos* group. FOREMAN. - RIEDEL & SANFILIPPO, p. 780, pl. 10, fig. 2; non figs 1, 3-7.
? 1979 *Stichomitra communis* SQUINABOL. - NAKASEKO *et al.*, p. , pl. 7, fig. 10.
1979 *Stichomitra tosaensis* n. sp. NAKASEKO & NISHIMURA (in NAKASEKO *et al.*), p. 24, pl. 7, fig. 11.
1981 *Stichomitra tosaensis* n. sp. NAKASEKO & NISHIMURA, p. 162, pl. 11, fig. 3.

Holotype: The single specimen illustrated in Nakaseko *et al.* (1979), on pl. 7, fig. 11 (originally without description) may be considered the holotype. It has been reported from the late Albian-Cenomanian (*Holocryptocanium barbui- H. geysersensis* assemblage) of the Suzaki Formation (Shimanto belt, SW Japan). The same specimen was again illustrated and described by Nakaseko & Nishimura (1981).

Photographed material: 24 specimens.

Description: Multi-segmented test, conical; usually with six to seven chambers. Cephalis long, typical knob-like to hemispherical or slightly conical. Test has well developed circumferential ridges situated at the middle part of chambers. Post-cephalic chambers with hexagonal closely packed layer of pores. In younger specimens, when present, spines solid, short and extending randomly from various post-abdominal chambers of the test; usually well developed at the base of terminal chamber (pl. 18, fig. 3-4). In older specimens only it is possible to observe that the final post-abdominal chamber may become narrower, developing usually a short terminal tube (pl. 18, fig. 1).

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	142	255	300	215
Maximum width of test	106	158	185	131

Remarks: This species shows a noticeable transformation of its test through the late Albian until the earliest Cenomanian, when it becomes extinct. This modification is expressed in the evolution of the apical portion, leading from a long knob-like to a shorter acutely conical cephalis, where occasionally a minute apical horn may emerge (pl. 20, fig. 8). In oldest specimens the final post-abdominal chamber becomes narrower, and usually develops a short terminal tube. This is rapidly resorpted, replaced by short lateral spines situated at the base of distalmost chamber. Simultaneously test shape becomes more conical distally.

Comparisons: Although there is a great resemblance in sculpture between *S. tosaensis* and *E. bonum*, the occurrence of these species at disjoint stratigraphic levels does not support a direct connection between the two species. Size, shape and number of chambers suggest that *S. tosaensis* evolved from *S. mediocris* by acquiring an externally pronounced segmental division and decreasing the size of pores. The shape of cephalis remained relatively stable during this transformation.

Stichomitra magna SQUINABOL, 1904

Pl. 17, figs. 17-21
Species code 36

1904 *Stichomitra magna* n. sp. SQUINABOL, p. 234, pl. 10, fig. 8.
pars ? 1961b *Stichocapsa arsa* sp. n. var. *cenomanica* var. n. ALIEV, p. 68, pl. 1, fig. 7; non fig. 8.

1965 *Lithocampe rotundata* sp. n. *polycamerata* var. n. ALIEV, p. 62, pl. 11, fig. 7.

pars ? 1965 *Stichocapsa arca* var. *cenomanica* ALIEV. - ALIEV, p. 71, pl. 13, fig. 7; non fig. 8 (= specimens of Aliev, 1961b, pl. 1, figs. 7, 8).

pars ? 1968 *Stichocapsa arca* ALIEV subsp. *varians* subsp. n. ALIEV, p. 31, pl. 1, fig. 8; non fig. 9 (= *S. communis*).

Holotype: Nominal species founded upon a single specimen, which was described and illustrated by Squinabol (1904) on pl. 10, fig. 8. The holotype has been reported from the red member of the Scaglia Bianca Formation at the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 14 specimens.

Description: Long test multi-segmented; usually test with fifteen or sixteen post-cephalic chambers. Externally, constrictions poorly developed or lacking completely. Cephalis hemispherical, knob-like. Relatively thick walled test, with hexagonal close-packed layer of pores per chamber. As growth proceeds, constrictions fade to disappear rapidly externally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	550	656	705	620
Maximum width of test	145	143	150	140

Remarks: Aliev (1961b, 1968) established the varieties *cenomanica* and *varians* for particular forms assigned to *Stichocapsa arsa*, which are characterised by poorly marked constrictions and by slightly narrower distalmost chambers. These species, poorly represented in the study material, could represent transitional forms which mark the beginning of morphological transformation from less constricted forms in the wide spectrum of variability of *S. communis*, which finally evolved to *S. magna*. Simultaneously, a lengthening of the test by adding new chambers occurs. The typical long cylindrical contour of *S. magna* is rapidly attained.

Comparisons: Among the wealth of nominal species assigned to *Stichomitra*, *S. magna* shows patent affinities with *S. communis*, but differs from the latter by having less inflated chambers separated by means of poorly developed strictures resulting in a form non-lobate in outline.

Stichomitra stocki (CAMPBELL & CLARK, 1944)

Pl. 18, figs. 9-15

Species code 370

? 1876 *Dictyomitra polypora* ZITTEL, p. 80, pl. 2, fig. 1.

1944 *Stichocapsa megalocephalia* n. sp. CAMPBELL & CLARK, p. 44, pl. 8, figs. 26, 34.

1944 *Stichocapsa* (?) *stocki* n. sp. CAMPBELL & CLARK, p. 44, pl. 8, figs. 31-33.

1966 *Dictyomitra uralica* sp. n GORBOVETZ (in KOZLOVA & GORBOVETZ), p. 116, pl. 6, figs. 6, 7.

1968 *Amphipyndax plousios* sp. nov. FOREMAN, p. 79, pl. 8, fig. 11.

1968 *Amphipyndax stocki* (CAMPBELL and CLARK). - FOREMAN, p. 78, pl. 8, figs. 12a-c.

1972 *Amphipyndax stocki* (CAMPBELL and CLARK). - PETRUSHEVSKAYA & KOZLOVA, p. 545, pl. 8, figs. 16, 17.

1973a *Amphipyndax stocki* (CAMPBELL and CLARK). - FOREMAN, p. 430, pl. 13, fig. 5.

1973 *Amphipyndax stocki* (CAMPBELL and CLARK). - MOORE, p. 827, pl. 11, fig. 6.

1973 *Lithocampe pseudochrysalis* var. α TAN SIN HOK. - MOORE, p. 828, pl. 8, figs. 4, 5.

pars 1974 *Amphipyndax stocki* (CAMPBELL and CLARK). - RIEDEL & SANFILIPPO, p. 775, pl. 15, fig. 11; pl. 11, figs. 1, 2; non fig. 3 (= *S. mediocris*).

1975 *Amphipyndax stocki* (CAMPBELL & CLARK). - DUMITRICA, text-fig. 2. 23.

1975 *Amphipyndax stocki* (CAMPBELL and CLARK). - PESSAGNO, p. 1016, pl. 4, figs. 4-8.
1978b *Amphipyndax plousios* FOREMAN. - FOREMAN, p. 745, pl. 4, fig. 5.
1978b *Amphipyndax stocki* (CAMPBELL). - FOREMAN, p. 745, pl. 4, fig. 4.
pars 1979 *Amphipyndax stocki* (CAMPBELL & CLARK). - NAKASEKO *et al.*, p. 21, pl. 6, fig. 20; non figs. 17-19 (= *S. mediocris*).
pars ? 1981 *Amphipyndax alamedaensis* (CAMPBELL & CLARK). - NAKASEKO & NISHIMURA, p. 143, pl. 17, fig. 11; non pl. 12. figs. 3, 4.
pars ? 1981 *Amphipyndax alamedaensis* (CAMPBELL & CLARK). - NAKASEKO & NISHIMURA, p. 143, pl. 17, fig. 11; non pl. 12. figs. 3, 4.
1981 *Amphipyndax mediocris* (TAN SIN HOK). - NAKASEKO & NISHIMURA, p. 144, pl. 12, fig. 6.
non 1981 *Amphipyndax plousios* FOREMAN. - NAKASEKO & NISHIMURA, p. 145, pl. 12, fig. 12 (= *S. communis* ?).
1981 *Amphipyndax stocki* (CAMPBELL & CLARK). - NAKASEKO & NISHIMURA, p. 145, pl. 12, fig. 5.
1982 *Protostichocapsa stocki* (CAMPBELL and CLARK). - EMPSON-MORIN, p. 516, text-figs. 1 A-F; text-figs. 2 D-F; pl. 4, figs. 1-12 (figs. 1-3, = lectotype refigured).
1982 *Protostichocapsa streckta* n. sp. EMPSON-MORIN, p. 516, pl. 3, figs. 8-12.
1982 *Amphipyndax stocki* (CAMPBELL et CLARK). - OKAMURA *et al.*, p. 97, pl. 18, figs. 5-6.
1982 *Amphipyndax stocki* (CAMPBELL and CLARK). - TAKETANI, p. 52, pl. 2, figs. 9a-b; pl. 10, figs. 13, 14.
1982 *Amphipyndax* sp. TAKETANI, p. 52, pl. 10, fig. 16.
non 1983 *Amphipyndax* sp. cf. *stocki* (CAMPBELL et CLARK). - ORIGLIA-DEVOS, p. 130, pl. 16, fig. 1.
1984 *Amphipyndax stocki* (CAMPBELL & CLARK). - YAO, pl. 5, fig. 25.
1986 *Amphipyndax stocki* (CAMPELL & CLARK). - KUHNT *et al.*, pl. 7, fig. u.
pars 1986a *Amphipyndax ellipticus* NAKASEKO & NISHIMURA. - SUYARI, pl. 9, fig. 3; pl. 12, fig. 7; non pl. 3, fig. 4 (= *S. mediocris*).
pars 1986a *Amphipyndax stocki* (CAMPBELL & CLARK). - SUYARI, pl. 5, figs. 10, 11; pl. 9, figs. 1, 2; pl. 10, fig. 5; pl. 11, fig. 10; pl. 14, fig. 5; pl. 16, fig. 3; pl. 18, fig. 2; pl. 19, figs. 5, 6; pl. 12, fig. 5, 6; non figs. 3, 4; non pl. 3, fig. 1 (= *S. mediocris*).
non 1986a *Amphipyndax* cf. *stocki* (CAMPBELL & CLARK). - SUYARI, pl. 3, fig. 3 (= *S. mediocris*).
1986 *Amphipyndax stocki* (CAMPBELL & CLARK). - TERAOKA & KURIMOTO, pl. 5, fig. 17; pl. 6, fig. 15; pl. 7, fig. 14, 15.
1988 *Stichomitra* (?) sp. *A*. THUROW, p. 406, pl. 1, fig. 17.
pars ? 1988 *Amphipyndax stocki* var *A*. VISHNEVSKAYA, pl. 12, fig. 14 ?; non pl. 5, figs. 9-10 (= *S. mediocris* ?).
non 1988 *Amphipyndax stocki* var *B*. VISHNEVSKAYA, pl. 3, figs. 5-8.
1988 *Amphipyndax stocki* var *C*. VISHNEVSKAYA, pl. 3, fig. 2.
1989 *Protostichocapsa stocki* (CAMPBELL et CLARK). - GORKA, p. 343, pl. 14, figs. 6, 7 ?.
1989 *Amphipyndax stocki* (CLARK & CAMPBELL). - IWATA & TAJIKA. pl. 1, fig. 8.
1989 *Amphipyndax stocki* (CAMPBELL & CLARK). - TUMANDA, p. 35, pl. 7, fig. 11.
non 1990 *Amphipyndax stocki* (CAMPBELL et CLARK). - OZVOLDOVA, p. 140, pl. 2, fig. 3 (= *S. mediocris*).
1991 *Protoamphipyndax stocki* (CAMPBELL and CLARK). - LING, p. 320, pl. 2, figs. 7-9; pl. 3, figs. 6-7.
? 1991 ? *Stichomitra livermorensis* (CAMPBELL and CLARK). - LING, p. 320, pl. 2, figs. 11-12.
non 1993 *Amphipyndax stocki* (CAMPBELL et CLARK). - BAK, p. 186, pl. 2, figs. 8-10 (= *S. mediocris*).
non 1993 *Amphipyndax stocki* CAMPBELL and CLARK var *A*. VISHNEVSKAYA. - VISHNEVSKAYA, pl. 3, fig. 10 (= specimen of Vishnevskaya, 1988, pl. 5, fig. 10, = *S. mediocris*).
1993 *Amphipyndax stocki* (CAMPBELL and CLARK). - VISHNEVSKAYA, pl. 5, fig. 9.
non 1993 *Amphipyndax* ex gr. *stocki* CAMPBELL and CLARK. - VISHNEVSKAYA, pl. 9, figs. 5-7.
1994 *Amphipyndax* (?) *conicus* NAKASEKO AND NISHIMURA. - WAKITA & BAMBANG, fig. 6.13.

Lectotype: The specimen designated by Empson-Morin (1982), figured on pl. 4, figs. 1-3, with new photographic illustrations under transmitted light from the original type material, which correspond to one of the three illustrated specimens of the type-series previously published by Campbell & Clark (1944, specimen on pl. 8, fig. 33). The lectotype comes from the Late Cretaceous (Campanian) of Tesla Quadrangle, California.

Photographed material: 13 specimens.

Description: Multi-segmented test, conical to cylindrical distally, generally with six to seven chambers. Hemispherical cephalis, knob-like. Post-cephalic chambers subtrapezoidal in outline; only distalmost chambers become cylindrical. Test weakly constricted externally. Thick walled test, with small polygonal pores in regular hexagonal close-packed layers. Final post-abdominal chamber may become narrowed.

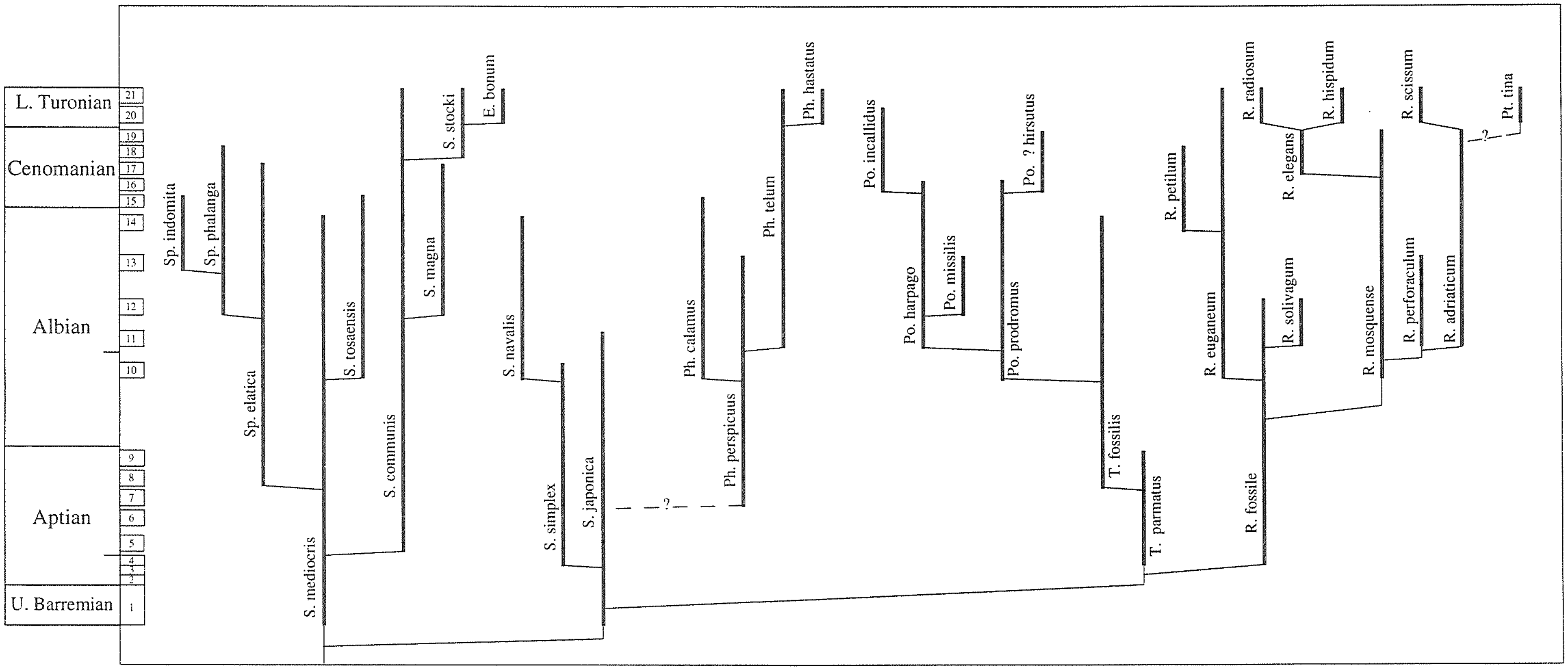

Fig. 18.- Stratigraphic range and phyletic relationships of genera and species of the family Amphipyndacidae and Rhopalosyringiidae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	325	200	258	150
Maximum width of test	131	93	123	75

Remarks: This species has been employed syntypically and with a wrong generic assignation for a long time. Since the illustrations by Foreman (1968) of a number of forms having a single layer of pores, which were tentatively grouped together as *Amphipyndax stocki*, many authors have subsequently identified this species as the most typical for the genus *Amphipyndax* FOREMAN, 1966, almost identifying this nominal species as the type of this group, although the authentic type species of *Amphipyndax* by original designation is *A. enesseffi* FOREMAN, 1966 (not *Lithostrobus (Lithostrobus) pseudoconulus* PESSAGNO, 1963, as was indicated by Empson-Morin, 1982). Nevertheless, this fact does not contradict that undoubtedly *S. stocki* gave rise to the genus *Amphipyndax* in the late Coniacian-Campanian by acquiring a new outer ornamental pattern on its test (single row of nodes at strictures and development of transverse and diagonal ridges). In the Late Cretaceous this tendency toward a major complexity of the test layer seems to be a pattern that will be common to different genera, directly or indirectly evolved from *Stichomitra*. For example, this double layer develops early with representives of the genus *Eostichomitra*. It attains its true structural differentiation with genera like *Foremanina* EMPSON-MORIN, 1981, *Schaumellus* EMPSON-MORIN, 1981 and a number of thick walled Campanian forms (morphologically resembling representatives of the new genus *Torculum*) tentatively grouped as *Xitus* ? and *Novixitus* ? by Empson-Morin 1984. In short, a similar evolutionary pattern of development of the outer layer, observed in diverse genera of Xitidae and Parvicingulidae during the late Aptian-Cenomanian, seems to take place in the Late Cretaceous, starting from species with a single layer of pores, pertaining to the genus *Stichomitra*.

Comparisons: *S. stocki* exhibits a considerable range of variation in the shape of the proximal portion of the test through different populations during Late Cretaceous, although there exists a marked tendency to decrease of size in its lineage. This species is homoemorphic with *S. mediocris* from older strata (Barremian to late Albian), but *S. stocki* may be distinguished by having smaller pores and frequently a sutural pore. Test shape and type of cephalis suggest a derivation of *S. stocki* from *S. communis*.

GENUS **EOSTICHOMITRA** EMPSON-MORIN, 1981

Type species: *Eostichomitra warzigita* EMPSON-MORIN, 1981, by original designation.

Included species:

1966 *Stichopilium bonum* KOZLOVA in KOZLOVA & GORBOVETZ, p. 113.
1968 *Stichomitra asymbatos* FOREMAN, p. 73.
1981 *Eostichomitra warzigita* EMPSON-MORIN, p.280.

Diagnosis: Multi-segmented elongate test, acutely conical, possessing five or more chambers. Cephalis free, neither completely nor partially encased in thoracic wall or cavity. Cephalis small to moderate, subspherical having a sturdy and well-developed apical horn. Thick walled test composed of a quite developed layer of large polygonal pore frames, arranged on each post-cephalic chamber in a hexagonal close-packed layer. Test wall much thicker and better developed on circumferential ridges, not coplanar with segmental division. Lobulate outline more or less pronounced, because it will be conditioned by intensity of the meshwork development. Test ornamented with several medial spines and/or large blunt nodes, that extend radially from circumferential ridges. Large circular aperture distally.

Remarks: A classical mistake in the vast Mesozoic literature, has been materialised upon one of the representatives assignable to this nominal genus, since the illustration by Riedel & Sanfilippo (1974, pl. 10, figs. 1-7) of a chaotic and heterogeneous assemblage of forms ranging through the Late Jurassic and the entire Cretaceous, under the specific name *Stichomitra asymbatos* FOREMAN group, but doubtfully associated with the nominal species. Thereafter frequently, in numerous papers about Late Jurassic or Cretaceous radiolarians, this species was misidentified, with the consequently wrong usage of the nominal species. Only the specimen figured by the cited authors on pl. 10 fig 1 corresponds to *E. asymbatos,* the remaining specimens seem to be assignable to different genera such as *Xitus* and *Stichomitra*. Furthermore, *E. asymbatos* seems to be restricted to younger strata, late Campanian to Maastrichtian (cf. Foreman 1968).

Eostichomitra seems to have evolved from *Stichomitra* by acquiring a sturdy apical horn, concomitantly with a major development of its lattice layer, that incorporate new ornamental features, like spines or blunt nodes at circumferential ridges, which are not situated at segmental division. These new ornamental features are considered as an outer lattice layer (see pictures of *E. bonum* on pl. 19, figs. 16-24). The same evolutive transformation was recorded in late Albian-earliest Cenomanian between *S. mediocris* and *S. tosaensis*. Both species are to be considered as heterochronical homoemorphs.

Comparisons: This nominal genus differs from the closely allied *Stichomitra* in having (1) a sturdy and long apical horn, (2) lateral spines that extend radially from circumferential ridges at post-abdominal chambers, and (3) thick walled test, usually with strong development of meshwork upon segmental division.

Range: Turonian to Maastrichtian.

Eostichomitra bonum (KOZLOVA) in KOZLOVA & GORBOVETZ, 1966

Pl. 18, figs. 16-24
Species code 14

1966 *Stichopilium bonum* sp. n. KOZLOVA (in KOZLOVA & GORBOVETZ), p. 113, pl. 5, fig. 12.
pars 1966 *Lithostrobus rostovzevi* LIPMAN. - KOZLOVA & GORBOVETZ, p. 115, pl. 5, fig. 9; non figs. 7, 8.
1978b *Stichomitra asymbatos* group. FOREMAN. - FOREMAN, p. 748, pl. 4, fig. 15.
1986 *Xitus* sp. *C.* KUHNT *et al.*, pl. 7, fig. y.
1986 *Parvicingulidae* THUROW & KUHNT, text-fig. 9. 9.
1994 *Parvicinglula* (?) sp. WAKITA & BAMBANG, fig. 7.7.
1994 *Stichomitra* sp. WAKITA & BAMBANG, fig. 7.11.

Holotype: The specimen designated and figured by Kozlova (in Kozlova & Gorbovetz, 1966) on pl. 5, fig. 12. The holotype has been reported from the early Campanian at the river Synya series in the western Siberian lowland (Central Asia).

Photographed material: 47 specimens.

Description: Multi-segmented test acutely conical, sometimes becoming cylindrical distally, composed of five or six chambers, trapezoidal in outline, increasing slightly in height toward the aperture; the last-preserved chamber occasionally slightly narrower than the preceding one. Cephalis subspherical, poreless, very thickened at the apex, smooth, except for some specimens which have tiny protrusions apically. Cephalis bearing a very long and quite robust apical horn, circular in cross-section. Thorax cylindrical, perforate. Cephalis and thorax tend to be dome-shaped; frequently both together are hidden by the outgrowing meshwork.

Thick-walled test, well ornamented, slightly constricted, with well developed circumferential ridges at the middle part of each post-cephalic chamber, except on the thorax, where the ridge is only slightly developed, or even completely lacking. Numerous noticeable lateral spines developed on circumferential ridges, slightly downwardly directed. Meshwork, usually with five rows of hexagonal to subcircular pores in a hexagonal close-packed layer arrangement between sharp circumferential ridges. Distalmost chamber with large circular aperture; terminal tube has never been observed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	343	299	323	280
Maximum width of test	129	141	153	132
Length of apical horn	138	87	97	80

Comparisons: It must be emphasized that *S. tosaensis* appears as the morphologically closest *Stichomitra* ally of *E. bonum*, with regard to both test shape and ornamentation. However, *E. bonum* differs from the latter by having the sturdy apical horn. Furthermore, these two species have disconnected stratigraphic ranges (cf. fig. 18). *E. bonum* is generally more stoutly ornamented than all the other congeneric species and is clearly distinguished by having a more sturdy and longer apical horn, and by having numerous, thick and long lateral spines that extend radially from post-abdominal chambers. These are distributed subequally around perimeter of the test and generally downwardly directed.

GENUS **SPONGOSTICHOMITRA** NOV. GEN.

Derivatio nominis: This genus is named from the Latin noun *spongia*, meaning sponge, plus *Stichomitra*; *Spongostichomitra* meaning genus like a spongy *Stichomitra*. Feminine gender.

Type species: *Spongostichomitra phalanga* nov. sp.

Diagnosis: Quite large conical to cylindrical test, with very thick spongy wall. Test not constricted. Primitive forms have probably a small number of chambers (five or six), but in most evolved species these are not visibly divided. Broken specimens exhibit segmental divisions lacking or poorly developed. Apical portion rounded conical to dome-shaped; details of internal structure unknown. Neither apical nor vertical horn appears on cephalis.

Remarks: Introduction of a new generic name is justified by the poor development of segmental division, which probably are hidden or resorpted by strong development of test wall. In addition, the representatives of this genus attain the biggest size among all the middle Cretaceous Nassellariina.

Dimension, shape and structure of test otherwise suggest that the potential ancestor should have a considerable adult size, and poorly constricted test. This is found in *Stichomitra mediocris* which agrees perfectly well in size and wall structure. Furthermore, the latter species shows a rapid, strong increase in size since the late Aptian. The specimens of the younger population attain the double size of the older ones. The first specimens of *S. elatica* show large size and initial stages of development similar to stichomitrids, which rapidly disappear in successive generations. In other words the morphological relationship observed suggests that the evolution of *Stichomitra* to *Spongostichomitra* appears probably as a particular case of ontogenetic heterochrony by accelerated hypermorphosis.

Range: Late Aptian to late Cenomanian.

Spongostichomitra elatica (ALIEV, 1968)

Pl. 18, figs. 25-28
Species code 62

1968 *Dictyomitra elatica* sp. n. ALIEV, p. 26, pl. 1, figs. 1, 2.
pars ? 1974 ? *Stichocapsa procera* HINDE. - RENZ, p. 797, pl. 11, fig. 25 ?; pl. 7, figs. 8, 9 ?; non figs. 10, 11.

? 1979 *Dictyomitra* cf. *elatica* ALIEV. - OZVOLDOVA, p. 14, pl. 5, fig. 3.

pars ? 1981 *Obesacapsula somphedia* (FOREMAN). - SCHAAF, p. 435, pl. 20, fig. 2 ; non pl. 4, fig. 8-9, pl. 20, figs. 1a-b and pl. 4, fig 6.

pars ? 1984 *Obesacapsula somphedia* (FOREMAN). SCHAAF, p. 138-139, text-figs. 4a-b (= specimen of Schaaf, 1981, pl. 20, fig. 2); non text-figs. 1 and 3 (= specimens of Schaaf, 1981, pl. 4, figs. 8, 9), 2 (= specimen of Schaaf, 1981, pl. 4, fig. 6 ; = *X. spinosus*), H (= specimen of Foreman, 1973b, pl. 14, fig. 18; = *X. spinosus*).

Lectotype: When the nominal species was established a holotype was apparently labelled, but Aliev (1968) did not specify which is the specimen chosen. So *Dictyomitra elatica* was essentially defined syntypically. In order to stabilize the taxonomy the specimen originally figured by Aliev on pl. 1, fig. 1, has been selected as the lectotype; it has been reported from the middle Albian of the Pre-Caspian area of Azerbaidzhan.

Photographed material: 12 specimens.

Description: Test as with genus. Four or five chambers separated by slight septal division are observable in transmitted light. Test very thick, spongy walled, externally weakly constricted or lacking constrictions. Cephalis conical to rounded apically; in youngest specimens apex becomes dome-shaped. Test somewhat conical proximally, it rapidly becomes cylindrical distally. Post-abdominal chambers trapezoidal to rectangular in outline, gradually increasing in width, strongly increasing in height; distalmost chamber reduced in width.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	724	546	620	540
Maximum width of test	277	258	300	220

Remarks: *S. elatica* seems to have evolved from *Stichomitra mediocris*, by losing the stichomitrid type cephalis and acquiring a large rounded apex; concomitantly a strong development of the spongy wall took place. Nevertheless, *S. elatica* differs from its ancestor by having a bigger size and lacking constrictions externally. See also remarks under generic description.

Comparisons: The nominal species is easily distinguishable from the type-species *S. phalanga* by possessing a wider test, shorter and usually less rounded apical portion.

Spongostichomitra phalanga nov. sp.

Pl. 19, figs. 1-11
Species code 8

Holotype: Specimen 5213 (pl. 19, fig. 1), from locality no. Gb-84.40, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *phalanga*, -ae (f), meaning a kind of wood roller employed in the past to transport boats out to sea.

Photographed material: 24 specimens.

Description: Test enormously long, slender, cylindrical. Externally test without any constrictions on its spongy meshwork. Apical portion absolutely dome-shaped, somewhat globose. Test with very thick spongy wall. Test probably with few chambers, but these are not visibly divided. Septal divisions are missing, maybe they are faded out by resorption, as a consequence of the strongly outgrowing test wall.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	2220	1312	2220	547
Maximum width of test	200	184	273	133

Remarks: This species seems to have evolved from *S. elatica* (cf. fig. 18) by a strong lengthening of its test, reaching rapidly a long cylindrical stage.

Comparisons: *S. phalanga* differs from all other congeneric species by possessing the longest cylindrical test. Furthermore it differs from the closely allied *S. indomita* by lacking the long typical spines characteristic of this latter species.

Spongostichomitra indomita nov. sp.

Pl. 19, figs. 12-21
Species code 1

Holotype: Specimen 2061 (pl. 19, fig. 12), from locality no. Gc-1035.10, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *indomitus* -a -um, meaning indomitable.

Photographed material: 28 specimens.

Description: Very short test, probably composed of two or three segments. Cephalis globose, subspherical, lacking apical horn. Thorax approximately of same size as cephalis. Test composed of dense spongy meshwork. Distally four or five spines occur, which possibly represent the prolongation of cephalic spines. Usually they are relatively long, circular in cross-section, more or less regularly disposed, and very irregularly curved. The spongy velum frequently strongly developed (pl. 20, figs. 17-19). Test open distally. In some specimens the spines are connected by transverse bars forming a fine lattice framework (pl. 20, figs. 13, 16).

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	440	447	533	267
Maximum width of test	213	212	267	147
Length of longest spine	640	478	658	373

Remarks: This peculiar form has a restricted stratigraphic range (latest Albian to earliest Cenomanian). It appears to be an evolutionary offshoot from *S. phalanga*, and to have left no descendants (cf. fig. 18).

Comparisons: This bizarre form differs from all the other congeneric species by its smallest size, possessing the smallest number of segments and having distinctive distal spines.

GENUS **PHALANGITES** NOV. GEN.

Derivatio nominis: Latin noun *phalangites* -ae (m), meaning military from a phalanx, refers to the slender test.

Type species: *Phalangites calamus* nov. sp.

Diagnosis: Multi-segmented test possessing four or more chambers and having frequently a massive apical horn. Test cylindrical, relatively elongate and slim. Test may terminate in a open, narrow terminal tube tapering distally; only the longest specimens are closed distally. Test composed of single or double lattice layers of pore frames. Inner layer of meshwork consisting of thin, circular pore frames. Outer layer, usually, is formed by interconnected bars.

Remarks: The origin of this group is suspected in late Aptian representatives of *Stichomitra japonica* (see under remarks about the generic assignation of this species). This speciation seems to have occurred through rapid changes, as commonly happened during the Aptian, at least, among the earliest representatives of the different lineages arising from *Stichomitra mediocris* and *S. japonica.* These transformations would have probably been closely conditioned by a quite changeable physical environment, during which an important extinction period took place, affecting both orders of Radiolaria. When normal conditions, near the early-middle Albian boundary, were restored again after such a major extinction period, minor radiations gave rise to the occurrence of numerous species belonging to diverse genera of Amphipyndacidae and Rhopalosyringiidae (fig. 18).

The occurrence of a well-developed second lattice layer of pore frames seems to be a feature typical of most evolved species. In general, the group shows a tendency towards increasing number of chambers, length and complexity of ornamentation.

Comparisons: This genus shows slight resemblance with some early Cretaceous forms closely related to *Pseudoeucyrtis,* but *Phalangites* differs by possessing two lattice layers of pore frames. Furthermore, stratigraphic connection does not exist between the two taxa.

Range: Late Aptian to Turonian.

Phalangites perspicuus (SQUINABOL, 1904)

Pl. 20, figs. 1-6
Species code 242

	1904	*Sethocyrtis perspicua* n. sp. SQUINABOL, p. 215, pl. 7, fig. 10.
	1974	*Eucyrtidium* (?) *boodes* n. sp. RENZ, p. 791, pl. 8. figs. 21, 22; pl. 11, figs. 15a-b.
?	1977c	*Pseudoeucyrtis* sp. *A*. PESSAGNO, p. 59, pl. 11, figs. 5, 9, 10, 12.
pars	1982	*Stichomitra* sp. *A*. TAKETANI, p. 56, pl. 3, figs. 11a-b ; non pl. 11, fig. 10 (= *S. simplex*).

Holotype: The single specimen figured by Squinabol (1904) on pl. 7, fig. 10, may be considered as holotype. This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 11 specimens.

Description: Test multi-segmented, subcylindrical, very long, slim, with numerous post-abdominal chambers. Very small cephalis, conical, bearing a long apical horn. Width of the test gradually reduced distally. No visible constrictions or abdominal ridges separate chambers. Thick test wall; meshwork comprised of two layers: inner layer smooth with small circular pores; outer layer of large hexagonal pores somewhat spongy and arranged quincuncially in adjacent rows. In longest specimens, distalmost chambers quite constricted, probably of greater height and with large circular pores, suggesting the presence of a terminal extension; however, no specimens closed distally or tapering in a terminal spine have been observed.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	400	438	540	320
Maximum width of test	93	89	105	75
Length of apical horn	50	67	95	45

Remarks: Initial stages of development are somewhat comparable to these of *Rhopalosyringium fossile* (this species has in common with *Ph. perspicuus* the same ancestral form by way of *Trimulus parmatus*), but rapidly, *Ph. perspicuus* acquires by progressive addition of new segments a long test, quite different from the typical dicyrtid test of *Rhopalosyringium*. These initial morphological resemblances would be of phylogenetic significance. However, the presence of a multi-segmented test, together with the subsequent development of an outer lattice layer in the members of the generic lineage of *Phalangites*, support the inclusion of this genus into Amphipyndacidae rather than into Rhopalosyringiidae.

The origin of this species probably lay in co-occurring late Aptian *Stichomitra japonica*. The noticeable transformation from *S. japonica* to *Ph. perspicuus* involved the rapid shortening of the cephalo-thoracic portion, which became narrower and tapering in a long apical horn. Progressively, a strong increase in the number of post-abdominal chambers took place.

Comparisons: *Ph. perspicuus* differs from its possible ancestor *S. japonica* by having a very narrow proximal portion, bearing a long apical horn, and by its longer test possessing more post-abdominal chambers. General shape and size of the test, otherwise, comparable to these of *Ph. calamus,* but it differs in having a long apical horn and in lacking circumferential ridges on its test.

Phalangites calamus nov. sp.

Pl. 20, figs. 7-15
Species code 15

1969b *Nassellariina* PESSAGNO, pl. 5, fig. B.

Holotype: Specimen 2370 (pl. 20, fig. 7). The type of the nominal species comes from locality no. Ap2-12, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *calamus* -i (m), meaning fishing rod.

Photographed material: 21

Description: Very long, slender, cylindrically-shaped, multi-segmented test, usually having between thirty and thirty-five postcephalic chambers, separated by sharp circumferential ridges. Narrow conical proximal portion, composed usually of cephalis, thorax and abdomen. Cephalis conical, sparsely perforate, somewhat rounded apically, bearing occasionally a short apical horn. Thorax and abdomen well perforate, trapezoidal in outline with slight development of circumferential ridges. Post-abdominal chambers cylindrical with three rows of pore frames per chamber, distally tends to have only two rows of large subcircular pore frames. Test wall consists of a double lattice layer of pore frames. Pores of inner layer regular in size, subcircular to hexagonal in shape, set in well defined pore frames. Three rows of regular offset pores per chamber; outer rows slope steeply away from ridges, central row usually smaller or relict in proximal chambers, lacking on distalmost chambers. Outer layer of small nodes built slightly upon inner layer of pores and is confined to narrow circumferential ridges. Width of the test gradually reduced distally. Test closed distally, occasionally tapering to a sharply pointed terminal spine.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	920	739	920	593
Maximum width of test	83	70	83	65

Remarks: *Ph. calamus* clearly evolved from *Ph. perspicuus*. Range of variability of both species slightly overlap, but the former species includes robust ornamented forms generally with longer size.

Comparisons: This species is distinguished from its undoubted ancestor *Ph. perspicuus*, which it accompanies through part of its range, by having numerous prominent circumferential ridges and poor development of apical horn. *Ph. calamus* possesses, furthermore, a test generally longer than all other representatives of the genus.

Phalangites telum nov. sp.

Pl. 20, figs. 16-23
Species code 49

Holotype: Specimen 2057 (pl. 20, fig. 19), from locality no. Gc-1035.10, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin, *telum* -i (n), meaning a kind of offensive arm.

Photographed material: 26 specimens.

Description: Test multi-segmented, elongate, cylindrical, with undetermined number of chambers; these are not visibly divided, externally no constrictions or ridges are present between chambers. Cephalis acutely conical, tapering in a long, robust bladed apical horn, which is triradiate in cross-section. Test wall thick. Inner layer of meshwork consisting of thin, subcircular pore frames, arranged in single rows. Outer layer densely porous, built upon and fused to inner layer; pore frames, irregular in size, subcircular and slightly arranged, having some linearity distally. Outer layer is better developed and more irregular in proximal chamber. Test has a large aperture distally.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	508	375	508	262
Maximum width of test	138	138	154	108
Length of apical horn	123	95	123	69

Remarks: *Ph. telum* appears to have evolved from *Ph. perspicuus*, through reduction of the number of post-abdominal chambers, in consequence its test became distally more cylindrical. Progressively, took place a significant development of the outer lattice layer. Furthermore, the evolution of one into the other involved the narrowing of the initial chambers and the transformation from a circular in a triradiate apical horn. Through its stratigraphic range this species shows a gradual tendency towards decreasing size. Finally, *Ph. telum* gave rise to *Ph. hastatus,* a strongly ornamented Turonian form, which possesses, however, a larger size than co-occurring specimens of its ancestor.

Comparisons: *Ph. telum* differs from *Ph. hastatus* in having a much longer and more cylindrical test. Furthermore, the meshwork is finer and irregularly arranged proximally, having some linearity only distally.

Phalangites hastatus nov. sp.

Pl. 21, figs. 1-6
Species code 46

Holotype: Specimen 5820 (pl. 21, fig. 3), coming from locality no. Asv-5-43, early Turonian, (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *hastatus* -a -um, meaning lancer.

Photographed material: 12 specimens.

Description: Multi-segmented test, large, subcylindrical to conical, usually with four to seven post-cephalic chambers. Test lacking strictures or ridges. Cephalis acutely conical, with long, strong apical horn. Cephalocone with slit-like pores (pl. 21, figs. 4, 5). Test wall thick, composed of two lattice layers of pore frames. Inner layer of meshwork consisting of thin, subcircular pore frames with irregular arrangement. Outer layer built upon and fused to inner layer; pore frames large, triangular to polygonal and somewhat regularly arranged, with thickened and spinose walls especially on proximal chambers. Usually, cephalis and base of the apical horn hidden by strong development of the outer lattice layer. Frequently outer layer appears with some linearity on distal chambers. Test distally with large circular aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	363	302	387	227
Maximum width of test	147	149	157	137
Length of apical horn	113	88	113	67

Remarks: This species appears to be an evolutionary offshoot from *Ph. telum*. Range of variability of both species slightly overlap at the base of the Turonian. The evolution of one into the other involved the progressive growth of the outer lattice layer of pore frames.

Comparisons: *Ph. hastatus* differs from *Ph. telum* in having a much larger, more conical test with stronger apical horn. Furthermore, the test possesses a coarser and complex outer lattice layer of meshwork regularly arranged throughout.

SUPERFAMILY **ARTOSTROBIACEAE** RIEDEL, 1967a

This superfamily ranges from the Late Cretaceous through the entire Cenozoic (Riedel, 1967a,b; Petrushevskaya & Kozlova, 1972; Nigrini, 1977; Sanfilippo & Riedel, 1985) and includes at least the families Artostrobiidae Riedel, 1967a and Rhopalosyringiidae Empson-Morin, 1981.

FAMILY **RHOPALOSYRINGIIDAE** EMPSON-MORIN, 1981

(= subfamily Group A, Petrushevskaya & Kozlova, 1972)

Type genus: *Rhopalosyringium* CAMPBELL & CLARK, 1944.

This family includes those genera possessing a test with two, three or four chambers. Cephalis may possess a well-developed vertical tube. Occasionally some representatives of this family may present lateral or terminal appendages. This category comprises at lest, the genera herein considered and those forms classically included in the Cretaceous Artostrobiidae RIEDEL, 1967a.

GENUS **TRIMULUS** NOV. GEN.

Derivatio nominis: Latin *trimulus* -a -um, diminutive of *trimus*, meaning period of three years, refer to the tricyrtid origin of this genus. Masculine gender.

Type species: *Archicorys fossilis* SQUINABOL, 1904

Diagnosis: Test small, conical, commonly having two chambers (eventually three). Test not constricted. Cephalis conical, perforate, usually bearing a minute apical horn. Thorax and abdomen (when it occurs) subtrapezoidal in outline, somewhat inflated. Occasionally, sutural pore located at collar stricture. Test densely porous, pores are subcircular to hexagonal, more or less arranged with some linearity. Test, usually, with a large aperture distally.

Remarks: The test is usually two-segmented in most evolved populations, but earliest representatives show evidence of its tri-segmented ancestor by an abrupt change in shape and pore size between upper part of the thorax and the cephalis. The origin of this group (cf. fig. 18) lay in the Aptian representative of the genus *Stichomitra*. The first specimens of *Trimulus* evidently arose from a precursor of *Stichomitra japonica*. In the rapid transition, not only the number of chamber was reduced and the lumbar stricture lost, but the cephalis became irregularly perforate and the collar stricture externally indistinct.

Comparisons: This genus is distinguished from its undoubtedly closely allied *Stichomitra* in having no more than three chambers in earliest populations, but with time, the definitive and characteristic two-segmented test is rapidly achieved. It differs from *Rhopalosyringium* in having a not constricted test, and the cephalis tending to be conical rather than subspherical.

Range: Early Aptian to latest Albian.

Trimulus parmatus nov. sp.

Pl. 21, figs. 7-12

Species code 308

? 1974 ? *Stichomitra campi* (CAMPBELL & CLARK). - RENZ, p. 797, pl. 11, fig. 16.
? 1983 *Amphipyndax* sp. 2. ORIGLIA-DEVOS, p. 131, pl. 16, fig. 4.

Holotype: Specimen 8368 (pl. 21, fig. 9), from locality no. Ca1-22.30, early Aptian, Carbonero Formation (Valdepeñas de Jaén, S Spain).

Derivatio nominis: Latin substantive, *parmatus* -a -um, meaning in the past the armed soldier with buckler.

Photographed material: 32 specimens.

Description: Test as with genus, conical, with collar and lumbar strictures generally indistinct. Only few specimens among the earliest representatives of this species possess a lumbar stricture slightly expressed externally, upon which a large sutural depression appears. Cephalis conical, perforate, bearing a small acute apical horn. A sutural pore may occur at the junction between cephalis and thorax; occasionally the collar stricture may be somewhat marked externally. Cephalis and upper part of the thorax with large oval-shaped pores with irregular longitudinally arrangement. Distally pores tend to have some linearity.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	140	139	166	112
Maximum width of test	94	102	130	82

Remarks: *T. parmatus* is a transitional form between *Stichomitra* and *Rhopalosyringium*. This species shows a wide range of variation, preferentially at the initial part of its stratigraphic range. The collar and lumbar strictures are vaguely expressed externally in some specimens, in others not at all. With time, thorax and abdomen become smaller and fuse together, the lumbar stricture disappearing. This species appeared suddenly in the middle part of the early Aptian and it was the origin of a major radiation evolved from *Stichomitra japonica*. The transformation leading through this lineage (cf. fig. 18) appears to have been matter of phylogenetic size decrease, together with an important reduction of the number of segments, that gave rise to the important appearance of dicyrtids forms, *Rhopalosyringium*.

Comparisons: *T. parmatus* is distinguished from its ancestor *S. japonica* by its unconstricted test, with irregular arrangement of pores apically, and by bearing a large sutural pore between thorax and abdomen. Furthermore, the former has only two (occasionally three) rather than four chambers.

Trimulus fossilis (SQUINABOL, 1904)

Pl. 21, figs. 13-17
Species code 110

1904 *Archicorys fossilis* n. sp. SQUINABOL, p. 209, pl. 7, fig. 1.

Holotype: The single specimen figured by Squinabol (1904), on pl. 7, fig. 1, is to be treated as the valid holotype. This specimen was reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 10 specimens.

Description: Test as with genus, conical-campanulate to subspherical, test not constricted. Cephalis conical to hemispherical, with a short apical horn, which has the tendency to disappear with phylogeny. Collar and lumbar strictures poorly defined externally, or not at all. In older specimens a circular sutural pore frequently occurs between cephalis and thorax, besides a large sutural depression at joints between thorax and abdomen, even though this latter feature is somewhat rare.

Pores are subcircular to hexagonal, rather regular in size on individuals but vary moderately among specimens, either irregularly arranged (youngest specimens) or tending toward quincuncial arrangement with transverse rows (oldest specimens). Arrangement of pores and general shape of the test vary considerably from specimen to specimen. Test open distally, a small aperture is observable even in the most subspherical forms (pl. 21, fig. 11).

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	247	209	244	170
Maximum width of test	224	185	207	160

Remarks: *R. fossilis* may presumably be regarded as an offshoot from *T. parmatus* by development of a large thorax-abdomen, with dense pores in well-arranged transverse rows. This rapid transformation from *R. fossilis* represented at least a relative increase in size. However, gradually towards the youngest populations of *T. parmatus* a noticeable tendency to reduce the general dimension of the test is observable.

This species shows a spectacular variation in general shape and size of the test through successive populations. At the beginning of its stratigraphic range the length of the cephalis plus thorax is usually 230-245 µm and the test shape is conical to campanulate, while near the end of its range this dimension is about 150-170 µm and the shape tends to be noticeably spherical by reduction of the collar stricture. In earliest specimens, with a conical shape, the collar stricture is slightly expressed externally, so that the conical cephalis merges with the inflated thorax. The only criterion to distinguish the two segments externally is the occurrence of a sutural pore upon the collar stricture. With phylogeny, a progressive reduction of the cephalis takes place (by reducing collar stricture) and the longitudinal sutural pore is resorpted. Concomitantly the reduced cephalis becomes encased into the thoracic cavity, and the test becomes subspherical, not closed.

Comparisons: *T. fossilis* is distinguished from its ancestor *T. parmatus* by its larger size and the well-arranged pores in the thorax and by completely lacking strictures on its test.

GENUS **RHOPALOSYRINGIUM** CAMPBELL & CLARK, 1944

Type species: *Rhopalosyringium magnificum* CAMPBELL & CLARK, 1944, by monotypy.

Diagnosis: Test commonly of two segments. Cephalis usually hemispherical, bearing a well developed apical horn. As was indicated by Foreman (1968), internally the cephalis has a dorsal branch from the apical spine immediately below the top of the cephalic wall not forming a dorsal lobe. Thorax subspherical with or without apertural ring, which may possess up to three spines that extend radially and are frequently downwardly directed distally. Test may terminate in a open tube lacking septal partitions.

Remarks: The ornamentation on the abdomen is regarded as a distinguishing feature at the specific rather than at the generic level. The origin of this genus lay in the Aptian representatives of the genus *Trimulus*, however the biostratigraphic record of the diversification of this group did not take place until the middle Albian (fig. 18).

Comparisons: This genus is distinguished from *Erybotrys* FOREMAN, 1968, by the absence of an apical-dorsal cephalic lobe. It differs from its ancestor *Trimulus* by possessing always two segments with marked strictures and a tendency to develop radial spines, terminal tube and/or apertural ring on its thorax.

Range: Early Aptian to Maastrichtian.

Rhopalosyringium fossile (SQUINABOL, 1903b)

Pl. 21, figs. 18-22
Species code 307

1903b *Theocorys fossilis* n. sp. SQUINABOL, p. 135, pl. 10, fig. 29.
1989 *Diacanthocapsa* sp. *F.* TUMANDA, pl. 7, fig. 16.

Holotype: A valid designation may be considered the single specimen illustrated by Squinabol (1903b) in pl. 10, fig. 29, from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 10 specimens.

Description: Test as with genus. Cephalis imperforate, hemispherical, bearing an acute small apical horn. Collar stricture well marked. Thorax subspherical, with subcircular to hexagonal pores set in regular angular pore-frames. Distally, an initial development of a terminal tube may appear.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	224	139	166	118
Maximum width of test	125	113	124	108
Length of apical horn	14	15	21	12

Remarks: *R. fossile* shows a slight range of variation in the sphericity of the test, a consequence of the decrease of the cephalis. In youngest specimens there is a tendency to develop a premature velum. This feature was well achieved in *R. solivagum*, which evolved from the former by development of the tubular prolongation of the thorax, besides the occurrence of three radial spines.

This taxon appeared suddenly in the early Aptian, and seems to have evolved from *T. parmatus* leading through this lineages the origin of a minor radiation. In the early Albian, an initial offshoot gave rise to *R. mosquense,* a well constricted form with two well-differentiated segments, the former bearing a new character, the apertural ring. This species gave rise to further stocks through Albian and Cenomanian and they seem to be the source of a further important group, the *Pseudotheocampe*, around the Cenomanian-Turonian boundary. They were presumably the origin of the particular species traditionally included into Senonian Artostrobiidae, which implies one of the most important radiation occurring during the Late Cretaceous.

Comparisons: *R. fossile* is distinguished from *R. euganeum* by not having a terminal tube nor circumferential ring at the lumbar stricture. It differs from *R. solivagum* by lacking radial spines on the thorax.

Rhopalosyringium euganeum (SQUINABOL, 1903b)

Pl. 22, figs. 7-13
Species code 64

	1903b	*Pterocorys euganea* n. sp. SQUINABOL, p. 134, pl. 10, fig. 25.
?	1904	*Lychnocanium parvulum* n. sp. SQUINABOL, p. 212, pl. 7, fig. 7.
	1986	*Rhopalosyringium* sp. *A*. THUROW & KUHNT, text-fig. 9. 12.

Holotype: Nominal species based on a single specimen, illustrated by Squinabol (1903b) on pl. 10, fig. 25. The holotype was reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 48 specimens.

Description: Test as with genus. Cephalis hemispherical, poreless, bearing a long, strong, three-bladed apical horn. Cephalis occasionally with horizontal or slightly upward-directed tube (which may correspond to the prolongation of the vertical spine). Thorax subcylindrical, with three long three-bladed feet, downwardly directed. Thoracic pores are fairly large, hexagonal, set in irregular angular pore-frames. Thorax tapering in a long terminal tube, which lacks septal partitions. Pores in this tube are hexagonal with regular arrangement. Lumbar stricture marked by very little change or no change in contour between thorax and terminal tube.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test plus distal tube	300	580	733	342
Maximum width of test	87	116	150	100
Length of apical horn	100	84	117	67
Length of distal tube	187	375	483	217

Remarks: *R. euganeum* directly branched off from *R. fossile*. The former species seems to have evolved by development of a long terminal tube, simultaneously with the appearance on the thorax of three spines downwardly directed. These may correspond to the prolongation of cephalic spines (most probably two primary laterals and one dorsal).

Comparisons: *R. euganeum* is distinguished from the otherwise comparable *R. elegans* by lacking a circumferential ring after the lumbar stricture and by having long three-bladed rather than shorter and circular spines on its thorax.

Rhopalosyringium solivagum nov. sp.

Pl. 21, figs. 23-24
Species code 109

Holotype: Specimen 79 (pl. 21, fig. 24), from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *solivagus* -a um, meaning wandering.

Photographed material: 3 specimens.

Description: Test as with genus. Cephalis poreless, small subspherical, with long apical horn which is circular in cross-section. Test with very small cephalis, somewhat encased and hidden by the growth of the thoracic wall. Thorax spherical, with three short spines that expand radially and are downwardly directed. These radial spines are circular in cross-section. Thoracic pores are moderately large, hexagonal, set in regular circular to angular pore-frames. Thorax may be tapering to a narrow and short terminal tube, which does not possess septal partitions. Pores in this tube are subcircular to polygonal with irregular arrangement. The collar and lumbar strictures are vaguely expressed externally in some specimens, in others not at all.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	393	310	393	227
Maximum width of test	187	182	187	180
Length of apical horn	73	66	73	60
Length of distal tube	127	118	127	110

Remarks: The small subspherical cephalis is frequently obscured by progressive development of the thick test wall. Furthermore, a tendency exists toward a general spherical shape of the test, by reduction of the collar stricture and by a noticeable decrease of the cephalic size. *R. solivagum* is considered an evolutionary offshoot from *R. fossile* and did not leave known descendants (cf. fig. 18) .

Comparisons: This species is distinguished from *R. fossile* by possessing spines that extend radially from the thoracic chamber. From *R. mosquense* it differs, furthermore, in its larger size (the mean size of different populations of *R. solivagum* always attain a bigger size than co-occurring populations of *R. mosquense*) and by having a smaller cephalis.

Rhopalosyringium petilum (FOREMAN, 1975)

Pl. 22, figs. 14-18
Species code 118

1973b *Lithomelissa* (?) sp. FOREMAN, pl. 14, fig. 17.
1975 *Lithomelissa* (?) *petila* new species FOREMAN, p. 616, pl. 1G, figs. 2, 3; pl. 6, fig. 3.

Holotype: Holotype designated and labelled by Foreman (1975); it is the specimen figured in pl. 6, fig. 3, which has been reported from the late Albian (base of *Dictyomitra somphedia* zone of Foreman) of DSDP 307-3-1, 126-128, cored in the north Pacific Ocean.

Photographed material: 8 specimens.

Description: Test elongate, slim, possessing two chambers and terminal tube; test not constricted, or only slightly; the collar stricture may be more or less distinct, depending on the degree of inflation of the cephalic chamber. Cephalis small, spherical, poreless or very sparsely perforate. Cephalis bearing a stout three-bladed, long apical horn. Thorax cylindrical, long, with circular to hexagonal large pores arranged longitudinally. Thorax with two distinctive long, downward-directed spines: these represent the prolongation of vertical and dorsal cephalic spicules. No lumbar stricture occurs at the end of the thoracic chamber, which is prolonged distally as a long terminal cylindrical tube. Terminal tube lacks septal partitions; pores are disposed in continuity with those in thorax. Vertical spine strong, three-bladed and straight, although somewhat curved distally. Dorsal spine is very long, three-bladed and remarkably curved downwardly.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test plus distal tube	333	341	400	253
Maximum width of test	54	89	107	77
Length of apical horn	70	57	73	47

Remarks: It seems most probable that *R. petilum* evolved from *R. euganeum* and left no evolutionary descendants. The cylindrical form of this species is remarkably constant over its entire stratigraphic range. The only variable character in a population is the length and the curvature of the vertical and dorsal spines.

Comparisons: *R. petilum* is conspicuously distinguished from all other congeneric species, by possessing only two distinctive, long, downward-directed spines and by lacking a lumbar stricture with an internal septal division. In addition to this, it differs from its possible ancestor *R. euganeum* by the absence of collar and lumbar strictures (only those particular specimens that possess a thorax somewhat slightly inflated, may present an externally vaguely marked collar stricture).

Rhopalosyringium mosquense (SMIRNOVA & ALIEV) in ALIEV & SMIRNOVA, 1969

Pl. 22, figs. 1-6
Species code 101

?	1904	*Sethocyrtis communis* n. sp. SQUINABOL, p. 216, pl. 7, fig. 12.
	1969	*Sethocyrtis mosquensis* sp. n. SMIRNOVA & ALIEV (in ALIEV & SMIRNOVA), p. 66, pl. 2, fig. 4.
?	1973b	*Theoperid*, Gen and sp. indet. FOREMAN, pl. 14, fig. 14.
	1973	*Rhopalosyringium* sp. *A*. MOORE, p. 826, pl. 7, fig. 1.
?	1975	*Platycryphalus* spp. aff. *P. hirsuta* (SQUINABOL). - FOREMAN, p. 616, pl. 2G, fig. 2, pl. 6, figs. 7-9.
	1980	*Artostrobium urna* FOREMAN. - SCHMIDT-EFFING, p. 254, text-fig. 4.
	1981	*Rhopalosyringium majuroensis* SCHAAF. - NAKASEKO & NISHIMURA, p. 161, pl. 8, fig. 16; pl. 17, fig. 7.
	1981	*Rhopalosyringium majuroensis* n. sp. SCHAAF, p. 437, pl. 6, figs. 2, 3; pl. 23, fig. 5.
?	1981	*Rhopalosyringium* sp. indet. SCHAAF, pl. 23, figs. 2a-b.
	1982	*Rhopalosyringium* sp. cf. *R. magnificum* CAMPBELL & CLARK. - TAKETANI, p. 70, pl. 8, figs. 8a-b.
	1982	*Rhopalosyringium majuroensis* SCHAAF. - TAKETANI, p. 70, pl. 8, figs. 7a-b.
	1982	*Rhopalosyringium obiraensis* n. sp. TAKETANI, p. 70, pl. 8, figs. 4a-b.
	1984	*Rhopalosyringium majuroensis* SCHAAF. - SCHAAF, p. 120-121, text-figs. H (= specimen of Schaaf, 1981, pl. 23, fig. 5), 1a-b (= specimen of Schaaf, 1981, pl. 6, figs. 3, 2), 2-7b.
	1984	*Rhopalosyringium obiraensis* TAKETANI. - SCHAAF, p. 162-163, text-figs. 5a-b.
	1985	*Rhopalosyringuim* sp. cf. *R. majuroensis* SCHAAF. - YAO, pl. 5, fig. 5.
	1986a	*Sethocorys* sp. SUYARI, pl. 3, fig. 8.
	1988	*Rhopalosyringium majuroensis* SCHAAF. - THUROW, p. 405, pl. 4, fig. 15.
	1988	*Rhopalosyringium* sp. *B*. THUROW, p. 405, pl. 4, fig. 16.
	1988	*Rhopalosyringium* sp. *C*. THUROW, p. 405, pl. 4, fig. 17.
	1988	*Rhopalosyringium majuroensis* SCHAAF. - TUMANDA & SASHIDA, text-fig. 4. 17.
	1989	*Rhopalosyringium majuroensis* SCHAAF. - TUMANDA, p.39, pl. 7, fig. 13 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 17).

Holotype: Nominal species based on a single specimen, figured by Aliev & Smirnova (1969) in pl. 2, fig. 4, which is to be treated as the holotype; it comes from the late Albian of Vladimir (central areas of the Russian Platform).

Photographed material: 31 specimens.

Description: Test as with genus. Cephalis large hemispherical, poreless, with a robust three-bladed apical horn. Thorax annular to subglobose with large hexagonal pores, arranged in a regular circular to angular pore frames. At the base of the thorax occurs a prominent apertural ring, which is followed by a long tubular extension. This terminal tube is cylindrical, narrower than the lumbar strictures and composed of a single layer of meshwork which lacks septal partitions.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	127	270	350	238
Maximum width of test	85	118	141	90
Length of apical horn	28	56	80	43
Length of distal tube	-	88	125	60

Remarks: Through the greatest part of its stratigraphic range, the most variable feature is the breadth of the thorax (ranging from about 90 to 135 µm). This species appears to be an evolutionary offshoot from *R. fossile*, and gave rise to numerous species of *Rhopalosyringium* through its temporal range (middle Albian to latest Cenomanian).

Comparisons: *R. mosquense* differs from its ancestor *R. fossile* in tending toward a more subspherical cephalis by development of the collar stricture, and by possessing a marked lumbar stricture followed by a circumferential ring. Furthermore the thoracic chamber may develop a cylindrical terminal tube.

Rhopalosyringium perforaculum nov. sp.

Pl. 21, figs. 25-27
Species code 102

Holotype: Specimen 2727 (pl. 21, fig. 25), from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive, *perforaculum* -i, (n) meaning drill.

Photographed material: 3 specimens.

Description: Test as with genus. Cephalis large, hemispherical, sparsely perforate, without apical horn. Cephalis and thorax separated by a marked collar stricture upon which is frequently located a small sutural pore. Thorax subglobose to annular with bulging sides in outline and delimited by well deep-marked strictures. Thorax with robust longitudinal costae; usually six or seven costae visible in a lateral view. Thoracic pores are disposed longitudinally in single rows between adjacent costae. Lumbar stricture well marked and followed by a prominent circumferential apertural ring.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	108	105	108	98
Maximum width of test	98	90	98	83

Remarks: *R. perforaculum* apparently evolved from *R. mosquense* by the development of robust longitudinal costae on the thorax. In both species appears a strongly developed lumbar stricture, succeeded by a more or less prominent apertural ring. However, no specimens of *R. perforaculum* have been observed bearing a terminal tube.

The progressive resorption of the longitudinal sutural pore between cephalis and thorax might be closely related with the gradual loss of the collar stricture, giving rise to the first representatives of *R. adriaticum*, which rapidly achieves a spindle-shaped test, with longitudinal costae throughout.

Comparisons: *R. perforaculum* is distinguished from all other representatives of the genus by its longitudinal costae, only well developed on the typically bulged thoracic segment. In addition to this, it differs from co-occurring specimens of *R. adriaticum* in that the former species has an abrupt collar stricture, where a sutural pore is usually located.

Rhopalosyringium elegans (SQUINABOL, 1903b)

Pl. 23, figs. 1-6
Species code 365

1903b *Lychnocanium elegans* n. sp. SQUINABOL, p. 130, pl. 8, fig. 34.
1904 *Lychnocanium euganeum* n. sp. SQUINABOL, p. 212, pl. 7, fig. 6.

1975 *Lychnocanium elegans* SQUINABOL. - DUMITRICA, text-fig. 2. 4.

Holotype: The single specimen figured by Squinabol (1903b) on pl. 8, fig. 34, is to be considered the holotype. This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 17 specimens.

Description: Test as with genus. Cephalis large, hemispherical, sparsely perforate to imperforate, bearing a prominent, massive apical horn, which is circular in cross-section. Collar stricture deeply marked. Thorax subcylindrical, with three long massive spines. These appendages are circular in cross-section and are downwardly curved. Pores of the thorax are very regular in size, set in weak angular pore frames. Lumbar stricture more or less well-defined by a change in contour in those specimens possessing an apertural ring. Some specimens occasionally may present a short terminal cylindrical tube.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	125	192	228	172
Maximum width of test	110	121	132	108
Length of apical horn	70	53	64	40

Remarks: The presence of a marked terminal apertural ring in more stoutly ornamented specimens of *R. elegans* suggests a direct phylogenetic link from *R. mosquense*. On the other hand, the gradual retraction of the thoracic spines towards younger populations of *R. elegans*, together with the reduction of the lumbar stricture and the noticeable modification of the cephalic segment, will give rise to the earliest specimens of *R. hispidum* after the Cenomanian-Turonian boundary. The evolutionary process is achieved in this latter species by a progressive development of the thick wall continuing upward from the thorax, enclosing externally the primitive smooth, spherical cephalis.

Comparisons: *R. elegans* differs from its undoubted ancestor *R. mosquense* by having three robust spines in the thorax, which are downwardly directed. *R. elegans* is distinguishable from the otherwise comparable *R. euganeum* by possessing a marked apertural ring followed by a poor development of a terminal tube and by having three short circular rather than long three-bladed thoracic spines.

Rhopalosyringium hispidum nov. sp.

Pl. 23, figs. 7-11

Species code 299

1994 Nassellaria, gen. and sp. indet. WAKITA & BAMBANG, fig. 7.17.

Holotype: Specimen 7002 (pl. 23, fig. 8), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *hispidus*, -a -um, meaning bristly.

Photographed material: 10 specimens.

Description: Test as with genus. Cephalis hemispherical, sparsely perforate, bearing a stout three-bladed apical horn. Collar stricture indistinct externally or weakly marked; only a sutural pore appears at the stricture. The hemispherical cephalis tends to be enclosed by a progressive development of the thick wall continuing upward from the thorax. Gradual changes in the cephalic shape occurs simultaneously with this change in the ornamentation. Thorax annular to subglobose, with large hexagonal pores set in regular circular to angular pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	164	187	204	164
Maximum width of test	120	123	140	104
Length of apical horn	58	60	66	56

Remarks: *R. hispidum* appears to have evolved from *R. elegans* by loss of the radial thoracic spines, simultaneously with a strong development of pores in the cephalis, which noticeably changes from a subspherical to a more large conical shape, consequence of the progressive reduction of the collar stricture.

Comparisons: This species is distinguished from its ancestor *R. elegans* in having a well-perforate cephalis, frequently with sutural pore and by the absolutely absence of radial spines in the thoracic chamber. It differs from co-occurring *R. radiosum* by lacking spines in the thorax and in having more conical rather than a hemispherical cephalis.

Rhopalosyringium scissum nov. sp.

Pl. 23, figs. 12-16
Species code 106

1994 Nassellaria, gen. and sp. indet. WAKITA & BAMBANG, figs. 5.13-14.

Holotype: Specimen 6768 (pl. 23, fig. 13), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *scissus* -a -um, meaning slashed.

Photographed material: 8 specimens.

Description: Test as with genus, somewhat spindle-shaped, rounded apically or bearing a long protruding apical horn. Test lacking strictures, costate throughout, with costae wedging out to the apex; seven to eight costae visible in a lateral view, which arise very near the apex and extend distally on the thorax. Cephalis minute, hemispherical, sparsely perforate, with a tendency to develop a long apical horn, preferentially toward younger populations. Thorax subcylindrical, somewhat barrel-shaped; costae on the thorax may be bifurcated. Thoracic pores tending to form irregular longitudinal rows between adjacent costae; pores are slightly variable in size and are circular to elliptical in shape. Distally these costae may develop longitudinally lamellar feet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	160	140	160	124
Maximum width of test	100	114	130	100
Length of apical horn	-	-	72	-

Remarks: The form of this species is remarkably constant over its known stratigraphic range. The only variable character is the length of the lamellar feet, which depends principally on preservation. In contrast, the apical horn seems to be a character that is developed subsequently in younger populations. Although only rare transitional forms have been found, it appears that *R. scissum* evolved from *R. adriaticum*. In early representatives of *R. scissum* it is observable that the apical portion becomes rapidly more rounded; distally the loss of the circumferential apertural ridge will allow the progressive development of lamellar feet.

Comparisons: *R. scissum* is distinguished from *R. adriaticum* by lacking a circumferential apertural ring and by possessing a well-developed apical horn.

Rhopalosyringium radiosum nov. sp.

Pl. 23, figs. 17-20
Species code 108

Holotype: Specimen 5972 (pl. 23, fig. 19), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *radiosus*, meaning shining.

Photographed material: 9 specimens.

Description: Test as with genus, lacking constrictions externally. Cephalis very small hemispherical, bearing a long three-bladed apical horn. Thorax cylindrical, with a mixture of massive pentagonal and hexagonal pore frames. Thoracic pores very regular in size, set in weak transverse frames, usually with prongs on their margins. Three short feet extending from base of thorax and downwardly directed; feet are triradiate in cross-section at the origin, but rapidly tending to be circular distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	205	186	205	155
Maximum width of test	135	133	140	125
Length of apical horn	75	62	75	53

Remarks: *R. radiosum* is undoubtedly evolved from *R. elegans* by loss of the three thoracic radial spines and by an important modification of the shape and ornamentation of the cephalic segment. An evidence of this morphologic change is the occurrence of a longitudinal sutural pore near the collar stricture.

Comparisons: *R. radiosum* differs from *R. hispidum* in lacking three spines downwardly directed on its thorax and in having a hemispherical cephalis well-perforate, which can be slightly differentiated externally from the thorax, or not at all. In addition to this, it differs from its closely allied *R. elegans* by not possessing a marked circumferential apertural ring.

Rhopalosyringium adriaticum nov. sp.

Pl. 24, figs. 1-2
Species code 93

1979 *Theoperid*, Gen. et sp. indet. NAKASEKO *et al.*, p. 24, pl. 7, fig. 9.

1981 Unnamed Nassellaria NAKASEKO & NISHIMURA, pl. 13, fig. 8 (= specimen of Nakaseko *et al.*, 1979, pl. 7, fig. 9).

1981 Gen. and sp. indet. SCHAAF, pl. 5, figs. 5a-b.

1988 *Theocampe* sp. TUMANDA & SASHIDA, text-fig. 4. 16.

1989 *Theocampe* sp. TUMANDA, p. 40, pl. 8, fig. 13.(= specimen of Tumanda & Sashida, 1988, text-fig. 4. 16).

Holotype: Specimen 4266 (pl. 24, fig. 1), from locality no. Gc-1094.48, latest Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: *Adriaticum*, Latin name of the Adriatic sea.

Photographed material: 3 specimens.

Description: Test as with genus, costate throughout. Cephalis small, conical to rounded apically, lacking apical horn. Thorax spindle-shaped, with approximately five to seven costae in a lateral view, costae wedging out toward the apex. Pores are variable in size, circular to elliptical in shape, tending to form irregular longitudinal rows between the costae. Some costae elements are occasionally bifurcated or staggered. Lumbar stricture narrow, well marked, and followed by a circumferential apertural ring. Test may terminate in a long open terminal tube. This massive terminal appendage possesses large circular pores in irregular arrangement.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	107	108	114	105
Maximum width of test	82	88	94	80

Remarks: *R. adriaticum* is the last member of the rapid lineage leading from *R. mosquense* through *R. perforaculum*, and seems to give rise to the earliest representatives of *Pseudotheocampe* since the Turonian.

Comparisons: *R. adriaticum* differs from its probable ancestor *R. perforaculum* by lacking a sutural pore and a collar stricture on the proximal part of its test. Furthermore it is distinguished by having well developed costae from the apex up to the lumbar stricture.

GENUS **PSEUDOTHEOCAMPE** EMPSON-MORIN, 1981

Synonyms: ? *Theocampe* Haeckel, 1887 (nomen dubium).

Type species: *Pseudotheocampe abschnitta* EMPSON-MORIN, 1981, by original designation.

Diagnosis: Test possesses three segments. Cephalis usually hemispherical to subspherical, sparsely perforate and bearing or not an apical horn. Collar stricture not visible externally. Thorax small, conical to subcylindrical, perforate, occasionally with thickened irregular ridges that produce a slightly rough surface. Lumbar stricture well marked and preceded by a protuberant circumferential ring. Third segment elongate, somewhat inflated, commonly with longitudinal costae and transverse ridges that delimit square areas. The ornamentation on the abdomen is regarded as a criterion of classification at the specific level. Test distally with a restricted aperture surrounded by a distinct apertural ring.

Remarks: During the last twenty years many workers (Burma, 1959; Foreman, 1968; Petrushevskaya & Kozlova, 1972; Foreman, 1973a; Nigrini, 1977; Sanfilippo & Riedel, 1985; Empson-Morin, 1981) have included species assignable to this genus under *Theocampe*. Unfortunately, the single illustration of the type species of this latter genus, *Dictyomitra ehrembergi* ZITTEL, 1876 (subsequent designation by Campbell, 1954) is exceedingly poor to establish classification at the specific level; furthermore the Zittel's diagnosis involves that a broad assemblage of Late Cretaceous tricyrtids might be placed in this group though belonging to different genera. It is suggested, therefore, that the name *Theocampe* be regarded as *nomen dubium*. In this way, it is to be considered that only all of the Late Cretaceous species classically assigned to the genus *Theocampe* (sensu Sanfilippo & Riedel, 1985) belong to *Pseudotheocampe*, and all other Cenozoic forms are excluded. *Pseudotheocampe abschnitta* (type species of *Pseudotheocampe*) seems to be closely related to the Late Cretaceous species previously placed in the genus *Theocampe*; for this reason, I employ the nominal genus *Pseudotheocampe* as valid name for the Late Cretaceous "theocampids".

Pseudotheocampe appears to have evolved from latest Cenomanian representatives of *Rhopalosyringium*, by introduction of a new segment on its test, concomitantly with strong development of a circumferential ring at the base of thorax and abdomen, which are directly controlled by the strictures; progressively the test becomes more or less strongly constricted depending on the degree of the inflation of the abdomen.

Comparisons: *Pseudotheocampe* is distinguished from *Rhopalosyringium* by having more constricted test with thorax and abdomen both followed by a well-developed circumferential ring and by possessing always three rather than two segments.

Range: Turonian to Maastrichtian.

Pseudotheocampe tina (FOREMAN, 1971)

Pl. 24, figs. 3-5

Species code 103

	1971	*Artostrobium tina* new species FOREMAN, p. 1678, pl. 4, fig. 3.
	1973	*Artostrobium tina* FOREMAN. - MOORE, p. 826, pl. 8, fig. 6.
pars	1974	*Artostrobium urna* FOREMAN. - RIEDEL & SANFILIPPO, p. 775, pl. 11, fig. 5; non figs. 4, 6 (= *Pt. urna*).
	1975	*Artostrobium tina* FOREMAN. - FOREMAN, p. 613, pl. 1F, figs. 3, 4 ?, 5; pl. 6, fig. 5.
non	1981	g. sp. indét. (cf. *Artostrobium tina*) DE WEVER (in DE WEVER & THIEBAULT), p. 594, pl. 1, figs. 11, 12.
?	1981	*Artostrobium tina* FOREMAN. - SCHAAF, p. 432, pl. 24, figs. 6a-b.
	1982	*Artostrobium tina* FOREMAN. - TAKETANI, p. 53, pl. 2, figs. 11a-b.
	1985	*Theocampe tina* SANFILIPPO & RIEDEL, p. 605, text-figs. 9. 5a-c.
non	1988	*Theocampe tina* (FOREMAN). - THUROW, p. 407, pl. 1, fig. 6 (= *Pt. urna*).
pars	1994	*T. urna* (FOREMAN). - WAKITA & BAMBANG, fig. 6.10, non fig. 6.9 (= *Pt. urna*).
	1994	*Theocampe* sp. cf. *T. urna* (FOREMAN). - WAKITA & BAMBANG, fig. 7.20.
	1994	*Theocampe* sp. WAKITA & BAMBANG, fig. 7.23.

Holotype: Nominal species designated and labelled by Foreman (1971); it is the single specimen figured by this author in pl. 4, fig. 3. The holotype has been reported from the Site 61 Hole 0-1-CC cored on DSDP Leg 7 in the W Pacific Ocean.

Photographed material: 4 specimens.

Description: Tri-segmented test, relatively elongate. Cephalis small hemispherical, bearing a short, somewhat bladed apical horn. Thorax subtrapezoidal, perforate; small pores circular, disposed in longitudinal arrangement. Lumbar stricture well marked and preceded by a thick circumferential ring. Abdomen large, expanded medially to distally but constricted at the distalmost end, having a deeply marked abdominal stricture followed by a prominent circumferential apertural ring. Pores of abdomen small circular. Abdominal costae most strongly developed proximally with gradual thinning distally and occasionally bifurcating at its upper part.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	155	149	168	133
Maximum width of test	87	82	92	75

Remarks: This species shows a wide range of variation in the development of ornamentation, and varies only slightly in the lumbar and terminal stricture being more or less distinct, depending on the degree of inflation of the abdomen, likewise in the development of the abdominal and apertural ring. This species appears to have evolved from the latest specimens of *R. adriaticum*, which possess longitudinal costae, preferentially developed on the inflated portion.

Comparisons: According to Foreman (1968) and Sanfilippo & Riedel (1985), *Pt. tina* is distinguished from its closely allied *Pseudotheocampe urna* (FOREMAN, 1971) by possessing a more elongate abdomen and by having a relatively less constricted test. Superficial similarities between both, otherwise, suggests that *Pt. urna* evolved directly from this species.

GENUS **POGONIAS** NOV. GEN.

Derivatio nominis: Latin substantive *pogonias* -ae (m), meaning comet.

Type species: *Pogonias prodromus* nov. sp.

Diagnosis: Two-segmented test with small spherical cephalis, usually with apical horn. Thorax subcylindrical to tetrahedral, frequently drawn out distally into three or multiple divergent appendages arranged in a trigonal symmetry. Thorax commonly closed antapically. Thorax and appendage are generally perforate with, usually, thick walled and somewhat spongy test. Pores are subcircular to hexagonal. Stricture between cephalis and thorax generally poorly developed or absent.

Remarks: The origin of this new nominal genus lies in co-occurring *T. fossilis*. This species gave rise to an initial offshoot, *Po. prodromus*, in which the size and the feature in earliest ontogenetic stage of development are comparable to its ancestor, but it differs by possessing three tubular feet in a distinctly tetraheral test. The diversification of the genus took place rapidly during the middle-late Albian, developing different species with a progressively thicker test-wall. This minor radiation was extinguished at the base of the Turonian.

Introduction of a new nominal genus is justified by the presence of a tetrahedral thorax drawn out distally into divergent appendages, a feature hitherto not known among Cretaceous closed dicyrtids. It must be emphasised that the stratigraphic range of this new genus seems to be restricted to the middle Albian-latest Cenomanian (cf. fig. 18) . Furthermore, it is relatively abundant in almost all samples of this age, and the representatives of this genus are considered as useful markers for this interval of time.

Comparisons: Homoemorphic species occurs in the middle Eocene, but they belong to the genus *Sethochytris* HAECKEL, 1881, like *S. tricorniscus* Haeckel 1887, or *S. babylonis* (Clark & Campbell, 1942). Reference to taxonomy and good figures, of these latter species are documented in Riedel & Sanfilippo (1970, p. 527-528) and Sanfilippo *et al.* (1985, p. 680-681).

Range: Middle Albian to earliest Turonian.

Pogonias prodromus nov. sp.

Pl. 24, figs. 6-10
Species code 100

Holotype: Specimen 3297 (pl. 24, fig. 10), from locality no. Bo-685.20, late Albian, (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *prodromus* -i (m), meaning precursor, predecessor, refers to the first representative of the genus.

Photographed material: 23 specimens.

Description: Test as with genus, two-segmented with small spherical cephalis, bearing a relatively massive apical horn. Cephalocone eventually may present slit-like pores. Collar stricture absent externally. Thorax tetrahedral, densely porous and drawn out distally into three divergent, long, subcylindrical porous feet. These thoracic appendages are open, somewhat narrow terminally, or even are closed tapering in a spine distally. Thoracic pores are subcircular to hexagonal . With some specimens, distally, feet provide a framework for secretion of a thorax, which becomes densely porous and forms a spongy meshwork.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	462	337	462	315
Maximum width of test	196	177	246	154
Length of longest tube	215	117	215	62

Remarks: It seems that *Po. prodromus* evolved from *Trimulus parmatus* by way of *T. fossilis* which developed a densely porous thorax. The sudden appearance of three feet and the progressive increase of the thick test-wall, a feature developed at once in *Po. prodromus*, will be a feature common to representatives of the genus.

Comparisons: This species differs from its closely allied *Po. harpago* in having three feet more subcylindrical rather than three-bladed.

Pogonias harpago nov. sp.

Pl. 24, figs. 11-19
Species code 114

Holotype: Specimen 3014 (pl. 24, fig. 18), from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *harpago* -onis (m), meaning harpoon.

Photographed material: 44 specimens.

Description: Test as with genus, di-chambered, with small spherical cephalis, tapering to a small acute apical horn. Stricture absent between cephalis and thorax. Thoracic chamber tetrahedral, densely porous and drawn out distally into three divergent, long, three-bladed porous feet. These thoracic appendages are closed and tapering to three acute spines terminally. In cross-section, internally, each foot is provided with three canals. Thoracic pores are subcircular to hexagonal . Frequently, the arrangement of the feet provide a framework for secretion of thoracic wall, which becomes densely porous and forms a thick spongy meshwork. In some specimens the distal part of the test is composed of spongy material, rather than of small regularly closed hexagonal pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	417	376	433	317
Maximum width of test	250	237	275	192
Length of longest tube	125	92	133	50

Remarks: Ranges of variability of *Po. harpago* and its undoubtedly close relative *Po. prodromus* overlap slightly, or not at all.

Comparisons: *Po. harpago* is distinguished from its direct ancestor *Po. prodromus* by having three closed three-bladed feet ending in acute spines rather than tubular appendages tapering distally.

Pogonias missilis nov. sp.

Pl. 25, figs. 1-5
Species code 115

Holotype: Specimen 3295 (pl. 25, fig. 1), from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *missilis* -e (n), meaning missile.

Photographed material: 6 specimens.

Description: Test as with genus. Cephalis large subspherical, well perforate and bearing a long apical horn. Cephalic pores are hexagonal, tending to form transverse as well as longitudinal rows. Collar stricture moderately distinct. Thorax large, conical truncated, possessing nine divergent longitudinal ribs, which extend throughout the length of the thorax and are disposed in a trigonal symmetry. In some specimens may appear a system of transverse ridges between adjacent ribs (pl. 26, fig. 2). Thoracic pores tend toward transverse alignment.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	293	244	293	207
Maximum width of test	187	176	200	140
Length of apical horn	53	39	53	27

Remarks: *Po. missilis* appears to have evolved from *Po. harpago*, through a rapid development of a marked collar stricture, as a consequence of the inflation of the cephalis which becomes hemispherical. Concomitantly the thorax increases in length and tends to be conical, truncated distally, having nine divergent longitudinal ribs, disposed in trigonal symmetry. Each group of three of these ribs corresponds to the edges of an old pyramidal foot, now missing, which was a typical feature of the ancestral form. The transformation involved a reduction of the triangularity of each foot in order to attain a whole circular cross-section of its thorax. In other words, these longitudinal ribs are the relict of the edges of undistinguished feet.

Comparisons: This species differs from all other congeneric species by possessing an inflated spherical cephalis with a marked collar stricture; furthermore nine longitudinal ribs occur divergent from its subcylindrical thorax.

Pogonias incallidus nov. sp.

Pl. 25, figs. 6-8
Species code 85

Holotype: Specimen 5340 (pl. 25, fig. 8), from locality no. Gb-84.40, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *incallidus* -a -um, meaning without sagacity.

Photographed material: 9 specimens.

Description: Test as with genus, two-chambered. Test wall thick and spongy. Cephalis relatively large, subglobose to conical and tapering to a very long apical horn. Stricture poorly developed between cephalis and thorax. Thoracic chamber having a large tetrahedral shape, densely porous and drawn out distally into three divergent, short, massive tubular porous feet, which are tapered distally and frequently closed at its termination. These thoracic appendages expand radially, although they are slightly curved distally in some specimens. In cross-section, internally, each foot is composed of a single canal. As in other congeneric species, the arrangement of the feet provide a framework for secretion of thoracic wall, which is densely porous and forms a thick spongy meshwork; thoracic pores are very small, subcircular and irregularly disposed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	420	400	450	330
Maximum width of test	240	237	250	220
Length of apical horn	110	88	110	45

Comparisons: *Po. incallidus* differs from its probable ancestor *Po. harpago* in having a much larger tetrahedral test with stronger apical horn and shorter appendages; these latter tend to be developed radially rather than downwardly directed. Furthermore, the meshwork is coarser and denser throughout rather than having some linearity.

Pogonias ? hirsutus (SQUINABOL, 1904)

Pl. 25, figs. 9-13

Species code 87

	1904	*Sethocyrtis ? hirsuta* n. sp. SQUINABOL, p. 215, pl. 7, fig. 11.
?	1904	*Corocalyptra euganea* n. sp. SQUINABOL, p. 219, pl. 8, fig. 2.
?	1975	*Spumellaria* gen et sp. indet. DUMITRICA, text-fig. 2. 27.
non	1975	*Platycryphalus* spp. aff. *P. hirsuta* (SQUINABOL). - FOREMAN, p. 616, pl. 2G, fig. 2; pl. 6, figs. 7-9 (= *R. mosquense* ?).

Holotype: Nominal species based on a single specimen, which was described and illustrated by Squinabol (1904) on pl. 7, fig. 11. The holotype has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, central Italy).

Photographed material: 22 specimens.

Description: Test having two chambers with thick spongy wall. Cephalis small hemispherical, having robust vertical and apical horns. Collar stricture marked by a distinct change in contour; a large nodose circumferential ridge occurs just below the collar stricture. Thorax densely porous, subcylindrical to subspherical, lacking terminal appendages.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	132	253	313	187
Maximum width of test	110	205	233	190
Length of apical horn	-	56	60	47

Remarks: Generic assignment queried because this species shows noticeable modifications in the common generic structure of the test and it might belong in a new nominal genus. It would be a monotypic genus which arose probably from the latest representatives of *Po. prodromus* and have left no evolutionary descendants.

It is suspected that *Po. ? hirsutus* may have evolved from *Po. prodromus* in the earliest Cenomanian, through loss of thoracic appendages (this supposes an important reduction in length of the terminal chamber), together with an increase in width of the thorax, principally by strong development of the thick-walled test. Forms intermediate between the two species have been observed, although they are very rare in the studied material. Forms similar in outline and segmentation, but possessing apically three well-developed horns, have been illustrated by Dumitrica (1975).

Comparisons: *Po. ? hirsutus* differs from all other species of *Pogonias* by possessing a small cephalis bearing an apical and a vertical horn, and by having a subcylindrical to subspherical thorax without terminal appendages. Furthermore, this species possesses a thick nodose circumferential ridge, which is located just below the collar stricture.

SUPERFAMILY **SYRINGOCAPSACEAE** FOREMAN, 1973b

In this superfamily are included at least the following families: Syringocapsidae FOREMAN, 1973b; Spongocapsulidae PESSAGNO, 1977b and Obeliscoitidae nov. fam.

FAMILY **SYRINGOCAPSIDAE** FOREMAN, 1973b

(= Favocyrtidiinae STEIGER, 1992; Collicyrdidiinae STEIGER, 1992)

Type genus: *Syringocapsa* NEVIANI, 1900.

Multi-segmented forms with a slender conical proximal portion of the test composed of several small chambers, opposed to a single very large and expanded distalmost chamber. Test may have appendages as lateral porous arms or spines that extend more or less radially from the distal post-abdominal chamber. Test terminates in a closed terminal porous tube that lacks septal partitions.

GENUS **PODOBURSA** WISNIOWSKI, 1889

Synonyms: *Dibolachras* FOREMAN, 1973b; *Collicyrtidium* STEIGER, 1992; *Favosyringium* STEIGER, 1992; *Helocingulum* STEIGER 1992.

Type species: *Podobursa dunikowskii* WISNIOWSKI, 1889, by monotypy.

Diagnosis: Test as with family. Multi-segmented test possessing four or more chambers and a porous closed terminal tube. Cephalis acutely conical, bearing a massive apical horn. Distalmost post-abdominal chamber with two or more solid lateral spines, arranged in different order of symmetry around perimeter of the chamber.

Remarks: The number of spines on the expanded chamber is here considered as a distinguishing feature at the specific rather than at the generic level. Consequently, some nominal genera has been synonymized

Comparisons: *Podobursa* differs from *Podocapsa* RÜST, 1885, by possessing appendages developed as lateral spines on the distalmost chamber instead of lateral porous arms. Furthermore this genus is clearly distinguishable from the type-genus by having appendages on its last post-abdominal chamber.

Range: Middle Jurassic (Bajocian) to early Aptian.

Podobursa typica (RÜST, 1898)

Pl. 25, figs. 14-17

Species code 391

1898 *Eusyringium typicum* n. sp. RÜST, p. 60, pl. 17, fig. 7.
1914 *Pterocorys longispina* n. f. SQUINABOL, p. 280, pl. 20 [1], fig. 9.
1916 *Theosyringium acanthophorum* RÜST var. *hexacanthus* FISCHLI, p. 46-47, text-fig. 40.
1916 *Theosyringium acanthophorum* RÜST var. *polyacanthus* FISCHLI, p. 46-47, text-fig. 41.
1916 *Theosyringium acanthophorum* RÜST var. *tetracanthus* FISCHLI, p. 46-47, text-fig. 39.
? 1916 *Theosyringium acanthophorum* RÜST var. *triacanthus* FISCHLI, p. 46-47, text-fig. 38.
pars 1969 *Staurostylus* sp. LOZYNIAK, pl. 1, fig. 4, non fig. 5.
1969 *Stylostauros* sp. LOZYNIAK, pl. 1, fig. 6.
pars 1973b *Dibolachras apletopora* new species FOREMAN, p. 265, pl. 11, fig. 3; non pl. 16, figs. 10 ?, 11 (= *P. tytthopora*).
1973b *Podobursa triacantha* (FISCHLI). - FOREMAN, p. 266, pl. 13, figs. 1-7.
1973b *Podobursa tricola* new species FOREMAN, p. 267, pl. 13, fig. 9; pl. 16, fig. 12.
1973b *Podobursa tricola* (?) FOREMAN, pl. 13, fig. 8.
1973 *Eusyringium typicum* RÜST. - MOORE, p. 829, pl. 1, figs. 5-7.
1974 *Theoperid* gen. et sp. indet. cf. *Podobursa* sp. RIEDEL & SANFILIPPO, pl. 9, figs. 1, 2.
pars ? 1975 *Dibolachras tytthopora* FOREMAN. - FOREMAN, p. 617, pl. 6, fig. 16; non pl. 2L, figs. 2 ?, 3 (= *P. tytthopora*).
1975 *Podobursa* (?) *polylophia* FOREMAN. - FOREMAN, p. 617, pl. 2L, fig. 1.
1975 *Podobursa triacantha* (FISCHLI). - FOREMAN, p. 617, pl. 2L, figs. 4-6.
1975 *Podobursa tricola* FOREMAN. - FOREMAN, p. 617, pl. 2L, figs. 7, 8.
1977 *Podobursa triacantha* (FISCHLI). - MUZAVOR, p. 110, pl. 7, figs. 1-3.
1977b *Podobursa triacantha* (FISCHLI). - PESSAGNO, p. 92, pl. 12, fig. 6.
1977c *Podobursa triacantha* (FISCHLI). - PESSAGNO, p. 57, pl. 11, fig. 6.
1979 *Podobursa triacantha* (FISCHLI). - NAKASEKO *et al.*, p. 23, pl. 3, fig. 8 ?; pl. 4, figs. 3, 4.
1981 *Podobursa triacantha* (FISCHLI). - NAKASEKO & NISHIMURA, p. 157, pl. 11, figs. 13 (= specimen of Nakaseko et. al., 1979, pl. 4, fig. 3), 14.
pars 1981 *Podobursa triacantha* (FISCHLI). - SCHAAF, p. 436, pl. 25, figs. 1a-b; non pl. 5, fig. 11.
pars 1981 *Podobursa tricola* FOREMAN. - SCHAAF, p. 436, pl. 25, figs. 2a-b; non pl. 6, figs. 1a-b.
1982 *Podobursa triacantha* (FISCHLI). - OKAMURA & UTO, pl. 3, figs. 1, 8 ?
1983 *Dibolachras tytthopora* FOREMAN. - ORIGLIA-DEVOS, p. 185, pl. 21, figs. 6, 7.
pars 1983 *Podobursa spinosa* gr. (OZVOLDOVA). - ORIGLIA-DEVOS, p. 187, pl. 21, fig. 11; non figs. 12, 13.
1983 *Podobursa triacantha* gr. (FISCHLI). - ORIGLIA-DEVOS, p. 188, pl. 22, figs. 4, 5, 7, 8.
pars 1984 *Podobursa triacantha* (FISCHLI). - SCHAAF, p. 144-145, text-figs. 1, 3 (= specimen of Schaaf, 1981, pl. 25, fig. 1a), 4a-b; non text-fig. 2 (= specimen of Schaaf, 1981, pl. 5, fig. 11).
1985 *Podobursa triacantha* SANFILIPPO & RIEDEL, p. 611, text-figs. 11. 1a-b.
1985 *Podobursa tricola* SANFILIPPO & RIEDEL, p. 611, text-figs. 11. 3a-b.
1986 *Podobursa triacantha* (FISCHLI). - LI, pl. 3, fig. 7.
1986 *Podobursa torustornis* sp. nov: LI, p. 313, pl. 3, fig. 6.
non 1986b *Podobursa triacantha* (FISCHLI). - SUYARI, pl. 4, figs. 7, 8.
1988 *Podobursa triacantha* (FISCHLI). - THUROW, p. 404, pl. 7, figs. 16, 19.
1988 *Podobursa tricola* FOREMAN. - THUROW, p. 404, pl. 7, fig. 17.
1989 *Podobursa triacantha* (FISCHLI). - IWATA & TAJIKA, pl. 4, fig. 5.
1989 *Podobursa triacantha* (FISCHLI). - TUMANDA, p. 38, pl. 3, fig. 3.
1990 *Podobursa triacantha* (FISCHLI). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 2.
1992 *Podobursa triacantha* (FISCHLI). - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 2; pl. 4, fig. 11.
1992 *Podobursa helvetica* (RÜST). - STEIGER, p. 75, pl. 20, figs. 8, 9.
1992 *Podobursa* sp. cf. *P. tetracola* FOREMAN. - STEIGER, p. 75, pl. 20, fig. 10.
1992 *Podobursa triacantha hexaradiata* n. ssp. STEIGER, p. 73, pl. 20, figs. 4, 5.
1992 *Podobursa triacantha octaradiata* n. ssp. STEIGER, p. 74, pl. 20, figs. 6, 7.
1992 *Podobursa triacantha tetraradiata* n. ssp. STEIGER, p. 72, pl. 20, figs. 1-3.
1992 *Podobursa triacantha triacantha* (FISCHLI). - STEIGER, p. 72, pl. 19, figs. 12, 13.

1992 *Podobursa triacantha* (FISCHLI). - TAKETANI & KANIE, text-fig. 4. 11.
1993 *Podobursa triacantha* (FISCHLI). - WU, p. 128, pl. 4, fig. 8.

Holotype: As holotype may be considered the single specimen included in the nominal series by Rüst (1898 on pl. 17, fig. 7) upon which the nominal species was founded. This specimen seems to be reported from the Maiolica of Cittiglio (Neocomian, without more precision), Province of Varese (southern Alps, N Italy)

Photographed material: 11 specimens.

Description: Test as with genus. Test has four chambers. The first three form a narrow conical portion, the distalmost chamber is globose and extended distally as a porous terminal tube tapering to a solid spine, tube without septal partitions. Cephalis small, conical, imperforate, with massive apical horn. Thorax and abdomen with small pores longitudinally aligned. Externally, chambers on the apical portion not marked by visible constrictions. Distalmost chamber globose with spines that extend radially. These spines are conical in section, varying considerably in proportions and in number (three to six). Distalmost chamber with large polygonal pores regularly disposed in an oblique arrangement. Terminal closed tube also with large, longitudinally aligned pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	623	419	450	392
Maximum width of test	173	224	250	204
Length of terminal tube	209	152	192	125

Remarks: This species shows a wide range of variation in the number and dimensions of lateral spines through successive populations. Only distinguishable is a decrease in the general size of the test in younger specimens.

Podobursa tytthopora (FOREMAN, 1973b)

Pl. 25, figs. 18-19
Species code 76

pars 1973b *Dibolachras apletopora* new species FOREMAN, p. 265, pl. 16, figs. 10 ?, 11; non pl. 11, fig. 3 (= *P. typica*).
1973b *Dibolachras tytthopora* new species FOREMAN, p. 265, pl. 11, fig. 4; pl. 16, fig. 15.
pars 1975 *Dibolachras tytthopora* FOREMAN. - FOREMAN, p. 617, pl. 2L, figs. 2 ?, 3; non pl. 6, fig. 16 (= *P. typica* ?).
pars 1981 *Dibolachras tytthopora* FOREMAN. - SCHAAF, p. 433, pl. 26, figs. 1a-b, 4 ?; non pl. 5, figs. 3a-b.
non 1983 *Dibolachras tytthopora* FOREMAN. - ORIGLIA-DEVOS, p. 185, pl. 21, figs. 6, 7 (= *P. typica*).
pars 1984 *Dibolachras tytthopora* FOREMAN. - SCHAAF, p. 146-147, text-figs. H (= holotype refigured), 2 (= specimen of Schaaf, 1981, pl. 26, fig. 4), 3a-b; non text-figs 1a-b (= specimen of Schaaf, 1981, pl. 5, figs. 3a-b).
1985 *Dibolachras tytthopora* SANFILIPPO & RIEDEL, p. 609, text-figs. 11. 4a-b.
1988 *Dibolachras tytthopora* FOREMAN. - THUROW, p. 400, pl. 7, fig. 20.
non 1989 *Dibolachras* cf. *apletopora* FOREMAN. - KATO & IWATA, pl. 5, fig. 8.
1993 *Dibolochras tytthopora* FOREMAN. - AGUADO *et al.*, pl. 3, fig. 10.
1994 *Dibolachras tytthopora* FOREMAN. - JUD, p. 75, pl. 9, figs. 2-4.

Holotype: Specimen designated by Foreman (1973b) on pl. 11, fig. 4. The holotype comes from the *Sethocapsa trachyostraca* assemblage of Foreman, ranging Valanginian-early Hauterivian in age; level 196-4-1 (DSDP Leg 20, NW Pacific Ocean).

Photographed material: 2 specimens.

Description: Test as with genus. Test with four chambers. Cephalis, thorax and abdomen together form a broad conical part, that lacks external constrictions. Small cephalis sparsely perforate, bearing a sharply pointed apical horn, which becomes slightly bladed and similar in size to the lateral spines in younger specimens. All postcephalic chambers thick-walled. The inflated chamber is somewhat flattened in the same plane in which are disposed two relatively slender, solid lateral spines. These coplanar spines are tetraradiated in cross-section. The inflated distalmost chamber has small circular pores, with a strong development of connected ridges on its surface, forming an irregular network of triangles, which delimit irregular areas with three or four small pores. Terminal closed tube with large pores, longitudinally aligned, sometimes tapering to a solid spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	367	347	364	338
Width of test plus spines	353	332	341	324
Length of terminal tube	143	107	110	98

Remarks: *P. tytthopora* appears to be an evolutionary offshoot from *P. typica* in the late Valanginian, and to have left no descendants. Its upper stratigraphic limit corresponds with the extinction of the genus at the top of early Aptian.

Comparisons: *P. tytthopora* differs from all other congeneric species by possessing only two slender and solid lateral spines on its distalmost chamber.

GENUS **PSEUDOEUCYRTIS** PESSAGNO, 1977c

Type species: *Eucyrtis* (?) *zhamoidai* FOREMAN, 1973b, by original designation. This specie is considered herein as a synonym of *Lithocampe hanni* TAN, 1927.

Diagnosis: Test multi-segmented, elongate, spindle-shaped, terminating in a long, slender, closed tube. Test with four or more chambers. Cephalis sparsely perforate or imperforate with short, often massive apical horn. Remaining chambers coarsely perforate with two lattice layers of polygonal pore frames, outer lattice layer frequently spinose. Test weakly constricted externally.

Remarks: I venture to suggest that the origin of this genus is to be found in early Cretaceous times, from specimens closely related to *Syringocapsa* NEVIANI, 1900 (like *Syringocapsa agolarium* FOREMAN, 1973b or *Syringocapsa* sp. A. in Steiger, 1992), which gave rise probably to the first representatives of the genus *Pseudoeucyrtis* by progressive reduction in width of the distalmost chamber. Simultaneously a progressive lengthening of the test takes place which gains in development of the terminal tube; furthermore, the number of post-abdominal chambers increases slightly. It may be asserted, however, that this familial grouping is only a first approach. A detailed revision of the different genera and species included in the superfamily Syringocapsaceae through the Jurassic and early Cretaceous is required in order to establish more solid phylogenetic relationships between the representatives of this group.

Comparisons: *Pseudoeucyrtis* differs from its close descendant *Distylocapsa* by developing a long conical-cylindrical terminal tube rather than a short acutely conical appendage or a bladed spine on the terminal chamber. Furthermore, the representatives of the latter genus are characterized by possessing a more broad spindle-shaped test.

Range: Berriasian to earliest Turonian.

Pseudoeucyrtis ? columbaria (RENZ, 1974)

Pl. 25, figs. 20-22
Species code 74

- 1974 *Eucyrtis columbarius* n. sp. RENZ, p. 792, pl. 7, figs. 14-20; pl. 12, figs. 13a-c.
- 1975 *Eucyrtis columbaria* RENZ. - FOREMAN, p. 615, pl. 2I, fig. 19.
- 1981 *Eucyrtis columbaria* RENZ. - SCHAAF, p. 434, pl. 5, figs. 1a-b; pl. 27, figs. 2a-b, 3a-b.
- 1984 *Eucyrtis columbaria* RENZ. - SCHAAF, p. 100-101, text-figs. H (= holotype refigured), 1a-b (= specimen of Schaaf, 1981, pl. 5, figs. 1b, 1a-b), 2-4, 5a-b (= specimen of Schaaf, 1981, pl. 27, figs. 2a-b), 6-7, 8a-b (= specimen of Schaaf, 1981, pl. 27, figs. 3a-b), 9a-b.
- 1985 *Eucyrtis columbaria* SANFILIPPO & RIEDEL, p. 618, text-fig. 12. 3a-b (= specimen of Schaaf, 1981, pl. 5, figs. 1a-b), 3c-d.
- 1991 *Eucyrtis columbaria* RENZ. - AGUADO *et al.*, text-figs. 7. 5-6.
- 1992 *Eucyrtis columbaria* RENZ. - BAUMGARTNER, p. 320, pl. 6, figs. 1-3.
- 1994 *Eucyrtis columbaria* RENZ. - JUD, p. 77, pl. 10, figs. 3-6.

Holotype: Specimen designated by Renz (1974) on pl. 12, fig. 13c. This specimen has been reported from the Barremian-early Aptian of the Leg 27, at level 261-12-2, 11-12, in the Argo Abyssal Plain (eastern Indian Ocean). The holotype has been recently refigured by Schaaf (1984).

Photographed material: 14 specimens.

Description: Thin-walled multi-segmented test, asymmetrical spindle shaped. Test closed terminally, with the longitudinal axis so curved that one contour is straight or slightly concave, and the other is strongly convex distally, resulting in an unique silhouette for this species. Cephalis is subspherical, with a massive, often long apical horn, and occasionally may develop a short vertical horn. Cephalis is partly sunken into the thorax. Postcephalic chambers gradually increasing in height and width as added. Externally no constrictions or circumferential ridges are present between chambers. Minute pores are transversely aligned on thorax and abdomen. After the first post-abdominal chamber arise numerous delicate longitudinal costae; small circular pores longitudinally disposed between costae. Frequently an additional inverted cap-like chamber appears terminally. A narrow aperture appears obliquely antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	240	234	276	172
Maximum width of test	87	99	116	88

Remarks: Generic assignment queried because this species possesses longitudinal costae distally and lacks a close terminal tube.

Comparisons: The curved longitudinal axis of the test resulting in a typical asymmetrical outline, together with a thin walled test, it is quite sufficient to distinguish this species from all other Cretaceous Nassellariina.

Pseudoeucyrtis hanni (TAN, 1927)

Pl. 26, figs. 1-13
Species code 27

- ? 1885 *Stichocapsa tenuis* m. RÜST, p. 318, pl. 41 [16], figs. 13, 14.
- ? 1890 *Archicapsa fusus* n. f. PARONA, p. 164, pl. 5, fig. 5.

1927 *Lithocampe Hanni* spec. nov. TAN, p. 64, pl. 13, fig. 109.

1968 *Eusyringium* sp. *A*. ZHAMOIDA *et al.*, pl. 1, fig. 8.

1969 *Eusyringium* sp. *A*. ZHAMOIDA, p. 19, text-fig. 2. 8 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 8).

1972 *Eusyringium* sp. ? *A* ZHAMOIDA, p. 121, pl. 27, fig. 3 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 8).

1973b *Eucyrtis* (?) *zhamoidai* new species FOREMAN, p. 264, pl. 10, figs. 9, 10; pl. 16, figs. 1, 2.

pars 1973 *Eucyrtidium grandis* (CAMPBELL and CLARK). - MOORE, p. 828, pl. 8, figs. 8; non fig. 7.

pars 1974 *Eucyrtis bulbosus* n. sp. RENZ, p. 792, pl. 12, figs. 15a-b; pl. 7, figs. 26, 28 ?, 29; non fig. 27.

1974 *Eucyrtis hanni* (TAN SIN HOK). - RENZ, p. 792, pl. 7, figs. 21-25; pl. 12, figs. 16a-b.

pars 1974 *Eucyrtis hanni* (TAN SIN HOK). - RIEDEL & SANFILIPPO, p. 779, pl. 5, figs. 9, 10, 11 ?, 12, 14 ?, non fig. 13; pl. 12, fig. 18 (= specimen of Riedel & Sanfilippo, 1974, pl. 5, fig. 12), non figs. 16, 17.

pars 1974 *Stichocapsa tenuis* RÜST. - RIEDEL & SANFILIPPO, p. 780, pl. 9, figs. 13, 14; non fig. 12.

non 1975 *Eucyrtis bulbosa* (?) RENZ. - FOREMAN, p. 615, pl. 2K, figs. 4-5 (= *Theosyringium vicetinum*, Squinabol, 1914), 3 (= *P. spinosa*).

1975 *Eucyrtis micropora* (SQUINABOL). - FOREMAN, p. 615, pl. 2I, figs. 2-5.

1975 *Eucyrtis micropora* (?) FOREMAN, pl. 2I, fig. 1.

pars 1975 *Eucyrtis tenuis* RÜST. - FOREMAN, p. 615, pl. 2I, figs. 8 ?, 9; non fig. 7.

1975 *Eucyrtis tenuis* (?) FOREMAN, pl. 2I, fig. 6.

1977 *Pseudoeucyrtis paskentaensis* n. sp. PESSAGNO, p. 59, pl. 11, figs. 3, 4, 13, 14, 17, 18.

1979 *Eucyrtis micropora* (SQUINABOL). - NAKASEKO *et al.*, p. 22, pl. 3, figs. 11, 12.

1981 *Eucyrtis micropora* (SQUINABOL). - DE WEVER (in DE WEVER & THIEBAULT), p. 587, pl. 1, figs. 15, 17.

1981 *Eucyrtis tenuis* RÜST. - DE WEVER (in DE WEVER & THIEBAULT), p. 588, pl. 1, fig. 16.

1981 *Eucyrtis tenuis* (RÜST). - NAKASEKO & NISHIMURA, p. 152, pl. 11, fig. 5; pl. 17, fig. 5.

non 1981 *Eucyrtis* sp. cf. *E. bulbosa* RENZ. - SCHAAF, p. 433, pl. 26, fig. 2 (= *P. apochrypha*).

1981 *Eucyrtis elido* n. sp. SCHAAF, p. 434, pl. 5, fig. 6; pl. 25, figs. 3a-b.

1981 *Eucyrtis tenuis* s. l. (RÜST). - SCHAAF, p. 434, pl. 25, fig. 8.

non 1982 *Pseudoeucyrtis* cf. *pasketaensis* PESSAGNO. - OKAMURA & UTO, pl. 7, fig. 6.

1983 *Eucyrtis micropora* gr. (SQUINABOL). - ORIGLIA-DEVOS, p. 160, pl. 18, figs. 3, 4.

1983 *Eucyrtis tenuis* (RÜST). - ORIGLIA-DEVOS, p. 162, pl. 18, figs. 5, 6.

1984 *Eucyrtis hanni* (TAN SIN HOK). - SCHAAF, p. 156-157, text-fig. 8 (= specimen of Schaaf, 1981, pl. 5, fig. 6).

1984 *Eucyrtis tenuis* (RÜST). - SCHAAF, p. 158-159, text-fig. 9.

1985 *Eucyrtis hanni* sensu lato SANFILIPPO & RIEDEL, p. 618, text- fig. 13. 7 (= specimen of Riedel & Sanfilippo, 1974, pl. 5, fig. 12).

1985 *Eucyrtis micropora* SANFILIPPO & RIEDEL, p. 619, text-fig. 13. 6.

1985 *Eucyrtis tenuis* SANFILIPPO & RIEDEL, p. 619, text-fig. 13. 5.

1986 *Eucyrtis elido* SCHAAF. - OKAMURA & MATSUGI, pl. 1, fig. 10.

1986 *Eucyrtis tenuis* s. l. (RÜST). - OKAMURA & MATSUGI, pl. 1, fig. 9.

1986 *Eucyrtis* sp. TERAOKA & KURIMOTO, pl. 1, fig. 20.

1989 *Eucyrtis micropora* (SQUINABOL). - KATO & IWATA, pl. 4, fig. 1.

1989 *Eucyrtis micropora* (SQUINABOL). - TUMANDA, p. 37, pl. 1, fig. 16.

1989 *Eucyrtis* sp. TUMANDA, p. 37, pl. 1, fig. 17.

1990 *Eucyrtis hanni* (TAN SIN HOK). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 9.

1990 *Eucyrtis tenuis* (RÜST). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 8.

1992 *Eucyrtis hanni* (TAN SIN HOK). - BAUMGARTNER, p. 320, pl. 6, fig. 4.

non 1992 *Eucyrtis micropora* (SQUINABOL) sensu SANFILIPPO and RIEDEL. - BAUMGARTNER, p. 320, pl. 6, fig. 5.

? 1992 *Eucyrtis tenuis* (RÜST) sensu SANFILIPPO and RIEDEL. - BAUMGARTNER, p. 320, pl. 6, fig. 6.

1992 *Eucyrtis micropora* (SQUINABOL). - TAKETANI & KANIE, text-fig. 3. 12.

1992 *Eucyrtis tenuis* (RÜST). - TAKETANI & KANIE, text-fig. 3. 13.

1993 *Eucyrtis hanni* (TAN). - AGUADO *et al.*, pl. 3, fig. 3.

Holotype: The specimen illustrated by Tan (1927) on pl. 13, fig. 109. The holotype seems to be reported from early Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 63 specimens.

Description: Test as with genus. Test spindle-shaped, with usually six to eight post-abdominal chambers and a long terminal tube. Cephalis and thorax conical; cephalis imperforate, thorax very sparsely perforate. Cephalis bearing a long, robust apical horn. Abdomen and post-abdominal chambers subtrapezoidal in outline; initial chamber gradually increasing in width, final two-three chambers narrower.

Test composed of two lattice layers of pore frames: inner layer of pore frames large, circular; outer layer strongly spinose. Test weakly to well constricted externally. Test terminates in a slender, long, closed tube, with large circular pores, with longitudinal arrangement.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	274	334	465	230
Maximum width of test	117	102	120	80

Remarks: The chaotic nomenclatorial state of this nominal species may be observed in the long and complex list of synonyms. This species shows a strong range of variation through its range. The whole of nominal species described around *P. hanni* were founded on some differences (more or less developed) in the degree of inflation of segments and the development of spines. These characters are strongly variable and not useful to establish disjointed groups. There is a continuum of all morphological transitions from specimens weak lobulate to well constricted, possessing independently more or less development of a spinose surface.

Comparisons: Some late Aptian specimens of *P. hanni* are quite comparable to *Pseudoeucyrtis spinosa* (SQUINABOL) originally described from the Albian-Cenomanian of the Colli Euganei. It is, however, distinguished from *P. spinosa* in having fewer chambers and lacking spines on the inflated post-abdominal chambers.

Pseudoeucyrtis apochrypha nov. sp.

Pl. 26, figs. 14-18

Species code 18

?	1898	*Cyrtocapsa uvaria* n. sp. RÜST, p. 63, pl. 18, fig. 12.
	1975	*Lithocampe chenodes* RENZ. - FOREMAN, p. 616, pl. 2K, fig. 6.
?	1979	*Eusyringium musylevi* ZHAMOIDA. - NAKASEKO *et al.*, p. 22, pl. 3, figs. 6, 7.
	1981	*Eucyrtis* sp. cf. *E. bulbosa* RENZ. - SCHAAF, p. 433, pl. 26, fig. 2.
	1991	*Eucyrtis* (?) *spinosus* (SQUINABOL). - AGUADO *et al.*, text-fig. 7. 10.
	1993	*Eusyringium spinosum* SQUINABOL. - AGUADO *et al.*, pl. 3, fig. 9.
	1994	*Syringocapsa spinosa* (SQUINABOL). - JUD, p. 112, pl. 22, figs. 13-14.

Holotype: Specimen 9319 (pl. 26, fig. 16), from locality no. Ca1-22.30, early Aptian, Carbonero Formation (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: Latin *apochryphus*, -a -um, meaning apocryphal.

Photographed material: 6 specimens.

Description: Test as with genus, usually with eight to nine post-abdominal chambers. Cephalis subspherical, imperforate, rounded apically, lacking apical horn. Thorax and abdomen trapezoidal in outline, sparsely perforate. Succeeding chambers trapezoidal in outline, increasing more noticeably in width than height. Test becomes quite inflated medially (with chambers of greater width and height) then gradually constricts, terminating in a long tapering tube, which is seldom preserved or complete.

Test composed of two lattice layers of large, irregular pore frames. Inner layer with subcircular pores, outer layer with spinose nodes connected by numerous transverse bars.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	305	311	370	285
Maximum width of test	155	149	155	145
Length of terminal tube	-	-	85	-

Remarks: *P. apochrypha* differs from all other congeneric species by possessing an outer lattice layer composed of nodes with connected rays.

Pseudoeucyrtis spinosa (SQUINABOL, 1903b)

Pl. 27, figs. 1-8
Species code 45

	1903b	*Eusyringium spinosum* n. sp. SQUINABOL, p. 141, pl. 8, fig. 42.
non	1975	*Eucyrtis bulbosa* (?) RENZ. - FOREMAN, p. 615, pl. 2K, fig. 3; non figs. 4-5 (= *Theosyringium vicetinum* Squinabol, 1914).
	1975	*Eucyrtis spinosus* (SQUINABOL). - DUMITRICA, text-fig. 2. 25.
	1979	*Obesocapsula ezoensis* n. sp. NAKASEKO & NISHIMURA (in NAKASEKO *et al.*), p. 23, pl. 7, figs. 14 ?, 15.
pars	1979	*Obesocapsula* (?) spp. NAKASEKO *et al.*, p. 23, pl. 7, fig. 13, non fig. 12.
	1981	*Cyrtocapsa grutterinki* TAN SIN HOK. - NAKASEKO & NISHIMURA, p. 149, pl. 13, figs. 9 (= specimen of Nakaseko *et al.*, 1979, pl. 7, fig. 15), 10 (= specimen of Nakaseko *et al.*, 1979, pl. 7, fig. 13).
	1982	*Eusyringium* (?)*foremanae* n. sp. TAKETANI, p. 64, pl. 6, figs. 1a-b; pl. 13, fig. 2 ?.
pars	1982	*Eusyringium spinosum* SQUINABOL. - TAKETANI, p. 64, pl. 13, figs. 4, 5; pl. 6, figs. 3a-b; non figs. 2a-c, 4a-b (= *P. pulchra* ?).
	1983	*Syringocapsa* (?) sp. aff. *limatum* FOREMAN. - ORIGLIA-DEVOS, p. 198, pl. 23, figs. 4, 8.
?	1984	Gen. et sp. indet. SCHAAF, p. 162-163, text-fig. 7a-b.
?	1986	*Eucyrtis* sp. OKAMURA & MATSUGI, pl. 2, fig. 11.
	1988	*Eusyringium* (?)*formanae* TAKETANI. - THUROW, p. 401, pl. 4, fig. 19.
	1988	*Eusyringium spinosum* SQUINABOL. - THUROW, p. 401, pl. 4, fig. 18.
	1988	*Eusyringium* sp. cf. *E. spinosum* SQUINABOL. - THUROW, p. 401, pl. 4, fig. 20.
	1988	*Eusyringium spinosum* SQUINABOL. - TUMANDA & SASHIDA, text-fig. 4. 8.
	1989	*Eusyringium spinosum* SQUINABOL. - KATO & IWATA, pl. 8, fig. 8.
	1989	*Eusyringium spinosum* SQUINABOL. - TUMANDA, p. 37, pl. 7, fig. 8 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 8).
non	1991	*Eucyrtis* (?) *spinosus* (SQUINABOL). - AGUADO *et al.*, text-fig. 7. 10 (= *P. apochrypha*).
	1992	*Eusyringium* (?)*foremanae* TAKETANI. - TAKETANI & KANIE, text-fig. 3. 14.
non	1993	*Eusyringium spinosum* SQUINABOL. - AGUADO *et al.*, pl. 3, fig. 9 (= *P. apochrypha*).
non	1994	*Syringocapsa spinosa* (SQUINABOL). - JUD, p. 112, pl. 22, figs. 13-14 (= *P. apochrypha*).

Holotype: Nominal species defined on a single specimen, described and illustrated by Squinabol (1903b) on his pl. 8, fig. 42. The holotype has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, central Italy).

Photographed material: 48 specimens.

Description: Test consisting of four chambers. Cephalis conical, poreless, rounded apically, bearing a long robust apical horn. Thorax and abdomen subtrapezoidal in outline. Post-abdominal chamber quite inflated, spherical to subspherical, densely spinose, with irregular pores. The spines are triradiate in cross-section, occasionally somewhat bladed. Test with a long closed (narrower distally) terminal cylindrical tube, that lacks septal partitions.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	473	351	427	287
Maximum width of test	175	158	180	130
Length of terminal tube	238	103	160	60

Remarks: This species probably evolved from *P. hanni* at the early Albian? by a progressive increase of the distalmost post-abdominal chambers; simultaneously, the distal segmental divisions of the test gradually fade out, giving rise to the occurrence of a single globose post-abdominal chamber. The distinctive specific feature was achieved by strong development of a spinose stage upon the outer lattice layer in the post-abdominal chamber.

Comparisons: *P. spinosa* differs from its direct descent *P. pulchra* by possessing a spherical to subspherical last post-abdominal chamber, instead of an elongate spindle-shaped one. Furthermore, it is distinguished by the presence of numerous spines on its surface.

Pseudoeucyrtis pulchra (SQUINABOL, 1904)

Pl. 27, figs. 9-13

Species code 44

1904 *Theosyringium pulchrum* n. sp. SQUINABOL, p. 222, pl. 8, fig. 7.

1981 *Eusyringium* sp. aff. *Theosyringium pulchrum* SQUINABOL. - NAKASEKO & NISHIMURA, p. 153, pl. 11, fig. 9; pl. 17, fig. 4.

1982 *Theosyringium pulchrum* SQUINABOL. - OKAMURA *et al.*, p. 101, pl. 18, fig. 9.

pars ? 1982 *Eusyringium spinosum* SQUINABOL. - TAKETANI, p. 64, pl. 6, figs. 2a-c, 4a-b; non figs. 3a-b and pl. 13, figs. 4, 5 (= *P. spinosa*).

Holotype: The single specimen described and figured by Squinabol (1904) on pl. 8, fig. 7 is to be considered the holotype. This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 9 specimens.

Description: Test as with genus. Test long, slender, spindle-shaped, usually with four or five chambers. Test with a proximal portion acutely conical in overall outline, which is composed of cephalis, thorax, abdomen and, seldom, first post-abdominal chamber. Cephalis small conical, imperforate, sharply pointed apically and tapering in a strong apical horn. Remaining chamber in the conical portion perforate; width slightly increasing, height almost constant. Fourth chamber becoming somewhat expanded; fifth chamber relatively inflated, forming maximum expansion of the test, height about twice its width; final chamber again constricted and reduced in width. Pore frames relatively larger and very irregular. Terminal tube long and tapering, composed of a single layer of large rectangular pore frames, longitudinally disposed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	630	525	592	462
Maximum width of test	118	122	146	100
Length of terminal tube	285	239	277	192

Remarks: *P. pulchra* appears to be an evolutionary offshoot from *P. spinosa,* and to have left no descendants (fig. 19). The latest specimens of this species seem to cross the Cenomanian-Turonian boundary, but immediately become to extinct, only leaving very few specimens.

Theosyringium vicetinum SQUINABOL, 1914, very frequent in the early Cretaceous (stratigraphic range restricted to Berriasian-early Valanginian), is to be regarded as an homoemorphic species, which probably belongs to the same genus or to an ancestor common to both.

Comparisons: This species differs from its closely allied *P. spinosa* by having more slender test, lacking nodes or spines on the post-abdominal chamber and by possessing a longer terminal tube. Although *P. pulchra* may have attained a large size comparable to that of *D. micropora*, it is readily distinguished from this younger species by its longer terminal tube, slender proximal portion and less inflated post-abdominal chambers.

GENUS **DISTYLOCAPSA** SQUINABOL, 1904

Type species: *Distylocapsa nova* SQUINABOL, 1904, subsequent designation by Campbell (1954).

Diagnosis: Test multi-segmented, spindle shaped, consisting usually of four chambers. Terminal chamber with a short conical tube tapering antapically, or possessing a sharply pointed spine. Cephalis sparsely perforate with short, acute apical horn. Remaining chambers coarsely perforate. Thick-walled test, with two lattice layers of polygonal pore frames, outer lattice layer of pore frames spinose and strongly developed. Test weakly to not constricted externally.

Remarks: It is quite probable that *Distylocapsa* evolved directly from *Pseudoeucyrtis* (fig. 19; undoubtedly from *P. hanni*) by gradual retraction of the long terminal porous conic-cylindrical tube, typical of the latter genus. The result of this transformation is an appendage relatively short, acutely conical and closed terminally, that gradually, as phylogeny progresses, is replaced by a short bladed spine. Progressively the test has a noticeable tendency to increase strongly in width after the initial ontogenetic stages, leading to a veritable spindle-shaped morphology. Concomitantly, a progressive development of the outer lattice layer occurs, developing a thick-walled test. Outer layer, sometimes, may be densely porous enough to resemble a veritable spongy meshwork. For comparisons, see comments under *Pseudoeucyrtis*.

Range: middle Albian to Turonian.

Distylocapsa micropora (SQUINABOL, 1903b)

Pl. 27, figs. 14-18; Pl. 28, figs. 1-7
Species code 41

1903b *Archicapsa euganea* n. sp. SQUINABOL, p. 129, pl. 9, fig. 13.
1903b *Archicapsa* cf. *fusus* PARONA. - SQUINABOL, p. 129, pl. 9, fig. 11.
1903b *Archicapsa micropora* n. sp. SQUINABOL, p. 129, pl. 9, fig. 14.
non 1975 *Eucyrtis micropora* (SQUINABOL). - FOREMAN, p. 615, pl. 2I, figs. 2-5 (= *P. hanni*).
non 1975 *Eucyrtis micropora* (?) FOREMAN, pl. 2I, fig. 1 (= *P. hanni*).
non 1979 *Eucyrtis micropora* (SQUINABOL). - NAKASEKO *et al.*, p. 22, pl. 3, figs. 11, 12 (= *P. hanni*).
non 1980 *eucyrtis micropora* (SQUINABOL). - BAUMGARTNER *et al.*, p. 54, pl. 3, fig. 15 (= *Pseudoeucyrtis* sp.).
non 1981 *Eucyrtis micropora* (SQUINABOL). - DE WEVER (in DE WEVER & THIEBAULT), p. 587, pl. 1, figs. 15, 17 (= *P. hanni*).
non 1983 *Eucyrtis micropora* gr. (SQUINABOL). - ORIGLIA-DEVOS, p. 160, pl. 18, figs. 3, 4 (= *P. hanni*).
non 1985 *Eucyrtis micropora* SANFILIPPO & RIEDEL, p. 619, text- fig. 13. 6 (= *P. hanni*).
non 1989 *Eucyrtis micropora* (SQUINABOL). - KATO & IWATA, pl. 4, fig. 1 (= *P. hanni*).

non 1989 *Eucyrtis micropora* (SQUINABOL). - TUMANDA, p. 37, pl. 1, fig. 16 (= *P. hanni*).

1989 *Spongodruppa cocos* RÜST. - TUMANDA, p. 35, pl. 7, fig. 9.

non 1992 *Eucyrtis micropora* (SQUINABOL) sensu SANFILIPPO and RIEDEL. - BAUMGARTNER, p. 320, pl. 6, fig. 5.

non 1992 *Eucyrtis micropora* (SQUINABOL). - TAKETANI & KANIE, text-fig. 3. 12 (= *P. hanni*).

Holotype: Nominal species apparently based on a single specimen, described and illustrated by Squinabol (1903b) on pl. 9, fig. 13. The holotype has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 47 specimens.

Description: Test as with genus, spindle-shaped. Cephalis small, hemispherical, very sparsely perforate, sharply pointed apically and bearing a short, robust apical horn. Thorax subtrapezoidal in outline, perforate. Abdomen and single post-abdominal chamber broadly cylindrical to spindle-shaped, both chambers form together an inflated portion, somewhat narrower in the proximal and distal parts. In some specimens there appears to be one slight constriction between abdomen and post-abdominal chambers.

Test wall thick, composed of two lattice layers of pore frames. Inner layer of meshwork consisting of thin circular to irregular pore frames. Outer layer built upon and fused to inner layer; pore frames polygonal to rectangular and very irregularly arranged, with thickened wall especially on central part, near the junction between abdomen and post-abdominal chamber. Frequently outer lattice layer with pore frames very irregular in size and arrangement, but densely porous enough to form spongy meshwork especially in the inflated portion of the test. Test with a short terminal tube, tapering antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	300	408	500	292
Maximum width of test	100	140	173	120
Length of terminal tube	115	114	153	60

Remarks: Outer lattice layer gradually becomes thicker, densely porous and spinose. Gradual increase in width of inflated portion occurs simultaneously with this change in ornamentation.

It must be emphasized that *D. micropora* was originally described from the Scaglia Formation of the Colli Euganei by Squinabol (1903b). This confers a middle Albian to early Turonian age. Nevertheless, the totality of species assigned to *D. micropora* by different authors have been erroneously identified in a chain reaction with *Pseudoeucyrtis hanni* (TAN), which ranges throughout the early Cretaceous. In my opinion, this mistake was generated after the first illustrations by Foreman (1975) of particular specimens of pseudoeucyrtids under *D. micropora* from the Hauterivian-Barremian strata, but undoubtedly belong to the nominal species *P. hanni*.

Comparisons: This species appears to be transitional between *Distylocapsa* and *Pseudoeucyrtis*. Generic attribution to the former results from the characteristic broad spindle-shaped test, beside a narrower and shorter apical portion.

Distylocapsa veneta (SQUINABOL, 1904)

Pl. 28, figs. 10-15

Species code 59

1904 *Eusyringium venetum* n. sp. SQUINABOL, p. 235, pl. 10, fig. 10.

pars ? 1974 *Artocapsa bicornis* TAN SIN HOK. - RENZ, p. 788, pl. 6, fig. 21, non figs. 22, 23; pl. 11, fig. 12b, non fig. 12a.

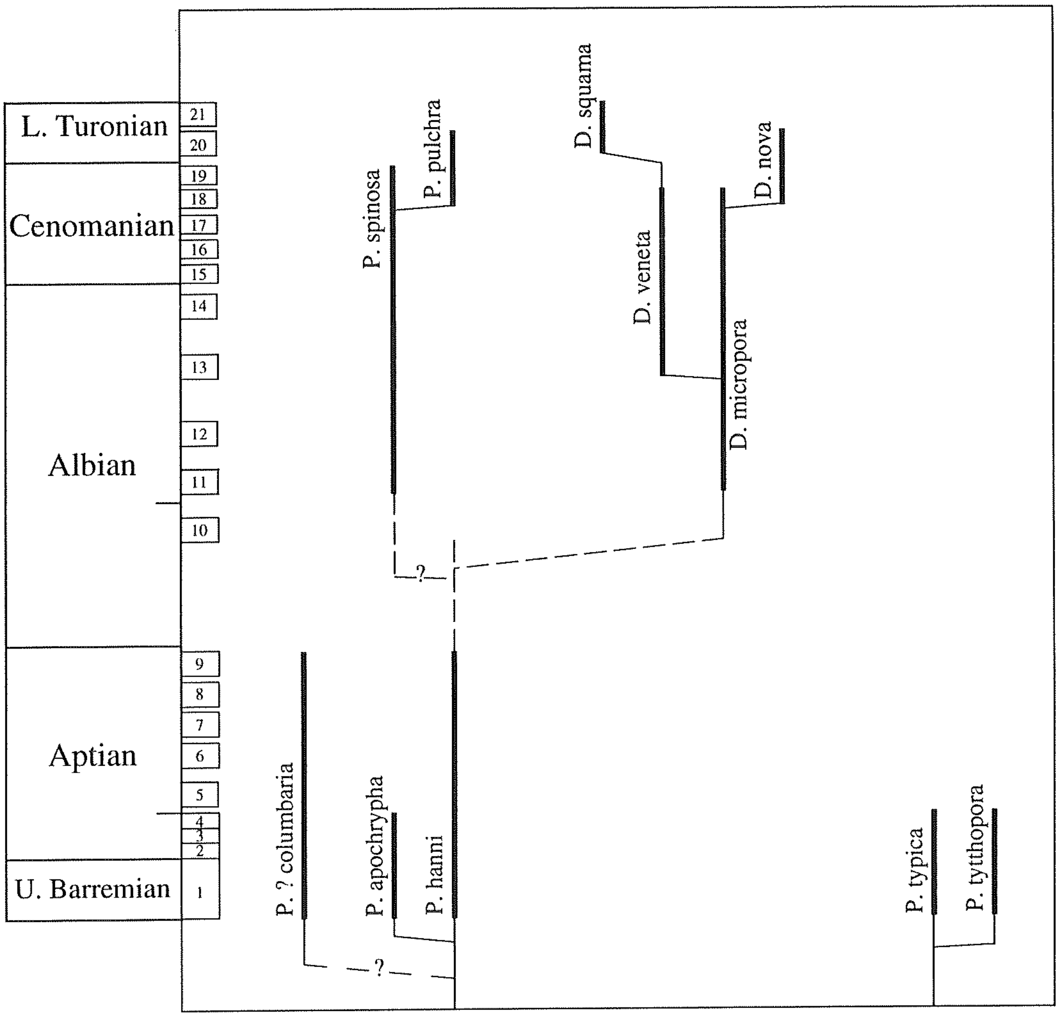

Fig. 19.- Stratigraphic range and possible phyletic relationships of species of *Podobursa*, *Pseudoeucyrtis* and *Distylocapsa*.

? 1974 *Artocapsa ultima* TAN SIN HOK. - RENZ, p. 788, pl. 6, fig. 24; pl. 11, fig. 13.
? 1975 *Stichomitra* ex gr. *indonesiensis* (TAN SIN HOK). - DUMITRICA, text-fig. 2.43.
1982 *Stichomitra foraminosa* n. sp. TAKETANI, p. 55, pl. 3, figs. 5a-b, 6a-b.
1989 *Stichomitra* sp. *A*. TUMANDA, pl. 9, fig. 13.

Holotype: Nominal species based on a single specimen, which was described and illustrated by Squinabol (1904) on pl. 10, fig. 10. The holotype is from the red member of the Scaglia Bianca Formation, in the Teòlo series of the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 11 specimens.

Description: Test as with genus, broad spindle-shaped; usually with four or five chambers. Test strongly increasing in width from initial chamber, and gradually in height as added; distalmost chambers gradually narrowing in width. Cephalis small, hemispherical with a small acute apical horn. Test wall thick, densely porous. In some specimens there appear to be very weakly marked constrictions between post-cephalic chambers, although in others smaller specimens this feature is not apparent. Pore frames large, circular and somewhat regularly disposed on post-cephalic chambers. Test with a very short terminal spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	285	222	250	190
Maximum width of test	102	112	120	100

Remarks: This species seems to be evolved from *D. micropora* which accompanies it through much of its range, and gave rise to *D. squama*, near to the Cenomanian-Turonian boundary (cf. fig. 19) . With further increase in test size the minute terminal spine will become covered by the distalmost post-abdominal chambers, being only visible as a minute terminal spine.

Comparisons: *D. veneta* differs from its probable ancestor *D. micropora* by possessing a veritable spindle-shaped test, without constrictions or changes in contour of the test, and by having weaker ornamentation.

Distylocapsa nova SQUINABOL, 1904

Pl. 28, figs. 8-9
Species code 372

1904 *Distylocapsa nova* n. sp. SQUINABOL, p. 225, pl. 9, fig. 1.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 9, fig. 1, may be considered as the valid holotype. The type-specimen seems to be from the red cherty limestones of the Scaglia Bianca Formation, of the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 2 specimens.

Description: Test as with genus, usually with four or five chambers. Test amphiconical, spindle-shaped, externally with very slight visible constrictions. Thick-walled test, densely porous, with development of numerous minute spines, irregularly disposed over the surface. Some specimens show small spines upwardly directed in the proximal conical portion of the test. Meshwork densely porous and somewhat spongy. Distal end of the test is closed by a small, acute spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	285	360	374	347
Maximum width of test	102	113	120	106

Remarks: Test shape and smaller size otherwise suggest derivation from *D. micropora*. The type-species appears to be an evolutionary offshoot from *D. micropora*, which accompanies it through much of its range, and to have left no descendants (cf. fig. 19) .

Comparisons: *D. nova* differs from all other congeneric species by its typical amphiconical test, which is also characterized by the presence of numerous massive spines over its surface.

Distylocapsa squama nov. sp.

Pl. 28, figs. 16-21
Species code 50

Holotype: I designate as holotype specimen 6960 (pl. 28, fig. 16), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin *squama* -ae (f), meaning scale of fish, refers to the presence of numerous spines that occur on the outer layer of the test.

Photographed material: 33 specimens.

Description: Test spindle-shaped, possessing usually four or five chambers; weak constrictions developed between post-cephalic chambers. Test strongly increasing in width from initial chamber, and gradually in height as added; distalmost chambers gradually narrowing in width. Cephalis small, hemispherical, with a long bladed apical horn. Test wall thick, consisting of two lattice layers of pore frames. Inner layer of thin circular pore frames, densely porous. Outer layer of large circular pore frames, regularly disposed on post-cephalic chambers; four or five rows of large circular pores per chamber. Outer layer develops strong short spines, randomly arranged. Test with a slender terminal triradiate spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	325	284	325	255
Maximum width of test	130	118	140	100
Length of distal spine	70	55	70	40

Remarks: *D. squama* evolved from *D. veneta.* With further increase in test size the terminal spine changes into a thicker, slender, bladed spine. Concomitantly, a rapid development of the outer lattice layer occurs, leading to the test reaching a well developed spinose surface.

Introduction of a new specific name is justified by the presence of a narrower, slender, robust terminal spine, as well as by having numerous acute spines, irregularly disposed over the surface of its test, a feature hitherto not developed before the Turonian, among the older species of *Distylocapsa.*

Comparisons: *D. squama* differs from its undoubtedly closely allied *D. veneta* by possessing numerous well-develop of spines on its outer layer.

FAMILY **OBELISCOITIDAE** NOV. FAM.

Type genus: *Obeliscoites* nov. gen.

Multi-segmented elongate forms with a proximal part acutely conical composed of numerous chambers; distal part is subcylindrical to subspherical and wider. Last chamber may be closed or possess a large aperture antapically. This last feature will be a criterion for generic assignment.

GENUS **OBELISCOITES** NOV. GEN.

Derivatio nominis: Derived from Latin substantive *obeliscus* -i (m), meaning obelisk, monolithic shaft that tapers slightly from bottom to top and has a conical apex.

Type species: *Cyrtocapsa turris* SQUINABOL, 1903b.

Diagnosis: Multi-segmented large forms, elongate. Proximal part of the test is acutely conical and the distal part is generally cylindrical and wider. Test slightly constricted with many chambers, separated by strictures. Moderately thick-walled test consists of a single lattice layer of pore frames, which appear to be uniform in size and circular to polygonal in shape. Externally each chamber only has numerous distinct longitudinal rows of pores, lacking other ornamental features.

Remarks: The different species clearly assignable to the new nominal genus have been during the last years (see synonymy) indistinctly referred to *Stichocapsa* HAECKEL, 1881 or *Cyrtocapsa* HAECKEL, 1881. Both genera were originally defined syntypically, and so subsequently Campbell (1954) designated for each genus the corresponding type-species, among the nominal species first subsequently referred to them by Rüst (1885). Both genera were defined as very heterogeneous groups of multi-segmented forms. The type-species (*Stichocapsa jaspidea* and *Cyrtocapsa ovalis* respectively) are specimens having few post-abdominal chambers (three or four) and always quite smaller size than all the nominal species referred herein to *Obeliscoites*. This fact justifies the creation of the new nominal genus for this particularly long species restricted to the Cretaceous. The origin of this group is not clear. It is, however, possible to suppose a close phylogenetic link from *Sethocapsa dorysphaeroides* NEVIANI, 1900, that directly involves a connection from closed Obeliscoitidae typical of the Middle-Late Jurassic.

Through the middle Albian to earliest Cenomanian this group could be considered as almost a monophyletic taxon, showing an assemblage of tremendous variability with long vertical range in time. In this way, there comes a point when differences between some species vertically are smaller than those between others horizontally. Nevertheless the present early stage of knowledge, I have preferred in this study to consider these variations as the expression of marked intraspecific variability of different morphospecies, in contrast to a horizontal classification that would regard all the members of a contemporaneous, morphologically diverse assemblage as merely variants of a single biospecies. On the other hand, taking into account the biometrical study made upon the abundant material led to recognition of the intertaxial relationships among the different nominal species of *Obeliscoites* (figs 21 and 22).

Comparisons: *Obeliscoites* is easily distinguished from *Stichomitra* by having a long slender test strongly acute apically and composed of numerous post-abdominal chambers. It is further differentiated by its peculiar vertical pattern of pore frames disposed in well pronounced longitudinal rows.

Range: Late Hauterivian to latest Cenomanian.

Obeliscoites vinassai (SQUINABOL, 1903b)

Pl. 29, figs. 1-4

Species code 51

1903b	*Halicapsa Vinassai* n. sp. SQUINABOL, p. 128, pl. 8, fig. 29.
1973	*Archcapsa similis* PARONA. - MOORE, p. 825, pl. 16, figs. 3, 4.
1973	*Sethocapsa dorysphaeroids* NEVIANI. - MOORE, p. 826, pl. 16, figs. 1, 2.
1981	*Archicapsa similis* PARONA. - SCHAAF, p. 432, pl. 22, figs. 4, 5; pl. 23, fig. 7.
1983	*Halicapsa vinassai* SQUINABOL. - ORIGLIA-DEVOS, p. 148, pl. 17, fig. 13.
1984	*Stichocapsa euganea* SQUINABOL. - SCHAAF, p. 158-159, text-fig. 8 (= specimen of Schaaf, 1981, pl. 23, fig. 7).
1985	*Stichocapsa euganea* SANFILIPPO & RIEDEL, p. 622, text-fig. 13. 4.

pars 1988 *Cyrtocapsa (? Sethocapsa) perspicua* SQUINABOL. - THUROW, pl. 3, fig. 13; non fig. 5 (= *O. perspicuus*).

1988 *Stichocapsa euganea* SQUINABOL. - THUROW, p. 406, pl. 3, figs. 6, 7.

Holotype: The nominal species based on a single specimen, described and illustrated by Squinabol (1903b) on pl. 8, fig. 29. The holotype has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 20 specimens.

Description: Test as with genus, bottle-shaped. Proximal part of the test is elongate-conical with relatively abrupt transition to a distally closed, inflated-barrel portion. Cephalis smooth tapering apically, bearing a small apical horn. Thorax and abdomen sparsely perforate, conical to trapezoidal in outline. Test with five to seven post-abdominal chambers, separated by very weak strictures. Distalmost chambers are quite inflated, about half the height of entire test. Thick-walled test with large pore frames, which appear to be uniform in size and hexagonal in shape. Pore frames arranged in well pronounced longitudinal rows. Test closed distally or with small terminal aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	774	619	800	430
Maximum width of test	185	287	373	220

Remarks: It is possible to suppose that *O. vinassai* evolved directly from *S. dorysphaeroides* by gradually acquiring a more constricted stage in its test, together with a relative increase in size during the Barremian. This species appears to have no evolutionary descendants (fig. 20).

Comparisons: *O. vinassai* differs from *O. maximus* in having a smaller size and a terminal chamber with more barrel-shaped outline.

Obeliscoites perspicuus (SQUINABOL, 1903b)

Pl. 29, figs. 5-18
Species code 54

1903b *Cyrtocapsa perspicua* n. sp. SQUINABOL, p. 142, pl. 10, fig. 16.

1903b *Stichocapsa euganea* n. sp. SQUINABOL, p. 142, pl. 8, fig. 30.

1961a *Dictyomitra producta* sp. n. ALIEV, p. 58, pl. 2, fig. 1.

1961b *Cyrtocapsa perspicua* SQUINABOL. - ALIEV, p. 65, pl. 1, figs. 2, 3.

1965 *Cyrtocapsa perspicua* SQUINABOL. - ALIEV, p. 68, pl. 13, figs. 2, 3; pl. 15, fig. 9.

1965 *Dictyomitra producta* ALIEV. - ALIEV, p. 44, pl. 7, fig. 7.

1968 *Cyrtocapsa turritica* sp. n. ALIEV, p. 30, pl. 1, fig. 7.

1976 *Stichomitra euganea* ? SQUINABOL. - PESSAGNO, p. 54, pl. 3, fig. 11.

1982 *Stichomitra* (?) *euganea* (SQUINABOL). - TAKETANI, p. 55, pl. 8, figs. 6a-b; pl. 11, fig. 6.

1983 *Cyrtocapsa turritica* ALIEV. - ORIGLIA-DEVOS, p. 152, pl. 17, figs. 20 ?, 21.

1984 *Cyrtocapsa perspicua* SQUINABOL. - SCHAAF, p. 162-163, text-fig. 10.

non 1984 *Stichocapsa euganea* SQUINABOL. - SCHAAF, p. 158-159, text-fig. 8 (= specimen of Schaaf, 1981, pl. 23, fig. 7, = *O. vinassai*).

non 1985 *Stichocapsa euganea* SANFILIPPO & RIEDEL, p. 622, text-fig. 13. 4 (= *O. vinassai*).

1986 *Mita* sp. *A*. KUHNT *et al.*, pl. 7, fig. p

pars 1988 *Cyrtocapsa (? Sethocapsa) perspicua* SQUINABOL. - THUROW, pl. 3, fig. 5; non fig. 13 (= *O. vinassai*).

1988 *Eucyrtis* sp. *A*. THUROW, p. 400, pl. 4, fig. 7.

non 1988 *Stichocapsa euganea* SQUINABOL. - THUROW, p. 406, pl. 3, figs. 6, 7 (= *O. vinassai*).

1991 *Stichocapsa perspicua* SQUINABOL. - AGUADO *et al.*, text-fig. 7. 8.

? 1992 *Stichocapsa perspicua* SQUINABOL. - BAUMGARTNER, p. 326, pl. 13, figs. 4, 5.
1992 *Stichocapsa euganea* (SQUINABOL). - TAKETANI & KANIE, text-figs. 5. 7, 8.
? 1993 *Stichocapsa euganea* SQUINABOL. - TAKAHASHI & LING, p. 98, pl. 1, fig. 5.
1994 *Stichomitra* (?) sp aff. *S. euganea* (SQUINABOL). - JUD, p. 109, pl. 21, figs. 10-13.

Holotype: Nominal species apparently based on a single specimen, which was described and illustrated by Squinabol (1903b) on pl. 10, fig. 16. The cited specimen may be treated as the holotype and has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 124 specimens.

Description: Multi-segmented test elongate, conical to spindle-shaped distally. Test consisting of more than fifteen post-abdominal chambers which gradually expand, becoming relatively inflated distally. This feature varies considerably within the same population. Cephalis smooth conical, with small apical horn. Thorax and abdomen sparsely perforate and trapezoidal in outline. Usually the thick-walled post-abdominal chambers increase gradually in height and strongly increasing in width; two distalmost post-abdominal chambers noticeably reduced in width. Externally, faintly impressed constrictions are present between chambers. Pores small, subcircular to hexagonal, increasing gradually in size distally. There is a marked trend toward longitudinal alignment of pores throughout. Test frequently closed or having a narrow aperture antapically; occasionally small basal spines occur.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	818	712	970	520
Maximum width of test	111	233	267	150

Remarks: This species shows a wide range of variability, expressed by differences in size, shape and unequal development of strictures; two principal extreme morphotypes (*perspicua-euganea*) can be identified in a continuum without solution of continuity. Frequently this assemblage of high variability partially overlaps the range of variation of neighbouring assemblages pertaining to other congeneric nominal species, principally *O. vinassai* and *O. giganteus*, and only slightly with *O. turris*. The morphological differences, when the material is plentiful, are nevertheless quite sufficient to merit a specific distinction according to the traditional taxonomic scheme (cf. fig. 21).

Obeliscoites giganteus (ALIEV, 1968)

Pl. 29, figs. 19-24
Species code 53

1968 *Cyrtocapsa gigantea* sp. n. ALIEV, p. 29, pl. 1, figs. 5, 6.

Lectotype: Although a holotype was labelled by Aliev (1968), this author did not specify, which was the specimen chosen among his illustrations. In the absence of the holotype for this nominal species, I designate a lectotype, the specimen figured by Aliev on pl. 1, fig. 5. The lectotype was reported from the middle Albian of Konakhkend (south-eastern Caucasus, NE Azerbaidzhan).

Photographed material: 21 specimens.

Description: Test large, conical, highly inflated terminally, usually with twelve post-abdominal chambers. Cephalis conical and imperforate, with short, robust apical horn. Thorax conical, sparsely perforate. Abdomen and

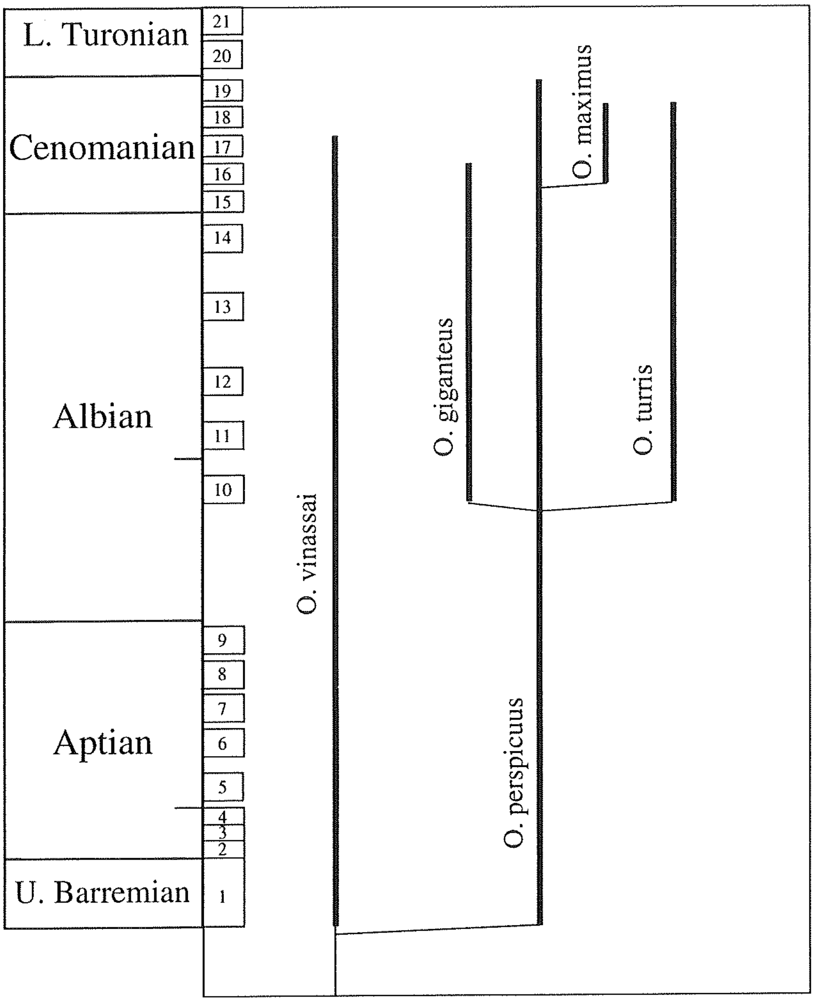

Fig. 20.- Stratigraphic range and possible phyletic relationships of species of *Obeliscoites*.

first post-abdominal chamber form together an inflated portion. Remaining post-abdominal segments increase gradually in height and slightly in width, except the distalmost chamber which is inflated annular. Strictures at segmental divisions, externally marked by little change in contour. A large circular aperture occurs basally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	1306	729	800	653
Maximum width of test	350	341	367	307

Remarks: Ranges of variability of *O. giganteus* and *O. perspicuus* partially overlap, but *O. giganteus* distinctly includes robust forms with a typical terminal chamber very inflated annular and a proximal portion resembling an arrowhead in outline.

Obeliscoites turris (SQUINABOL, 1903b)

Pl. 30, figs. 1-6
Species code 56

	1903b	*Cyrtocapsa turris* n. sp. SQUINABOL, p. 142, pl. 8, figs. 35, 35a.
	1976	*Archaeodictyomitra* (?) *turris* (SQUINABOL). - PESSAGNO, p. 50, pl. 3, figs. 4, 5.
	1983	*Archaeodictyomitra* (?) *turris* (SQUINABOL). - ORIGLIA-DEVOS, p. 137, pl. 16, figs. 16-18.
	1986	*Mita turris* (SQUIN.). - KUHNT *et al.*, pl. 7, fig. n.
non	1989	*Archaeodictyomitra* (?) *turris* PESSAGNO. - TUMANDA, p. 36, pl. 9, fig. 4.
	1991	*Stichomitra* sp. MARCUCCI *et al.*, text-fig. 3. d.
?	1993	*Dictyomitra*? sp. cf. *Eucyrtidium turritum* MOORE. - TAKAHASHI & LING, p. 97, pl. 3, fig. 5.

Holotype: The nominal species was based apparently in a single specimen, which was figured by Squinabol (1903b) on pl. 8, figs. 35-35a (lateral view and close-up of a post-abdominal segment). This specimen may be considered as the valid holotype, reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 40 specimens.

Description: Multi-segmented test, slender conical initially, then rapidly becoming cylindrical. Cephalis and thorax imperforate, markedly narrow conical. Cephalis bearing sharp apical horn. Abdomen and first post-abdominal chamber constitute a distinct, relatively inflated portion. The degree of inflation varies considerably from specimen to specimen. Test with twenty-two to thirty post-abdominal chambers, rectangular in outline and faintly constricted. Pores small, subcircular to circular, with uniform size. Pores arranged in conspicuous longitudinal rows throughout. However, there is also superposed a marked tendency towards transverse alignment, because some specimens have subcircular, or even square pores. Distally a circular aperture appears.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	1800	1186	1480	912
Maximum width of test	165	176	212	147

Comparisons: This species is distinguished from all other congeneric species by its longest size, and narrow, cylindrical, elongate shape.

Obeliscoites maximus (SQUINABOL, 1903b)

Pl. 30, figs. 7-11
Species code 52

1903b *Halicapsa maxima* n. sp. SQUINABOL, p. 128, pl. 10, fig. 19.

Holotype: The single specimen figured by Squinabol (1903b) on pl. 10, fig. 19, may be considered the holotype. This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 13 specimens.

Description: Test as with genus. Proximal part of the test is elongate, acutely conical, with very abrupt transition to a distally closed, inflated-ellipsoidal portion. Cephalis with long, sharply pointed apical horn. Cephalis, thorax, abdomen and first post-abdominal chambers form all together a very narrow conical portion, covered by a layer of microgranular silica, sparsely perforate towards its base. Test with indeterminate number of post-abdominal chambers lacking strictures entirely. The globose terminal chamber is quite inflated, about two thirds of the height of entire test. Thick walled-test, with large, circular to elliptical pores frames arranged in pronounced longitudinal rows. Test closed distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	800	891	960	840
Maximum width of test	272	321	360	253

Remarks: *O. maximus* is described here as a separate species because its distinctive shape and restricted range make it a useful marker for the Cenomanian.

Comparisons: This species differs from all other congeneric species by the peculiar slender spine-like character of the early portion of its test, by completely lacking constrictions and by having pore frames almost exclusively on the last chamber. It is the most similar to *O. vinassai*, to which it is compared under that species.

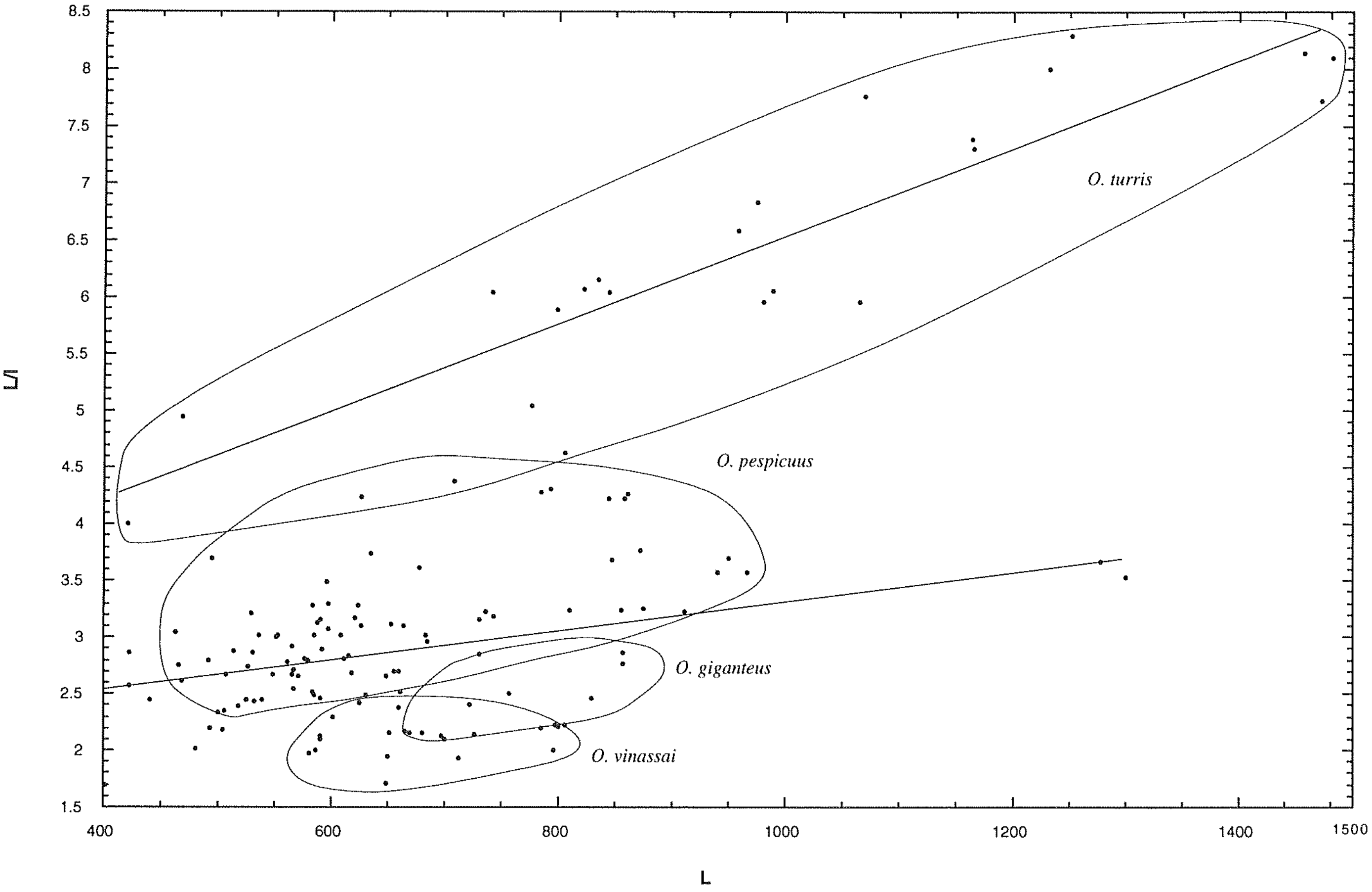

Fig. 21.- Test measurements in *Obeliscoites*. Bivariates scatter diagram (L: height, l: width), where continuous variation field are exhibited by several taxa from one sample (GC-1035.10).

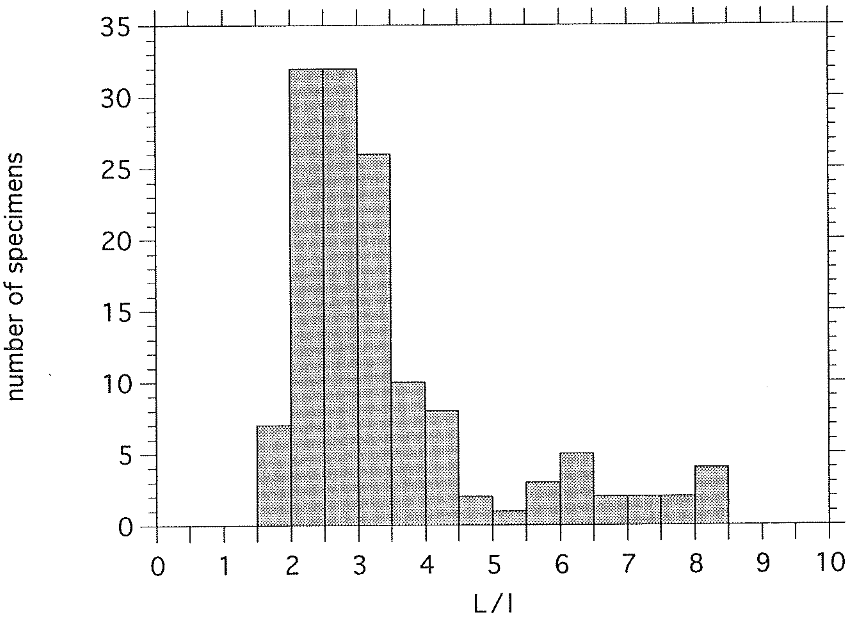

Fig. 22.- Stack bar diagram (L/l) showing divers populations of *Obeliscoites* from one same sample (GC-1035.10).

SUPERFAMILY **WILLIRIEDELLACEAE** DUMITRICA, 1970

This polyphyletic superfamily includes tri- or tetra-segmented nassellarians with cephalothorax partly or completely depressed into the abdominal cavity. Last chamber with or without distal aperture; having or not sutural pore.

FAMILY **DORYPYLIDAE** NOV. FAM.

Type genus: *Dorypyle* SQUINABOL, 1904

This family includes those Late Jurassic and Cretaceous tri- or tetra-segmented forms including into the same phyletic lineage, which are characterized by possessing a test pyriform to subspherical, with a large globose terminal chamber that lacks a terminal tube. This distalmost chamber may terminate in a constricted aperture or is completely closed and terminated in an antapical spine. The earliest representatives of this family possess a robust cephalo-thoracic portion (*Hiscocapsa*). Through successive populations the cephalis becomes divided into two chambers (lineage leading by *Hiscocapsa asseni-Squinabollum*) or have a tendency to reduce progressively the size of the apical segments, showing rapidly an encasement of the cephalothorax into the globose abdomen; this migration is accompanied simultaneously by a strong development of apical horn and terminal spine (*Dorypyle*). The marked tendency to reduce the size of the apical portion of the test will be a distinctive and common feature for the different genera that compose this family

GENUS **HISCOCAPSA** NOV. GEN.

Derivatio nominis: Latin adjective *hisco* meaning open, plus Latin noun *capsa* meaning chest. Feminine gender.

Type species: *Cyrtocapsa grutterinki* TAN, 1927.

Diagnosis: Nassellariina possessing three or four chambers, and having a large, globose, open terminal chamber without tube or spine. Cephalis small, smooth, generally round without apical horn. Cephalis may be simple or di-chambered. Cephalis, thorax and/or abdomen form together a narrow conical portion. Distalmost chamber always globose, with a narrow aperture antapically. Thick lattice layer of polygonal pore frames, sometimes with a spinose or even nodose superimposed ornamentation. Some species may present the thorax or abdomen sunken into the terminal chamber.

Remarks: Recently Widz & De Wever (1993), describe the new genus *Birkenmajeria* in order to establish a correct arrangement for a heterogeneous group of Mesozoic species classically attributed to *Sethocapsa* HAECKEL, 1881. I fully agree with their opinion; however, unfortunately the proposed solution it is exclusively limited to a single modification in the generic name, because the included species form more or less the same old heterogeneous group. The main reason of the argument presented by Widz & De Wever (op. cit.) to justify the institution of a new genus was that *Sethocapsa* is a objective synonym of *Adelocyrtis* PANTANELLI, 1880 (this remark was earlier presented by Campbell, (1954)), considering furthermore its type-species: *A. pala* PANTANELLI, 1880 (subsequent designation by Campbell, op. cit.) as nomen dubium. On other hand, contradicting it with themselves, they regard *A. cometa* PANTANELLI, 1880 among the included species of *Birkenmajeria*, which in my opinion, is also to be regarded as nomen dubium, for the same kind of arguments presented for *A. pala* by the former authors. And as if that were not enough the type-species chosen for its new genus: *Sethocapsa elevata* HINDE, 1900, following the same criteria, is to be also considered as nomen dubium. In short, the problem remains in disorder. In consequence has been established the new genus *Hiscocapsa* for those particular forms traditionally assigned to *Sethocapsa*, but considering only multi-segmented nassellarians with three or four chambers, having a large, globose, open terminal chamber without tube or spine. All species studied that have been included herein in this genus possess, without exception, a very narrow aperture antapically in the distalmost chamber.

A marked evolutionary trend in the progressive encasement of some segments can be observed in this group through the Barremian-early Aptian. This process affects exclusively the initial conical portion of the test, without any apparent changes in the terminal inflated chamber. Some particular species (like *H. uterculus* or *H. verbeeki*) show a rapid fusion of the abdomen with the thorax. Simultaneously takes place an important reduction of the strictures on the conical portion, preferentially the lumbar stricture, the original structural division between thorax and abdomen fading away. Consequently specimens of succeeding populations will present one less chamber, therefore the inflated terminal chamber from a constructional standpoint will become the abdomen. The new thoracic segment undergoes progressive migration into the abdominal cavity, and may become partially or completely encased into it.

The occurrence of a sutural pore on the lumbar stricture (situated between thorax and abdomen) could be explained as a phenomenon originated when the major modification of the structural parameters of the test are occurring, in this case, by reduction of the number of segments and by progressive migration of the cephalo-thoracic portion into the abdominal cavity. In other nassellarian, contrarily, the development of a sutural pore or a depression on the lumbar stricture (situated between thorax and abdomen) or between abdomen and first post-abdominal chamber could appear as a consequence of a stretching of the chamber, directly controlled by a rapid growing of the test.

Comparisons: *Hiscocapsa* is distinguishable from *Obeliscoites* by having only one post-abdominal chamber, frequently globose and possessing a more narrow antapical aperture.

Range: Berriasian to middle Albian.

Hiscocapsa uterculus (PARONA, 1890)

Pl. 30, figs. 12-16
Species code 133

	1890	*Theocapsa uterculus* n. f. PARONA, p.168, pl. 5, fig. 17.
	1989	*Theocapsa Zacherlii* n. sp. RÜST, p. 53, pl. 15, fig. 16.
?	1989	*Sethocapsa crucigera* n. sp. RÜST, p. 46, pl. 14, fig. 10.
?	1901	*Teocapsa tricornis* n. f. VINASSA, p. 507, pl. 1, fig. 56.
pars	1969	*Cyrtocapsa* sp. *I.* LOZYNIAK, p. 40, pl. 2, fig. 17; non figs. 16a-b.
	1975	*Sethocapsa* spp. cf. *Theocapsa uterculus* FOREMAN, p. 617, pl. 2I, figs. 21, 22.
non	1978	*Sethocapsa* sp. cf. *Theocapsa uterculus* PARONA. - FOREMAN, p. 749, pl. 2, fig. 8.
	1981	*Sethocapsa uterculus* (PARONA). - SCHAAF, p. 437, pl. 5, figs. 8a-b; pl. 26, figs. 5a-b.
	1982	*Sethocapsa uterculus* PARONA. - OKAMURA & UTO, pl. 3, fig. 15; pl. 9, figs. 2a-b.
	1982	*Sethocapsa* (?) *lagenaria* sp. nov. WU & LI, p. 70, pl. 2, fig. 9.
non	1983	*Sethocapsa uterculus* (PARONA). - ORIGLIA-DEVOS, p. 195, pl. 22, figs. 16, 17 (= *H. asseni*)
	1984b	*Sethocapsa uterculus* (PARONA). - BAUMGARTNER, p. 784, pl. 8, fig. 15.
pars	1984	*Sethocapsa uterculus* (PARONA). - SCHAAF, p. 150-151, text-fig. H (= holotype refigured), 1a-b (= specimen of Schaaf, 1981, pl. 5, figs. 8a-b), 3a-b, 4; non text-figs. 2a-c.
	1984	*Sethocapsa uterculus* (PARONA). - YAO, pl. 4, figs. 1, 2.
	1985	*Sethocapsa uterculus* SANFILIPPO & RIEDEL, p. 613, text-fig. 10. 6a-c, 6d (= specimen of Okamura & Uto, 1982, pl. 3, fig. 15), 6e (= specimen of Schaaf, 1981, pl. 5, fig. 8a).
	1986	*Sethocapsa pseudouterculus* n. sp. AITA (in AITA & OKADA), p. 116, pl. 3, fig. 12; pl. 4, figs. 1-4; pl. 7, figs. 5a-b, 12a-b.
	1986	*Sethocapsa* sp. *A.* AITA & OKADA, p. 118, pl. 3, fig. 13.
pars ?	1986	*Sethocapsa* spp. AITA & OKADA, pl. 5, fig. 13; non figs. 14-16.
	1986b	*Sethocapsa uterculus* (PARONA). - SUYARI, pl. 4, figs. 1, 2.
	1988	*Sethocapsa uterculus* (PARONA). - THUROW, p. 406, pl. 7, fig. 21.
	1988	*Sethocapsa* sp. cf. *S. uterculus* (PARONA). - THUROW, p. 406, pl. 7, fig. 22.
	1989	*Sethocapsa uterculus* (PARONA). - TUMANDA, p. 39, pl. 5, fig. 7.
	1991	*Sethocapsa uterculus* (PARONA). - AGUADO *et al.*, text-fig. 7. 12
?	1992	*Sethocapsa uterculus* (PARONA). - STEIGER, p. 63, pl. 17, fig. 14.
	1992	*Sethocapsa uterculus* (PARONA). - TAKETANI & KANIE, text-fig. 5. 4.
	1992	*Sethocapsa* cf. *uterculus* (PARONA). - TAKETANI & KANIE, text-fig. 5. 5.
	1994	*Sethocapsa uterculus* (PARONA) sensu FOREMAN, p. 106, pl. 20, figs. 15-16.

Holotype: In spite of the precarious preservation of Parona's specimen, this single illustration, actually, is to be considered as the valid designation of the holotype. The description of the nominal species seems to be based on a single specimen, which was illustrated by Parona (1890, on pl. 5, fig. 17) and was reported from the Early Cretaceous of the Maiolica formation at the locality of Cittiglio (northern Venetian Alps, North Italy). Further investigation in connection with revisory work is required, to provide the designation of a neotype in the interests of stability of nomenclature.

Photographed material: 12 specimens.

Description: Test as with genus, pyriform, possessing four or five chambers. Cephalis rounded apically, somewhat dome-shape and lacking apical horn. Cephalis and thorax smooth, imperforate. The uppermost three or four chambers form a short, large cone, the four chamber being annular, with a contour flattened proximally. This feature is observable only when the first post-abdominal chamber is well differentiated and is not resorpted with the abdomen. Postcephalic chamber on the conical portion are finely perforate. The last chamber is large, subspherical and flattened proximally, its surface is divided into large and depressed polygonal areas, delimited by obvious ridges. These areas are disposed in irregular arrangement, with only a single row of polygonal depression regularly arranged and situated in the most proximal position of the chamber. Furthermore, this single row possess the largest and deepest polygonal areas of the test. On the centre of each polygonal areas is located a small circular pore with protruding rim.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	183	163	192	148
Maximum width of test	128	118	132	112

Remarks: A reduction of the strictures may occur between thorax and abdomen or between abdomen a first-post-abdominal chamber, leading to reduction of the number of chambers on the conical portion

Comparisons: The flattened proximal surface of the last chamber (occasionally also the penultimate) distinguish this species from all other congeneric species.

Hiscocapsa verbeeki (TAN, 1927)

Pl. 31, figs. 1-6
Species code 128

1927 *Dicolocapsa exquisita* spec. nov. TAN, p. 44, pl. 8, fig. 43.
1927 *Dicolocapsa Verbeeki* spec. nov. typ. TAN, p. 44, pl. 8, fig. 40.
1927 *Dicolocapsa Verbeeki* spec. nov. var. α TAN, p. 44, pl. 8, fig. 41.
? 1930 *Dicolocapsa* aff. *abbreviata* NEVIANI. - HEITZER, p. 394, pl. 28, fig. 40.
? 1930 *Dicolocapsa globosa* NEVIANI. - HEITZER, p. 394, pl. 28, fig. 41.
non 1968 *Gongylothorax verbeeki* (TAN SIN HOK). - FOREMAN, p. 20, pl. 2, figs. 8a-c.
non 1970 *Gongylothorax verbeeki* (TAN SIN HOK). - DUMITRICA, text-fig. 2. 20.
non 1972 *Gongylothorax* sp. aff *G. verbeeki* (TAN SIN HOK). - PETRUSHEVSKAYA & KOZLOVA, p. 541, pl. 7, figs. 18, 19.
non 1973a *Gongylothorax verbeeki* TAN SIN HOK. - FOREMAN, p. 429, pl. 13, fig. 4.
non 1975 *Gongylothorax verbeeki* (TAN SIN HOK). - DUMITRICA, p. 57, pl. 1, figs. 6a-b; pl. 2, figs. 7-10.
? 1981 *Cryptamphorella challengeri* n. sp. SCHAAF, p. 433, pl. 9, figs. 6a-b.
1981 *Gongylothorax verbeeki* (TAN SIN HOK). - SCHAAF, p. 434, pl. 1, figs. 1a-b; pl. 9, figs. 9a-b ?.
non 1982 *Gongylothorax verbeeki* (TAN SIN HOK). - WU & LI, p. 66, pl. 1, fig. 10.
? 1983 *Cryptamphorella dumitricai* SCHAAF. - ORIGLIA-DEVOS, p. 205, pl. 24, fig. 13.
1988 *Williriedellum* sp. aff. *W. carpathicum* DUMITRICA. - THUROW, p. 408, pl. 8, fig. 11.
? 1989 *Gongylothorax verbeeki* (TAN SIN HOK). - TUMANDA, p. 37, pl. 8, fig. 18.
1992 *Tricolocapsa* sp. *B*. BAUMGARTNER, p. 326, pl. 13, fig. 9.

Lectotype: Nominal species described syntypically. In order to stabilize a type for this species I designate as lectotype the larger specimen figured by Tan (1927) on pl. 8, fig. 40. This specimen has been reported from early Cretaceous of the Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 38 specimens.

Description: Tricyrtid with small, poreless cephalis. Thorax partly or completely depressed in a large and inflated abdomen. The abdomen is large, subspherical to spherical, with surface divided into large hexagonal areas by obvious ridges. In the centre of each hexagonal area there is a small circular pore with protruding rim. A sutural pores occurs near of the junction between the cephalis and thorax.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	95	117	130	110
Maximum width of test	61	101	107	97

Remarks: Although Tan's lectotype has been reported from the early Cretaceous, classically some Late Cretaceous dicyrtids specimens has been erroneously assigned to this nominal species (Foreman, 1968; Dumitrica, 1970; etc.). The oldest specimens that have been examined (from early Aptian) show clearly three well differentiated chambers. Nevertheless in the earliest populations there is a noticeable decrease in height of the thoracic segment, besides a strong reduction of the collar and lumbar strictures, the collar stricture rapidly disappearing and the cephalothorax forming an inseparable portion. Simultaneously, a sutural pore appears at the lumbar stricture, and a progressive migration of the cephalothorax assemblage into the abdominal cavity begins. In this way the youngest populations reach a true cryptothoracic stage.

Comparisons: *H. verbeeki* is morphologically closely related to the species belonging to the genus *Cryptamphorella* DUMITRICA, 1970 (like *Cryptamphorella dumitricai* SCHAAF, 1981; *Tricolocapsa pilula* HINDE, 1900 or *Hemicryptocapsa conara* FOREMAN, 1968), but *H. verbeeki* is distinguished by having an abdomen with a narrow aperture situated antapically.

Hiscocapsa asseni (TAN, 1927)

Pl. 31, figs. 7-13
Species code 261

	1927	*Cyrtocapsa Asseni* spec. nov. typ. TAN, p. 67, pl. 14, fig. 118.
	1927	*Cyrtocapsa Asseni* spec. nov. var. α TAN, p. 67, pl. 14, fig. 119.
pars ?	1975	*Sethocapsa* spp. FOREMAN, p. 617, pl. 2I, figs. 10, 11; non figs. 12, 14 (= *S. fossile* ?).
	1981	*Siphocampium ? davidi* n. sp. SCHAAF, p. 437, pl. 5, fig. 7; pl. 27, figs. 10a-b.
	1982	*Sethocapsa simplex* n. sp. TAKETANI, p. 63, pl. 5, figs. 8a-c; pl. 13, fig. 1.
	1983	*Sethocapsa uterculus* (PARONA). - ORIGLIA-DEVOS, p. 195, pl. 22, figs. 16, 17.
?	1984	*Siphocampium ? davidi* SCHAAF. - SCHAAF, p. 102-103, text-figs. H (= specimen of Schaaf, 1981, pl. 27, figs. 10a-b), 1 (= specimen of Schaaf, 1981, pl. 5, fig. 7), 2-6.
	1986	*Siphocampium ? davidi* SCHAAF. - LI, pl. 1, fig. 20.
non	1986	*Siphocampium davidi* SCHAAF. - LI, pl. 2, fig. 2.
	1986b	*Siphocampium ? davidi* SCHAAF. - SUYARI, pl. 4, fig. 5.
non	1988	*Sethocapsa* sp. *A*. cf. *S. simplex* THUROW, p. 405, pl. 4, fig. 23 (= *S. fossile*).
	1988	*Siphocampium* (?) *davidi* SCHAAF. - THUROW, p. 406, pl. 7, fig. 25.
	1988	*Squinabollum fossilis* (SQUINABOL). - THUROW, p. 406, pl. 4, fig. 21.
?	1989	*Siphocampium davidi* SCHAAF. - TUMANDA, p. 39, pl. 6, fig. 10.
	1994	*Sethocapsa simplex* TAKETANI. - JUD, p. 105, pl. 20, fig. 8.

Holotype: The single specimen described and figured by Tan (1927) on pl. 14, fig. 118 may be considered the holotype. This specimen has been reported from the early Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 41 specimens.

Description: Test as with genus, possessing four chambers. Cephalis conical, acute to rounded apically, usually without apical horn and poreless. Cephalis somewhat dichambered, slightly divided by an initial development of a transverse septum. Thorax and abdomen subcylindrical, with closely disposed rows of small circular pores. Cephalis, thorax and abdomen form together a narrow conical portion, separated by well developed strictures (contour somewhat lobate); these chambers increasing gradually in width. The terminal post-abdominal chamber is inflated subspherical, about half the height of the entire test, with large polygonal pores in irregular arrangement. Sporadically tiny spines occur randomly disposed on the last chamber. A very narrow aperture occurs antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	174	174	196	156
Maximum width of test	139	126	140	112

Remarks: Through its stratigraphic limits this species shows a strong range of variation in the size and arrangement of pores in the globose post-abdominal chamber. Also a noticeable decrease of the lobate contour of the conical portion is observable towards younger populations; concomitantly takes place a lengthening of the cephalis, which becomes more rounded apically, acquiring progressively a dome-shape contour.

Schaaf (1981) established the species *Siphocampium* ? *davidi* with the purpose of differentiating a group of late Barremian tetracyrtids in which the cephalis is divided into a lower and upper chamber, as occurs in the genus *Amphipyndax*. However, in my opinion, the cephalo-thoracic structure that may be observed in Schaaf's holotype (Schaaf, 1981, pl. 27, figs. 10a-b. = specimen of Schaaf 1984, p. 103, text-figs. H) does not correspond to the concept of Foreman (1966) of cephalis divided into two chambers. Schaaf's specimen seems rather to have an initial development of a planiform stricture or a transverse septum, growing to the centre of test, which is generated by a vertical stretching of the cephalis, that allows it to reach rapidly a dome-shape contour. This phenomenon has been observed through successive late Aptian populations of *H. asseni*. This initial modification of the cephalo-thoracic portion, in earliest ontogenetic stages, strongly suggests an origin (fig. 23) for the dichambered cephalis-type (see Dumitrica 1970, text-fig. 4) developed later in *Squinabollum* DUMITRICA, 1970.

Comparisons: *H. asseni* differs from *Sethocapsa dorysphaeroides* NEVIANI, 1900, by possessing a smaller number of post-abdominal chambers and a shorter and rounded apical portion.

Hiscocapsa grutterinki (TAN, 1927)

Pl. 31, figs. 14-16; Pl. 32, figs. 1-3
Species code 253

1927 *Cyrtocapsa Grutterinki* spec. nov. typ. TAN, 1927, p. 64, pl. 13, fig. 110.
non 1927 *Cyrtocapsa Grutterinki* spec. nov. var. α TAN, 1927, p. 65, pl. 13, fig. 111.
non 1973 *Cyrtocapsa grutterinki* TAN SIN HOK. - MOORE, p. 828, pl. 2, figs. 3, 4.
non 1974 ? *Cyrtocapsa grutterinki* var α TAN SIN HOK. - RENZ, p. 790, pl. 6, figs. 1-2 (= *T. echitonicum* ?), 3; pl. 11, fig. 7 (= *T. echitonicus* ?).
non 1981 *Cyrtocapsa grutterinki* TAN SIN HOK. - NAKASEKO & NISHIMURA, p. 149, pl. 13, figs. 9, 10 (= *P. spinosa*).
1981 *Cyrtocapsa grutterinki* TAN SIN HOK. - SCHAAF, p. 433, pl. 6, figs. 6a-b.
1982 Gen. et sp. indet. OKAMURA & UTO, pl. 3, fig. 13.
1983 *Williriedellum* sp. *1*. ORIGLIA-DEVOS, p. 209, pl. 24, figs. 15, 16.
1984 *Cyrtocapsa grutterinki* TAN SIN HOK. - SCHAAF, p. 156-157, text-figs. 3a-b (= specimen of Schaaf, 1981, pl. 6, figs. 6a-b).
1988 *Cyrtocapsa* sp. cf. *C. grutterinki* TAN SIN HOK. - THUROW, p. 400, pl. 8, figs. 2, 3.
? 1989 *Cyrtocapsa grutterinki* TAN SIN HOK. - GORKA & GEROCH, p. 188, pl. 1, fig. 4.
1989 *Cyrtocapsa grutterinki* TAN SIN HOK. - TUMANDA, p. 36, pl. 5, fig. 6.
1990 *Cyrtocapsa grutterinki* TAN SIN HOK. - OZVOLDOVA, p. 141, pl. 3, figs. 1, 2.
pars 1992 *Cyrtocapsa grutterinki* TAN SIN HOK. - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 13; non fig. 11.
non 1994 *Cyrtocapsa* (?) *grutterinki* TAN. - JUD, p. 74, pl. 8, fig. 12; pl. 9, fig. 1.

Holotype: As the type for this nominal species may be considered the single specimen described and figured by Tan, 1927, in pl. 13, fig. 110, reported from early Cretaceous strata of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 67 specimens.

Description: Test as with genus, possessing four chambers. Cephalis rounded to acutely conical, poreless and with slightly developed apical horn. Thorax and abdomen subcylindrical; thorax sparsely perforate, abdomen with circular pores and small nodes. Cephalis, thorax and abdomen together form a narrow conical portion; externally collar and lumbar strictures in this portion weakly developed. Abdomen and post-abdominal chamber with test thick-walled, composed by a lattice layer of pore frames; layer composed of small circular pores, upon which are developed large massive spiny nodes connecting different pores. Test with a large circular aperture antapically.

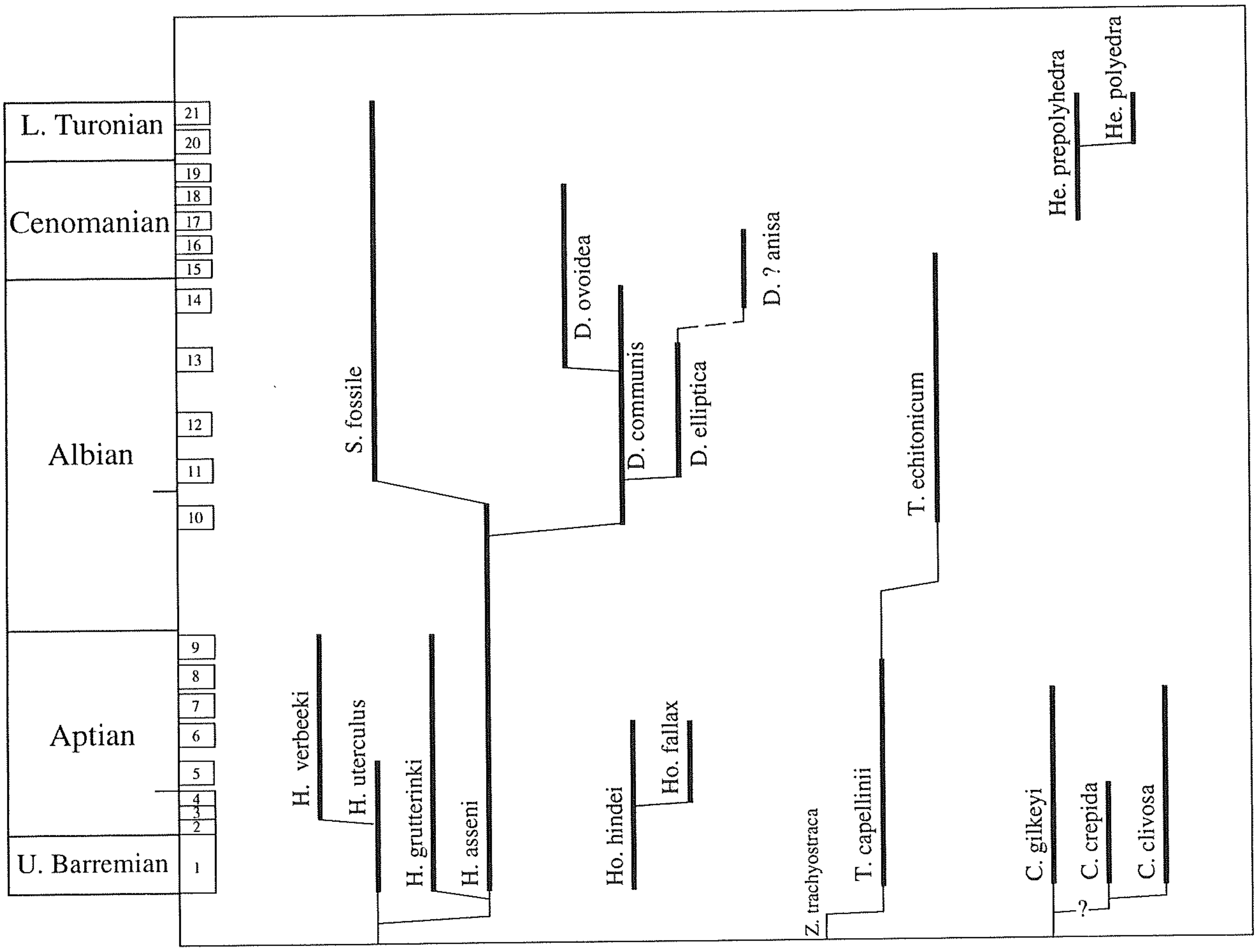

Fig. 23.- Stratigraphic range and possible phyletic relationships of the genera and species of the families Dorypylidae and Williriedellidae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	153	204	240	165
Maximum width of test	126	162	180	135

Remarks: Although the lateral view of the holotype as given by Tan (1927) is somewhat simplistic, the diagnostic pattern of the spinose tubercles and the antapical aperture permit recognition of the species. The varieties "alpha" of Tan (1927) and Renz (1974), both with a terminal spine, correspond probably to younger morphotypes closely related to *Trisyringium echitonicum* (ALIEV, 1967).

Comparisons: *H. grutterinki* differs from *Williriedellum petershmittae* SCHAAF, 1981, by having an abdomen with a narrow aperture antapically. Also this species is distinguished of *Cryptamphorella clivosa* by possessing an antapical aperture and in lacking a sutural pore.

GENUS **SQUINABOLLUM** DUMITRICA, 1970

Type species: *Clistophaena fossilis* SQUINABOL, 1903b, by original designation.

Diagnosis: Tricyrtid nassellarians. Cephalis long, imperforate, divided into two chambers or compartments by a transverse annular septum. Cephalis bearing a robust apical horn. The lower cephalic chamber is open in three collar pores. Thorax sparsely perforate and partly depressed into the abdominal cavity. Abdomen quite large, inflated, lacking sutural pore. Test without distal aperture or terminal tube.

Remarks: The complex cephalic structure of *Squinabollum* was extensively studied by Dumitrica (1970); his results do not concern us here, and interested readers are referred to that paper.

Comparisons: This genus seems to represent a terminal lineage arising from particular specimens of *Hiscocapsa* (fig. 23) having a cephalo-thoracic portion tending to the encasement (see comments above under *H. asseni*). This genus is to be regarded as monospecific.

Range: Middle Albian to Turonian.

Squinabollum fossile (SQUINABOL, 1903b)

Pl. 32, figs. 4-10
Species code 132

	1903b	*Clistophaena fossilis* n. sp. SQUINABOL, p. 130, pl. 10, fig. 11.
	1903b	*Micromelissa ventricosa* n. sp. SQUINABOL, p. 130, pl. 10, fig, 22.
?	1904	*Lithomespilus coronatus* n. sp. SQUINABOL, p. 198, pl. 4, fig. 7.
	1970	*Squinabollum fossilis* (SQUINABOL). - DUMITRICA, p. 83, pl. 19, figs. 118a-122.
non	1972	*Squinabollum* sp. aff. *S. fossilis* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 541, pl. 1, fig. 4.
	1975	*Squinabolum fossilis* (SQUINABOL). - DUMITRICA, text-fig. 2. 29.
pars ?	1975	*Sethocapsa* spp. FOREMAN, p. 617, pl. 21, fig. 14; non figs. 10, 11 (= *H. asseni* ?), 12.
	1979	*Squinabollum fossilis* (SQUINABOL). - NAKASEKO *et al.*, p. 23, pl. 5, fig. 12.
	1981	*Squinabollum fossilis* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 161, pl. 5, figs. 3, 4; pl. 14, fig. 9 ?
?	1982	*Sethocapsa* sp. *A*. TAKETANI, p. 63, pl. 5, figs. 7a-b; pl. 13, fig. 3.
	1982	*Squinabollum fossilis* (SQUINABOL). - TAKETANI, p. 70, pl. 6, figs. 10a-b, 11a-b; pl. 13, figs. 10, 11.
	1984	*Squinabollum* sp. cf. *S. fossilis* (SQUINABOL). - YAO, pl. 5, fig. 4.
	1984	*Squinabollum* sp. YAO, pl. 5, fig. 21.
?	1985	*Sethocapsa congduensis* sp. nov. LI & WU, p.74, pl. 2, fig. 11.
?	1985	*Sethocapsa echinata* sp. nov. LI & WU, p.74, pl. 2, fig. 10.
	1986	Fam. gen. et sp. indet. OKAMURA & MATSUGI, pl. 3, fig. 12.
	1986	*Squinabollum fossilis* (SQUINABOL). - TERAOKA & KURIMOTO, pl. 4, fig. 4.
	1988	*Sethocapsa* sp. *A*. cf. *S. simplex* THUROW, p. 405, pl. 4, fig. 23.
non	1988	*Squinabollum fossilis* (SQUINABOL). - THUROW, p. 406, pl. 4, fig. 21 (= *H. asseni*).
pars ?	1989	*Squinabollum fossilis* (SQUINABOL). - TUMANDA, p. 40, pl. 7, fig. 15; non pl. 8, fig. 17 (= *D. elliptica* ?)
	1991	*Sethocapsa* sp. MARCUCCI *et al.*, text-fig. 4. o.
	1992	*Squinabollum fossilis* DUMITRICA. - TAKETANI & KANIE, text-fig. 5. 6.
?	1992	*Squinabollum fossilis* (SQUINABOL). - BAK, p. 198, pl. 4, figs. 3-4.

Holotype: The single specimen illustrated by Squinabol (1903b) on pl. 10, fig. 11 may be considered the type of the nominal species. It has been reported from Teòlo series, Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 57 specimens.

Description: Test as with genus, with cephalo-thoracic portion cylindrical. Cephalis conical, imperforate, bearing a robust apical horn. Cephalic cavity divided into two chambers by a transverse annular septum: the upper chamber is subspherical and the lower is cylindrical, possessing three collar pores. Thorax porous, partly depressed into the abdominal cavity. Abdomen very large, spherical or subspherical, with polygonal pores.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	152	192	200	185
Maximum width of test	132	137	150	125
Length of apical horn	22	28	40	20

Remarks: The complex cephalic structure of *Squinabollum* has been perfectly described by Dumitrica (1970). Since the description of this genus only a single species has been recorded till the present time. The rare occurrence of representatives of this genus could indicate that the encasement phenomenon had little influence in tri- or multicyrtid Nassellariina with dichambered cephalis. *Squinabollum fossile* seems to have evolved from the youngest representatives of the genus *Hiscocapsa* (see figure 21), the cephalo-thoracic portion of which presents the same tendency to encasement. The gross resemblance in sculpture between *S. fossile* and some dorypylids is probably of phylogenetic significance.

Comparisons: *Squinabollum fossile* differs from all other Cretaceous closed tricyrtids by possessing the dichambered cephalis exclusive of this genus.

GENUS **DORYPYLE** SQUINABOL, 1904

Type species: *Dorypyle cretacea* SQUINABOL, 1904, by monotypy. This species is considered to be a synonym of *Lithapium ellipticum* SQUINABOL, 1903b.

Diagnosis: Cryptothoracic nassellarians, tricyrtid, with polygonal surface. Cephalis relatively small, imperforate, bearing a robust apical horn. Thorax partly depressed into the abdominal cavity. Abdomen well perforate, quite large and inflated, lacking sutural pore. Test without distal aperture, although commonly terminated in a robust spine.

Remarks: The oldest representatives of this genus seem to have a strongly tendency to encasement of the cephalo-thoracic portion into the abdominal cavity, the cephalo-thorax being partly or completely depressed into the abdomen. Simultaneously a strong development of the apical horn takes place, which is a common feature to all representatives of this genus.

Comparisons: This genus differs from *Trisyringium* by possessing a smaller cephalic portion and by not having a marked collar and lumbar strictures. *Dorypyle* is distinguished from its possible ancestor *Hiscocapsa* in not having an antapical aperture on the abdomen.

Range: Middle Albian to latest Cenomanian.

Dorypyle communis (SQUINABOL, 1903b)

Pl. 32, figs. 11-19
Species code 99

1903b *Xyphostylus communis* n. sp. SQUINABOL, p. 111, pl. 10, fig. 20.
1903b *Xiphosphaera euganea* n. sp. SQUINABOL, p. 110, pl. 8, fig. 11.
non 1975 *Diacanthocapsa communis* (SQUINABOL). - FOREMAN, p. 613, pl. 2I, fig. 17; pl. 6, fig. 11.
1988 Gen. et sp. indet. 7. THUROW, pl. 4, fig. 26.

Holotype: The single specimen illustrated by Squinabol (1903b, on pl. 10, fig. 20), upon which this author seems to found the nominal species, may be considered the holotype. This specimen has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy)

Photographed material: 21 specimens.

Description: Test as with genus. Cephalis subspherical, poreless, bearing a long, massive apical horn. Thorax sparsely perforate and partly depressed into the abdominal cavity. Abdomen very large, spherical, with rough surface and without aperture. Abdomen with circular pores of uniform size, set in depressions with sharp hexagonal frames. Abdomen possesses a strong terminal spine. Both apical and antapical horn are circular in cross-section.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	150	246	275	210
Maximum width of test	137	145	150	133
Length of apical horn	46	46	70	23
Length of distal spine	26	44	60	25

Remarks: The ancestry of this species has not been traced in detail, but it is probable that the earliest representatives of the genus *Dorypyle* evolved from a form of *Hiscocapsa* close to *H. asseni* (most probably) or *H. verbeeki*.

Comparisons: *D. communis* is quite similar to *Squinabollum fossile,* but it is distinguished by possessing a massive spine antapically, and not having a true dichambered cephalis.

Dorypyle ovoidea (SQUINABOL, 1904)

Pl. 33, figs. 1-7
Species code 97

1904	*Lithomespilus ovoideus* n. sp. SQUINABOL, p. 198, pl. 4, fig. 8.
1904	*Ellipsoxiphus euganeus* n. sp. SQUINABOL, p. 197, pl. 4, fig. 5.

Holotype: The specified type is the single specimen upon which Squinabol (1904, on pl. 4, fig. 8) founded the species. It has been reported from the Teòlo series in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 19 specimens.

Description: Test as with genus. Elongate, approximately ellipsoidal test, somewhat tapering toward the cephalis and usually rounded distally. Small cephalis, poreless, generally sunken into the thorax. Cephalis bearing a small apical horn. Abdomen subspherical to ellipsoidal, generally thin-walled, without aperture. Abdomen with circular pores set in hexagonal frames. Abdomen bearing a long antapical spine, and occasionally an oblique auxiliary spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	165	226	275	185
Maximum width of test	135	138	150	115
Length of apical horn	-	24	35	18

Remarks: This species seems to have evolved from *D. communis* by a progressive encasement of the cephalothorax, acquiring a more ellipsoidal shape, and did not leave any know descendants.

Comparisons: *D. ovoidea* differs from *D. communis* in having a poorly developed apical horn and having an ellipsoidal rather than spherical abdomen.

Dorypyle elliptica SQUINABOL, 1903b

Pl. 33, figs. 8-15
Species code 134

	1903b	*Lithapium ellipticum* n. sp. SQUINABOL, p. 117, pl. 10, fig. 27.
?	1903b	*Dorysphaera euganea* n. sp. SQUINABOL, p. 111, pl. 10, fig. 28.
	1904	*Dorypyle cretacea* n. sp. SQUINABOL, p. 196, pl. 3, fig. 5.
pars ?	1989	*Squinabollum fossilis* (SQUINABOL). - TUMANDA, p. 40, pl. 8, fig. 17; non pl. 7, fig. 15 (= *D. fossile* ?).

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 27 may be regarded the holotype; it has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 26 specimens.

Description: Test as with genus. Ellipsoidal test, tapering toward the cephalis and bearing a long three-bladed apical horn. Test frequently flattened antapically, lacking both aperture and distal spine. Abdomen generally thin-walled, with circular pores of uniform size, set in hexagonal frames. Lower part of the test may develop four short, downwardly directed abdominal spines, which are usually three-bladed. These abdominal spines in many specimens are reduced to very short spikes projecting from the lower part of the abdomen.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	119	247	293	207
Maximum width of test	76	166	213	84
Length of apical horn	125	59	100	33

Remarks: Through its short stratigraphic range the only variation observed is the degree of inflation of the abdomen, and the development of four abdominal spines. *D. elliptica* appears to be an evolutionary offshoot from *D. communis* and apparently gave rise to *Dorypyle* ? *anisa* at late Albian times. The occurrence of four radial abdominal spines on the youngest specimens seems to represent an important structural modification, allowing in its descendants the development of four abdominal feet.

Comparisons: *D. elliptica* differs from *D. ovoidea* by lacking a terminal spine and in having a relatively longer apical horn.

Dorypyle ? anisa (FOREMAN, 1978a)

Pl. 33, figs. 16-23; Pl. 34, figs. 1-2
Species code 111

1978a	*Histiastrum anisum* new species FOREMAN, p. 841, pl. 1, figs. 5-7.
1980	*Podocapsa* cf. *guemelii* RÜST. - SCHMIDT-EFFING, p. 251, text-fig. 27.

1983 *Podocapsa* sp. *1*. ORIGLIA-DEVOS, p. 191, pl. 22, figs. 3, 6.
1983 *Podocapsa* sp. *2*. ORIGLIA-DEVOS, p. 192, pl. 22, figs. 9, 12.

Holotype: The specimen designated and figured by Foreman (1978a) in pl. 1, fig. 7. The holotype has been reported from the late Albian-Cenomanian of DSDP Leg 40, in the eastern South Atlantic.

Photographed material: 37 specimens.

Description: Test as with genus. Cephalis subspherical, bearing a sturdy apical horn. Cephalo-thorax partly hidden in the abdominal cavity. Abdomen rough, with circular pores of uniform or somewhat variable size, set in angular frames. Four slender and massive conical feet expand radially from the base of the abdomen. The four feet vary in length, and are irregularly perforated.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	320	237	246	227
Maximum width of test	218	166	180	146
Length of apical horn	-	59	66	33

Remarks: The thicker wall, the massive feet and the stronger apical horn allow a specific distinction with the type species. Nevertheless generic assignment is queried because the presence of well-developed feet might justify the introduction of a new generic name.

Comparisons: This species differs from *Dorypyle elliptica* by having four well developed radial feet rather than four radial threebladed spines on its abdomen, furthermore it has a more thick walled test.

FAMILY **WILLIRIEDELLIDAE** DUMITRICA, 1970

Type genus: *Williriedellum* DUMITRICA, 1970.

According to Dumitrica (1970) this family includes all tri- or tetra-segmented cryptothoracic forms possessing a simple cephalis, with cephalo-thorax partly or completely depressed into the abdominal cavity; abdomen with or without aperture and having or not a sutural pore.

The different genera includes in this family are: *Williriedellum* DUMITRICA, 1970; *Hemicryptocapsa* TAN, 1927; *Holocryptocapsa* TAN, 1927; *Holocryptocanium* DUMITRICA, 1970; *Excentropylomma* DUMITRICA, 1970; *Immersothorax* DUMITRICA, 1970; *Zhamoidellum* DUMITRICA, 1970; *Cryptamphorella* DUMITRICA, 1970 and *Trisyringium* VINASSA, 1901. The first six genera are characterized by the presence of a very constricted antapical aperture, and the last three by its absence.

GENUS **TRISYRINGIUM** VINASSA, 1901

Type species: *Trisyringium capellinii* VINASSA, 1901, by monotypy.

Diagnosis: Included are those early Cretaceous cryptothoracic tricyrtids species with a large globose abdomen. Test without sutural pore, closed terminally and bearing antapically several massive spines. Cephalis poreless, conical, with apical horn minute or lacking entirely. Thorax campanulate, porous, partly depressed into the abdominal cavity which is open, without descending spines. Numerous massive spines upwardly directed are present on the upper part of the abdomen. Abdominal aperture absent.

Remarks: The origin of this group lay in the late Neocomian representatives of the genus *Zhamoidellum* DUMITRICA, 1970. The phyletic lineage leading through *Zhamoidellum leiostracum* (FOREMAN, 1973b) - *Z. trachyostracum* (FOREMAN, 1973b) during the Early Cretaceous gave rise to the first specimens of *Trisyringium capellinii* VINASSA, 1901 having spines only in apical and distal positions instead of upon the equatorial region.

Comparisons: *Trisyringium* differs from its ancestor *Zhamoidellum* by having spines well-developed only in the upper part of the abdomen and these are upwardly directed. Furthermore, its test occasionally possesses a massive spine antapically.

Range: Late Valanginian to earliest Cenomanian.

Trisyringium capellinii VINASSA, 1901

Pl. 34, figs. 3-4
Species code 264

	1901	*Trisyringium Capellinii* VINASSA, p. 507, pl. 1, fig. 49.
?	1983	*Sethocapsa leiostraca* FOREMAN. - ORIGLIA-DEVOS, p. 193, pl. 22, fig. 10.
	1988	Cryptocephalic and cryptothoracic *Nassellaria*, gen. et sp. indet. 8. THUROW, pl. 8, fig. 17.
	1991	*Sethocapsa testata* JUD. - AGUADO *et al.*, text- fig. 7. 19.
	1994	*Zhamoidellum testatum* n. sp. JUD, p. 119, pl. 24, figs. 12-15.

Holotype: The single specimen illustrated by Vinassa (1901, pl. 1, fig. 49) may be considered the holotype. The type has been reported from the Cretaceous of Karpathos, a Greek Island located in the Mediterranean Sea between Rhodes and Crete.

Photographed material: 3 specimens.

Description: Test as with genus. Cryptothoracic tricyrtids with a large globose abdomen without sutural pore, closed terminally and bearing antapically a relatively strong distal spine (pl. 34, fig. 4). Cephalis conical without apical horn or with a very short one. Thorax campanulate, porous, partly depressed into the abdominal cavity. Abdomen slightly flattened at its upper part and bearing massive spines projected upward. Lumbar stricture pronounced. Abdominal wall somewhat nodose, with circular pores arranged within irregular pore frames. Its rough surface covered by nodes, resulting from outward thickening of the abdominal wall.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	120	185	205	165
Maximum width of test	100	149	155	143
Length of distal spine	40	-	32	-

Remarks: This species seems to have evolved from Early Cretaceous representatives of *Zhamoidellum trachyostracum* (FOREMAN, 1973b) by a preferential concentration of spines around the cephalo-thoracic portion, and development of a strong antapical spine.

Comparisons: *T. capellinii* differs from its closely allied *Z. trachyostracum* by having spines only in apical and distal positions rather than in the equatorial region. Otherwise, size and ornamentation on its abdomen are identical to these of *Z. trachyostracum* that evolve directly from this latter Neocomian tricyrtid.

Trisyringium echitonicum (ALIEV, 1967)

Pl. 34, figs. 5-8
Species code 129

	1967	*Tricolocapsa echitonica* sp. nov. ALIEV, p. 25, text-figs. b, v.
	1967	*Tricolocapsa echitonica varians* subsp. nov. ALIEV, p. 26, text-figs. g, d, e, zh.
pars ?	1974	? *Cyrtocapsa grutterinki* var α TAN SIN HOK. - RENZ, p. 790, pl. 11, fig. 7; pl. 6, figs. 1, 2; non fig. 3.
	1988	Gen. et sp. indet *6*. THUROW, pl. 4, fig. 24.

Lectotype: This species was originally described syntypically. In order to stabilize the taxonomy I designate as lectotype the specimen illustrated by Aliev (1967), on text-fig. b. This specimen comes from the middle Albian of Kelevudag mountain (NE Azerbaidzhan).

Photographed material: 11 specimens.

Description: Test as with genus. Cephalis conical, poreless, without apical horn. Thorax campanulate, with small pores. A sutural pore has never been observed. Lumbar stricture generally pronounced. Abdomen large, subspherical to spherical, slightly flattened at its upper part, where short conical massive spines can be upwardly directed. Abdomen with circular pores set in polygonal frames; occasionally very small spines arise from the angles of the frames. Abdominal aperture absent. Usually some massive conical spines are situated antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	254	267	307	240
Maximum width of test	309	220	243	193

Remarks: It appears to be an evolutionary offshoot from *T. capellinii* in early Albian time and left no descendants.

Comparisons: *T. echitonicum* is distinguished from its ancestor *T. capellinii* by possessing a distinct arrangement of circular pores on the abdomen, and lacks the nodose surface structure which characterizes that species

GENUS **CRYPTAMPHORELLA** DUMITRICA, 1970

Type species: *Hemicryptocapsa conara* FOREMAN, 1968, by original designation.

Diagnosis: Cryptothoracic tri-chambered nassellarians with large spherical to subspherical abdomen. Test with or without well-individualised sutural pore and lacking antapical aperture. Cephalo-thoracic portion small, imperforate, partly to almost completely depressed into the abdominal cavity. Thorax without spines descending into the abdominal cavity. Abdomen spherical to subspherical, with rough surface. Size of pores and surface ornamentation varies considerably from species to species. Abdomen generally thin-walled, without aperture and lacking tube or terminal spines.

Remarks: In this chapter the type species has not been treated. *C. conara* ranges throughout the middle Cretaceous and seems to be the origin of all the other Late Cretaceous cryptamphorellids.

Comparisons: *Cryptamphorella* is distinguished from *Zhamoidellum* and *Trisyringium* by possessing a sutural pore well developed on its test; from *Williriedellum* by lacking a distal aperture on its abdomen.

Range: Berriasian to early Campanian.

Cryptamphorella gilkeyi (DUMITRICA, 1972)

Pl. 34, figs. 9-14
Species code 127

	1972	*Williriedellum* (?) *gilkeyi* n. sp. DUMITRICA, p. 841, pl. 3, figs. 4, 6; pl. 4, figs. 1, 2.
	1981	*Williriedellum gilkeyi* DUMITRICA. - SCHAAF, p. 440, pl. 2, figs. 6a-c.
pars	1988	*Williriedellum gilkeyi* DUMITRICA. - THUROW, p. 408, pl. 8, figs. 10, 13; non fig. 14 (= *C. crepida*).
	1991	*Williriedellum gilkeyi* DUMITRICA. - AGUADO *et al.*, text-fig. 7. 17.
non	1991	*Williriedellum* sp. aff. *W. gilkey* DUMITRICA. - MARCUCCI *et al.*, text-fig. 4. n (= *A. ? mellifera*).
	1993	*Williriedellum gilkeyi* DUMITRICA. - AGUADO *et al.*, pl. 3, fig. 5.

Holotype: Specimen figured and described by Dumitrica (1972) on pl. 3, figs. 4, 6 (lateral views) and pl. 4, figs. 1, 2 (apical views). This specimen has been reported from DSDP Leg 13 site 120-2-1, level 116 (Northwest Atlantic Ocean). An Albian age was assigned to this level, even though the radiolarian assemblage suggests rather an older age, probably early Aptian.

Photographed material: 140 specimens.

Description: Cryptothoracic tricyrtids with subspherical test. Cephalo-thorax partly depressed into abdominal cavity. Small cephalis, poreless, rounded apically and lacking apical horn. Collar stricture is not externally marked. Thorax campanulate, perforate with rough surface. Abdomen large subspherical, completely covered by triangular or polygonal depressions limited by sharp crests and having three or more pores per depression. Lumbar stricture well defined by a sharp change in contour. Abdomen without aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	152	161	170	155
Maximum width of test	128	139	148	135

Remarks: The new generic assignment is justified by the presence of a distal aperture. Through all its stratigraphic range the only variable characters are the inflation of the abdomen and consequently the density of polygonal depressions on it.

Comparisons: *C. gilkeyi* differs from its possible descendant *C. crepida* in having smaller size, triangular instead of irregular polygonal depressions on its abdomen, and single rather than double crest limiting the depressed surfaces.

Cryptamphorella crepida nov. sp.

Pl. 34, figs. 15-21
Species code 126

	1981	Cryptothoracic *Nassellaria* gen. and sp. indet. SCHAAF, pl. 2, fig. 3.
?	1981	Cryptocephalic *Nassellaria* gen. and sp. indet. SCHAAF, pl. 2, fig. 7.
pars	1988	*Williriedellum gilkeyi* DUMITRICA. - THUROW, p. 408, pl. 8, fig. 14; non figs. 10, 13.
	1991	*Hemicryptocapsa* sp. *A*. AGUADO *et al.*, text-fig. 7. 13.
	1992	*Williriedellum peterschmittae* SCHAAF. - TAKETANI & KANIE, text-fig. 5. 13.

Holotype: Specimen 9020 (pl. 34, fig. 16). The holotype comes from locality no. Ca1-22.30, early Aptian of Cortijo Carbonero (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: Latin *crepida* -ae (f), meaning sandal.

Photographed material: 67 specimens.

Description: Cryptothoracic tricyrtid having a subspherical test with small cephalis. Cephalis sparsely perforate, subspherical, without apical horn. Collar and lumbar strictures are not defined externally. A large and complex sutural pore occurs at the lumbar stricture. Abdominal surface somewhat rough with wall thickened. Abdomen large subspherical, completely covered by polygonal depressions limited by sharp double crests. Depressed polygonal areas have usually small circular pores, irregular in size and distribution. Test commonly spherical antapically, lacking aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	165	180	193	160
Maximum width of test	170	181	193	170

Remarks: This species seems to evolve from *C. gilkeyi* by loss of the lumbar stricture and more encasement of the cephalothorax, becoming the abdomen widest.

Comparisons: Ranges of variability of *C. crepida* and *C. clivosa* partially overlap, but *C. clivosa* distinctly includes robust forms with marked stricture and having dense, rounded tubercles. Special mention must be made here that both species co-occur in the late Asseni and early Turbocapsula zone, but their morphological differentiation is already fully achieved. Furthermore it differs by possessing greater density of depressed polygons on its abdominal surface.

Cryptamphorella clivosa (ALIEV, 1967)

Pl. 35, figs. 1-8
Species code 255

?	1930	*Conosphaera sphaeroconus* RÜST. - HEITZER, p. 386, pl. 27, fig. 4.
?	1930	*Lithobotrys undulata* spec. n. HEITZER, p. , pl. 28, fig. 22.
	1967	*Tricolocapsa clivosa* sp. nov. ALIEV, p. 23, text-fig. a.
	1975	*Zhamoidellum ornatum* (ZHAMOIDA). - FOREMAN, p. 618, pl. 2I, figs. 15 ?, 16.
pars ?	1979	*Zhamoidellum ornatum* (ZHAMOIDA). - NAKASEKO *et al.*, p. 24, pl. 3, fig. 13; non fig. 14.
	1981	*Hemicryptocapsa* sp. cf. *H. prepolyhedra* DUMITRICA. - SCHAAF, p. 434, pl. 1, fig. 4.
	1982	*Hemicryptocapsa* cf. *tuberosa* DUMITRICA. - WU & LI, p. 67, pl. 1, fig. 14.
pars ?	1983	*Sethocapsa cetia* FOREMAN. - ORIGLIA-DEVOS, p. 192, pl. 21, fig. 16; non fig. 17.
	1988	*Williriedellum* sp. *A*. THUROW, p. 408, pl. 8, fig. 12.
	1988	*Zhamoidellum ornatum* (?) (ZHAMOIDA). - THUROW, p. 408, pl. 8, fig. 15.
	1989	*Sethocapsa trachyostraca* FOREMAN. - TUMANDA, p. 39, pl. 5, fig. 8.
	1990	*Praeconocaryomma lipmanae* PESSAGNO. - OZVOLDOVA, p. 143, pl. 1, fig. 3.
?	1990	*Praeconocaryomma* sp. *A*. OZVOLDOVA, p. 143, pl. 1, fig. 2.

Holotype: The specimen figured and described by Aliev (1967) on text-fig. a. The holotype has been reported from the Valanginian deposit along the Kyzulkazmachai River, near the locality of Khaltan, eastern Caucasus (NE Azerbaidzhan).

Photographed material: 101 specimens.

Description: Cryptothoracic tricyrtid having a tuberculated test with small cephalis. Cephalis sparsely perforate, subspherical, lacking apical horn. Collar and lumbar strictures well marked externally in smaller specimens. A large and complex sutural pore occurs at the lumbar stricture. Thorax and abdomen, when they are well differentiated, may be flattened at their upper parts. Abdominal surface rough with wall thickened by large blunt nodes. Nodes are interconnected by means of a double set of sharp crests. These double crests bound depressed polygonal areas. Commonly these depressed surfaces between the crests are covered by numerous circular pores. Nodes have usually small circular pores, irregular in size and distribution. Test may be almost spherical or flattened antapically, lacking aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	247	177	200	135
Maximum width of test	206	169	200	128

Remarks: Size of nodes and surface ornamentation vary greatly. Small specimens generally have nodes with poor development of polygonal depressions. Individuals with small size tend to have well marked strictures, while specimens with larger size show major encasement of the cephalothorax, and strictures are not defined externally. *C. clivosa* apparently branched off from *C. crepida*, and left no descendants.

Comparisons: *C. clivosa* differs from its closely allied *C. crepida* in having only rectangular or polygonal depressions on its abdomen, lacking the characteristic blunt nodes typical of the former species.

GENUS **HOLOCRYPTOCAPSA** TAN, 1927

Synonym: *Stylocryptocapsa* TAN, 1927.

Type species: *Holocryptocapsa fallax* TAN, 1927, subsequent designation by Campbell (1954). This species is considered herein as a synonym of *Holocryptocapsa hindei* TAN, 1927.

Diagnosis: Cryptothoracic tricyrtids with generally spherical or subspherical test. Cephalo-thorax almost completely depressed into the abdominal cavity. Cephalis poreless, with or without apical horn. Thorax campanulate, well perforate, with four to six spines descending into the abdominal cavity. Thorax completely depressed into the abdomen. Test with a very constricted aperture and having a sutural pore, which is somewhat depressed and presents a complicated structure.

Remarks: The possible phylogenetic relationships of this group are not clear. Further detailed biostratigraphic research on Cretaceous cryptothoracic nassellarians is required to establish precise generic relations.

Comparisons: *Holocryptocapsa* differs from *Holocryptocanium* DUMITRICA, 1970, but the latter possess only three thoracic spines and a complex sutural pore (Dumitrica, loc. cit. p .74)

Range: Late Valanginian to middle Aptian.

Holocryptocapsa hindei TAN, 1927

Pl. 35, figs. 9-17
Species code 254

1927	*Holocryptocapsa fallax* spec. nov. TAN, p. 52, pl. 10, figs. 73, 74 ? (homonym of *S. fallax* TAN, 1927).
1927	*Holocryptocapsa Hindei* spec. nov. TAN, p. 52, pl. 10, fig. 75.

non 1970 *Holocryptocapsa* cf. *hindei* TAN SIN HOK. - DUMITRICA, p. 74, pl. 15, figs. 100a-d.
1972 *Holocryptocapsa* (?) sp. DUMITRICA, p. 842, pl. 3, figs. 1-3, 5.
non 1972 *Holocryptocapsa* sp. aff. *H. hindei* TAN SIN HOK. - PETRUSHEVSKAYA & KOZLOVA, p. 541, pl. 1, fig. 1.
non 1975 *Holocryptocapsa hindei* TAN SIN HOK. - DUMITRICA, text-fig. 2. 39.
1981 *Holocryptocapsa hindei* TAN SIN HOK. - SCHAAF, p. 435, pl. 9, figs. 4a-b, 14.

Holotype: The specimen illustrated by Tan (1927, pl. 10, fig. 75) may be regarded as the holotype. This specimen has been reported from the Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 228 specimens.

Description: Cryptothoracic tricyrtids with subspherical test. Cephalo-thorax almost completely depressed into the abdominal cavity. Test bearing a large depressed sutural pore of complicated structure, which occupies an important surface of the test. Cephalis poreless, with a very small apical horn. Thorax campanulate, well perforate, with several spines descending into the abdominal cavity. Thorax completely depressed into the abdomen. Abdomen somewhat cylindrical in shape, with rough surface. Abdomen with circular pores of uniform size set in hexagonal frames. Most specimens have tiny spines at the angles of the frames. Test flattened antapically, having a large circular depression in which is a short cylindrical aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	137	139	155	128
Maximum width of test	113	128	145	123

Remarks: The origin of this species is unknown. I do not discard a possible phylogenetic relationship with Early Cretaceous representatives of the genus *Hemicryptocapsa*.

Comparisons: This species differs from its closely allied *H. fallax* by having a larger sutural pore and by possessing a more cylindrical test.

Holocryptocapsa fallax (TAN, 1927)

Pl. 35, figs. 18-21
Species code 249

1927 *Stylocryptocapsa fallax* spec. nov. TAN, p. 52, pl. 10, fig. 72.
1927 *Stylocryptocapsa Verbeeki* spec. nov. typ. TAN, p. 51, pl. 10, fig. 70.
1927 *Stylocryptocapsa Verbeeki* spec. nov. var α TAN, p. 52, pl. 10, fig. 71.
? 1988 Cryptothoracic *Nassellaria*, gen. et sp. indet. *14*. THUROW, pl. 8, fig. 16.

Holotype: The specimen illustrated by Tan (1927, pl. 10, fig. 72) may be regarded as the holotype. This specimen has been reported from the Cretaceous of Rotti Island (Moluccas Archipelago, East Indian Ocean).

Photographed material: 23 specimens.

Description: Cryptothoracic tricyrtids with generally spherical or subspherical test. Cephalo-thorax partly depressed into the abdominal cavity. Test bearing a small circular sutural pore. Cephalis subspherical, poreless, having a small apical horn. Strictures are not defined externally. Thorax completely depressed into the abdomen. Abdomen large spherical, with rough surface. Abdomen with circular pores of uniform size set in hexagonal frames. Most specimens have tiny spines at the angles of the frames, and also may develop robust spines, preferentially disposed at the base of abdomen. Test slightly flattened antapically, having a large circular depression in which is located a small cylindrical aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	163	146	155	140
Maximum width of test	121	138	150	125

Remarks: *H. fallax* seems to be an evolutionary offshoot from *H. hindei* and did not leave any known descendants, whit this species the genus *Holocryptocapsa* apparently becomes extinct in late Aptian time.

Comparisons: See comparisons under *H. hindei.*

GENUS **HEMICRYPTOCAPSA** TAN, 1927

Type species: *Hemicryptocapsa capita* TAN, 1927, subsequent designation by Campbell (1954).

Diagnosis: Cryptothoracic tricyrtids having a large inflated abdomen, with a simple sutural pore and a very constricted aperture. Cephalis simple, poreless, with four collar pores. Cephalis subspherical, usually without apical horn. Thorax partially depressed into the abdominal cavity, and possessing three basal spines.

Comparisons: This genus is distinguished from *Williriedellum* by having three characteristic descending thoracic spines and by possessing a simple sutural pore. *Hemicryptocapsa* differs from *Holocryptocapsa* by its less depressed thorax.

Range: Hauterivian to Campanian.

Hemicryptocapsa prepolyhedra DUMITRICA, 1970

Pl. 35, figs. 22-25
Species code 362

?	1904	*Cenosphaera polyedrica* n. sp. SQUINABOL, p. 186, pl. 2, fig. 3.
	1970	*Hemicryptocapsa prepolyhedra* n. sp. DUMITRICA, p. 71, pl. 13, figs. 80-84; pl. 20, fig. 131.
	1975	*Hemicryptocapsa prepolyhedra* DUMITR. - DUMITRICA, text-fig. 2. 26.
	1980	*Hemicryptocapsa* cf. *palyhedra* DUMITRICA. - OKAMURA, pl. 21, fig. 10.
non	1981	*Hemicryptocapsa* sp. cf. *H. prepolyhedra* DUMITRICA. - SCHAAF, p. 434, pl. 1, fig. 4 (= *C. clivosa*).
	1989	*Hemicryptocapsa* cf. *polyhedra* DUMITRICA. - KATO & IWATA, pl. 8, fig. 12.
pars	1992	*Hemicryptocapsa polyhedra* DUMITRICA. - MARCUCCI & GARDIN, text-fig. 3. g; non text-fig. 3. f.

Holotype: The specimen figured and described by Dumitrica (1970) on pl. 13, figs. 80a-c, reported from the Cenomanian of the Podu Dîmbovitei (Romanian Eastern Carpathians).

Photographed material: 40 specimens.

Description: Test as with genus. Test possesses a rough surface composed of polygonal facets. Cephalis spherical, poreless, without apical horn. Cephalothorax encased into the abdomen. Thorax porous and completely depressed into the abdominal cavity. Sutural pore small, circular, situated in the centre of a polygonal facet and surrounded by a ring of circular pores. Occasionally collar stricture slightly marked externally. Abdomen large, subspherical, having a thick wall. The polygonal facets are separated by rough ridges; these result from an exaggerated development of the polygonal pore frames. Antapical aperture strongly constricted, set in the centre of a polygonal facet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	120	148	170	123
Maximum width of test	105	146	155	125

Comparisons: Ranges of variability of *H. prepolyhedra* and *H. polyhedra* partially overlap, but *H. prepolyhedra* distinctly includes robust forms with polygonal facets distinctly limited by rough and perforate ridges. The ancestry of this species remains unknown.

Hemicryptocapsa polyhedra DUMITRICA, 1970

Pl. 35, figs. 26-30
Species code 125

	1970	*Hemicryptocapsa polyhedra* n. sp. DUMITRICA, p. 72, pl. 14, figs. 85a-c.
non	1973	*Hemicryptocapsa polyhedra* DUMITRICA. - MOORE, p. 827, pl. 8, figs. 1, 2.
	1979	*Hemicryptocapsa polyhedra* DUMITRICA. - NAKASEKO *et al.*, p. 23, pl. 5, fig. 9.
non	1980	*Hemicryptocapsa* cf. *palyhedra* DUMITRICA. - OKAMURA, pl. 21, fig. 10 (= *H. prepolyhedra*).
	1981	*Hemicryptocapsa polyhedra* DUMITRICA. - NAKASEKO & NISHIMURA, p. 153, pl. 4, fig. 2 (= specimen of Nakaseko *et al.*, 1979, pl. 5, fig. 9); pl. 14, fig. 5.
?	1982	*Hemicryptocapsa polyhedra* DUMITRICA. - TAKETANI, p. 66, pl. 7, figs. 5a-b.
non	1983	*Hemicryptocapsa polyhedra* DUMITRICA. - ORIGLIA-DEVOS, p. 206, pl. 24, figs. 17, 20, 21 (= *A. ? mellifera*).
?	1986	*Hemicryptocapsa* cf. *polyhedra* DUMITRICA. - TERAOKA & KURIMOTO, pl. 3, fig. 2; pl. 4, fig. 5.
non	1986	*Hemicryptocapsa polyhedra* DUM. - THUROW & KHUNT, text-fig. 9. 21 (= *A. ? mellifera*).
non	1988	*Hemicryptocapsa polyhedra* DUMITRICA. - THUROW, p. 401, pl. 1, fig. 1 (= *A. ? mellifera*).
non	1988	*Hemicryptocapsa* sp. cf. *H. polyhedra* DUMITRICA. - THUROW, p. 401, pl. 5, fig. 2 (= *A. ? mellifera*).
non	1989	*Hemicryptocapsa* cf. *polyhedra* DUMITRICA. - KATO & IWATA, pl. 8, fig. 12 (= *H. prepolyhedra*).
pars	1992	*Hemicryptocapsa polyhedra* DUMITRICA. - MARCUCCI & GARDIN, text-fig. 3. f; non text-fig. 3. g (= *H. prepolyhedra*).

Holotype: The specimen figured and described by Dumitrica (1970), on pl. 14, figs. 85a-c, from early Turonian Deva Beds, Bretelin (Southern Carpathians).

Photographed material: 35 specimens.

Description: Test as with genus. Test large, subspherical, with rough surface composed of polygonal facets. Cephalis spherical, poreless, without apical horn. Cephalothorax almost completely encased into the abdomen. Lumbar and collar strictures not defined externally. Sutural pore very small, circular. Abdomen large, globular, having a thick wall. The polygonal facets are separated by sharp, ridged, winglet-like frames. These are distributed over all the surface, even reaching the apex of the test. Antapical aperture very constricted, set in the centre of a polygonal facet.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	117	230	242	217
Maximum width of test	110	232	250	225

Comparisons: This species is undoubtedly an evolutionary offshoot from *H. prepolyhedra* (Dumitrica, 1970). *H. polyhedra* is distinguished from its ancestor by possessing polygonal facets more regular and better outlined, which are distinctly limited by sharp ridges, forming winglet-like frames.

FAMILY **DIACANTHOCAPSIDAE** NOV. FAM.

Type genus: *Diacanthocapsa* SQUINABOL, 1903b.

The new family includes the following Cretaceous genera: *Diacanthocapsa* SQUINABOL, 1903a; *Turbocapsula* nov. gen.; *Guttacapsa* nov. gen.; *Kozurium* PESSAGNO, 1977c; *Myllocercion* FOREMAN, 1968; *Schadelfusslerus* EMPSON-MORIN, 1981. This family includes all those Cretaceous tri- or tetracyrtids possessing a cephalis with a tendency toward encasement. Cephalis small with or without apical horn. Test usually oval or spindle-shaped, with or without sutural pore

GENUS **DIACANTHOCAPSA** SQUINABOL, 1903a

Synonyms: *Eastonerius* EMPSON-MORIN, 1981; *Novodiacanthocapsa* EMPSON-MORIN, 1981.

Type species: *Diacanthocapsa euganea* SQUINABOL, 1903b, by monotypy.

Diagnosis: Cryptocephalic tricyrtids, with spindle-shaped test. Cephalis small, poreless, with or without apical horn. Cephalis completely or partly encased in the thorax. Thorax campanulate, porous, having a constricted aperture. Abdomen elongate, usually fusiform, larger than thorax and frequently tapering distally. Test may develop a sutural pore in a lumbar position. Abdomen usually has a tendency to be triangular in transverse section.

Remarks: The origin of this group probably lies in particular Early Cretaceous cryptocephalic tricyrtids (a possible phylogenetic link from *Turbocapsula* is tentatively suspected), but these have not been studied in this work, so that it is very difficult to determine their ancestry.

Comparisons: Representatives of this genus are distinguishable from *Turbocapsula* by lacking longitudinal costae and by having a generally larger abdomen.

Range: Aptian to early Campanian.

Diacanthocapsa betica nov. sp.

Pl. 36, figs. 1-7
Species code 311

Holotype: Specimen 9967 (pl. 36, fig. 1). From locality no. Mc-268b, middle Aptian, Carbonero Formation, (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: The name of the nominal species is derived form the noun *Betica* (Latin), roman name of the southern Spain.

Photographed material: 83 specimens.

Description: Cryptocephalic tricyrtids, with spindle-shaped test. Cephalis spherical small, poreless, without apical horn. Cephalis partly encased in the thorax. Test rounded apically. Thorax campanulate, porous; usually a sutural pore occurs at the lumbar position. This sutural pore is circular and surrounded by a ring of small circular pores. Abdomen elongate, fusiform, usually larger than thorax and slightly tapering distally. Lumbar stricture gently defined externally. Test with circular pores irregularly disposed, and with a constricted aperture antapically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	153	122	153	106
Maximum width of test	87	75	90	63

Comparisons: *D. betica* differs from all other described species of *Diacanthocapsa* by possessing a large circular sutural pore and a small ovoid test.

Diacanthocapsa fossilis (SQUINABOL, 1904)

Pl. 36, figs. 8-11

Species code 90

	1904	*Dicolocapsa fossilis* n. sp. SQUINABOL, p. 218, pl. 7, fig. 19.
?	1904	*Sethocapsa fossilis* n. sp. SQUINABOL, p. 216, pl. 7, fig. 13.
	1979	*Diacanthocapsa brevithorax* DUMITRICA. - NAKASEKO *et al.*, p. 21, pl. 5, fig. 14.
	1981	*Diacanthocapsa brevithorax* DUMITRICA. - NAKASEKO & NISHIMURA, p. 149, pl. 5, fig. 6 (= specimen of Nakaseko *et al.*, 1979, pl. 5, fig. 14).
?	1989	*Kozurium* sp. *B.* PESSAGNO. - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, figs. 12, 13.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 7, fig. 19 may be regarded as the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 13 specimens.

Description: Tricyrtid test, spindle-shaped. Very small cephalis, lacking apical horn. Test rounded apically. Cephalis completely or partly encased in the thorax. Lumbar stricture well defined externally. Sutural pore slightly defined. Thorax hemispherical to campanulate with large circular pores in hexagonal frames and longitudinally aligned. Abdomen gradually expanded, becomes quite inflated, then constricts to form a small aperture. Abdomen tends to be trilobate, having a rounded-triangular cross section. Abdominal pores are smaller than thoracic pores, tending to form dense longitudinal rows. Abdomen inverted conical and larger than thorax.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	135	188	205	175
Maximum width of test	80	109	118	100

Remarks: Through its relatively long stratigraphic range, *D. fossilis* exhibits only slight variability in the roundness of the apical part and length of the abdomen, the latter having a tendency to become trilobate in mature specimens. *D. fossilis* appears to have evolved from *D. betica* and seems to be the origin of a minor radiation giving rise to the occurrence of numerous species in late Cenomanian times.

Comparisons: This species is distinguished from *D. ovoidea* by possessing an abdomen with triangular cross-section instead of a circular one, and externally by having a better defined lumbar stricture.

Diacanthocapsa rara SQUINABOL, 1904

Pl. 36, figs. 12-18
Species code 151

1904 *Diacanthocapsa rara* n. sp. SQUINABOL, p. 218, pl. 7, fig. 17.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 7, fig. 17 may be considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 15 specimens.

Description: Tri-segmented cryptocephalic test, with abdomen strongly expanded, becoming quite inflated, then constricting to form a closed terminal tube. Cephalis small, spherical, bearing a long sturdy threebladed apical horn. Cephalis completely encased in the thoracic cavity. Collar stricture indistinct. Thorax campanulate to subspherical. Thoracic pores large, circular, set in hexagonal frames. Thorax partly hidden by the outgrowing of the abdominal wall. Abdomen large, strongly trilobate, having a triangular cross-section. Abdomen has a thick wall, densely porous, with occasionally minute spines upwardly directed in its upper part. Abdomen with small circular to ellipsoidal pores. Three broad lamellar feet are incorporated in the external wall of the abdomen. Terminal tube usually long, acutely conical and densely porous.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Maximum length of test	232	309	430	240
Maximum width of test	76	124	165	105
Length of apical horn	25	53	75	35

Remarks: This species shows a wide range of morphologic variability through all its stratigraphic range. Thorax changes from campanulate to subspherical and is partly to almost completely hidden in the thorax. Abdomen varies in degree of inflation from spindle-shaped to strongly trilobate, with additional development of three lamellar feet incorporated in the wall of abdomen. The outgrow of the abdominal wall may completely hide the thorax, only a sturdy apical horn being visible. *D. rara* appears to have evolved from *D. fossilis* and seems to be the origin of the genus *Guttacapsa* (probably evolved into *G. biacuta*).

Comparisons: *D. rara* is distinguished from all other congeneric species by having a sturdy threebladed apical horn, a prominent trilobate abdomen and a long terminal tube.

Diacanthocapsa euganea SQUINABOL, 1903b

Pl. 36, figs. 19-21
Species code 150

1903b *Diacanthocapsa euganea* n. sp. SQUINABOL, p. 133, pl. 8, fig. 26.
1982 *Diacanthocapsa euganea* SQUINABOL. - TAKETANI, p. 68, pl. 8, figs. 2a-3b; pl. 12 , fig. 15.
1989 *Diacanthocapsa euganea* SQUINABOL. - KATO & IWATA, pl. 8, fig. 4.
1989 *Diacanthocapsa euganea* SQUINABOL. - TUMANDA, p. 36, pl. 7, fig. 5.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 26 may be considered the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 8 specimens.

Description: Tri-segmented cryptocephalic nassellarians. Cephalis subspherical, poreless, completely hidden in the thorax, so that the collar stricture is absent. Cephalis bearing an acutely conical apical horn. Thorax is circular to slightly elliptical in transverse section. Lumbar stricture slightly defined externally. Thorax and abdomen with uniform circular pores (sometimes recessed in hexagonal frames) increasing slightly in size distally, and arranged quincuncially in longitudinal rows. Abdomen slightly increasing in width distally, becoming somewhat inflated, then constricting and tapering distally. Abdomen with very constricted aperture, or usually closed by overgrowth of the abdominal wall, bearing a minute antapical spine.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	168	188	216	160
Maximum width of test	118	87	90	84
Lenght of apical horn	10	21	28	16

Remarks: This species appears to have evolved from *D. rara,* which accompanies it for much of its range, and may also have given rise to the earliest representative of the genus *Guttacapsa* in early-middle Cenomanian time.

Comparisons: *D. euganea* differs from its closely allied *D. matsumotoi* by its less robust and less trilobate abdomen, and by lacking the three typical longitudinal lamellar crests on its abdomen.

Diacanthocapsa matsumotoi (TAKETANI, 1982)

Pl. 36, figs. 22-24
Species code 152

1982 *Eucyrtidium* (?) *matsumotoi* n. sp. TAKETANI, p. 57, pl. 4, figs. 1a-3b; pl. 11, figs. 11 ?, 12.

Holotype: The specimen designed and figured by Taketani (1982) on pl. 4, figs. 3a-b. The holotype is reported from locality CB07, Urakawa Formation (Cenomanian-Turonian?), southern Hokkaido.

Photographed material: 5 specimens.

Description: Cryptocephalic tetracyrtids with small spherical cephalis; this latter is completely hidden in the thorax, so that, the collar stricture there is not defined. Cephalis bearing a small apical horn, circular in cross-section. Lumbar stricture well marked externally by a sharp change in contour. Abdomen large, with a triangular transverse section. Abdomen with thick wall having numerous tiny circular to ellipsoidal pores set in hexagonal frames, arranged quincuncially in longitudinal rows. Distally, abdomen presents three lamellar crests with irregular wavy ridges, resembling somewhat a fish-tail. These ridges result from downward thickening of the abdominal wall. The additional post-abdominal chamber is inversely conical, having a triangular transverse section, with pores showing a slight tendency towards longitudinal alignment. Test very constricted distally.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	210	233	260	220
Maximum width of test	90	103	110	100
Lenght of apical horn	28	40	50	35

Remarks: *D. matsumotoi* apparently evolved from *D. euganea* and did not leave any known descendant. This species differs from its ancestor in having the abdomen wider, trilobate, with longitudinal lamellar crests. It differs from *D. rara* by lacking a terminal tube and by having a short circular rather than long threebladed apical horn.

Diacanthocapsa antiqua (SQUINABOL, 1903b)

Pl. 36, figs. 25-28
Species code 368

1903b *Theocorys antiqua* n. sp. SQUINABOL, p. 135, pl. 8, fig. 25.
? 1903b *Sethocapsa microacanthos* n. sp. SQUINABOL, p. 133, pl. 9, fig. 29
1904 *Tricolocapsa oblonga* n. sp. SQUINABOL, p. 226, pl. 9, fig. 3.
? 1973 *Theopera* sp. A. MOORE, p. 827, pl. 17, fig. 4.
non 1974 *Theocorys* sp. aff. *T. antiqua* SQUINABOL. - RENZ, p. 798, pl. 6, figs. 4-7; pl. 11, fig. 4 (= *T. fugitiva*).
non 1974 *Theocorys antiqua* SQUINABOL. - RIEDEL & SANFILIPPO, p. 781, pl. 10, fig. 9 (= *T. costata*), figs. 10, 11 (= *T. fugitiva*).
1975 *Myllocercion antiquum* (SQUINABOL). - DUMITRICA, text-fig. 2. 34.
non 1981 *Theocorys antiqua* SQUINABOL. - SCHAAF, p. 440, pl. 24, figs. 10a-b.
non 1985 *Theocorys antiqua* SANFILIPPO & RIEDEL, p. 623, text-figs. 14. 6a-c (= *T. fugitiva*), 6d (= *T. costata*).
1991 *Myllocercion cf. acineton* FOREMAN. - MARCUCCI *et al.*, text-fig. 4. m.
? 1994 Nassellaria, gen. and sp. indet. WAKITA & BAMBANG, fig. 7.16.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 25 may be regarded as the holotype. It is reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 11 specimens.

Description: Cryptocephalic tricyrtid with amphiconical test. Cephalis very small, subspherical, poreless, hidden partially in the thoracic cavity. Its place is marked on the top of the thorax by a poreless surface, tapering apically. Cephalis with no or poorly developed apical horn. Thorax campanulate, with small circular pores, tending to be longitudinally arranged. Collar and lumbar strictures slightly marked externally. Abdomen slightly trilobate, with small circular pores, densely disposed in longitudinal rows. Test possesses a very constricted aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	135	184	216	164
Maximum width of test	66	94	100	88

Remarks: The great affinity in sculpture between *D. antiqua* and some representatives of the genus *Myllocercion* FOREMAN, 1968, (common in the Late Cretaceous) is quite probably of phylogenetic significance. *D. antiqua* seems to have evolved from those representatives of *D. rara* with reduced cephalothorax (pl. 36, fig. 17). This species is distinguished from all other congeneric species in having a more amphiconical test. It differs from *Guttacapsa gutta* (SQUINABOL) by having strictures slightly defined externally and a triangular transverse section.

Diacanthocapsa ovoidea DUMITRICA, 1970

Pl. 37, figs. 1-6
Species code 361

1904 *Dicolocapsa euganea* n. sp. SQUINABOL, p. 218, pl. 7, fig. 18.
1970 *Diacanthocapsa ovoidea* n. nov. DUMITRICA, p. 63, pl. 5, figs. 25a-b; pl. 6, figs. 26-29b.

1982 *Diacanthocapsa brevithorax* DUMITRICA. - TAKETANI, p. 68, pl. 8, figs. 1a-b.
1994 *Diacanthocapsa* sp. WAKITA & BAMBANG, fig. 7.15
1994 *Novodiacanthocapsa* sp. WAKITA & BAMBANG, fig. 7.14

Holotype: The single specimen included by Squinabol (1904, pl. 7, fig. 18) in the nominal series of *Dicolocapsa euganea*. It is reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 33 specimens.

Description: Test as with genus. Tri-segmented cryptocephalic test. Cephalis small, spherical, poreless, lacking apical horn. Test rounded apically. Cephalis completely encased in the thoracic cavity. Thorax having a thick-walled test. Lumbar stricture in oldest specimens slightly marked externally, in younger not at all. Abdomen cylindrical, tapering distally and having a very constricted aperture. Sutural pore has never been observed in the studied specimens. Thorax and abdomen have circular pores, of quite regular size, which are longitudinally to irregularly arranged (quite irregularly in youngest specimens).

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	155	195	210	180
Maximum width of test	89	99	110	93

Remarks: *D. ovoidea* evolved from *D. fossilis* by loss of the triangular section, and evolved into *D. brevithorax* by acquiring a more cylindrical shape.

Comparisons: *D. ovoidea* is distinguished from its undoubted ancestor *D. fossilis* by possessing an abdomen with more circular rather than triangular section and by having a more regular pore size on its test.

Diacanthocapsa brevithorax DUMITRICA, 1970

Pl. 37, figs. 7-11
Species code 98

1970 *Diacanthocapsa brevithorax* n. sp. DUMITRICA, p. 62, pl. 7, fig. 41.
1973 *Myllocercion* sp. aff. *M. minima* PETRUSHEVSKAYA and KOZLOVA. - MOORE, p. 826, pl. 17, fig. 8.
1975 *Diacanthocapsa brevitorax* DUMITR. - DUMITRICA, text-fig. 2. 36.
non 1979 *Diacanthocapsa brevithorax* DUMITRICA. - NAKASEKO *et al.*, p. 21, pl. 5, fig. 14 (= *D. fossilis*).
non 1981 *Diacanthocapsa brevithorax* DUMITRICA. - NAKASEKO & NISHIMURA, p. 149, pl. 5, fig. 6 (= specimen of Nakaseko *et al.*, 1979, pl. 5, fig. 14, = *D. fossilis*).
non 1982 *Diacanthocapsa brevithorax* DUMITRICA. - TAKETANI, p. 68, pl. 8, figs. 1a-b (= *D. ovoidea*).

Holotype: The specimen figured by Dumitrica (1970), on pl. 7, fig. 41. It is reported from the Cenomanian of Podu Dimbovitci (Romanian Carpathians).

Photographed material: 22 specimens.

Description: Test as with genus. Tri-segmented cryptocephalic test. Cephalis small, spherical, poreless, without apical horn (occasionally may develop a minute apical spine). Cephalis completely encased in the thoracic cavity. Thorax having a thick-walled test. Lumbar stricture usually is not defined externally, or is only slightly marked. Abdomen tends to be cylindrical and is somewhat tapering distally. A large and depressed sutural pore occurs at the lumbar stricture. This sutural pore is surrounded by a ring of small circular pores. Test with pores more or less regular in size, but quite irregularly arranged. The constricted aperture is large and has a smooth circular rim.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	142	184	216	164
Maximum width of test	77	94	100	88

Remarks: Pores tend to be arranged longitudinally in oldest specimens. *D. brevithorax* appears to have evolved from *D. ovoidea* by a change in its general shape, acquiring a barrel-shaped test, the wall becoming thicker which causes the loss of the lumbar stricture.

Comparisons: The cylindrical shape, the large sutural pore and the tubular constricted aperture enable a specific distinction from all other congeneric species.

GENUS **TURBOCAPSULA** NOV. GEN.

Derivatio nominis: Latin noun *turbo*, meaning whirl, plus Latin noun *capsa* meaning chest. Feminine gender.

Type species: *Tricapsula costata* WU, 1986.

Diagnosis: Tri- or tetra-segmented nassellarians possessing an ellipsoidal test, costate throughout; with slight encasement of the cephalis. Test without sutural pore and possessing a constricted aperture (occasionally closed antapically). Small cephalis, spherical, without apical horn. Thorax campanulate to subspherical. Collar and lumbar strictures may be gently defined externally. Abdomen large, inflated, ellipsoidal, having longitudinal costae.

Remarks: The origin of this group is completely unknown, because Early Cretaceous material has not been studied in detail in this work, so that it is very difficult to determine their ancestry.

Comparisons: Representatives of this genus differ from individuals of *Guttacapsa* by possessing smaller pores, otherwise size and shape are almost identical. Only distinguishable because both genera have separated stratigraphic ranges. In other words, the two genera may be regarded as heterochronous homoemorphous.

Range: Aptian.

Turbocapsula fugitiva nov. sp.

Pl. 37, figs. 12-17
Species code 247

? 1930 *Dicolocapsa radiata* spec. n. HEITZER, p. 395, pl. 28, figs. 44a-b.
? 1930 Aff. *Halicapsa gutta* SQUINABOL. - HEITZER, p. 392, pl. 28, fig. 30.
1974 *Theocorys* sp. aff. *T. antiqua* SQUINABOL. - RENZ, p. 798, pl. 6, figs. 4-7; pl. 11, fig. 4.
pars 1974 *Theocorys antiqua* SQUINABOL. - RIEDEL & SANFILIPPO, p. 781, pl. 10, figs. 10, 11; non fig. 9 (= *T. costata*).
pars 1985 *Theocorys antiqua* SANFILIPPO & RIEDEL, p. 623, text-fig. 14. 6a-c; non text-fig. 14. 6d (= *T. costata*).

Holotype: Specimen 9802 (pl. 37, fig. 14), from locality no. Mc-268b, middle Aptian, Carbonero Formation (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: Latin noun *fugitivus* -a -um, meaning fugitive.

Photographed material: 45 specimens.

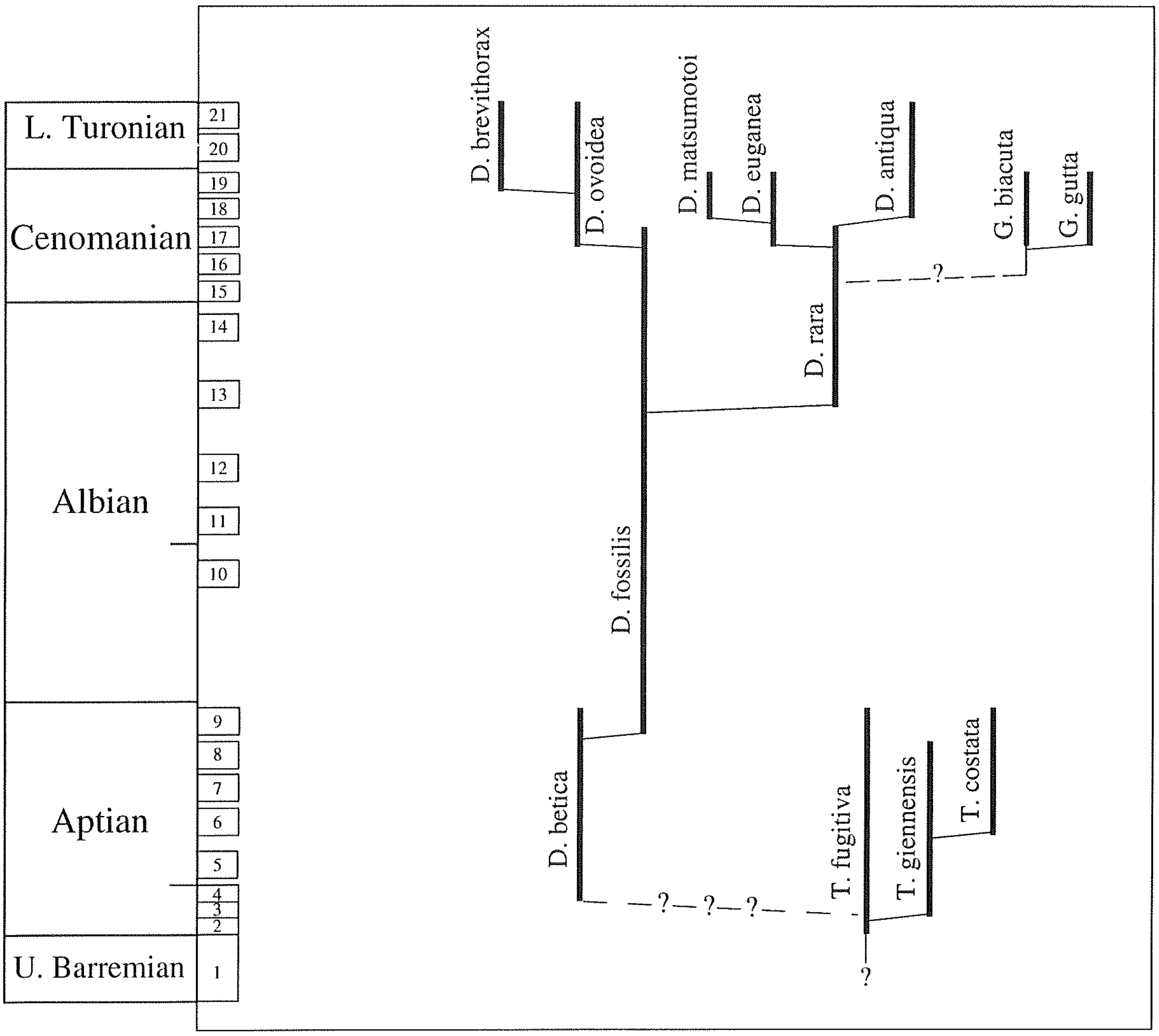

Fig. 24.- Stratigraphic range and possible phyletic relationships of genera and species of the family Diacanthocapsidae.

Description: Tri-segmented ellipsoidal test, with very slight encasement of the cephalis. Test costate throughout, without sutural pore and possessing a constricted circular aperture (occasionally closed antapically). Small cephalis, spherical, sparsely perforate, without apical horn. Thorax campanulate to subspherical, costate. Collar and lumbar strictures not defined externally. Abdomen large, inflated, ellipsoidal having well marked longitudinal costae. Costae wedging out apically and antapically. Usually a single row of circular to ellipsoidal pores between costae. Usually eighteen to twenty costae visible in a lateral view.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	190	174	190	145
Maximum width of test	105	114	135	103

Remarks: The ancestry of *T. fugitiva* has not been traced in detail. It seems quite probable that the origin of these tri-segmented forms lay in bizarre early Barremian dichambered nassellarians. Subsequent studies are required to understand when the development of this group took place.

Comparisons: This species differs from *T. giennensis* by possessing longitudinal costae instead of staggered discontinuous costae and by having usually three to five rows of pores longitudinally between adjacent costae.

Turbocapsula giennensis nov. sp.

Pl. 37, figs. 18-23
Species code 248

1993 *Tricolocapsa* sp. AGUADO *et al.*, pl. 3, fig. 7.

Holotype: Specimen 9367 (pl. 37, fig. 23), from locality no. Ca1-26.05, early Aptian Carbonero Formation (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: *Giennensis* Latin adjective of *Giennium*, now Jaén province (south Spain).

Photographed material: 21 specimens.

Description: Tri-segmented ellipsoidal test, with very slight encasement of the cephalis. Test costate throughout, without sutural pore and possessing a constricted circular aperture (occasionally closed antapically). Small cephalis, spherical, sparsely perforate, without apical horn. Thorax campanulate to subspherical, costate. Collar and lumbar strictures may be gently defined externally. Abdomen large, inflated, ellipsoidal, having well-marked staggered costae. Costae wedging out apically and antapically. Usually a single or double row of circular to ellipsoidal pores between costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	147	124	147	110
Maximum width of test	107	90	107	73

Remarks: This species appear to have evolved from *T. fugitiva* by acquiring a more inflated test and the development of staggered costae. The latter species accompanies it for much of its range and gave rise to *T. costata*.

Comparisons: *T. giennensis* is distinguishable from its closely allied *T. fugitiva* by developing staggered discontinuous costae and in having a pyriform rather than an ellipsoidal test.

Turbocapsula costata (WU, 1986)

Pl. 37, figs. 24-30
Species code 80

? 1930 *Archicapsa costata* spec. n. HEITZER, p. 392, pl. 28, fig. 33.
pars 1974 *Theocorys antiqua* SQUINABOL. - SANFILIPPO & RIEDEL, p. 781, pl. 10, fig. 9, non figs. 10, 11 (= *T. fugitiva*).

? 1978b Gen et sp. indet. FOREMAN, pl. 2, fig. 4.
pars 1985 *Theocorys antiqua* SANFILIPPO & RIEDEL, p. 623, text-fig. 14. 6d; non text-fig. 14. 6a-c (= *T. fugitiva*).
1986 *Tricapsula costata* gen. et sp. nov. WU, p. 359, pl. 3, figs. 6, 16, 17.
1989 *Protunuma* sp. GORKA & GEROCH, p. 190, pl. 2, fig. 4.
1989 *Tricolocapsa* cf. *plicarum* YAO. - GORKA & GEROCH, p. 191, pl. 2, fig. 3.
1989 *Protunuma* sp. TUMANDA, pl. 6, fig. 19.
1990 *Protunuma* sp. OZVOLDOVA, p. 143, pl. 2, figs. 4, 5.
1991 *Cyrtophormis* (?) *costata* SQUINABOL. - AGUADO *et al.*, text-fig. 7. 15.

Lectotype: Nominal species described syntypically. I designate as lectotype the specimen illustrated by Wu (1986 on pl. 3, fig. 17. This specimen has been reported from Southern Xizang (Tibet). Wu's presumed Cenomanian occurrences are regarded herein as Aptian.

Photographed material: 102 specimens.

Description: Tri-segmented ellipsoidal test, with very slight encasement of the cephalis. Test costate throughout, without sutural pore. Small cephalis, spherical, sparsely perforate, without apical horn. Thorax campanulate to subspherical, costate. Collar and lumbar strictures may be gently defined externally. Abdomen large, inflated, ellipsoidal, having well marked longitudinal costae (five to six costae visible in a lateral view). Costae wedging out apically and antapically. Commonly three to five longitudinal rows of pores between adjacent costae. Some costae may be bifurcated. Abdomen possesses a constricted circular aperture.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	177	173	205	155
Maximum width of test	122	133	150	120

Remarks: This species seems to be an evolutionary offshoot from *T. giennensis* by development of well uniform costae, and left no known descendant. Wu (1986) established the nominal genus *Tricapsula* for Mid-Cretaceous radiolarians clearly assignable to the new genus *Turbocapsula*, but this author originally designated *Tricolocapsa plicarum* YAO, 1979 as the type-species for the nominal genus. In consequence the new nominal genus *Turbocapsula* is proposed because the genus *Tricapsula* restricts its stratigraphic range at the Jurassic.

Comparisons: *T. costata* is easily distinguished from the other congeneric species by the characteristic pore arrangement (three to five longitudinal rows of pores between adjacent costae) and its thick longitudinal costae. It differs from *T. giennensis* by possessing longitudinal costae instead of staggered discontinuous costae and by having usually three to five rows of pores longitudinally between adjacent costae.

GENUS **GUTTACAPSA** NOV. GEN.

Derivatio nominis: Latin noun *gutta*, meaning drop, plus Latin noun *capsa* meaning chest. Feminine gender.

Type species: *Halicapsa gutta* SQUINABOL, 1903b.

Diagnosis: Tricyrtid nassellarians possessing an ellipsoidal test, with slight encasement of the cephalis. Test without sutural pore and possessing a very constricted aperture. Small cephalis, spherical, with apical horn poorly developed. Thorax campanulate to subspherical. Collar and lumbar strictures are not marked externally. Abdomen large, ellipsoidal, having longitudinal costae.

Remarks: This genus is apparently an evolutionary offshoot from *Diacanthocapsa* and left no other generic descendants. With this latter genus, both strictures and abdominal lobes gradually lose their strength. Transition to the characteristic *Guttacapsa* morphology is enhanced by definitive obliteration of strictures. Concomitantly the test develops longitudinal costae.

Comparisons: *Guttacapsa* is quite difficult to distinguish from its homoemorphous *Turbocapsula*. Only its disconnected stratigraphic range enable a differentiation. The small number of external morphological elements in the test of these tri or tetra-segmented forms, as well as the scarcity of different environments repeated through time, probably gives rise to these morphological recurrences.

Range: Middle-late Cenomanian.

Guttacapsa biacuta (SQUINABOL, 1903b)

Pl. 37, figs. 31-35

Species code 363

1903b *Cenellipsis biacutus* n. sp. SQUINABOL, p. 116, pl. 8, fig. 24.
1903b *Cyrtophormis costata* n. sp. SQUINABOL, p. 127, pl. 10, fig. 31.
1903b *Cyrtophormis fossilis* n. sp. SQUINABOL, p. 127, pl. 10, fig. 32.
1975 *Hemicryptocapsa* ? n. sp. DUMITRICA, text-fig. 2. 6.
1981 Gen. et sp. indet. SCHAAF, pl. 23, figs. 3a-b.
non 1991 *Cyrtophormis* (?) *costata* SQUINABOL. - AGUADO *et al.*, text-fig. 7. 15 (= *T. costata*).

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 24, may be regarded as the holotype. It is reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 11 specimens.

Description: Tri-segmented ellipsoidal test, with slight encasement of the cephalis. Test has a tendency to be amphiconical. Test costate throughout, lacking sutural pore and possessing a very constricted aperture. Small spherical cephalis, having an apical horn poorly developed. Thorax campanulate. Collar and lumbar strictures are not marked externally. Abdomen very large, ellipsoidal, having longitudinal costae; six to seven thick costae visible in lateral view. Costae converging both apically and antapically. Some costae wedge out toward the apex. Two or three rows of circular pores between adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	105	156	180	128
Maximum width of test	89	92	106	88

Remarks: *G. biacuta* apparently branched off from *Diacanthocapsa rara* by reduction of the cephalothorax and development of longitudinal costae. Range of variability of *G. biacuta* and *G. gutta* partially overlap, but *G. biacuta* distinctly includes robust forms with marked costae, with two longitudinal rows of pores between adjacent costae.

Comparisons: This species is distinguished from *D. euganea* by lacking strictures and by having two rows of pores between adjacent longitudinal costae.

Guttacapsa gutta (SQUINABOL, 1903b)

Pl. 38, figs. 1-6
Species code 91

1903b *Halicapsa gutta* n. sp. SQUINABOL, p. 128, pl. 8, fig. 23.
1989 *Dicolocapsa* sp. TUMANDA, pl. 8, fig. 12.

Holotype: The single specimen illustrated by Squinabol (1904) on pl. 8, fig. 23 may be considered the holotype. it is reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 21 specimens.

Description: Test as with genus, ellipsoidal, with slight encasement of the cephalis. Test has a tendency to be conical apically and rounded antapically. Test with very delicate costae throughout; lacking sutural pore and possessing a very constricted aperture. Small spherical cephalis, with poor development of apical horn. Thorax small, campanulate. Collar and lumbar strictures no defined externally. Abdomen very large, inflated ovoid to subspherical, having a variable number of longitudinal costae; twelve to nineteen costae visible in lateral view. A single row of circular pores between adjacent costae.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	150	256	300	220
Maximum width of test	90	184	233	130

Remarks: This species appears to be a rapid offshoot from its closely allied *G. biacuta*, and left no descendants. It shows through its short stratigraphic range a wide range of variability in the inflation of the test, from ellipsoidal to quite inflated forms.

Comparisons: *G. gutta* differs from its closely allied *G. biacuta* by possessing simple instead of double rows of pores between adjacent longitudinal costae.

SUPERFAMILY **NEOSCIADIOCAPSACEAE** PESSAGNO, 1969a

FAMILY **NEOSCIADIOCAPSIDAE** PESSAGNO, 1969a

Type genus: *Neosciadiocapsa* PESSAGNO, 1969a (subjective junior synonym of *Sciadiocapsa* SQUINABOL, 1904).

This family includes dicyrtids with helmet-conical to hat-shaped test. A detailed study of the cephalic structure of Neosciadiocapsidae was made by Pessagno (1969a)

GENUS **SCIADIOCAPSA** SQUINABOL, 1904

Synonyms: *Cassideus* PESSAGNO, 1969a; *Coniforma* PESSAGNO, 1969a; *Ewingella* PESSAGNO, 1969a (subsequent homonym of *Ewingella* EICHLER, 1941, Insecta); *Ewingium* PESSAGNO, 1976; *Lipmanium* PESSAGNO, 1969a; *Microsciadiocapsa* PESSAGNO, 1969a; *Neosciadiocapsa* PESSAGNO, 1969a; *Petasiforma*

PESSAGNO, 1969a; *Scyphiforma* PESSAGNO, 1969a; *Squinabolella* PESSAGNO, 1969a, *Squinabolella* KOZUR & MOSTLER, 1979 (subsequent homonym of *Squinabolella* PESSAGNO, 1969a).

Type species: *Sciadiocapsa euganea* SQUINABOL, 1904, by monotypy.

Diagnosis: Hat-shaped dicyrtid test. Hemispherical cephalis with or without apical horn. Cephalis with or without cephalopyle. Collar stricture may be defined externally or not at all. Thorax conical to cylindrical, frequently flaring distally to form a thoracic skirt. Thorax with or without pores, occasionally with radial bars extending downward upon the thoracic skirt. Test may develop antapically a thoracic velum, showing occasionally a very constricted aperture.

Remarks: According to Pessagno (1969a) this group reaches its greatest radiation during the middle-Late Cretaceous (more exactly in the Albian-Coniacian interval). A possible phylogenetic connection from *Ultranapora* in Early Cretaceous time is suspected. Both genera are dicyrtid and present similar cephalic spicules. Further research is required to understand the possible phylogenetic relationship suggested.

Comparisons: Sciadiocapsa embodies a combination of characters that enable a clear differentiation from all other Cretaceous Nassellariina.

Range: Late Valanginian to Maastrichtian.

Sciadiocapsa patera nov. sp.

Pl. 38, figs. 7-10
Species code 393

? 1981 *Microsciadiocapsa* ? sp. aff. *M. monticelloensis* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 589, pl. 2, fig. 13.
? 1977 ? *Neosciadiocapsa* cf. *reginae* (RÜST). - MUZAVOR, p. 92, pl. 9, fig. 9.
? 1981 *Neosciadocapsa* sp. SCHAAF, p. 435, pl. 25, figs, 4a-b.
? 1988 *Neosciadiocapsidae* gen. et sp. indet. THUROW, pl. 7, fig. 23.
? 1992 *Microsciadiocapsa monticelloensis* PESSAGNO. - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 10.

Holotype: Specimen R-449 (pl. 38, fig. 8), from locality no. Bo-566.50, early Barremian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *patera* -ae (f), meaning a kind of vessel employed in the past for the sacrifice.

Photographed material: 18 specimens.

Description: Test as with genus, hat-shaped. Cephalis hemispherical, imperforate, lacking apical horn. Collar stricture weakly developed or not defined externally. Thorax subconical proximally; flaring distally to form a very broad, planiform thoracic skirt. Thoracic pores are small, circular to ellipsoidal, in quincuncial arrangement. Thoracic skirt quite flat, with small circular pores of uniform size.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	100	113	120	100
Diameter thoracic skirt	265	235	265	215

Remarks: This species is apparently the oldest representative of the genus *Sciadiocapsa*. The ancestry remains unknown, but a phylogenetic link with Early Cretaceous individuals of the genus *Ultranapora* seems probable.

Comparisons: *S. patera* differs from *S. speciosa* by possessing a typical flattened thoracic skirt.

Sciadiocapsa speciosa (SQUINABOL, 1903b)

Pl. 38, figs. 11-20
Species code 156

1903b *Sethoconus speciosus* n. sp. SQUINABOL, p. 131, pl. 9, figs. 16, 16b.
1969a *Cassideus riedeli* n. sp. PESSAGNO, p. 395, pl. 25, figs. 1-8; pl. 27, fig. 1.
1969a *Cassideus yoloensis* n. sp. PESSAGNO, p. 396, pl. 25, figs. 9-12; pl. 26, figs. 1-3.
1969a ? *Ewingella capayensis* n. sp. PESSAGNO, p. 399, pl. 29, figs. 1-3, 6.
1969a *Ewingella jonesi* n. sp. PESSAGNO, p. 401, pl. 27, fig. 2; pl. 28, figs. 1-7.
1969a *Petasiforma foremanae* n. sp PESSAGNO, p. 411, pl. pl. 23, figs. 6-10; pl. 24, fig. 2.
1969a *Petasiforma glascockensis* n. sp. PESSAGNO, p. 412, pl. 23, figs. 1-5; pl. 24, fig. 1.
1969a *Petasiforma* n. sp. (1). PESSAGNO, p. 413. pl. 23, fig. 12.
1969a *Petasiforma* n. sp. (2). PESSAGNO, p. 413. pl. 23, fig. 11.
1976 *Cassideus riedeli* PESSAGNO. - PESSAGNO, p. 46, pl. 2, figs. 4-5 (= specimens of Pessagno, 1969a, pl. 25, figs. 1, 3).
1976 *Cassideus yoloensis* PESSAGNO. - PESSAGNO, p. 46, pl. 2, figs. 14, 15-16 (= specimens of Pessagno, 1969a, pl. 25, figs. 9, 10).
1976 *Ewingium jonesi* (PESSAGNO). - PESSAGNO, p. 46, pl. 2, figs. 12-13 (= specimen of Pessagno, 1969a, pl. 28, figs. 1, 2).
1976 *Petasiforma foremanae* PESSAGNO. - PESSAGNO, p. 47, pl. 2, fig. 1 (= specimen of Pessagno, 1969a, pl. 23, fig. 8).
1976 *Petasiforma glascockensis* PESSAGNO. - PESSAGNO, p. 47, pl. 2, figs. 2, 3 (= specimen of Pessagno, 1969a, pl. 23, fig. 1).
1977c *Cassideus yoloensis* PESSAGNO. - PESSAGNO, p. 36, pl. 4, figs. 13, 17, 20, 21.
1977c *Cassideus* sp. *A*. PESSAGNO, p. 37, pl. 4, fig. 9.
1977c *Lipmanium* (?) *caseyi* n. sp. PESSAGNO, p. 37, pl. 4, figs. 11, 14.
1977c *Petasiforma foremanae* PESSAGNO. - PESSAGNO, p. 37, pl. 4, figs. 15, 16.
1983 *Ewingium sp. cf. jonesi* (PESSAGNO). - ORIGLIA-DEVOS, p. 166, pl. 18, fig. 12.
1983 *Petasiforma foremanae* PESSAGNO. - ORIGLIA-DEVOS, p. 167, pl. 18, figs. 14, 15.
? 1983 *Petasiforma* sp. indet. *1*. ORIGLIA-DEVOS, p. 167, pl. 18, fig. 13.
? 1983 *Petasiforma* sp. indet. 2. ORIGLIA-DEVOS, p. 168, pl. 19, fig. 1.
1985 *Cassideus yoloensis* PESSAGNO. - LI & WU, pl. 1, fig. 15.
1985 *Petasiforma foremanea* PESSAGNO. - LI & WU, pl. 1, fig. 18
1985 *Petasiforma* sp. (1) PESSAGNO. - LI & WU, pl. 1, fig. 14.
1986 *Cassideus yoloensis* PES. - KUHNT *et al.*, pl. 7, fig. c.
1986 *Neosciadiocapsidae* THUROW & KUHNT, text-fig. 9. 20.
1991 *Squinabolella puthaensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 3.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 16, 16b may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 138 specimens.

Description: Test as with genus; mexican-hat shaped. Cephalis conical to subspherical, with or without apical horn, which is commonly three-bladed. Thorax large, conical to subcylindrical. Pore frames on the proximal part of the thorax small, circular to polygonal, of uniform size. Distal portion of the thorax flaring to form a well-developed broad conical thoracic skirt. Size of pores in distal part very variable from specimen to specimen, and are quincuncially arranged. Test in larger forms may develop numerous concentric ridges between adjacent rows of pores, resulting in a terrace-shaped structure. Thoracic skirt usually strongly arched.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	120	152	169	123
Diameter thoracic skirt	430	371	400	323

Remarks: This nominal species shows a strong range of morphologic variation, well represented by the pair foremanae-yoloensis (both junior synonyms of *S. speciosa*). The number of available specimens is sufficient to demonstrate such as a continuous variation. The continuum expressed in the faunal spectrum between both extreme morphotypes (differing only in the size and density of thoracic pores) make a real division difficult. On the other hand, this division seems not useful for biostratigraphy, because this remarkable intraspecific variability was always present through all its stratigraphic range.

Comparisons: Range of variation of *S. patera* and *S. speciosa* partially overlap, but the former includes delicate forms possessing a smaller conical portion and a flat thoracic skirt.

Sciadiocapsa pertica nov. sp.

Pl. 39, figs. 1-8
Species code 155

Holotype: Specimen 7299 (pl. 39, fig. 1), from locality no. Gb-108.60, middle-late Cenomanian, (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *pertica* -ae (f), meaning pole; this name refers to the very long apical horn.

Photographed material: 31 specimens.

Description: Test as with genus; hat-shaped, bearing a very long and quite robust apical horn. Cephalis small conical, poreless. Apical horn circular in transverse section. Collar stricture slightly defined externally. Thorax subconical proximally; flaring distally to form a broad, convexly arched thoracic skirt. Thorax coarsely perforate, thoracic pores large, circular, gradually increasing in size distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	150	133	160	100
Diameter thoracic skirt	450	399	500	320
Length of test plus horn	710	568	710	410
Length apical horn	460	326	460	170

Remarks: This species presents great resemblance to some representatives of *S. speciosa* (particularly, those with large circular pores). It is described here as a separate species because its distinctive shape and sturdy apical horn (even when poorly preserved) and restricted range make it a useful marker for the middle-late Cenomanian. *S. pertica* seems to be an evolutionary offshoot from *S. speciosa*, and left no descendants.

Comparisons: *S. pertica* is distinguished from all other congeneric species by possessing a long apical horn. It differs from particular specimens of *S. speciosa* by having more convex thoracic skirt and a very long and sturdy apical horn, otherwise test shape and size identical.

Sciadiocapsa monticelloensis (PESSAGNO, 1969a)

Pl. 39, figs. 9-12
Species code 158

1969a *Microsciadiocapsa monticelloensis* n. sp. PESSAGNO, p. 407, pl. 32, figs. 3-9; pl. 34, figs. 1, 2.

1969a *Squinabolella putahensis* n. sp. PESSAGNO, p. 418, pl. 33, figs. 6-10.

1976 *Microsciadiocapsa monticelloensis* PESSAGNO. - PESSAGNO, p. 47, pl. 7, fig. 10-11 (= specimens of Pessagno, 1969a, pl. 32, figs. 3, 5).

1976 *Squinabolella puthaensis* PESSAGNO. - PESSAGNO, p. 48, pl. 7, fig. 13 (= specimen of Pessagno, 1969a, pl. 33, fig. 6).

non 1981 *Microsciadiocapsa* ? sp. aff. *M. monticelloensis* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 589, pl. 2, fig. 13 (= *S. patera* ?).

? 1982 *Squinabolella puthaensis* (?) PESSAGNO. - TAKETANI, p. 66, pl. 13, figs. 12, 13.

non 1992 *Microsciadiocapsa monticelloensis* PESSAGNO. - OZVOLDOVA & PETERCAKOVA, pl. 3, fig. 10 (= *S. patera* ?).

non 1991 *Squinabolella puthaensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 3 (= *S. speciosa*).

non 1991 *Squinabolella putahensis* PESSAGNO. - LING, p. 320, pl. 1, fig. 13.

Holotype: The specimen illustrated and figured by Pessagno (1969a) on pl. 32, fig. 3-5 (figs. 4-5 close view), from locality NSF 483, late Turonian-Coniacian of the Yolo Formation, California Coast Ranges.

Photographed material: 7 specimens.

Description: Test as with genus, hat-shaped dicyrtid. Cephalis rugose, hemispherical, having a sturdy three-bladed apical horn. Collar stricture weakly to strongly developed. Thorax large, subconical proximally, gradually increasing in width distally, then flaring to form a large planiform thoracic skirt distally. Thoracic meshwork coarse; pore frames circular to hexagonal distally. Pores are small and arranged slightly quincuncially. Usually, discontinuous ridges on proximal portion of the thorax, just above the thoracic skirt.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	300	165	185	131
Diameter thoracic skirt	108	375	392	346

Remarks: This species is tentatively regarded as an offshoot of the earliest *S. speciosa*.

Comparisons: *S. monticelloensis* differs from the largest representatives of *S. speciosa* by having a strongly three-bladed apical horn, and by possessing a large, flattened thoracic skirt.

Sciadiocapsa elegans (SQUINABOL, 1904)

Pl. 39, figs. 13-15
Species code 154

1904 *Phormocampe elegans* n. sp. SQUINABOL, p. 227, pl. 9, fig. 5.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 9, fig. 5 may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 154 specimens.

Description: Test as with genus, quite large, conical to cylindrical in shape. Cephalis small conical, poreless, possessing a slim apical horn, which is circular in transverse section. Collar stricture is not developed externally. Thorax conical proximally, rapidly becoming cylindrical and relatively wide; terminally flaring to form a small thoracic skirt. Thoracic meshwork is coarse, with circular pores, set in hexagonal frames. Pores are situated in transverse rows and arranged quincuncially. Thoracic skirt somewhat arched.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	165	113	120	100
Diameter thoracic skirt	245	-	232	-
Length of test	287	289	327	267

Comparisons: *S. elegans* differs from its undoubted ancestor *S. speciosa* by possessing a longer, thick cylindrical thorax.

Sciadiocapsa hibrida nov. sp.

Pl. 39, fig. 16
Species code 153

Holotype: Specimen 6761 (pl. 39, fig. 16), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *hibrida* -ae (m, f), meaning hybrid.

Photographed material: 5 specimens.

Description: Test as with genus, long conical-shaped. Cephalis small, poreless, sharply pointed. Cephalis bearing an acute apical horn, which is circular in cross-section. Collar stricture absent. Thorax conical, only toward its distalmost part becoming cylindrical. Thoracic pores are large, circular to subhexagonal, in horizontal rows with quincuncial arrangement. Thoracic skirt not developed

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	294	277	294	265
Length of test	233	225	233	215
Length of apical horn	47	44	52	36

Remarks: Specimens assigned to *S. hibrida* could represent more conical and more weakly ornamented variants of *S. elegans*. However, the amount of available specimens is not suitable to demonstrate such a continuous variation.

Comparisons: *S. elegans* is distinguished from *S. hibrida* by possessing a conical instead of a large cylindrical thorax.

Sciadiocapsa euganea SQUINABOL, 1904

Pl. 39, figs. 17-21
Species code 157

1904 *Sciadiocapsa euganea* n. sp. SQUINABOL, p. 211, pl. 7, figs. 5, 5a.

? 1969a *Lipmanium sacramentoensis* n. sp. PESSAGNO, p. 402, pl. 26, figs. 4-12.
? 1969a *Microsciadiocapsa berryessaensis* n. sp. PESSAGNO, p. 404, pl. 31, figs. 8-12.
1969a *Microsciadiocapsa lipmanae* n. sp. PESSAGNO, p. 405, pl. 28, figs. 8-12; pl. 30, figs. 1, 2; pl. 31, figs. 1-3.
1977c *Petasiforma* (?) *inusitata* n. sp. PESSAGNO, p. 37, pl. 4, figs. 1, 6, 10, 18, 19.

Holotype: The specimen described and illustrated by Squinabol (1904) on pl. 7, fig. 5, 5a may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 14 specimens.

Description: Test as with genus; rounded apically. Test having commonly a small size. Cephalis rugose, subspherical, without apical horn. Collar stricture only slightly developed. Thorax relatively small, cylindrical. Thoracic skirt flattened, small, with irregular shelf-like structure on its inner portion. Thoracic pores circular to elliptical, becoming minute distally on the thoracic skirt.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	102	79	85	75
Diameter thoracic skirt	197	187	215	170
Length of test	65	68	71	63

Remarks: This species appears to have evolved from *S. patera* and did not leave any known descendants.

Comparisons: *S. euganea* differs from all the other congeneric species by possessing a minute size, planiform thoracic skirt and very short cylindrical thorax.

Sciadiocapsa radiata (SQUINABOL, 1903b)

Pl. 40, figs. 1-5
Species code 281

1903b *Sethophormis radiata* n. sp. SQUINABOL, p. 130, pl. 9, figs. 17, 17a.
1969a *Microsiadiocapsa sutterensis* n. sp. PESSAGNO, p. 409, pl. 29, fig. 9; pl. 31, figs. 4-7.
1976 *Microsciadiocapsa sutterensis* PESSAGNO. - PESSAGNO, p. 47, pl. 2, fig. 7 (= specimen of Pessagno, 1969a, pl. 31, fig. 4).
1977c *Microsciadiocapsa sutterensis* PESSAGNO. - PESSAGNO, p. 37, pl. 4, fig. 4; pl. 5, figs. 15, 18, 20.
1986 *Micorsciadiocapsa sutterensis* PES. - KUHNT *et al.*, pl. 7, fig. h.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 9, fig. 17, 17a may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 24 specimens.

Description: Test as with genus, having radial bars extending throughout the thorax. Cephalis small, conical, without apical horn. Collar stricture weakly developed. Thorax subconical proximally; them flaring distally to form a very broad planiform thoracic skirt. The flattened thoracic skirt possesses rectangular pore frames of uniform size. Pore frames arranged longitudinally between adjacent radial bars.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	112	122	146	108
Diameter thoracic skirt	306	322	385	278

Remarks: This species probably evolved from the lineage leading from *S. patera* to *S. speciosa* during the early Albian, and give rise to *S. multiradiata* at early Turonian times.

Comparisons: *S. radiata* differs from *S. speciosa* by possessing radial bars extending downward from the proximal portion of the thorax onto the thoracic skirt, and by having a generally larger and flattened thoracic skirt.

Sciadiocapsa multiradiata nomen novum

Pl. 40, figs. 6-11
Species code 283

1969a *Microsciadiocapsa radiata* n. sp. PESSAGNO, p. 408, pl. 32, figs. 10-12; pl. 33, figs. 1, 2.
? 1975 *Microsciadiocapsa* n. sp. DUMITRICA, text-fig. 2. 24.
1976 *Microsciadiocapsa radiata* PESSAGNO. - PESSAGNO, p. 47, pl. 7, figs. 14-15 (= specimens of Pessagno, 1969a, pl. 32, figs. 11, 12).

Holotype: Following article 72 (d) of the I.C.Z.N., the specimen figured by Pessagno (1969a), in pl. 32, fig. 11-12 (lateral and apical views respectively), is to be treated as the holotype. This specimen comes from the Late Cretaceous (Coniacian) at locality NSF 327c. Upper part of the Sites Formation at Cache creek, Yolo County. (California, North America).

Derivatio nominis: The new name for the nominal replacement is derived by adding the prefix *multi* (Latin) meaning multi, various, to the prior nominal species.

Photographed material: 19 specimens.

Description: Test as with genus, with coarsely rugose cephalis. Cephalis small, subspherical, poreless, bearing a short but quite massive apical horn. Collar stricture well defined externally. Thorax possesses radial bars extending downwards throughout the surface. A particular type of structure appears between the proximal part of the thorax and the thoracic skirt, they are denominated "thoracic arcs" (pl. 40, fig. 10). These curved structures are circular in cross-section and are disposed at right angles between thorax and the plane of the thoracic skirt. Thoracic pores are rectangular, longitudinally arranged between adjacent radial bars. Thoracic skirt large and flattened.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter thorax at base	69	83	100	75
Diameter thoracic skirt	145	197	205	175

Remarks: This nominal species undoubtedly evolves from *S. radiata*, by firstly, inflation of the thorax, becoming campanulate with better definition of the collar stricture, and secondly, by development of thoracic arcs.

Comparisons: *S. multiradiata* differs from its closely allied *S. radiata* by having a coarsely rugose cephalis, collar stricture well defined, and by possessing thoracic arcs.

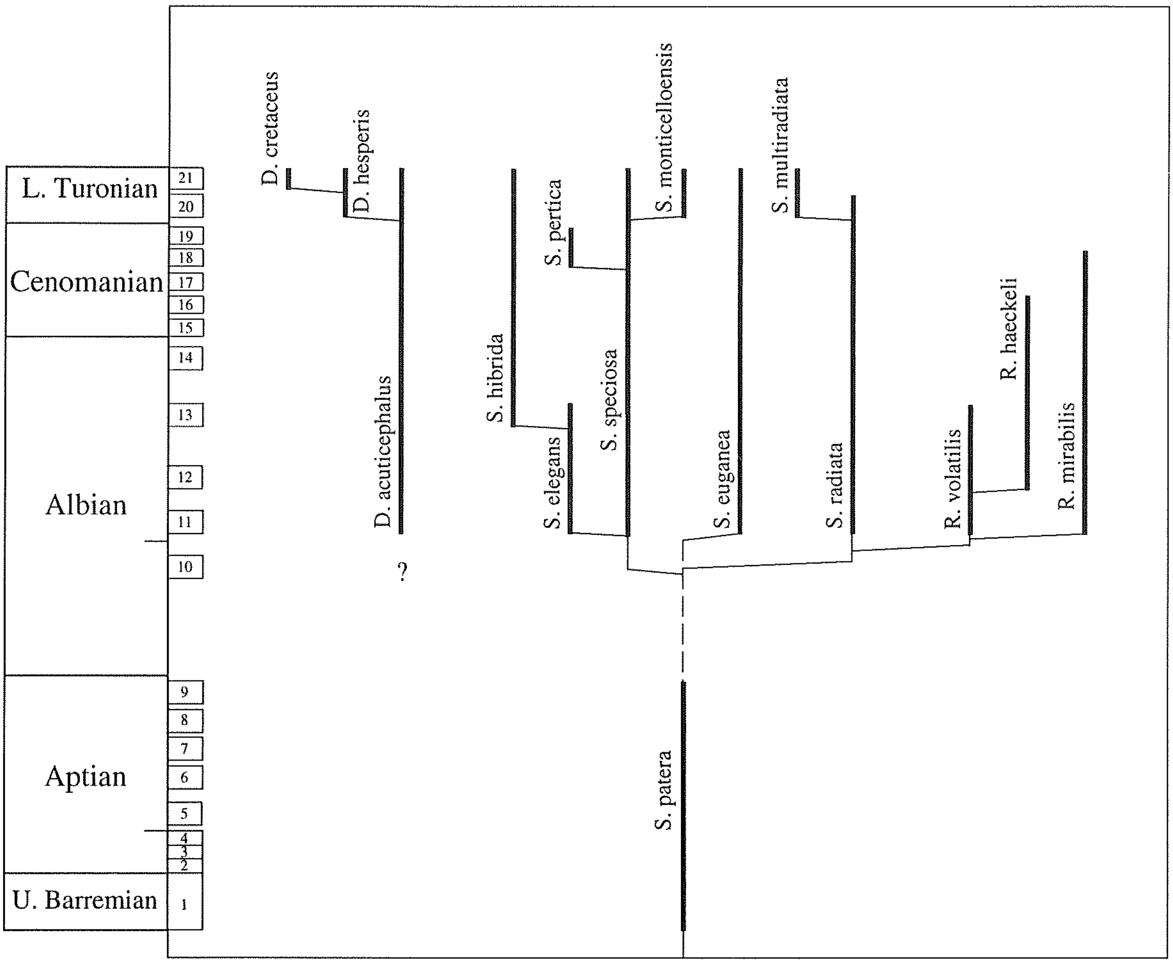

Fig. 25.- Stratigraphic range and possible phyletic relationships of genera and species of the families Neosciadiocapsidae and Rotaformidae.

GENUS **DICTYODEDALUS** NOV. GEN.

Derivatio nominis: Nominal genus named *Dictyo* plus *Dedalus*, who in Latin mythology was Icarus' father. Masculine gender.

Type species: *Dictyodedalus hesperis* nov. sp.

Diagnosis: Test dicyrtid, conical, with small subspherical cephalis. Test circular or ellipsoidal in cross-section. Cephalis very small, poreless, commonly bearing a massive apical horn. Cephalis defined only by a gentle indentation of the test wall. Collar stricture is absent. Thorax conical to subcylindrical, with circular or rectangular pores, usually longitudinally arranged. Thorax with or without massive longitudinal costae. Test open distally.

Remarks: It seems possible that these forms with a fragile dicyrtid test are closely related to forms belonging to the genus *Sciadiocapsa*. Nevertheless, this is a premature assumption and future researches in late Aptian-early Albian materials are necessary to elucidate the origin of this group.

Comparisons: *Dictyodedalus* embodies a unique combination of characters quite unlike that of any previously known Cretaceous genus. However, the partial resemblance with Jurassic *Bathropyramis* is to be stressed, but such similarity is probably not of direct phylogenetic significance.

Range: Middle Albian to Maastrichtian.

Dictyodedalus acuticephalus (SQUINABOL, 1904)

Pl. 41, figs. 1-6
Species code 117

1904 *Sethopyramis acuticephala* n. sp. SQUINABOL, p. 214, pl. 7, fig. 8.
1974 *Bathropyramis timorensis* n. sp. RENZ, p. 789, pl. 4, figs. 8, 9; pl. 12, figs. 4a-c.
1974 *Bathropyramis* spp. HAECKEL. - RIEDEL & SANFILIPPO, p. 775, pl. 3, figs. 9-11; pl. 14, fig. 9 .
1982 *Bathropyramis campbelli* n. sp. TAKETANI, p. 64, pl. 6, fig. 8a-9; pl. 13, fig. 6.
1991 *Bathropyramis campbellii* TAKETANI. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 8.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 7, fig. 8 may be considered the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 21 specimens.

Description: Test as with genus, conical in shape. Test circular in cross-section. Cephalis very small, subspherical, poreless, bearing a sharply pointed apical horn. Cephalis defined only by a gentle indentation of the test wall. Collar stricture is absent. Thorax with longitudinal massive costae; four to six costae in lateral view. Thorax conical, with rectangular pores, usually in single or double longitudinal rows between adjacent costae. Costae usually strongly projected downwardly (pl. 41, fig. 3). Test open distally.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	265	211	247	180
Width of test	123	127	160	100

Comparisons: *D. acuticephalus* differs from all other congeneric species by possessing rectangular pores. A possible phylogenetic link is suspected with representatives of *Sciadiocapsa*.

Dictyodedalus hesperis nov. sp.

Pl. 41, figs. 7-12
Species code 120

Holotype: Specimen 6379 (pl. 41, fig. 11), from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *Hesperis* -idis (f), from noun *Hesperia*, this is the name received in the past for the regions located to the west of Italy, that is to say Spain.

Photographed material: 12 specimens.

Description: Test dicyrtid, acutely conical, with small subspherical cephalis. Test circular in cross-section. Cephalis very small, poreless, bearing a small apical horn, occasionally bifurcated. Cephalis defined only by a gentle indentation of the test wall. Collar stricture only slightly or not at all developed. Thorax with longitudinal massive costae; four to five costae in lateral view. Thorax conical, gradually increasing in width to the distal part. Thorax with small circular to elliptical pores, which have a tendency to be longitudinally aligned. Costae usually downwardly projected.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	227	272	353	220
Width of test	147	158	187	107

Remarks: This species appears to be an evolutionary offshoot from *D. acuticephalus,* and seems to have given rise to *D. cretaceus* in early Turonian times.

Comparisons: *D. hesperis* differs from *D. cretaceus* by possessing well developed longitudinal costae and having smaller circular pores.

Dictyodedalus cretaceus (TAKETANI, 1982)

Pl. 41, figs. 13-14

Species code 376

pars	1974	*Cyrtocalpis operosa* TAN SIN HOK. - RIEDEL & SANFILIPPO, p. 778, pl. 14, fig. 10; non pl. 4, figs. 1-3.
pars ?	1982	*Cornutella californica* CAMPBELL AND CLARK var. B RENZ. - TAKETANI, p. 65, pl. 6, figs. 6a-7; non pl. 13, fig. 7.
	1982	*Cornutella cretacea* n. sp. TAKETANI, p. 65, pl. 6, figs. 5a-b; pl. 13, fig. 9.
	1989	*Plectopyramis* sp. IWATA & TAJIKA, pl. 3, fig. 1.
	1989	*Cornutella califormica* CAMPBELL & CLARK. - TUMANDA, p. 36, pl. 8, fig. 19.

Holotype: The specimen designed and figured by Taketani (1982) on pl. 6, figs. 5a-b. It is from locality My 76-164, Efue Formation (late Cenomanian?), southern Hokkaido.

Photographed material: 2 specimens.

Description: Test dicyrtid, conical, without longitudinal costae. Test circular to ellipsoidal in cross-section. Cephalis very small, poreless, bearing a short apical horn. Collar stricture is not defined externally. Thorax conical, with circular pores, with indistinct longitudinal arrangement. Thorax without longitudinal massive costae. Test open distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of test	185	188	190	185
Width of test	85	115	135	95

Comparisons: *D. cretaceus* differs from all other congeneric species by lacking longitudinally costae on its test.

FAMILY **ROTAFORMIDAE** PESSAGNO, 1970

Type genus: *Rotaforma* PESSAGNO, 1970.

Dicyrtid, cartwheel-shaped nassellarians having concentric thoracic rings and radii. This family includes the genera *Rotaforma* PESSAGNO, 1970 and *Saturniforma* PESSAGNO (1970).

GENUS **ROTAFORMA** PESSAGNO, 1970

Type species: *Rotaforma mirabilis* PESSAGNO, 1970, by original designation.

Diagnosis: Test possesses two segments, cartwheel-shaped. Cephalis small, hemispherical, occasionally bearing a small, massive apical horn. Thorax large, strongly funnel-shaped. Thoracic ring attached by radii to posterior margin of the thorax.

Remarks: Pessagno (1970) proposed hypothetically a phylogenetic relationship with Neosciadiocapsidae. My own stratigraphic study confirms this hypothesis. This genus undoubtedly evolved from early Albian sciadiocapsids by development of thoracic rings and radii. The hypothetical ancestral forms supposed by Pessagno (loc. cit. text-fig. 4) could correspond to forms belonging to the *volatilis-haeckeli* group (pl. 40, figs. 12-19).

Comparisons: *Rotaforma* is distinguished from *Sciadiocapsa* by its typical cartwheel-shaped test, provided with thoracic rings, which are interconnected by radii.

Range: Middle Albian to middle-late Cenomanian, insofar as known.

Rotaforma volatilis nov. sp.

Pl. 40, figs. 12-14
Species code 285

Holotype: Specimen 3140 (pl. 40, fig. 14), from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *volatilis* -e, meaning ephemeral.

Photographed material: 3 specimens.

Description: Test dicyrtid, cartwheel-shaped. Cephalis small, hemispherical, bearing occasionally a small, massive apical horn. Collar stricture slight to well developed. Thorax large, strongly porous. Test has two thoracic rows of pores. Pore frames subcircular to hexagonal. Pores tend to be gradually larger toward the periphery and they are arranged quincuncially.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of ring and cavity	333	347	375	333
Diameter of cortical shell	92	92	100	83

Remarks: This species seems to be evolved from *S. radiata* by development of well expressed thoracic rings.

Comparisons: *R. volatilis* is distinguished from *R. haeckeli* (1) by possessing two instead of three rows of thoracic pores, (2) by having circular to hexagonal rather than rectangular pore frames, which are disposed quincuncially, and (3) by lacking radii.

Rotaforma haeckeli (SQUINABOL, 1903b)

Pl. 40, figs. 15-19
Species code 286

1903b *Sethocephalus Haeckeli* n. sp. SQUINABOL, p. 132, pl. 9, figs. 20, 20a.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 20, 20a may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 16 specimens.

Description: Test dicyrtid, somewhat cartwheel-shaped. Cephalis small, hemispherical, bearing occasionally a small, massive apical horn. Collar stricture slight to well developed. Thorax large, strongly porous. Test has three thoracic rings attached by well developed radii to posterior margin of the thorax. Pore frames square to subrectangular. Pores tend to be gradually larger toward the periphery

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of ring and cavity	106	343	417	283
Diameter of thorax	56	102	117	92

Remarks: *R. haeckeli* apparently branched off from *R. volatilis* and left no descendants.

Comparisons: *R. haeckeli* differs from *S. radiata* and *S. multiradiata* by possessing well developed radii and by having rectangular pore frames.

Rotaforma mirabilis PESSAGNO, 1970

Pl. 40, figs. 20-23
Species code 288

1970 *Rotaforma hessi* n. sp. PESSAGNO, p. 16, pl. 3, figs. 4-6; pl. 4, figs. 1-4b.
1970 *Rotaforma mirabilis* n. sp. PESSAGNO, p. 16, pl. 1, figs. 1-6; pl. 2, figs. 1, 2; pl. 3, figs. 1-3; pl. 9, figs. 1, 2.
1970 *Saturniforma peregrina* n. sp. PESSAGNO, p. 20, pl. 6, figs. 3-5.
1976 *Rotaforma hessi* PESSSGNO. - PESSAGNO, p. 48, pl. 2, fig. 11 (= specimen of Pessagno, 1970, pl. 3, fig. 4).
1976 *Rotaforma mirabilis* PESSAGNO. - PESSAGNO, p. 48, pl. 2, figs. 9-10 (= holotype refigured).
1976 *Saturniforma peregrina* PESSAGNO. - PESSAGNO, p. 48, pl. 2, fig. 8 (= specimen of Pessagno, 1970, pl. 6, fig. 3).
1977c *Saturniforma peregrina* PESSAGNO. - PESSAGNO, p. 38, pl. 5, fig. 6 (= specimen of Pessagno, 1970, pl. 6, fig. 3).
1986 *Rotaforma mirabilis* PES. - KUHNT *et al.*, pl. 7, fig. a.

Holotype: The specimen designated and figured by Pessagno (1970) on pl. 1, figs. 1-4. The holotype is from locality NSF 350 early Cenomanian portion of Antelope shale/Fiske Creek Formation, California Coast Ranges. The holotype was refigured by Pessagno (1976) on pl. 2, figs. 9-10.

Photographed material: 20 specimens.

Description: Test as with genus, having six to ten long, slender, radii. Test has a tendency to present a biconvex cephalo-thoracic body. Cephalis very small. Collar stricture may be slightly or not at all developed. Radii usually seven in number, quadriradiate in cross-section. Pores are very large. Thoracic ring somewhat spinose. Cephalo-thorax body closed, without portae. Fringe on thoracic ring comprised of small elliptical to subcircular pores frames

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of ring and cavity	324	273	313	240
Diameter of cortical shell	118	115	127	87

Remarks: It seems that *R. mirabilis* evolved from *R. volatilis* by resorption of the first row of small thoracic pores, acquiring a single row of large subcircular pores.

Comparisons: The type-species is distinguished from all other congeneric species by being pronouncedly cartwheel-shaped. Furthermore, it differs from representatives of the genus *Saturniforma* by lacking portae between each of the secondary radii.

SUPERFAMILY **PYLENTONEMIACEAE** DEFLANDRE, 1963

This superfamily includes at least the following subordinate taxa: Pylentonemidae DEFLANDRE, 1963; Silicarmigeridae KOZUR & MOSTLER in DUMITRICA *et al.* 1980; Foremanellinidae DUMITRICA, 1982; Poulpidae DE WEVER, 1981a; Farcidae PESSAGNO, WHALEN & YEH, 1986; Hilarisiregidae TAKEMURA & NAKASEKO, 1982 and Ultranaporidae PESSAGNO, 1977c.

FAMILY **ULTRANAPORIDAE** PESSAGNO, 1977c

Type genus: *Ultranapora* PESSAGNO, 1977c.

This family includes the genera *Napora* PESSAGNO, 1977b; *Ultranapora* PESSAGNO, 1977c; *Jacus* DE WEVER, 1982.

GENUS **ULTRANAPORA** PESSAGNO, 1977c

Type species: *Ultranapora durhami* PESSAGNO, 1977c, by original designation.

Diagnosis: Test dicyrtid with small, globular cephalis. Cephalis usually with prominent three-bladed apical horn; with or without massive, perforate spine externally at base of the cephalis (cephalocone). Cephalis imperforate or sparsely perforate. Collar stricture poorly developed or absent between cephalis and thorax. Thorax large, subtetrahedral, with coarse polygonal pore frames and possessing three well developed thoracic feet, which are frequently threebladed. Thoracic aperture subtriangular to triangular in outline.

Range: Late Valanginian to Turonian.

Ultranapora praespinifera PESSAGNO, 1977c

Pl. 41, figs. 15-23
Species code 294

?	1900	*Tripilidium obliquum* sp. nov. HINDE, p. 26, pl. 2, fig. 9.
?	1927	*Tripocalpis Ellyae* spec. nov. TAN, p, 38, pl. 7, fig. 18.
	1973b	*Tripilidium* (?) sp. *A*. FOREMAN, p. 265, pl. 10, figs. 13 ?, 14, 15.
pars ?	1973b	*Tripilidium* (?) sp. *B*. FOREMAN, p. 265, pl. 10, figs. 16, 18; non fig. 17, (= *U. crassispina* ?).
	1973b	*Tripilidium* (?) sp. *C*. FOREMAN, p. 265, pl. 10, figs. 19.
?	1974	*Dictyophimus gracilis* TAN SIN HOK. - RENZ, p. 791, pl. 5, figs. 14-16; pl. 11, fig. 11.
?	1974	*Dictyophimus obliquum* (HINDE). - RENZ, p. 791, pl. 5, fig. 17; pl. 11, fig. 1.
	1976	*Tripilidium* (?) *dendrocanthos* SQUINABOL. - PESSAGNO, p. 55, pl. 3, fig. 1.
	1977c	*Ultranapora praespinifera* n. sp. PESSAGNO, p. 39, pl. 5, figs. 4, 8-10.
	1977c	*Ultranapora spinifera* n. sp. PESSAGNO, p. 39, pl. 5, figs. 5 (= specimen of Pessagno, 1976, pl. 3, fig. 1), 11, 12; pl. 12, fig. 7.
	1977c	*Ultranapora* sp. *A*. PESSAGNO, p. 40, pl. 6, fig. 8.
	1977c	*Ultranapora* sp. *B*. PESSAGNO, p. 40, pl. 6, figs. 9, 12.
	1979	*Ultranapora praespinifera* PESSAGNO. - NAKASEKO *et al.*, p. 24, pl. 4, figs. 14-16.
	1981	*Ultranapora praespinifera* PESSAGNO. - NAKASEKO & NISHIMURA, p. 164, pl. 10, figs. 6 and 11 (= specimens of Nakaseko *et al.*, 1979, pl. 4, figs. 14, 15).
	1981	*Ultranapora spinifera* PESSAGNO.- SCHAAF, p. 440, pl. 25, figs. 9a-b.
?	1983	*Napora* sp. cf. *bukryi* PESSAGNO. - ORIGLIA-DEVOS, p. 200, pl. 23. figs. 12, 13.
	1983	*Ultranapora* sp. cf. *dumitricai* PESSAGNO. - ORIGLIA-DEVOS, p. 203, pl. 24, figs. 6, 7.
?	1983	*Ultranapora* sp. cf. *durhami* PESSAGNO. - ORIGLIA-DEVOS, p. 204, pl. 24, fig. 8.
	1983	*Ultranapora* sp. A. ORIGLIA-DEVOS, p. 204, pl. 24, figs. 9, 10.
	1985	*Ultranapora praespinifera* PESSAGNO. - LI & WU, pl. 2, fig. 4.
	1986	*Napora praespinifera* (PESSAGNO). - WU, pl. 2, fig. 7.
	1988	*Napora durhami* (PESSAGNO). - THUROW, p. 402, pl. 5, fig. 4.
	1988	*Napora praespinifera* (PESSAGNO). - THUROW, p. 402, pl. 5, fig. 3.
	1989	*Ultranapora praespinifera* PESSAGNO. - TUMANDA, p. 40, pl. 1, fig. 10.

Holotype: The specimen designated and figured by Pessagno (1977c) on pl. 5, fig. 8. It is from locality NSF 860, late Albian portion of the Great Valley Sequence, California.

Photographed material: 99 specimens.

Description: Test as with genus, having relatively long threebladed apical horn, with secondary spines upwardly directed. Cephalis usually with cephalocone, having slit-like pores at its base. Thorax subspherical, having hexagonal pore frames with small nodes at vertices. Thorax develops three long thoracic feet, which are threebladed. Test with subsidiary meshwork extending beyond thorax, between thoracic feet, this meshwork quite irregular and fragile, although pores tend to be arranged more or less in horizontal rows. Thoracic aperture triangular.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of thorax	110	184	227	147
Width of thorax	140	91	103	80
Length of apical horn	130	77	120	67

Remarks: This species represents an earliest stock, which gave rise during the middle Cretaceous to numerous representatives of *Ultranapora* (see fig. 24).

Comparisons: *U. praespinifera* differs from *U. durhami* by having a spinose and more complex apical horn; furthermore it develop a subsidiary meshwork between thoracic feet.

Ultranapora crassispina (SQUINABOL, 1903b)

Pl. 42, figs. 1-5
Species code 292

1903b *Lychnocanium crassispina* n. sp. SQUINABOL, p. 129, pl. 8, fig. 33.
1927 *Dictyophimus gracilis* spec. nov. TAN, p. 42, pl. 7, fig. 33.
pars ? 1973b *Tripilidium* (?) sp. *B.* FOREMAN, p. 265, pl. 10, fig. 17; non fig. 16, 18, (= *U. praespinifera* ?).
pars ? 1974 ? *Tripocalpis ellyae* TAN SIN HOK. - RENZ, p. 798, pl. 11, fig 10; pl. 5, figs. 18; non fig 19.
1981 *Lithomelissa* (?) sp. cf. *L.* (?) *amazon* FOREMAN. - DE WEVER (in DE WEVER & THIEBAULT), p. 588, pl. 1, fig. 10.
1981 *Tripocalpis ellyae* TAN SIN HOK. - SCHAAF, p. 440, pl. 23, figs. 6a-b.

Holotype: Specified type, the specimen illustrated by Squinabol (1903b) on pl. 8, fig. 33. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 14 specimens.

Description: Test as with genus, with small thorax. Cephalis small, poreless, having a small but very thick apical horn. The apical horn is threebladed and it has the same height as the thorax. Collar stricture slightly to well defined externally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length test plus horn	200	179	200	147
Width of thorax	105	92	100	87
Length of apical horn	92	67	73	50

Remarks: This species apparently branched off from *U. praespinifera,* which accompanies it through much of its range, and it left no descendants.

Comparisons: *U. crassispina* is distinguished from all other congeneric species by possessing a relatively minute test and a very thick apical horn.

Ultranapora durhami PESSAGNO, 1977c

Pl. 42, figs. 6-9
Species code 291

1977c *Ultranapora durhami* n. sp. PESSAGNO, p. 39, pl. 5, figs. 1-3, 13, 14, 19; pl. 12, fig. 4.
1981 *Ultranapora durhami* PESSAGNO. - DE WEVER (in DE WEVER & THIEBAULT), p. 594, pl. 2, fig. 5.
? 1981 *Ultranapora durhami* PESSAGNO. - SCHAAF, p. 440, pl. 23, figs. 8a-b.
non 1983 *Ultranapora* sp. cf. *durhami* PESSAGNO. - ORIGLIA-DEVOS, p. 204, pl. 24, fig. 8 (= *U. praespinifera* ?).
1985 *Napora xizangensis* sp. nov. LI & WU, p. 74, pl. 2, figs. 1, 2.

1985 *Ultranapora durhami* PESSAGNO. - LI & WU, pl. 2, fig. 3.
non 1988 *Napora durhami* (PESSAGNO). - THUROW, p. 402, pl. 5, fig. 4 (= *U. praespinifera*).

Holotype: The specimen designated and figured by Pessagno (1977c) on pl. 5, figs. 1, 3, 13. It is from locality NSF 884, late Albian portion of the Great Valley Sequence, California.

Photographed material: 23 specimens.

Description: Test as with genus, having a long, straight, threebladed apical horn. Cephalis having cephalocone, with well developed slit-like pores at its base. Thorax subtetrahedral, with hexagonal pore frames with small nodes at vertices. Thorax develops three long thoracic feet, which are threebladed and strongly arched. Test without subsidiary meshwork between thoracic feet. Thoracic aperture large, triangular.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length test plus horn	180	235	247	227
Width of thorax	80	105	113	100
Length of apical horn	70	132	140	127

Remarks: This species appears to have evolved from *U. praespinifera,* and left no descendants.

Comparisons: *U. durhami* is distinguished from its closely allied *U. praespinifera* by having a simple apical horn without secondary spines.

Ultranapora dendroacanthos (SQUINABOL, 1903b)

Pl. 42, figs. 10-12
Species code 293

1903b *Tripilidium dendroacanthos* n. sp. SQUINABOL, p. 126, pl. 8, fig. 32.
non 1976 *Tripilidium* (?) *dendrocanthos* SQUINABOL. - PESSAGNO, p. 55, pl. 3, fig. 1 (= *U. praespinifera*).
1977c *Ultranapora dumitricai* n. sp. PESSAGNO, p. 38, pl. 5, figs. 7, 16, 17, 21.
non 1983 *Ultranapora* sp. cf. *dumitricai* PESSAGNO. - ORIGLIA-DEVOS, p. 203, pl. 24, figs. 6, 7 (= *U. praespinifera*).

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 32 may be considered the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 5 specimens.

Description: Test as with genus, having a strongly developed cephalocone. Cephalis hemispherical, poreless, bearing a relatively long, three-bladed apical horn. Cephalocone with well developed slit-like pores. Thorax subtetrahedral, with very small circular pore frames. Thorax develops three long thoracic feet, which are threebladed and strongly arched. Test may develop subsidiary meshwork, extending beyond thorax and between thoracic feet. Thoracic aperture large, triangular.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length test plus horn	200	170	185	140
Width of thorax	72	100	105	95
Length of apical horn	100	57	65	45

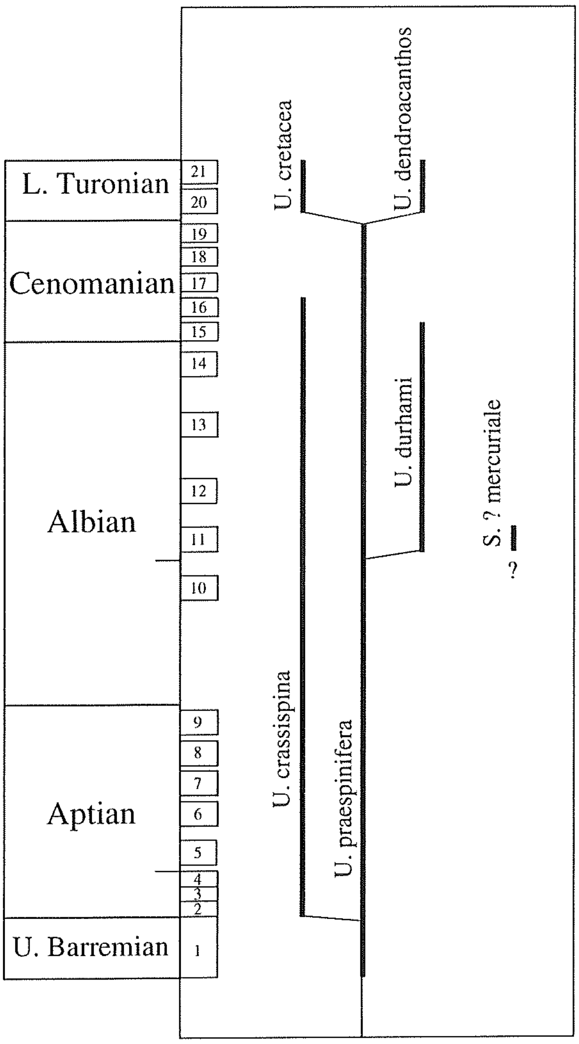

Fig. 26.- Stratigraphic range and possible phyletic relationships of species of *Ultranapora*.

Comparisons: *U. dendroacanthos* differs from *U. cretacea* by having fewer and smaller circular pores on its thorax and by possessing a strong cephalocone.

Ultranapora cretacea (SQUINABOL, 1904)

Pl. 42, figs. 13-18
Species code 290

1904 *Acanthocorys cretacea* n. sp. SQUINABOL, p. 214, pl. 7, fig. 9.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 7, fig. 9 may be regarded as the holotype. It is from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 18 specimens.

Description: Test as with genus, with dentate apical horn and thoracic feet. Cephalis small, subspherical, bearing a sturdy, somewhat dentate, apical horn. Apical horn three-bladed with small subsidiary spines. Cephalis having a well developed cephalocone. Collar stricture slightly marked or absent. Thorax subtetrahedral with large subcircular to hexagonal pore frames. Thoracic feet are threebladed and strongly dentate. Test possesses a subtriangular aperture.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length test plus horn	139	213	253	194
Width of thorax	115	110	120	86
Length of apical horn	39	82	94	72

Comparisons: This nominal species is distinguished from all other congeneric species by having both apical horn and thoracic feet three-bladed and dentate.

FAMILY **POULPIDAE** DE WEVER, 1981a

Type genus: *Poulpus* DE WEVER in DE WEVER *et al.* 1979.

GENUS **SAITOUM** PESSAGNO, 1977b

Type species: *Saitoum pagei* PESSAGNO, 1977b, by original designation.

Diagnosis: Test small, having only one segment, a hemispherical cephalis. Test with or without apical horn, with three prominent feet, which are commonly circular in transverse section.

Remarks: *Saitoum* differs from *Ultranapora* by possessing a monocyrtid test which is usually hemispherical.

Range: Middle Jurassic (late Bajocian-Bathonian) to late Barremian; middle Albian ?.

Saitoum ? mercuriale nov. sp.

Pl. 42, figs. 19-22
Species code 295

pars ? 1974 Spyrid (?) gen. et sp. indet. RIEDEL & SANFILIPPO, p. 780, pl. 3, fig. 4; non figs. 5-8 and pl. 12, fig. 5 (= *Saitoum cepeki* SCHAAF, 1981).

Holotype: Specimen 557 (pl. 42, fig. 21), from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin *Mercurialis* -e, from Mercury, Latin God with winged feet.

Photographed material: 4 specimens.

Description: Monocyrtid test perforate with subcircular to hexagonal minute pores, with winged feet. Test densely perforate having at its base a prominent circular rim. Apical horn straight and very long, circular in cross-section. Test possesses three feet, which are circular in cross-section. Distally, these feet are lamellar with irregular wavy ridges resembling somewhat a fish-tail. These structures are very fragile and rarely preserved whole.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of thorax	70	78	90	70
Width of thorax	70	74	88	68
Length of apical horn	70	78	85	70

Remarks: Generic assignment queried because these forms occur disconnected stratigraphically from late representatives clearly assignable to *Saitoum* (late Hauterivian-early Barremian).

Comparisons: This species differs from all other known species of *Saitoum* by possessing winged feet.

NASSELLARIINA INCERTAE SEDIS

GENUS **AFENS** RIEDEL & SANFILIPPO, 1974

Type species: *Afens liriodes* RIEDEL & SANFILIPPO, 1974, by monotypy.

Remarks: *Afens* is not similar to any radiolarian skeleton, and its affinities are completely unknown. This genus seems to be monospecific.

Range: Turonian to Campanian.

Afens liriodes RIEDEL & SANFILIPPO, 1974

Pl. 42, figs. 23-26
Species code 113

1973 Incert. sed. sp. *A.* MOORE, p. 830, pl. 13, figs. 1-3.
1974 *Afens liriodes* new genus and new species RIEDEL & SANFILIPPO, p. 775, pl. 11, fig. 11; pl. 13, figs. 14-16,
1978b *Afens liriodes* RIEDEL and SANFILIPPO. - FOREMAN, p. 750, pl. 5, fig. 24.
1981 *Afens liriodes* RIEDEL and SANFILIPPO. - KLING, p. 548, pl. 1, figs. 23, 24; pl. 3, figs. 5, 6.
1985 *Afens liriodes* SANFILIPPO & RIEDEL, p. 624, text-figs. 13. 3a-c.
1988 *Afens liriodes* RIEDEL and SANFILIPPO. - THUROW, pl. 2, fig. 1.

Holotype: Described and illustrated by Riedel & Sanfilippo (1974); the specimen figured on pl. 13, fig. 15. It is from the Late Cretaceous (Campanian) of the southern Indian Ocean, DSDP leg 26.

Photographed material: 6 specimens.

Diagnosis: The siliceous skeleton consists of a gently sinuous and very long cylindrical stem (apical horn ?) in complete specimens. Test composed generally of a calyx-like arrangement of long subparallel, lamellae, completely lacking ornamentation. Test rounded apically.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of thorax	105-240	260	294	227
Width of thorax	75-150	112	133	92
Length of apical horn	294	-	-	-

Remarks: This species is not similar to any radiolarian skeleton, its affinities being completely unknown, but it presents more similarities with Nassellariina than Spumellariina.

GENUS **ERIBOTRYS** FOREMAN, 1968

Type species: *Eribotrys despoena* FOREMAN, 1968, by original designation.

Remarks: It is not certainly proven that the species described here and assigned to the genus *Eribotrys* really belong to it.

Range: Campanian to Maastrichtian *sensu* Foreman, (1968). Middle Albian-earliest Cenomanian in the Umbria-Marche Apennines.

Eribotrys ? sp. **1**

Pl. 42, figs. 27-28
Species code 77

Photographed material: 2 specimens.

Diagnosis: Test long, elongate, cylindrical, having two or three segments. Cephalis seems to have cephalic lobes, bearing an apical horn in lateral position. Test having relatively long acute spines, downwardly directed.

Remarks: The specimens included here are not abundant in the studied material and it is not certainly proven that the species described here belong really to the genus *Eribotrys*.

Eribotrys ? sp. **2**

Pl. 42, figs. 29-30
Species code 116

Photographed material: 2 specimens.

Diagnosis: Test of two segments. Cephalis small, subspherical, with strong apical and vertical horns. Thorax small, cylindrical, with strong bladed spines at its base.

Remarks: Nomenclature left open because of relative scarcity of specimens.

SUBORDER **SPUMELLARIINA** EHRENBERG, 1875

SUPERFAMILY **SATURNALIACEAE** DEFLANDRE, 1953

FAMILY **SATURNALIDAE** DEFLANDRE, 1953

(= Acanthocircidae PESSAGNO, 1977c; Vitorfidae PESSAGNO, 1977c; Pseudacanthocircidae KOZUR & MOSTLER, 1990 (pro. pars.); Saturnalideidae KOZUR & MOSTLER, 1990)

Type genus: *Saturnalis* HAECKEL, 1881.

Saturnalideidae KOZUR & MOSTLER, 1990 homonym, of Saturnalidae DEFLANDRE, 1953 (according to Article 55 of the ICZN).

Saturnaliaceae with initial skeleton type Saturnalidae (see Dumitrica, 1985). Forms with spherical, subspherical, cylindrical, or irregular central shell; surrounded by a single, double, or multiple ring, armed or not, with spines. Ring connected to shell by means of two polar spines originating in a heteropolar microsphere, and eventually also by auxiliary or subsidiary spines originating at various levels of the many layered shell.

GENUS **DICEROSATURNALIS** DUMITRICA & JUD, in press

Type species: *Saturnulus trizonalis* RÜST, 1898, by original designation. This species is found to be invalid and must be considered as a nomen dubium. The additional ring situated upon the cortical shell, which is perpendicularly disposed to the equatorial ring on the Rüst's specimens (op. cit. pl. 2, fig. 4) is considered to be a fragmentary particle stuck to the test, and not as pertaining to the specimen, as the original picture seems to represent. This species is probably a senior synonym of *Saturnalis amissus* SQUINABOL, 1914.

Diagnosis: Saturnalidaea with a three-bladed elliptical ring, possessing an edge on the inner margin and two edges on the outer. End of ring with a single or bifurcated axial spine, which occasionally may be accompanied by small lateral spines. Central shell spongy-layered and usually spherical. Upper and lower surfaces of ring frequently develop thick triangular buttons at distal ends.

Remarks: According to Dumitrica & Jud (in press) this group seems to have an origin in late Jurassic representatives of *Hexasaturnalis*.

Comparisons: *Dicerosaturnalis* differs from *Acanthocircus* by possessing two thick spines situated on the longer axis instead of numerous spines radiating from the periphery of the ring, and a strongly bladed ring.

Range: Late Jurassic to late Aptian.

Dicerosaturnalis amissus (SQUINABOL, 1914)

Pl. 43, figs. 1-3
Species code 357

? 1898 *Saturnulus trizonalis* n. sp. RÜST, p. 9, pl. 2, fig. 4 (nomen dubium).

1914 *Saturnalis amissus* n. f. SQUINABOL, p. 296, pl. 23 [4], figs. 2-5.
1916 *Saturnulus trizonalis* RÜST. - FISCHLI, p. 46-47, text-fig. 52.
? 1968 *Saturnalis* (?) aff. *amissus* SQUINABOL. - ZHAMOIDA *et al.*, pl. 1, fig. 9.
? 1969 *Saturnalis* (?) aff. *amissus* SQUINABOL. - ZHAMOIDA, p. 19, text-fig. 9 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 9).
pars ? 1972 *Saturnalis* ? *amissus* SQUINABOL. - ZHAMOIDA, p. 104, pl. 17, fig. 1 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 9); pl. 9, fig. 2; non figs. 3-5.
1973b *Acanthocircus trizonalis* (?) (RÜST). - FOREMAN, p. 261, pl. 4, figs. 6, 7, 8 ?; pl. 16, fig. 22 ?.
1973 *Spongosaturnalis amissus* (SQUINABOL). - MOORE, p. 824, pl. 3, fig. 2.
1975 *Acanthocircus trizonalis* (?) (RÜST). - FOREMAN, p. 610, pl. 2D, figs. 1-4.
1977 *Acanthocircus trizonalis* (RÜST). - MUZAVOR, p. 40, pl. 9, fig. 1.
1977b *Acanthocircus* sp. *A*. PESSAGNO, p. 74, pl. 3, figs. 7-12.
1978 *Acanthocircus amissus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 23, pl. 1, figs. 1, 10; pl. 5, figs. 1 ?, 2-4, 6, 9; pl. 6, figs. 2, 4, 6 ?, 8, 11.
pars 1978 *Acanthocircus longispinosus* n. sp. DONOFRIO & MOSTLER, p. 29, pl. 6, fig. 1; pl. 5, fig. 8, non fig. 5.
1978b *Acanthocircus trizonalis* (?) (RÜST). - FOREMAN, p. 744, pl. 1, fig. 9.
1979 *Saturnalis* ? *amissus* SQUINABOL. - OZVOLDOVA, p. 4, pl. 3, fig. 3.
1981 *Acanthocircus trizonalis* (RÜST). - DE WEVER (in DE WEVER & THIEBAULT), p. 584, pl. 2, fig. 16.
1981 *Acanthocircus trizonalis* (RÜST). - SCHAAF, p. 431, pl. 16, fig. 1.
1981 *Acanthocircus* sp. SCHAAF, p. 431, pl. 7, fig. 7.
1983 *Acanthocircus trizonalis* (RÜST). - ORIGLIA-DEVOS, p. 61, pl. 4, figs. 6, 7.
1983 *Acanthocircus* sp. *A*. gr. ORIGLIA-DEVOS, p. 63, pl. 4, figs. 8-10; pl. 5, figs. 1-3.
1984 *Acanthocircus trizonalis* (RUST). - SCHAAF, p. 154-155, text-fig. 5.
1985 (?) *Acanthocircus trizonalis* (RÜST). - LI & WU, pl. 2, figs. 6, 9.
1985 *Acanthocircus trizonalis* SANFILIPPO & RIEDEL, p. 592, text-figs. 5. 1a (= specimen of Pessagno, 1977b, pl. 3, fig. 7), 1b (= specimen of Schaaf, 1981, pl. 7, fig. 7), 1c-d.
1988 *Acanthocircus trizonalis* (RÜST). - THUROW, p. 396, pl. 10, fig. 2.
1988 *Acanthocircus* sp. THUROW, p. 396, pl. 10, fig. 1.
1990 *Acanthocircus amissus* (SQUINABOL). - OZVOLDOVA, p. 139, pl. 5, fig. 2.
? 1992 *Acanthocircus* sp. *A*. OZVOLDOVA & PETERCAKOVA, p. 315, pl. 1, fig. 4.
1992 *Acanthocircus amissus* (SQUINABOL). - STEIGER, p. 34, pl. 5, fig. 7.
non 1992 *Acanthocircus trizonalis* (RÜST). - TAKETANI & KANIE, text-fig. 3. 3.
1994 *Acanthocircus trizonalis* (RÜST). - JUD, p. 60, pl. 9-11.
(in press) *Dicerosaturnalis trizonalis* (RÜST). - DUMITRICA & JUD.

Lectotype: Nominal species described syntypically. I designate as lectotype the specimen illustrated by Squinabol (1914) on pl. 23 [4], fig. 3. This specimen has been reported from the middle Cretaceous of Novale (Vicentino southern venetian Alps, N Italy)

Photographed material: 4 specimens and much fragmentary material.

Description: Test as with genus with two strong distal spines. Early Cretaceous saturnalids with a strongly three-bladed ring, which possess thick triangular buttons at distal ends. Distal spines occasionally forked. Cortical shell spherical, spongy, formed by numerous concentric layers.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Inner diameter of ring	483	460	510	400
Diameter of cortical shell	156	125	158	104
Length of longest spine	183	83	100	60

Remarks: *D. amissus* represents the last representative of this genus, which became extinct in late Aptian times. The amount of available material does not allow phylogenetic discussion.

GENUS **AURISATURNALIS** DUMITRICA & JUD, 1994

Type species: *Acanthocircus carinatus* FOREMAN, 1973b, by original designation.

Diagnosis: Ring elliptical and strongly elongate perpendicular to the polar spines. Ring three-bladed with two edges on the inner margin and a single edge on the outer margin, and bearing two spines at extremities. In earliest representatives ring may possess an additional third long spine, which is situated between the lateral distal spines at each extremity. Saturnalids possessing a groove (older specimens) or button (younger specimens) at distal ends of ring located at the base of distal spines on both sides.

Remarks: Dumitrica & Jud (1994) erected this new generic name to include a short evolutionary lineage of Early Cretaceous saturnalids having a groove at the end of the ring, flanked by two relatively long and closely spaced spines. Throughout the lineage the distance decreases between lateral spines, and the groove becomes narrower, evolving into a thick, nearly square, characteristic button.

A possible origin has been signalled by Dumitrica & Jud (op. cit.) from some Early Cretaceous (late Berriasian-Valanginian) representatives of *Acanthocircus* which bear three spines at both extremities of the ring.

Range: Late Valanginian to earliest Aptian.

Aurisaturnalis carinatus (FOREMAN, 1973b)

Pl. 43, fig. 4

Species code 392

?	1968	*Saturnalis* (?) *bifurcatus* sp. nov. ZHAMOIDA (in ZHAMOIDA *et al.*), p. 38, pl. 1, fig. 11.
?	1969	*Saturnalis* (?) *bifurcatus* ZHAMOIDA. - ZHAMOIDA, p. 19, text-fig. 11 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 11).
?	1972	*Saturnalis* (?) *bifurcatus* ZHAMOIDA. - ZHAMOIDA, p. 104, pl. 11, fig. 8 (= specimen of Zhamoida *et al.*, 1968, pl. 1, fig. 11); pl. 18, fig. 1.
	1973b	*Acanthocircus carinatus* new species FOREMAN, p. 260, pl. 5, figs. 1 ?, 2.
pars	1973	*Spongosaturnalis variabilis* (SQUINABOL). - MOORE, p. 824, pl. 6, figs. 1, 3; non fig. 2.
	1975	*Acanthocircus carinatus* s.s. FOREMAN. - FOREMAN, p. 610, pl. 2C, fig. 8; pl. 4, fig. 12.
	1981	*Acanthocircus carinatus* FOREMAN. - SCHAAF, p. 431, pl. 16, fig. 2.
	1984	*Acanthocircus carinatus* FOREMAN. - SCHAAF, p. 158-159, text- fig. 7.
non	1992	*Acanthocircus carinatus* FOREMAN. - OZVOLDOVA & PETERCAKOVA, pl. 1, fig. 5.
	1994	*Aurisaturnalis carinatus carinatus* (FOREMAN). - DUMITRICA & JUD, pl. 2, figs. 1-11; pl. 3, figs. 1-4, 6-9, 11-14.
	1994	*Aurisaturnalis carinatus inconstans* n. ssp. DUMITRICA & JUD, pl. 1, figs. 7-9, 11-16.
	1994	*Aurisaturnalis carinatus perforatus* n. ssp. DUMITRICA & JUD, pl. 2, figs. 12-16; pl. 3, figs. 5, 10.
	1994	*Aurisaturnalis carinatus transitorius* n. ssp. DUMITRICA & JUD, pl. 1, figs. 3, 4, 6, 10.
	1994	*Acanthocircus carinatus* FOREMAN. - JUD, p. 59, pl. 2, figs. 1-3.

Holotype: The specimen described and figured by Foreman 1973b on pl. 5, fig. 2. The holotype was reported from the Valanginian-Hauterivian? (no precise locality, interval between Hole 196-4-1 to 196-3-1, Sethocapsa trachyostraca assemblage) of DSDP Leg 20, northwest Pacific basin.

Photographed material: 5 specimens and much fragmentary material.

Description: Test as with genus, elliptical ring with strongly elevated button at each distal end on upper and lower surfaces. Ring with two acute ends armed with two divergent blade-like spines. Button perforated at the central part in newer populations.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Inner diameter of ring	-	330	344	332
Length of longest spine	94	100	104	68

Remarks: A detailed study showing the evolution of this species through the Early Cretaceous was recently illustrated by Dumitrica & Jud (1994)

Comparisons: *A. carinatus* is distinguished from its closely allied *A. variabilis* SQUINABOL, 1914, by possessing a thick elevated button at the distal ends instead of deep narrow grooves.

GENUS **ACANTHOCIRCUS** SQUINABOL, 1903b

Synonyms: *Spongosaturnalis* CAMPBELL & CLARK, 1944; *Palaeosaturnalis* DONOFRIO & MOSTLER, 1978; *Mesosaturnalis* KOZUR & MOSTLER, 1981.

Type species: *Acanthocircus irregularis* SQUINABOL, 1903b, subsequent designation by Campbell (1954).

Diagnosis: Saturnalids with bladed or unbladed ring. These carina can be more or less developed within the same species. Saturnalids normally have numerous auxiliary spines radiating from the periphery of the ring. Auxiliary spines may be conical or triangular. Ring generally bilaterally symmetrical with circular to subrectangular cross-section, and subcircular, elliptical, or rectangular in outline. Shell globular to cylindrical, quite spongy, with numerous concentric layers. Ring connected to the shell by means of two polar spines.

Comparisons: This genus is distinguished from *Dicerosaturnalis* by possessing numerous auxiliary spines radiating from the outer ring instead of two spines axially at either narrow end. Moreover, the latter genus may develop a triangular button on the distal end of the elliptical ring, which is absent in *Acanthocircus*.

Range: Late Valanginian to Maastrichtian.

Acanthocircus levis (DONOFRIO & MOSTLER, 1978)

Pl. 43, figs. 5-7
Species code 360

?	1898	*Zygostephanus aculeatus* n. sp. RÜST, p. 37, pl. 7, fig. 13.
non	1900	*Zygostephanus aculeatus* ? RÜST. - HOLMES, p. 703, pl. 38, fig. 13 (= *A. euganeus* ?).
pars	1914	*Saturnalis polymorphus* n. f. SQUINABOL, p. 293, pl. 22 [3], fig. 12; non figs. 11 (= *A. multidentatus*) and pl. 24 [5], figs. 2-4 (= *A. horridus*), 5-7 (= *A. dendroacanthos*).
	1916	*Zygostephanus aculeatus* RÜST. - FISCHLI, p. 46-47, text-figs. 50-51.
?	1972	*Zygostephanus* ? *hexagonus* sp. nov. ZHAMOIDA, p. 114, pl. 7, fig. 4; pl. 8, fig. 4.
?	1972	*Zygostephanus* ? *ovalis* sp. nov. ZHAMOIDA, p. 115, pl. 7, figs. 5, 6; pl. 8, fig. 5.
	1973b	*Spongosaturnalis* (?) *aculeatus* (?) (RÜST). - FOREMAN, p. 261, pl. 4, fig. 2.
non	1973b	*Spongosaturnalis* (?) sp. aff. *S.* (?) *aculeatus* (?) (RÜST). - FOREMAN, p. 261, pl. 4, figs. 1, 3 and pl. 14, figs. 1-3 (= *A. horridus*).
	1973	*Spongosaturnalis polymorphus* (SQUINABOL). - MOORE, p. 824, pl. 6, figs. 4, 6.

? 1973 *Spongosaturnalis* sp. *B*. MOORE, p. 824, pl. 6, fig. 5.
1974 *Spongosaturnalis* sp. aff. *Saturnalis polymorphus* SQUINABOL. - RENZ, p. 797, pl. 2, fig. 5; pl. 9, fig. 22.
pars 1975 *Spongosaturnalis* (?) spp. FOREMAN, p. 612, pl. 2C, figs. 2 ?, 4, 5; non figs. 3 (= *A. multidentatus* ?), 6 (= *A. dendroacanthos*) and pl. 1C, figs. 3-10.
1978 *Paleosaturnalis levis* n. sp. DONOFRIO & MOSTLER, p. 36, pl. 2, figs. 1, 2.
1981 *Spongosaturnalis* (?) *preclarus* FOREMAN. - DE WEVER (in DE WEVER & THIEBAULT), p. 592, pl. 2, fig. 15.
? 1981 *Spongosaturnalis horridus* group (SQUINABOL). - SCHAAF, p. 439, pl. 16, fig. 4.
1982 *Acanthocircus* sp. OKAMURA & UTO, pl. 7, fig. 10.
1983 *Mesosaturnalis huyei* gr. (PESSAGNO). - ORIGLIA-DEVOS, p. 66, pl. 5, figs. 6-8.
1984 *Spongosaturnalis aculeatus* (RÜST). - SCHAAF, p. 154-155, text-fig. 2.
? 1989 *Acanthocircus multidentatus* (SQUINABOL). - TUMANDA, p. 34, pl. 2, fig. 13.
1992 *Mesosaturnalis aculeatus* (RÜST). - OZVOLDOVA & PETERCAKOVA, pl. 1, fig. 9.
1992 *Mesosaturnalis hueyi* (PESSAGNO). - OZVOLDOVA & PETERCAKOVA, pl. 1, fig. 6.

Holotype: This specimen is described and illustrated by Donofrio & Mostler (1978) on pl. 2, fig. 1. The holotype is from Late Cretaceous cherty-limestones of Mollaro, Nonstal.

Photographed material: 12 specimens.

Description: Test as with genus, with spherical cortical shell, having an elliptical ring armed with a variable number of flat triangular spines (usually 8 to 12). Ring possesses a weakly developed carina on the inner margin. Auxiliary spines of variable length, relatively long and flattened. Spines are arranged more or less symmetrically.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Inner diameter of ring	63	201	217	192
Length of longest spine	43	119	150	92

Remarks: This species seems to be the origin of an enormous radiation which occurred in middle Albian times, giving rise to numerous species of *Acanthocircus* (fig. 27). Throughout younger populations there exists a marked tendency to develop a faint carina on the outer margin of the ring.

Comparisons: *A. levis* is distinguished from *A. dendroacanthos* by not having bifurcated auxiliary spines and by possessing only a slightly developed carina at the inner margin of its ring.

Acanthocircus dendroacanthos SQUINABOL, 1903b

Pl. 43, figs. 8-13
Species code 359

1903b *Acanthocircus dendroacanthos* n. sp. SQUINABOL, p. 125, pl. 9, fig. 9.
pars 1914 *Saturnalis polymorphus* n. f. SQUINABOL, p. 293, pl. 24 [5], figs. 5-7; non figs. 2-4 (= *A. horridus*); non pl. 22 [3], figs. 11 (= *A. multidentatus*), 12 (= *A. levis*).
pars 1973 *Spongosaturnalis* (?) sp. FOREMAN, p. 261, pl. 14, fig. 9; non figs. 4-5 (= *A. venetus* ?), 6-7 and 8 ? (= *A. bestiarius*) and pl. 15, figs. 2, 3.
non 1973 *Spongosaturnalis polymorphus* (SQUINABOL). - MOORE, p. 824, pl. 6, figs. 4, 6 (= *A. levis*).
non 1974 *Spongosaturnalis* sp. aff. *Saturnalis polymorphus* SQUINABOL. - RENZ, p. 797, pl. 2, fig. 5; pl. 9, fig. 22 (= *A. levis*).
pars 1975 *Spongosaturnalis* (?) spp. FOREMAN, p. 612, pl. 2C, fig. 6; non figs. 2 ?, 4, 5 (= *A. levis*), 3 (= *A. multidentatus* ?) and pl. 1C, figs. 3-10.
1977c *Acanthocircus dendrocanthos* (SQUINABOL). - PESSAGNO, p. 31, pl. 2, figs. 10, 11.
1978 *Palaeosaturnalis polymorphus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 36, pl. 2, figs. 4, 7, 8.

? 1979 *Acanthocircus dendroacanthos* SQUINABOL. - OZVOLDOVA, p. 13, pl. 1, fig. 2.

1983 *Mesosaturnalis dendroacanthos* (SQUINABOL). - ORIGLIA-DEVOS, p. 64, pl. 5, fig. 5.

non 1983 *Mesosaturnalis* sp. aff. *S. polymorphus* SQUINABOL. - ORIGLIA-DEVOS, p. 69, pl. 6, figs. 7-9 (= *A. venetus*)

non 1984 *Spongosaturnalis polymorphus* (SQUINABOL). - SCHAAF, p. 152-153, text-fig. 5 (= *Acanthocircus breviaculeatus* DONOFRIO & MOSTLER, 1978).

non 1992 *Acanthocircus dendroacanthos* (SQUINABOL). - STEIGER, p. 35, pl. 6, fig. 3.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 9 may be considered the holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 67 specimens.

Description: Test as with genus, with relatively wide, flat ring, elliptical to subcircular in outline. Ring with well-developed carinas on inner and outer edges. Auxiliary spines relatively thick and long, some of which are bi- or trifurcated; number observed to vary from 8 to 16. Occasionally, the outer edge of some auxiliary spines is faintly defined by a narrow carina. Cortical shell spherical, quite spongy. Peripheral spines radiating more or less symmetrically. Number of auxiliary spines on each half ring generally unequal.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	-	154	160	142
Diameter of ring and cavity	300	207	233	192
Length of longest spine	75	133	154	117

Remarks: This species shows a wide range of variation through all its stratigraphic range. The most conspicuous change is shown by the auxiliary spines, which are quite variable in number and in shape. *A. dendroacanthos* probably evolved from *A. levis* by acquiring two well-developed carinas on its ring. The outer wedge of spine may be defined by a massive carina. However, usually the narrow groove of the spines is lacking due to the growth of the carina. The complexity of auxiliary spines increases simultaneously, becoming bi- or trifurcated. *A. dendroacanthos* seems to give rise to *A. horridus* in late Albian times.

Comparisons: *A. dendroacanthos* differs from all other congeneric species by having bi- or trifurcated auxiliary spines radiating peripherally on its ring.

Acanthocircus horridus SQUINABOL, 1903b

Pl. 44, figs. 1-6

Species code 358

1903b *Acanthocircus horridus* n. sp. SQUINABOL, p. 125, pl. 9, fig. 3.

pars 1914 *Saturnalis polymorphus* n. f. SQUINABOL, p. 293, pl. 24 [5], figs. 2-4; non figs. 5-7 (= *A. dendroacanthos*); non pl. 22 [3], figs. 11 (= *A. multidentatus*), 12 (= *A. levis*).

1973b *Spongosaturnalis* (?) sp. aff. *S.* (?) *aculeatus* (RÜST). - FOREMAN, p. 261, pl. 4, figs. 1, 3.

pars ? 1975 *Spongosaturnalis horridus* (SQUINABOL). - FOREMAN, p. 610, pl. 2C, fig. 1; non pl. 4, fig. 3 (= *A. venetus* ?).

1978 *Palaeosaturnalis horridus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 34, pl. 1, figs. 7, 8, 8a, 11.

non 1981 *Spongosaturnalis horridus* group (SQUINABOL). - SCHAAF, p. 439, pl. 16, fig. 4 (= *A. levis* ?).

1983 *Mesosaturnalis horridus* (SQUINABOL). - ORIGLIA-DEVOS, p. 65, pl. 5, fig. 9.

1983 *Mesosaturnalis multidentatus* (SQUINABOL). - ORIGLIA-DEVOS, p. 67, pl. 6, figs. 1, 2.

1983 *Mesosaturnalis praeclarus* (FOREMAN). - ORIGLIA-DEVOS, p. 68, pl. 6, figs. 4-6.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 3 may be considered the holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 120 specimens.

Description: Test with very wide, flat ring, elliptical to subcircular in outline. Outer edges of ring and spines defined by a narrow carina. Inner edge of ring develops subsidiary spines, each of which corresponds to auxiliary spines. Subsidiary spines occasionally hidden by strongly developed of ring. Auxiliary spines very long, flat, and triangular in outline. Peripheral spines radiating more or less symmetrically; usually 14 to 18 spines surround periphery of ring. Polar spines narrow and relatively long. Auxiliary spines are rarely bifurcated.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Inner diameter of ring	175	213	245	180
Length of longest spine	98	154	170	140

Remarks: Because of the similarity of their ring and the arrangement of auxiliary spines, it seems likely that the form described above and *A. dendroacanthos* are closely related. *A. horridus* evolved into *A. venetus*.

Comparisons: *A horridus* is distinguished from both *A. levis* and *A. venetus* by having a wider ring, thicker and longer auxiliary spines, and subsidiary spines.

Acanthocircus angustus DONOFRIO & MOSTLER, 1978

Pl. 44, figs. 11-15
Species code 345

1973b	*Spongosaturnalis* (?) *multidentatus* (SQUINABOL). - FOREMAN, p. 261, pl. 15, fig. 4.
1975	*Spongosaturnalis* (?) *multidentatus* (SQUINABOL). - FOREMAN, p. 611, pl. 1A, figs. 1-3.
1978	*Acanthocircus angustus* n. sp. DONOFRIO & MOSTLER, p. 25, pl. 1, fig. 4; pl. 2, figs. 5, 6.

Holotype: The specimen figured and described by Donofrio & Mostler (1978) pl. 1, fig. 4. The holotype has been reported from Cenomanian beds (cherty limestones, Scaglia Formation) at Mollaro, Nonstal.

Photographed material: 14 specimens.

Description: Test with very large elliptical to nearly circular ring lacking carina. Ring with circular cross-section. Cortical shell small, approximately spherical. Polar spines very long and narrow, circular in cross-section. Relatively small auxiliary spines with somewhat spatulate tips surround the periphery of the ring. Auxiliary spines on ring rarely equal in number on the two parts; they number sixteen to twenty-two, and vary slightly in size and shape.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Max. diameter of ring	222	515	600	400
Min. diameter of ring	190	428	460	400
Length of longest spine	40	101	127	73

Remarks: *A. angustus* is closely related to *A. multidentatus* with which it occurs. This latter species apparently evolved from *A. levis* at about the same time. It seems likely that *A. angustus* corresponds to more massive variants of *A. multidentatus*, however the amount of available material is not suitable to consider this as a continuous variation. Intermediate forms between both morphotypes are extremely rare.

Comparisons: Compared to *A. multidentatus*, *A. angustus* has thicker, more spatulate auxiliary spines and a wider ring diameter. The ring becomes more massive, and is simplified by loss of carina on each edge.

Acanthocircus multidentatus (SQUINABOL, 1914)

Pl. 44, figs. 7-10
Species code 346

	1914	*Saturnalis multidentatus* n. f. SQUINABOL, p. 298, pl. 23 [4], figs. 11, 12.
pars	1914	*Saturnalis polymorphus* n. f. SQUINABOL, p. 293, pl. 22 [3], figs. 11, non fig. 12 (= *A. levis*) and pl. 24 [5], figs. 2-4 (= *A. horridus*), 5-7 (= *A. dendroacanthos*).
?	1968	? *Saturnalis deirpede* sp. nov. FOREMAN, p. 12, pl. 1, figs. 2a-c.
non	1973b	*Spongosaturnalis* (?) *multidentatus* (SQUINABOL). - FOREMAN, p. 261, pl. 15, fig. 4 (= *A. angustus*).
non	1975	*Spongosaturnalis* (?) *multidentatus* (SQUINABOL). - FOREMAN, p. 611, pl. 1A, figs. 1-3 (= *A. angustus*).
pars ?	1975	*Spongosaturnalis* (?) spp. FOREMAN, p. 612, pl. 2C, fig. 3; non figs. 2 ?, 4, 5 (= *A. levis*), 6 (= *A. dendroacanthos*) and pl. 1C, figs. 3-10.
	1977c	*Acanthocircus multidentatus* (SQUINABOL). - PESSAGNO, p. 32, pl. 2, figs. 15, 20.
pars	1978	*Acanthocircus italicus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 29, pl. 3, fig. 13; non pl. 4, figs. 1, 3, 5, 6 (= *A. irregularis*),.
	1978	*Acanthocircus multidentatus* SQUINABOL. - DONOFRIO & MOSTLER, p. 30, pl. 3, figs. 5, 9; pl. 4, fig. 2.
non	1983	*Mesosaturnalis multidentatus* (SQUINABOL). - ORIGLIA-DEVOS, p. 67, pl. 6, figs. 1, 2 (= *A. horridus*).
non	1989	*Acanthocircus multidentatus* (SQUINABOL). - TUMANDA, p. 34, pl. 2, fig. 13 (= *A. levis* ?).
non	1992	*Acanthocircus multidentatus* (SQUINABOL). - STEIGER, p. 35, pl. 6, fig. 4.

Lectotype: Subsequent designation by Pessagno (1977c). This specimen was figured by Squinabol (1914) on pl. 23 [4], fig. 11. The type specimen was reported from the middle Cretaceous of Novale, Vicentino (southern Venetian Alps, N Italy).

Photographed material: 20 specimens.

Description: Test as with genus, with a very wide ring armed with long polar spines, which are circular in cross-section. Ring cavity elliptical to slightly circular in outline. Inner edge with strongly developed carina. Outer edge of ring poorly defined. Eighteen to twenty-four small flat spines normally surround periphery of ring. Auxiliary spines, sharply pointed and on approximately equal in number on each half ring.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Max. diameter of ring	667	433	480	393
Min. diameter of ring	555	344	387	293
Length of longest spine	78	83	113	60

Comparisons: This species is distinguished from *A. angustus* by possessing a well-marked bladed ring. *A. multidentatus* seems to have evolved directly from *A. levis* by rapidly acquiring a larger ring diameter.

Acanthocircus venetus (SQUINABOL, 1914)

Pl. 45, figs. 1-8

Species code 355

? 1903b *Acanthocircus rarus* n. sp. SQUINABOL, p. 125, pl. 9, fig. 2.

1914 *Saturnalis venetus* n. f. SQUINABOL, p.269, 299, pl. 20 [1], fig. 2; pl. 24 [5], fig. 1.

1914 *Saturnalis venetus* SQUIN. - SQUINABOL, p. 299.

pars ? 1973 *Spongosaturnalis* (?) sp. FOREMAN, p. 261, pl. 14, figs. 4, 5; non figs. 6, 7, 8 ? (= *A. bestiarius*), 9 (= *A. dendroacanthos*) and pl. 15, figs. 2, 3.

pars ? 1975 *Spongosaturnalis horridus* (SQUINABOL). - FOREMAN, p. 610, pl. 4, fig. 3; non pl. 2C, fig. 1.

pars 1975 *Spongosaturnalis hueyi* group (PESSAGNO). - FOREMAN, p. 611, pl. 1B, figs. 1-3; non pl. 1A, figs. 7, 8 (= *A. tympanum* ?).

1975 *Spongosaturnalis* (?) *preclarus* new. species FOREMAN, p. 611, pl. 1A, figs. 4, 5; pl. 4, fig. 8.

non 1978 *Palaeosaturnalis* cf. *venetus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 39, pl. 6, fig. 3 (= *A. floridus* ?).

non 1981 *Spongosaturnalis* (?) *preclarus* FOREMAN. - DE WEVER (in DE WEVER & THIEBAULT), p. 592, pl. 2, fig. 15 (= *A. levis*).

1983 *Mesosaturnalis* sp. aff. *S. polymorphus* SQUINABOL. - ORIGLIA-DEVOS, p. 69, pl. 6, figs. 7-9.

non 1983 *Mesosaturnalis praeclarus* (FOREMAN). - ORIGLIA-DEVOS, p. 68, pl. 6, figs. 4-6 (= *A. horridus*).

1991 *Acanthocircus preclarus* (FOREMAN). - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 5.

1991 *Spongosaturnalis* ? cf. *preclarus* FOREMAN. - MARCUCCI *et al.*, text-fig. 4. i.

1992 *Spongosaturminus hueyi* PESSAGNO. - MARCUCCI & GARDIN, text-figs. 4. a-b.

? 1992 *Spongosaturminus* MARCUCCI & GARDIN, text-fig. 4. c.

Lectotype: I designate as lectotype the specimen figured by Squinabol (1914) on pl. 24 [5], fig. 1. This specimen was reported from the middle Cretaceous of Novale, Vicentino (southern Venetian Alps, N Italy).

Photographed material: 74 specimens.

Description: Test with relatively small dentate ring, surrounded by eight to fifteen relatively short auxiliary spines. Ring cavity nearly square in outline. Inner edge limited by a narrow carina. Auxiliary spines tend to be concentrated at distal sides. Size, shape, and distribution of peripheral spines strongly variable. Lateral sides of ring (perpendicular to polar spines) generally have either two or four peripheral spines. Number of auxiliary spines on each half ring generally unequal.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	123	82	112	39
Inner diameter of ring	184	158	169	131
Length of longest spine	40	73	115	39

Remarks: *A. venetus* shows a wide range of variation through an important portion of its stratigraphic record. Range of variability of *A. venetus* and *A. horridus* overlap slightly. These variations are most conspicuous among older populations, but *A. venetus* rapidly acquires a smaller size and more rectangular outline. Auxiliary spines get progressively smaller. Gradual decrease in ring diameter occurs simultaneously with this change in the ornamentation. In consequence, the ring becomes strongly reduced and slightly dentate. *A. venetus* undoubtedly evolved into *A. bestiarius.*

Comparisons: Among the wealth of the species assigned to *Acanthocircus*, *A. venetus* shows patent affinities with *A. horridus*. It differs by its smaller size, its lack of subsidiary spines, and by having smaller, less numerous auxiliary spines.

Acanthocircus bestiarius nov. sp.

Pl. 45, figs. 9-13
Species code 356

pars 1973 *Spongosaturnalis* (?) sp. FOREMAN, p. 261, pl. 14, figs. 6, 7, 8 ?; non figs. 4, 5 (= *A. venetus* ?), 9 (= *A. dendroacanthos*) and pl. 15, figs. 2, 3.

Holotype: Specimen 7016 (pl. 45, fig. 9). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *bestiarius* -ii (m), meaning roman circus warriors.

Photographed material: 28 specimens.

Description: Saturnalid with a typical sub-elliptical to polygonal ring and subspherical cortical shell. Ring cavity strongly constricted on the polar spines axis. Ring with a slightly developed carina on the inner edge. Outer edge poorly marked by a narrow carina. Longest auxiliary spines always arranged laterally where the inflexion of the ring changes. Ring displays a typical arrangement of auxiliary spines throughout the periphery. The most characteristic pairs of auxiliary spines are laterally disposed, close to each side of polar spines, and parallel to the minor axis (but always radiating in the opposite sense of polar spines). The smaller lateral spines radiate in a more or less parallel fashion, although they converge somewhat distally. The longest lateral spines always diverge strongly and are situated at the lateral inflexion points. Auxiliary spines tend to be concentrated on distal part of the ring (number observed on distal part varying from five to six). Peripheral spines of variable size and shape.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	-	-	250	-
Diameter of ring and cavity	400	318	400	250
Length of longest spine	120	117	120	110

Remarks: This species probably evolved from *A. venetus* and seems to have given rise to *A. euganeus* by loss of the smallest lateral spines and by the gradual increase of the curvature of the ring. In this manner the cavity attains a more elliptical outline.

Comparisons: *A. bestiarius* differs from all other congeneric species in its distinctive sub-elliptical to polygonal cavity and in having numerous long peripheral radiating spines. *A. bestiarius* is similar to *A. euganeus*, but is distinguished by its characteristic four pair of auxiliary spines, each one situated at either side of the polar spines.

Acanthocircus euganeus (SQUINABOL, 1914)

Pl. 45, figs. 14-16
Species code 341

1914 *Saturnalis euganeus* n. f. SQUINABOL, p. 300, pl. 24 [5], figs. 8-11.
? 1900 *Zygostephanus aculeatus* ? RÜST. - HOLMES, p. 703, pl. 38, fig. 13.
1971 *Spongosaturnalis* ? sp. cf. *Saturnalis euganeus* SQUINABOL. - FOREMAN, p. 1674, pl. 1, fig. 5.
1973b *Spongosaturnalis* (?) sp. cf. *Saturnalis euganeus* SQUINABOL. - FOREMAN, pl. 15, fig. 5.

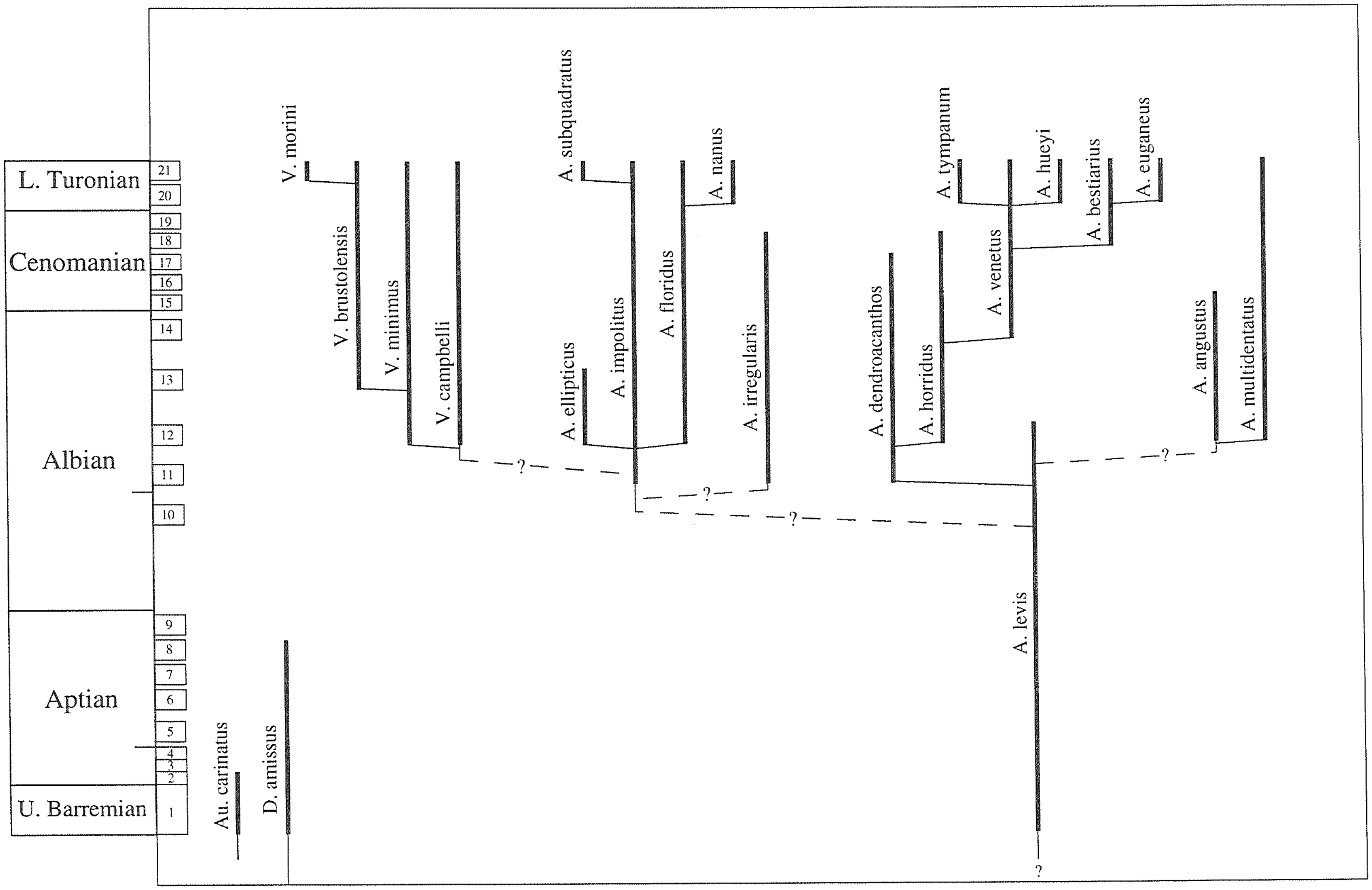

Fig. 27.- Stratigraphic range and possible phyletic relationships of genera and species of *Aurisaturnalis*, *Dicerosaturnalis*, *Acanthocircus* and *Vitorfus*.

Lectotype: I designate as lectotype the specimen figured by Squinabol (1914) on pl. 24 [5], fig. 9. This specimen is from the middle Cretaceous of Novale, Vicentino (southern Venetian Alps, N Italy).

Photographed material: 7 specimens.

Description: Test large with moderately wide ring, elliptical to subrectangular in outline. Ring surrounded by ten to twelve long narrow tapering spines. Auxiliary spines quite uniform in size and shape. Polar spines very long, acutely conical. Ring with only a well differentiated carina on its inner edge. Two auxiliary spines occur on each lateral side, diverging strongly distally. Number of spines on each half ring generally uniform.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Max. diameter of ring	286	243	260	210
Min diameter of ring	222	195	205	185
Length of longest spine	135	162	190	120

Remarks: It seems that *A. euganeus* evolved from *A. bestiarius* by simplification of the ring shape (changing from polygonal to subcircular cavity) and reduction of auxiliary spines.

Comparisons: *A. euganeus* more closely resembles *A. bestiarius* in shape, size and similar arrangement of auxiliary spines, but is distinguished by its more elliptical ring, and possesses only two instead of four auxiliary spines at each lateral side, and more strongly tapered spines.

Acanthocircus tympanum nov. sp.

Pl. 45, figs. 17-24
Species code 347

pars ? 1975 *Spongosaturnalis hueyi* group (PESSAGNO). - FOREMAN, p. 611, pl. 1A, figs. 7, 8; non pl. 1B, figs. 1-3 (= *A. venetus*).
1986 *Acanthocircus* sp. *D*. KHUNT *et al.*, pl. 8, fig. q.
1986 *Acanthocircus* sp. nov. KUHNT *et al.*, pl. 8, fig. m.
1986 *Acanthocircus* sp. nov. THUROW & KUHNT, text-figs. 9. 1, 2.
1991 *Acanthocircus* sp. HERNANDEZ-MOLINA *et al.*, text-fig. 12. 1.

Holotype: Specimen 6769 (pl. 45, fig. 17). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *tympanum* -i (n), meaning a kind of drum; refers to shape of the central shell.

Photographed material: 115 specimens.

Description: Test large with moderately wide ring, subcircular to elliptical in outline. Cortical shell, large, cylindrical, strongly elevated with raised central area. This cylindrical structure is slightly constricted in the plane of the ring. Number of spines on each half ring unequal. Four to fifteen flat spines on ring, varying slightly in size and shape from short and sharp, to longer with rounded or sharp ends. Auxiliary spines radiating more or less symmetrically.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	180	173	195	145
Length of cortical shell	102	103	110	100
Diameter of ring and cavity	270	253	208	190
Length of longest spine	80	78	95	65

Remarks: It is suspected that *A tympanum* may have evolved from *A. venetus* in the lowermost Turonian, through conspicuous change of the cortical shell and strong reduction in wideness of ring. Simultaneously, the ring cavity becomes larger. These changes seem to occur rapidly. It is abundant in almost all samples of this age, and is considered an important marker for the Cenomanian-Turonian boundary.

Comparisons: *A. tympanum* is distinguished from all other congeneric species by its cylindrical cortical shell.

Acanthocircus hueyi (PESSAGNO, 1976)

Pl. 46, figs. 1-5

Species code 340

? 1973b *Spongosaturnalis* (?) sp. cf. *Zygostephanus aculeatus* (?) RÜST in HOLMES. - FOREMAN, p. 261, pl. 14, fig. 10.

1975 *Spongosaturnalis hueyi* (PESSAGNO). - FOREMAN, p. 611, pl. 1A, fig. 6; pl. 4, fig. 10.

non 1975 *Spongosaturnalis hueyi* group (PESSAGNO). - FOREMAN, p. 611, pl. 1A, figs. 7, 8 (= *A. tympanum*); pl. 1B, figs. 1-3 (= *A. venetus*).

1976 *Spongosaturninus hueyi* n. sp. PESSAGNO, p. 39, pl. 12, fig. 1.

1978b *Spongosaturnalis hueyi* (PESSAGNO). - FOREMAN, p. 744, pl. 3, fig. 8.

non 1983 *Mesosaturnalis huyei* gr. (PESSAGNO). - ORIGLIA-DEVOS, p. 66, pl. 5, figs. 6-8 (= *A. levis*).

non 1992 *Mesosaturnalis hueyi* (PESSAGNO). - OZVOLDOVA & PETERCAKOVA, pl. 1, fig. 6 (= *A. levis*).

Holotype: This specimen is described and illustrated by Pessagno (1976) on pl. 12 fig. 1. The holotype comes from locality NSF 451, late Campanian, Del Valle Formation, Alameda County (Tesla Quadrangle, California)

Photographed material: 22 specimens.

Description: Test with very wide, flat ring, sub-rectangular in outline. Ring slightly wider on the axis of polar spines. Outer edges of ring and spines well-defined by carina. Inner edge also has a strongly develop carina. Auxiliary spines very long, flat, broad with spatulate tips; four to six spines on each half ring. Peripheral spines radiate more or less symmetrically. Normally, two auxiliary spines situated on either lateral side, although the position varies from specimen to specimen. Polar spines acutely conical. Cortical shell spherical and relatively spongy.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	140	130	-	-
Inner diameter of ring	200	230	270	200
Length of longest spine	98	106	120	90

Remarks: This species appears to have evolved from *A. venetus*. Forms intermediate between both species have been observed, although they are rare. The number of auxiliary spines in *A. hueyi* varies slightly but tends to be more constant and reduced in younger populations.

Comparisons: *A. hueyi* is close related to *A. venetus*, but it differs by possessing spatulate auxiliary spines and a strongly bladed ring.

Acanthocircus impolitus nov. sp.

Pl. 46, figs. 6-9
Species code 350

1977c *Acanthocircus* sp. *A*. PESSAGNO, p. 32, pl. 2, figs. 16, 22.
pars 1986 *Acanthocircus* sp. *B*. KUHNT *et al.*, pl. 8, fig. u; non fig. t.

Holotype: Specimen 583 (pl. 46, fig. 7) The holotype comes from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *impolitus* -a -um, meaning coarse.

Photographed material: 8 specimens.

Description: Ring elliptical, slightly narrow, flat, with a strong carina on inner margin. Ring without auxiliary spines on almost lateral sides. Ring finely dentate with numerous very short triangular peripheral spines. Ring surrounded generally by fourteen to sixteen auxiliary spines. Cortical shell, quite spongy, approximately spherical.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	108	110	158	58
Diameter of ring and cavity	375	302	375	258
Length of longest spine	42	39	42	33

Remarks: Through its stratigraphic range *A. impolitus* varies only slightly in the dentate shape of ring, being more or less distinct, depending on the degree of development of peripheral spines. It must be emphasized that *A. impolitus* shows a strong reduction in width of the ring, which is accompanied by a general decrease in size of the test. This species apparently branched off from *A. levis,* and gave rise to numerous species of *Acanthocircus.* Furthermore, *A. impolitus* appears to be the origin of the genus *Vitorfus*, ranging through the late Cretaceous. Forms intermediate between the two have been observed through the early-middle Albian times.

Comparisons: *A. impolitus* differs from *A. ellipticus* by its wider ring and by possessing more peripheral spines.

Acanthocircus ellipticus (SQUINABOL, 1903b)

Pl. 46, figs. 10-12
Species code 348

1903b *Saturnalis ellipticus* n. sp. SQUINABOL, p. 111, pl. 10, fig. 3.
1903b *Acanthocircus coronatus* n. sp. SQUINABOL, p. 126, pl. 9, fig. 5.
1914 *Saturnalis ellipticus* var. *major* mihi. SQUINABOL, p. 298.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 3 may be considered the holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, central Italy).

Photographed material: 7 specimens.

Description: Ring elliptical, longest dimension perpendicular to polar spines. Inner edge of ring defined by narrow carina. Cortical shell, spherical, with somewhat symmetrical meshwork comprised of small polygonal pore frames. A small, narrow triangular peripheral spine is located at either distal end. Polar spines short, smooth, slightly flattened. Equatorial ring weakly dentate with eighteen to twenty small peripheral spines uniformly distributed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	105	78	81	73
Inner diameter of ring	312	268	327	223
Length of longest spine	56	53	58	46

Remarks: *A. ellipticus* is close related to representatives of the genus *Vitorfus*. Generic attribution to *Acanthocircus* is justified by the possession of polar spines connecting the equatorial ring with the cortical shell, however this latter is not directly attached to the equatorial ring. It seems that *A. ellipticus* evolved from *A. impolitus* by a rapid reduction of the ring, preferentially in the axis of the polar spines, developing a more elliptical ring.

Comparisons: *A. ellipticus* is distinguished from *V. minimus* by having polar spines observable externally and not hidden by the cortical shell.

Acanthocircus floridus nov. sp.

Pl. 46, figs. 13-14
Species code 349

? 1978 *Palaeosaturnalis* cf. *venetus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 39, pl. 6, fig. 3.

Holotype: Specimen 1351 (pl. 46, fig. 14). The holotype comes from locality no. Gc-1027.10, middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *floridus* -a -um, meaning flowering.

Photographed material: 4 specimens.

Description: Test with relatively wide, flat ring, subrectangular in outline. Two pairs of short, sharp tapering spines situated laterally at each side. Equatorial ring strongly constricted antapically, and limited by two peripheral spines widely spaced, rest of ring without spines. Polar spines wide and flattened. Cortical shell spherical. Inner edge of ring slightly marked by a narrow carina.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	100	112	118	94
Diameter of ring and cavity	203	208	214	203
Length of longest spine	40	52	64	38

Remarks: This species probably evolved from *A. impolitus* by acquiring more subrectangular ring, strongly expanded laterally, except on the axis of polar spines, which consequently becomes relatively more constricted than the rest of ring. Concomitantly the peripheral spines disappear.

Comparisons: *A. floridus* differs from all others congeneric by its typical rectangular ring, which is strongly constricted antapically and in having only a pair of auxiliary spines situated at each lateral sides.

Acanthocircus nanus nov. sp.

Pl. 46, figs. 15-16
Species code 354

Holotype: Specimen 5152 (pl. 46, fig. 15). The holotype comes from locality no. Gc-1096.50, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *nanus* -i (n), meaning dwarf; refers to its size.

Photographed material: 2 specimens.

Description: Test small, moderately wide ring, rectangular in outline. Ring without peripheral spines and lacking differentiated carina. Polar spines short, somewhat flat.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of ring and cavity	227	239	252	227

Remarks: *A. nanus* seems to have evolved from *A. impolitus* by absolute loosing of ornamentation on its test.

Comparisons: *A. nanus* is clearly distinguished from *A floridus* by possessing flattened ring without carina and nearly rectangular outline, and by the complete absence of auxiliary spines. It differs from *A. subquadratus* in its bigger size and by having flattened instead of narrow ring of circular cross-section.

Acanthocircus subquadratus (DONOFRIO & MOSTLER, 1978)

Pl. 47, figs. 1-3
Species code 353

1978 *Saturnalis subquadratus* n. sp. DONOFRIO & MOSTLER, p. 40, pl. 6, figs. 9, 12.

Holotype: Specimen figured and described by Donofrio & Mostler (1978) pl. 6, fig. 9. The holotype has been reported from Cenomanian beds (cherty limestones, Scaglia Formation) at Mollaro, Nonstal.

Photographed material: 3 specimens.

Description: Very small saturnalids, with minute ring, nearly square in outline. Ring without peripheral spines and not having carina. Cross-section of equatorial ring circular. Cortical shell relatively large, quite spongy and spherical. Ring cavity occupied almost entirely by cortical shell. Polar spines very short, circular in cross-section.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	48	98	105	95
Max. diameter of ring	96	112	120	105
Min diameter of ring	72	107	115	100

Remarks: *A. subquadratus* apparently branched off from *A. impolitus* and did not leave any know descendants. These forms are extremely rare in the studied material.

Comparisons: This species is distinguished from all other *Acanthocircus* by its small subquadrate ring.

Acanthocircus irregularis SQUINABOL, 1903b

Pl. 46, figs. 17-25
Species code 367

1903b *Acanthocircus irregularis* n. sp. SQUINABOL, p. 125, pl. 9, fig. 6.
1914 *Saturnalis irregularis* SQUIN. - SQUINABOL, p. 295, pl. 23 [4], fig. 1.
1914 *Saturnalis italicus* n. f. SQUINABOL, p. 292, pl. 22 [3], fig. 10; pl. 23 [4], figs. 9, 10.
pars 1978 *Acanthocircus italicus* (SQUINABOL). - DONOFRIO & MOSTLER, p. 29, pl. 4, figs. 1, 3, 5, 6; non pl. 3, fig. 13 (= *A. multidentatus*).
1978 *Acanthocircus* sp. *A*. DONOFRIO & MOSTLER, p. 32, pl. 3, fig. 3.
1978 *Saturnalis simplex* SQUINABOL. - DONOFRIO & MOSTLER, p. 40, pl. 6, figs. 10, 13.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 6 may be considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, central Italy).

Photographed material: 94 specimens.

Description: Test with elliptical ring with or without carina, and with variable number of short tapering peripheral spines. Ring widest transversely and slightly narrowed where it meets the polar spines. The two parts of ring have a slight tendency to be unequal in size and shape. Inner edge of ring may develop a narrow carina. Auxiliary spines on ring rarely equal in number on each half part, however it is common to observe three distinct peripheral spines situated apically. Polar spines are conical, relatively long and narrow.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	-	146	180	75
Inner diameter of ring	500	419	490	360
Length of longest spine	137	50	85	30

Remarks: The type species shows a very wide range of variation throughout its stratigraphic range. Two extreme morphotypes can be distinguished through a continuum of morphologies. A first morphotype includes forms without carina, of circular cross-section, with more irregular outline and generally with a low number of auxiliary spines. The opposite extreme are forms possessing an equatorial ring with inner edge defined by a narrow carina, and with relatively longer, more numerous, peripheral spines. *A. irregularis* appears to have evolved from *A. impolitus*.

Comparisons: Range of variability of *A. irregularis* and *A impolitus* overlap slightly, but the latter is distinguished from the type species in having a dentate ring with a permanently major number of peripheral spines.

GENUS **VITORFUS** PESSAGNO, 1977c

Type species: *Saturnalis brustolensis* SQUINABOL, 1903b, by original designation.

Diagnosis: Saturnalids with elliptical ring and double cortical shell directly attached medially to the ring by two polar spines. Cortical shell latticed with symmetrical polygonal pore frames. Ring with two spines situated apically at either narrow end, which are occasionally accompanied by two or more small lateral spines. Polar spines short, smooth, only distinguished under transmitted light. Equatorial ring slightly bladed.

Remarks: *Vitorfus* seems to have evolved from *Acanthocircus* by progressive reduction of outer ring, which becomes gradually smaller and elliptical. Simultaneously the cortical shell tends to be attached directly to the ring. The cavities may become narrower and smaller disappearing with progression of the phylogeny.

Comparisons: This genus differs from *Acanthocircus* by its more elliptical and constricted ring, by lacking polar spines, and by being directly attached the cortical shell to the ring.

Range: Middle Albian to Maastrichtian.

Vitorfus campbelli PESSAGNO, 1977c

Pl. 47, figs. 16-20
Species code 351

	1977c	*Vitorfus campbelli* n. sp. PESSAGNO, p. 35, pl. 3, figs. 1, 2, 7.
	1977c	*Vitorfus* sp. *B*. PESSAGNO, p. 35, pl. 3, fig. 8.
?	1977c	*Vitorfus* sp. *C*. PESSAGNO, p. 35, pl. 3, fig. 3.
	1978	*Acanthocircus tuberosus* n. sp. DONOFRIO & MOSTLER, p. 31, pl. 3, figs. 2, 8.
	1983	*Acanthocircus brustolensis* ? (SQUINABOL). - ORIGLIA-DEVOS, p. 57, pl. 4, fig. 1.
	1985	*Vitorfus* sp. DUMITRICA, pl. 3, fig. 12.
	1985	*Vitorfus campbelli* PESSAGNO. - LI & WU, pl. 1, fig. 19.
non	1988	*Vitorfus campbelli* PESSAGNO. - THUROW, p. 408, pl. 10, fig. 5.
	1991	*Bitorfus* sp. *B* in PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 4.

Holotype: The specimen is described and figured by Pessagno (1977c) on pl. 3. figs. 1, 2, 7 (fig. 2, lateral view; fig. 7 close view). The holotype has been reported from locality NSF 884 late Albian portion of the Great Valley Sequence, California Coast Ranges.

Photographed material: 15 specimens.

Description: Test as with genus, equatorial ring dentate with numerous spines surrounding the periphery. Ring always possesses a typical pair of auxiliary spines situated antapically at either side of polar rays. A relatively long, robust peripheral spine occurs apically at either distal end.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	100	97	107	87
Inner diameter of ring	231	239	264	207
Length of longest spine	59	55	60	47

Remarks: *V. campbelli* appears to have evolved from *A. impolitus* by notice modification of the general shape of ring, which becomes more elliptical with a markedly reduced equatorial ring. In addition, the cortical shell tends to be attached to the ring. *V. campbelli* gave rise to *V. minimus* by loosing peripheral spines, retaining only three at either distal end.

Comparisons: This species is distinguished from its congeneric by the distinctive pattern of auxiliary spines surrounding the periphery of the ring. Among the species included in this lineage, *V. campbelli* shows close affinities with *S. minimus*, but it differs by possessing a pair of peripheral spines antapically at either sides of polar spines.

Vitorfus minimus (SQUINABOL, 1914)

Pl. 47, figs. 4-7
Species code 338

pars 1914 *Saturnalis minimus* n. f. SQUINABOL, p. 287, pl. 23 [4], figs. 6, 6a; non pl. 22 [3], fig. 1.
1944 *Saturnalis lateralis* n. sp. CAMPBELL & CLARK, p. 6, pl. 1, figs. 7, 10, 11, 13, 15.
non 1974 *Spongosaturnalis* sp. aff. *Saturnalis lateralis* group CAMPBELL and CLARK. - RENZ, p. 797, pl. 2, figs. 1-4; pl. 9, fig. 15.
? 1977 *Vitorfus* sp. *A*. PESSAGNO, p. 35, pl. 3, fig. 4.
1978 *Acanthocircus campbelli* (FOREMAN). - DONOFRIO & MOSTLER, p. 27, pl. 3, figs. 1, 11.
1989 *Spongosaturnalis lateralis* CLARK & CAMPBELL. - IWATA & TAJIKA, pl. 3, fig. 8.

Lectotype: I designate as lectotype the specimen figured by Squinabol (1914), on pl. 23 [3], fig. 6, 6a. The type has been reported from the middle Cretaceous series of Novale, Vicentino (southern Venetian Alps, central. Italy).

Photographed material: 15 specimens.

Description: Test as with genus, possessing an elliptical equatorial ring with moderately wide cavity. Ring strongly bladed, with outer edge defined by carina. Three auxiliary spines occur at either distal end: one centrally situated and two smaller ones occurring laterally. Peripheral spines stout, sharply pointed, with circular cross-section. Cortical shell spherical with coarse meshwork of hexagonal pore frames of uniform size.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	110	105	114	100
Max. diameter of ring	330	242	250	237
Min. diameter of ring	130	88	94	77
Length of longest spine	55	63	74	53

Remarks: It seems probable that *V. minimus* or a descendant gave rise to the first representatives of *Spongosaturninus* CAMPBELL & CLARK, 1944, in late Cretaceous (Campanian ?) times. *V. minimus* undoubtedly gave rise to *V. brustolensis* by gradual reduction of equatorial ring, consequently the cavity becomes narrower. Through its stratigraphic range *V. minimus* shows a weak tendency to decrease length of smaller spines.

Comparisons: *V. minimus* is distinguished from the type species by possessing a wider cavity and by having three well-differentiated peripheral spines apically. It differs from *V. campbelli* by not having a pair of peripheral spines situated antapically at either side of polar spines.

Vitorfus brustolensis (SQUINABOL, 1903b)

Pl. 47, figs. 8-11
Species code 379

1903b *Saturnalis Brustolensis* n. sp. SQUINABOL, p. 112, pl. 10, fig. 4.
1914 *Saturnalis ellipticus* var. *minor* mihi. SQUINABOL, p. 298.
1978 *Acanthocircus brustolensis* (SQUINABOL). - DONOFRIO & MOSTLER, p. 27, pl. 6, fig. 14.
? 1982 *Spongosaturninus ellipticus* CAMPBELL et CLARK. - OKAMURA *et al.*, p. 100, pl. 15, fig. 11.
pars 1982 *Vitorfus* spp. TAKETANI, p. 47, pl. 1, figs. 7a-b; non fig. 6 (= *V. morini*).
non 1983 *Acanthocircus brustolensis* ? (SQUINABOL). - ORIGLIA-DEVOS, p. 57, pl. 4, fig. 1 (= *V. campbelli*).
1985 *Vitorfus brustolensis* (SQUINABOL). - DUMITRICA, pl. 2, fig. 3; pl. 3, figs. 1, 2, 9, 10.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 10, fig. 4 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 7 specimens.

Description: Test as with genus, similar in sculpture to *V. minimus*, although having smaller and more contracted cavity. A very long, massive taper peripheral spine is located axially at each distal end. Also two minute auxiliary spines occur laterally at each side of median spine, on either distal end. Cortical shell spherical with coarse meshwork, comprised of hexagonal pore frames of regular size.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	85	102	107	94
Inner diameter of ring	185	204	228	180
Length of longest spine	62	84	94	70

Remarks: *V. brustolensis* undoubtedly evolved from *A. minimus* by progressive reduction of ring and gave rise to a small form without ring cavity: *V. morini.*

Comparisons: This species differs from its closely allied *V. morini* in constantly possessing, even if poorly developed, two lateral auxiliary spines on either apical end and a large, well defined cavity.

Vitorfus morini EMPSON-MORIN, 1981

Pl. 47, figs. 12-15
Species code 337

	1981	*Vitorfus morini* n. sp. EMPSON-MORIN, p. 261, pl. 4, figs. 7a-8d.
pars	1982	*Vitorfus* spp. TAKETANI, p. 47, pl. 1, fig. 6; non figs. 7a-b (= *V. brustolensis*).
	1985	*Vitorfus morini* EMPSON-MORIN. - DUMITRICA, pl. 1, figs. 7, 9; pl. 3, fig. 4.
	1994	*Viturfos* sp. WAKITA & BAMBANG, fig. 7.18.

Holotype: The specimen illustrated and described by Empson-Morin (1981) on pl. 4, figs. 8a-d. The holotype has been reported from the late Campanian at DSDP Leg 32, Site 313 (Mid-Pacific Mountains).

Photographed material: 7 specimens.

Description: Test as with genus, of relatively small size and very narrow lenticular ring. Equatorial ring fused distally terminating at either apical end into very elongate, strongly bladed spines. Ring with very small cavity. Peripheral spines of about equal length of cortical shell. Cortical shell, spherical with meshwork, comprised of small hexagonal pore frames irregularly disposed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	86	106	114	102
Length of test plus spine	109	84	106	67

Remarks: *V. morini* appears to be an off-shoot from the lineage connecting *V. minimus* and *V. brustolensis*. The most noticeable change observed is the strong reduction of ring cavity, which tends to disappear as population get younger populations. Late Cretaceous representatives are characterized by having only a spherical cortical shell and two strongly bladed spines, lacking completely the ring cavity.

Comparisons: *V. morini* embodies a combination of characteristics making a clear specific distinction among the members of this lineage possible.

FAMILY **QUINQUECAPSULARIIDAE** DUMITRICA, 1994

Type genus: *Quinquecapsularia* PESSAGNO, 1971b.

Globular spumellarians with concentrically multiple shells. Test having as initial skeleton a polyhedral structure composed of bars from which radiate primary radial beams connecting medullary with cortical shell. Test armed with variable number of spines radiating symmetrically upon medullary shell. These spines are the prolongation of primary radial beams. This family includes the following Cretaceous genera: *Quinquecapsularia* PESSAGNO, 1971b, *Falsocromyodrymus* nov. gen. and *Protoxiphotractus* PESSAGNO, 1973.

GENUS **QUINQUECAPSULARIA** PESSAGNO, 1971b

Type species: *Quinquecapsularia spinosa* PESSAGNO, 1971b, by original designation. This species is here considered as synonym of *Hexastylus ombonii* SQUINABOL, 1903b.

Diagnosis: Globular spumellarians with initial skeleton formed by a system of bars forming a pentagonal prism. From the corners of this polyhedral structure variable number of primary rays radiated. There are usually nine to ten, which connect one or more levels. This system of arches repeat more or less, at a larger scale, the initial pentagonal prism. Test usually has three concentric latticed layers. Spines generally strongly bladed and represent the prolongation of internal rays.

Remarks: The representatives of this genus are poorly known and they have been sparsely illustrated. According to Dumitrica (1994), the structure of the microsphere and the arches pattern are close related to some Triassic-Jurassic forms characterized by possessing a cubic microsphere.

Range: Latest Barremian ? to Turonian as far as know.

Quinquecapsularia ombonii (SQUINABOL, 1903b)

Pl. 47, figs. 21-24
Species code 86

?	1890	*Heliodiscus* (?) f. ind. PARONA, p. 155, pl. 2, fig. 8.
	1903b	*Hexastylus Ombonii* n. sp. SQUINABOL, p. 113, pl. 8, fig. 10.
	1904	*Acrosphaera mirabilis* n. sp. SQUINABOL, p. 187, pl. 2, fig. 5.
	1971b	*Quinquecapsularia spinosa* n. sp. PESSAGNO, p. 364, pl. 1, figs. 1-9.
	1976	*Quinquecapsularia spinosa* PESSAGNO. - PESSAGNO, p. 44, pl. 1, figs. 10-11(= holotype refigured), 12 (= specimen illustrated in Pessagno, 1971b, pl. 1, fig . 3)
	1977c	*Quinquecapsularia spinosa* PESSAGNO. - PESSAGNO, p. 36, pl. 4, figs. 7, 12 (= holotype refigured), 8 (= specimen illustrated in Pessagno, 1971b, pl. 1, fig . 3)

1988 *Hexatylurus magnificus* (SQUINABOL). - THUROW, p. 401, pl. 9, fig. 16.
? 1992 *Praeconocaryomma* (?) sp. *A*. BAUMGARTNER, p. 324, pl. 10, figs. 2-8.

Holotype: Specified type. The holotype is the specimen illustrated by Squinabol (1903b) on pl. 8, fig. 10. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 34 specimens.

Description: Test as with genus, possessing a subspherical cortical shell with broad, irregularly sized hexagonal and subcircular pore frames. Test with variable number of visible primary spines, usually nine to ten. Spines of relatively small size, but strongly bladed. Cortical shell with three smaller pores occurring between two adjacent blades at base of each spine. Meshwork composed of pore frames usually with sharply pointed nodes at pore vertices.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	174	168	174	160
Length of longest spine	33	56	64	47

Remarks: *Q. ombonii* seems to represent an important stock from which have arisen numerous quinquecapsularids during Mid-Cretaceous times (fig. 28). Ranges of variation of *Q. ombonii* and *Q. panacea* are slightly superposed, but the latter species distinctly includes forms with longer primary spines and permanently possessing nine primary spines.

Comparisons: This species is close related to *Q. parvipora*, with which it co-occurs. Nevertheless, it differs by possessing shorter primary spines and smaller pore frames and by lacking secondary spines.

Quinquecapsularia parvipora (SQUINABOL, 1903b)

Pl. 47, figs. 25-28
Species code 377

1903b *Acanthosphaera parvipora* n. sp. SQUINABOL, p. 115, pl. 8, fig. 5.
? 1983 *Hexastylus microporus* SQUINABOL, p. 55, pl. 3, fig. 14.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 5 may be considered the holotype. This specimen has been reported from an uncertain locality (Teòlo or Brustolo) in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 28 specimens.

Description: Test as with genus having a subspherical cortical shell. Pore frames of meshwork generally small, but variable in size, usually hidden by strongly developed secondary spines. Meshwork of irregular polygonal pore frames having short massive spines (secondary spines) at vertices of pore junctions. Primary spines moderately long, strongly three-bladed; usually nine to ten spines symmetrically disposed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	170	176	200	155
Length of longest spine	150	169	230	125

Remarks: *Q. parvipora* seem to have evolved from *Q. ombonii*, by development of spines at vertices of pore junctions and by strongly increasing the length of primary spines.

Comparisons: This species is distinguished from *Q. grandiloqua* by having well developed secondary spines and by possessing less robust primary spines.

Quinquecapsularia grandiloqua nov. sp.

Pl. 48, figs. 1-5
Species code 96

pars ? 1975 *Spumellaria* gen. et spp. indet. DUMITRICA, text-fig. 2. 41; non text-fig. 2. 40.

Holotype: Specimen 5831 (pl. 48, fig. 1). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *grandiloquus* -a -um, meaning boastful.

Photographed material: 18 specimens.

Description: Test as with genus possessing cortical shell of relatively small size. Primary spines strongly bladed, moderately massive, of uniform width, and slightly rounded at tips. Spines composed longitudinally of alternating ridges and grooves, ridges very thick and rounded, groves very narrow and moderately deep. Meshwork of small polygonal pore frames, irregular in size and shape. Some specimens with spines only slightly twisted.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	90	86	90	80
Length of longest spine	95	93	115	85

Remarks: *Q. grandiloqua* shows a slight range of variation principally in length and width of primary spines. This species apparently evolved from *Q. ombonii,* although the range of variability may overlap the spectrum of variation of *Q. panacea* in early Turonian populations.

Comparisons: This species differs from *Q. panacea* by always having a smaller cortical shell with a meshwork of smaller and less regular pore frames. Furthermore, it possesses thicker threebladed spines.

Quinquecapsularia panacea nov. sp.

Pl. 48, figs. 6-10
Species code 375

pars 1976 *Actinomma* (?) *douglasi* n. sp. PESSAGNO, p. 43, pl. 12, fig. 8, non figs. 6-7.
1991 *Hexapyramis* (?)*pantanellii* SQUINABOL. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 6.
? 1992 *Hexapyramis* (?) sp. MARCUCCI & GARDIN, text-fig. 3. h.

Holotype: Specimen 6288 (pl. 48, fig. 9). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *panacea* -ae (f), meaning legendary plant cure-all.

Photographed material: 15 specimens.

Description: Test as with genus possessing subspherical cortical shell. Meshwork composed of large, hexagonal and subcircular pore frames. The cortical shell usually possesses nine long tapered primary spines, slightly longer than the diameter of the cortical shell. Spines longitudinally composed of alternating ridges and grooves of about equal width. Ridges wide and rounded, grooves narrow and deep proximally, becoming shallow and wide at tips. Cortical shell with three small subcircular pores occurring between two adjacent blades at base of each spine. Meshwork composed of hexagonal pore frames bearing sharply pointed nodes at pore vertices.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	132	133	140	130
Length of longest spine	120	103	120	87

Remarks: *Q. panacea* apparently evolved from *Q. ombonii* by strongly increasing the size of the primary spines which attain an approximately equal or slightly longer length than the diameter of the cortical shell. It differs by possessing longer spines and by having more regular pore frames.

GENUS **FALSOCROMYODRYMUS** NOV. GEN.

Derivatio nominis: Generic name compound for *falso* (Spanish), meaning false and *Cromyodrymus*, because of the morphological resemblance with recent forms of *Cromyodrymus* HAECKEL, 1881. Masculine gender.

Type species: *Cromyodrymus mirabilis* SQUINABOL, 1903b.

Diagnosis: Test as with family. Globular form with relatively strong spines, which are taper in sharp robust tips. Latticed cortical shell, spherical to cubic, with meshwork composed of large polygonal pore frames, occasionally somewhat spongy. Eight to twelve spines radiating symmetrically upon the cortical surface. These spines are massive, relatively long, sharply pointed, and strongly three-bladed. As a common characteristic each spine develop near the tip three fluke-like extensions, which branch out from each bladed edge. Size, shape, and position of fluke-like extension vary from one species to another. Spines continuous, with massive radial beams connecting cortical shell to first medullary shell.

Remarks: The gross resemblance on sculpture with some species of *Quinquecapsularia* probably has phylogenetic significance. Some rare intermediate forms between *Q. ombonii-Q. parvipora* and *F. mirabilis* have been recognized.

Throughout the Mid-Cretaceous this group shows a marked tendency to a decreasing the number of spines. This phenomena may be related to the modification of the internal structure. In this manner the cortical shell changes from pentahedral to cubic. These modification become important at the Cenomanian-Turonian boundary, with the occurrence of the first representatives of *Protoxiphotractus*, in which the number of spines is reduced and the structure of cortical shell simplified.

Comparisons: *Falsocromyodrymus* is distinguished from *Quinquecapsularia* by its blade-like spines, which taper distally and by three fluke-like extensions that branch out from each bladed edge.

Range: Middle Albian to Turonian as far as know.

Falsocromyodrymus mirabilis (SQUINABOL, 1903b)

Pl. 48, figs. 11-15
Species code 226

	1903b	*Cromyodrymus mirabilis* n. sp. SQUINABOL, p. 116, pl. 10, fig. 15.
non	1982	*Cromyodrymus mirabilis* SQUINABOL. TAKETANI, p. 47, pl. 1, fig. 1.
?	1985	*Actinomma* (?) *hexocontum* sp. nov. LI & WU, p. 73, pl. 1, fig. 11.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 15 may be considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 12 specimens.

Description: Test as with genus, subspherical cortical shell, with variable number of thick primary spines, having fluke-like expansions. Meshwork of cortical shell composed of small polygonal pore frames, bearing short tiny spines at pore vertices. Cortical shell densely porate, having pore frames of variable size and shape, showing very irregular arrangement. Primary spines expand at tips, with broad fluke-like extensions. Spines are composed of three wide and shallow grooves, displaying moderate dextral torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	135	236	300	210
Length of longest spine	59	172	200	160

Remarks: The most conspicuous change is in the number of primary spines, which tends to increase gradually through time. Additional modification is expressed in the unstable geometry of cortical shell. *F. mirabilis* seems to have given rise to the lineage *F. cardulus-F. noxiosus*, characterized by a progressive reduction in the general size of the test and the geometric simplification of primary spines and meshwork.

Comparisons: *F. mirabilis* is distinguished from *F. noxiosus* in that it always has a major number of primary spines, and a more spherical test.

Falsocromyodrymus ? fragosus nov. sp.

Pl. 48, figs. 16-19
Species code 303

Holotype: Specimen 2197 (pl. 48, fig. 16). The holotype comes from locality no. Gc-1035.10, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *fragosus*, -a -um, meaning rough.

Photographed material: 19 specimens.

Description: Test with large subspherical to nearly cubic cortical shell. Test with spines projecting from each corner. Meshwork of cortical shell very irregular, composed of small pore frames, with sharp bars and tiny spines at pore vertices. Primary spines strongly bladed, relatively long, with well-developed fluke-like extensions toward middle-distal part. Spines longitudinally composed of relatively wide grooves; three broad pores occur at base of each spine between two adjacent blades. Specimens with more tetragonal cortical shells usually present sharp edges.

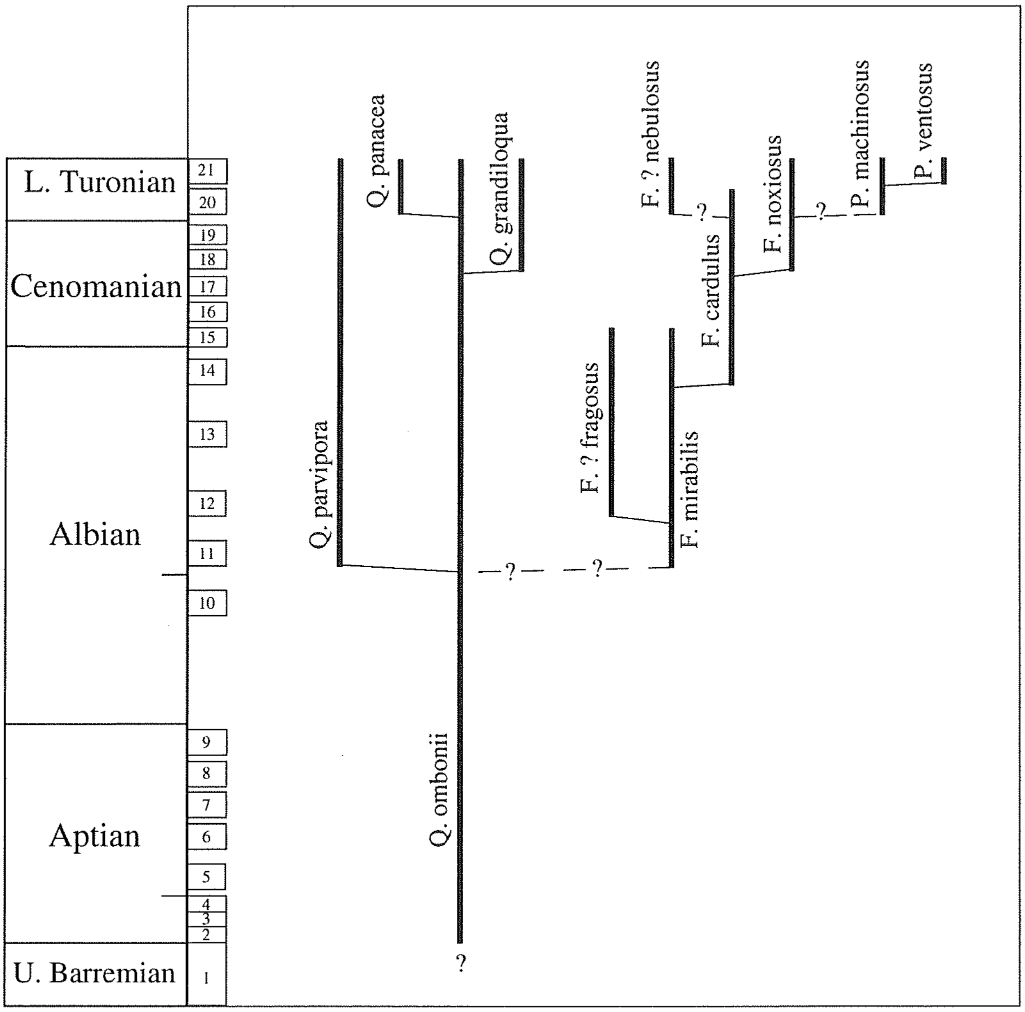

Fig. 28.- Stratigraphic range and possible phyletic relationships of the species of *Quinquecapsularia*, *Falsocromyodrymus* and *Protoxiphotractus*.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	200	174	200	134
Length of longest spine	258	221	258	188

Remarks: *F ?fragosus* might have arisen from *F. mirabilis*. Generic assignment queried because this form is characterized by a marked tetragonal symmetry, and its test always possesses eight primary spines.

Comparisons: *F. ?fragosus* differs from all other species herein included in Quinquecapsulariidae, by possessing a nearly cubic cortical shell with eight prominent primary spines at corners. In addition, primary spines are strongly bladed and possess fluke-like extensions towards the tips.

Falsocromyodrymus cardulus nov. sp.

Pl. 49, figs. 1-8
Species code 380

Holotype: Specimen 7302 (pl. 49, fig. 5). The holotype comes from locality no. Gb-108.60, middle-late Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: *Cardulus* diminutive of Latin noun *carduus* -i (m), meaning thistle.

Photographed material: 24 specimens.

Description: Forms of relatively small size, having subspherical cortical shell usually with eight primary spines, although the number may vary between eight to ten, but rarely more. Cortical shell composed of small polygonal pore frames, which show irregular to moderate arrangement. Pore frames have small sharply pointed nodes at vertices. Spines are usually smaller than diameter of cortical shell. Primary spines taper distally in three noticeable fluke-like expansion, strongly developed laterally. Spines regular in width, composed longitudinally of three broad grooves and three sharp ridges. Ridges and grooves straight, lacking torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	150	162	180	150
Length of longest spine	110	111	150	100

Remarks: This species undoubtedly evolved from *F. mirabilis* by , and seems to give rise to *F. noxiosus*.

Comparisons: *F. cardulus* is distinguished from all other congeneric by its smallest cortical shell and shortest primary spines, which develop prominent fluke-like expansions at distal ends.

Falsocromyodrymus noxiosus nov. sp.

Pl. 49, figs. 9-12
Species code 352

Holotype: Specimen 6078 (pl. 49, fig. 11). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *noxiosus* -a -um, meaning harmful.

Photographed material: 6 specimens.

Description: Cortical shell subspherical to moderately bipyramidal, with a variable number of primary spines; usually six to eight strongly bladed spines, which are tapered in large blunt vertices. Spines relatively short, with moderate to poorly developed fluke-like expansions at ray tips, which tend to disappear as populations get younger. Spines longitudinally composed of alternating ridges and grooves; ridges massive, grooves wide and somewhat deep. Some spines show slight torsion distally. Cortical shell composed of hexagonal pore frames in regular arrangement. Pore frames show faint nodes at pore vertices.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	99	106	125	85
Length of longest spine	90	64	90	75

Remarks: Range of variability of *F. noxiosus* and *Protoxiphotractus machinosus* partially overlaps. However the former species includes robust forms with more massive primary spines bearing fluke-like extensions at distal ends and less regularly arranged pore frames. *F. noxiosus* seems to have evolved from *F. cardulus*, through a reduction in the number of primary spines and by tending to have a more bipyramidal cortical shell. Additional modification is shown by the meshwork, which becomes more regularly arranged with larger pore frames. Some forms intermediate between the two have been observed.

Comparisons: *F. noxiosus* develops a more irregular cortical shell than *P. machinosus,* and is generally more stoutly ornamented.

Falsocromyodrymus ? nebulosus nov. sp.

Pl. 48, figs. 20-23
Species code 287

Holotype: Specimen 6857 (pl. 48, fig. 20). The holotype comes from locality no. Asv-5-43, early Turonian, (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *nebulosus* -a -um, meaning cloudy.

Photographed material: 6 specimens.

Description: Test as with genus showing externally a tetragonal, nearly cubic symmetry. Cortical shell quite small, subspherical to spherical with somewhat spongy meshwork of minute pore frames. Cortical shell possesses a complex system of rings; six elliptical rings on each side, connected by polar spines. These rings originate as prolongations of fluke-like extensions. A cube-like tridimensional structure results, with arched edges attached to the cortical shell by primary spines radiating from the corners. Ring and polar spines are three-bladed, and are composed longitudinally of alternating ridges and grooves, but only slightly marked.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	115	108	119	102

Remarks: It is suspected that *F. ? nebulosus* may have evolved from a small *Falsocromyodrymus*, like *F. cardulus,* which develops relatively long fluke-like extension at ray tips. Unfortunately, due to the scarcity of the available material intermediate forms have not been recognized. The complex system of ring probably originates in the progressive growth of any of the initial three fluke-like extensions at the ray tips. From each primary spine an extension grows following the edge until it reaches the mirror extension of the primary spines situated at the adjacent corners. The result is a conspicuous system of rings crowning each side of the cortical shell which are attached and originate from primary spines.

Comparisons: This species differs from all other Cretaceous Spumellariina in having a small spherical shell with tetragonal or nearly cubic symmetry and a distinctive system of rings.

GENUS **PROTOXIPHOTRACTUS** PESSAGNO, 1973

Type species: *Protoxiphotractus perplexus* PESSAGNO, 1973, by original designation.

Diagnosis: Test as with family. Cortical shell ellipsoidal to spherical with two to six spines. Cortical shell with coarse meshwork, comprised of large hexagonal pore frames. Spines are usually quite robust and strongly bladed, although, as the populations get younger the cross-sections gradually change to become circular or elliptical. Medullary shell ellipsoidal to spherical, connected to medullary shell by robust primary rays in continuity with spines. Central initial skeleton connected to medullary shell by an indeterminate number of delicate radial bars.

Remarks: This genus appears to be an heterochronous homoemorphous of early Cretaceous pantanellids. This hypothesis is supported because the representatives of the genus *Pantanellium* became extinct in late Aptian times. Otherwise the lattermost Cenomanian *Protoxiphotractus* shows a clear phylogenetic relationship with representatives of *Falsocromyodrymus,* from which it seems to have evolved.

Comparisons: *Protoxiphotractus* is identical externally in shape to *Pantanellium*, but it differs in always having a smaller cortical size.

Range: Turonian to Campanian.

Protoxiphotractus machinosus nov. sp.

Pl. 49, figs. 13-16
Species code 374

pars 1976 *Cromyomma* (?) *nodosa* n. sp. PESSAGNO, p. 44, pl. 13, fig. 1; pl. 12, figs. 13-16; non fig. 12.

Holotype: Specimen 6550 (pl. 49, fig. 13). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *machinosus* -a -um, meaning ingenuously constructed.

Photographed material: 7 specimens.

Description: Forms generally of relatively small size. Test as with genus, cortical shell nearly spherical with large, uniformly sized hexagonal pore frames. Cortical shell bearing slightly raised small nodes at pores vertices. Test armed with four or six moderately long primary spines. Two primary spines occur at either polar end and two or four spines are disposed equatorially at right angles. Primary spine three-bladed, tapers in blunt vertices; three broad pores occur at base of each spine, which are located at groove between two adjacent blades. Cross-sections of spines tend to be circular distally in specimens with only four spines. In addition, these forms possess shorter and more acute spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	120	97	120	88
Length of longest spine	70	46	70	26

Remarks: It seems that *P. machinosus* evolved from *F noxiosus* by acquiring less robust and shorter primary spines, furthermore the arrangement of the spines is more regular. Additional differences are shown by the cortical shell which becomes more spherical, and has fewer less numerous but larger, pore frames. Nevertheless, the style of the spines, and the strong resemblance in shape lead us to regard this species as a probable derivative of *Falsocromyodrymus*.

Comparisons: *P. machinosus* is distinguished from its closely allied *P. ventosus* by having less tapering spines and by possessing primary spines disposed equatorially.

Protoxiphotractus ventosus nov. sp.

Pl. 49, figs. 17-20
Species code 336

pars ? 1982 *Lithatractus pusillus* (CAMPBELL and CLARK).- TAKETANI, p. 48, pl. 1, figs. 8a-b; non pl. 9, figs. 5, 6.
1994 *Pantanellium* sp. WAKITA & BAMBANG, fig. 7.19.

Holotype: Specimen 5880 (pl. 49, fig. 18). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *ventosus* -a -um, meaning windy.

Photographed material: 15 specimens.

Description: Test as with genus with spherical to subspherical cortical shell. Forms of relatively small size. Cortical shell with coarse meshwork comprised of relatively large hexagonal pore frames, bearing small nodes at pore vertices. Test armed with two primary spines longitudinally aligned at either polar end; three relatively large pores occur at base of each spine. Primary spines vary from equal to unequal in length; spines are three-bladed and sharply pointed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	76	77	86	72
Length of longest spine	56	68	94	44

Remarks: This species seems to have rapidly evolved from *P. machinosus* by loosing equatorial primary spines, which leaves only two primary spines situated at polar ends. Otherwise, these changes seem not to have the basic configuration of cortical shell.

Comparisons: *P. ventosus* is distinguished from *P. machinosus* by having a cortical shell with two rather than four or six spines aligned at right angles. It differs also from the type species by having a spherical instead of a nearly cylindrical cortical shell.

SUPERFAMILY **ACTINOMMACEAE** HAECKEL, 1862

Solitary spumellarians with variable number of cortical shells, spherical to ellipsoidal, without internal spicule. Medullary shell, if existent, with or without radial beams. Cortical shell with or without spines. This polyphyletic superfamily ranges through at least the Mesozoic and Cenozoic and includes a great number of genera and species.

FAMILY **PANTANELLIIDAE** PESSAGNO, 1977c

Type genus: *Pantanellium* PESSAGNO, 1977b.

Spumellarians with ellipsoidal, subspherical, or pyramidal test with two to six stout primary spines oriented along one to three axes. Test with two concentric shells. Medullary shell spherical and delicate. Cortical shell robust, variable in shape, spherical, ellipsoidal to pyramidal, with coarse meshwork comprised of polygonal pore frames. Cortical shell connected to medullary shell by means of primary and secondary radial beams. Two or more primary radial beams extending outside into primary spines of variable size and shape.

GENUS **PANTANELLIUM** PESSAGNO, 1977b

Synonym: ? *Sphaerostylus* HAECKEL, 1881 (nomen dubium), *Cecrops* PESSAGNO, 1977c.

Type species: *Pantanellium riedeli* PESSAGNO, 1977b, by original designation. This species is regarded herein as posterior synonym of *Stylosphaera lanceola* PARONA, 1890.

Diagnosis: Test as with family with two concentric shells and two, four or six strongly bladed spines. Medullary shell usually delicate and spherical. Cortical shell spherical, ellipsoidal, or pyramidal, with coarse meshwork comprised of very large hexagonal pore frames, which frequently display a symmetrical arrangement. Cortical shell connected to medullary shell by primary radial beams and secondary radial beams. Primary radial beams extend into spines. Spines blade-like aligned along one, two, or three axes at right angles to each other.

Remarks: Classically two Cretaceous genera (*Cecrops* and *Pantanellium*) were differentiated, following a classification based on the number of primary spines. In this report the number of spines is regarded as classificatory criterion at specific instead of generic level.

Comparisons: *Pantanellium* is distinguished from *Dicroa* by possessing larger, hexagonal pore frames. However the cortical shell presents lower number of pores.

Range: Late Triassic to base of late Aptian.

Pantanellium lanceola (PARONA, 1890)

Pl. 49, figs. 21-24
Species code 326

? 1885 *Stylosphaera resistens* m. RÜST, p. 291, pl. 28 [3], fig. 15.
1890 *Stylosphaera lanceola* n. f. PARONA, p. 150, pl. 1, fig. 19.
? 1890 *Stylosphaera* f. indt. PARONA, pl. 1, fig. 18.
1900 *Stylatractus ovatus* sp. nov. HINDE, p. 19, pl. 4, figs. 29, 31-33, 36.
? 1900 *Stylatractus Paronæ* sp. nov. HINDE, p. 18, pl. 4, fig. 34.
? 1900 *Stylatractus tener* sp. nov. HINDE, p. 18, pl. 4, fig. 35.
1900 *Xiphostylus Felsinae* n. sp. NEVIANI, p. 649, pl. 9, fig. 7.
1900 *Xiphosphaera Manzonii* PANT. - NEVIANI, p. 648, pl. 9, fig. 5.
1927 *Stylosphaera Squinaboli* nov. spec. TAN, p. 35, pl. 6, figs. 9a-d.
1973b *Sphaerostylus lanceola* group. (PARONA). - FOREMAN, p. 258, pl. 1, figs. 7-11.
1973 *Stylatractus ovatus* HINDE. - MOORE, p. 823, pl. 2, fig. 1.
1973 *Protoxiphotractus* (?) *fischeri* n. sp. PESSAGNO, p. 81, pl. 9, fig. 1.

1974 *Sphaerostylus lanceola* (PARONA). - RENZ, p. 795, pl. 2, figs. 13-14 ?, 15, 16 ?; pl. 9, fig. 19.
non 1974 Form ancestral to *Sphaerostylus lanceola* PARONA. - RIEDEL & SANFILIPPO, pl. 12, fig. 1.
1974 *Sphaerostylus lanceola* PARONA. - RIEDEL & SANFILIPPO, p. 780, pl. 1, figs. 1-3.
1975 *Sphaerostylus lanceola* group (PARONA). - FOREMAN, p. 609, pl. 2E, figs. 3-6.
pars 1977 *Sphaerostylus lanceola* (PARONA). - MUZAVOR, p. 50, pl. 1, fig. 6; non fig. 7.
1977b *Pantanellium fischeri* PESSAGNO. - PESSAGNO, p. 78, pl. 6, figs. 3-4.
1977b *Pantanellium riedeli* n. sp. PESSAGNO, p. 78, pl. 6, figs. 5-10.
1977c *Pantanellium corriganesis* n. sp. PESSAGNO, p. 33, pl. 3, figs. 5, 6.
1977c *Pantanellium riedeli* n. sp. PESSAGNO, p. 33, pl. 3, fig. 12.
non 1978b Ancestral *Sphaerostylus lanceola* (PARONA). - FOREMAN, p. 743, pl. 1, fig. 11.
1978b *Sphaerostylus lanceola* group (PARONA). - FOREMAN, p. 743, pl. 1, fig. 10.
pars 1979 *Sphaerostylus lanceola* (PARONA). - NAKASEKO *et al.*, p. 23, pl. 2, figs. 1, 2; pl. 3, fig. 10; pl. 1, fig. 1; non fig. 2.
1980 *Pantanellium corriganensis* PESSAGNO. - OKAMURA, pl. 20, figs. 1, 7.
? 1980 *Pantanellium fischeri* (PESSAGNO). - OKAMURA, pl. 19, figs. 1, 6.
1981 *Pantanellium* gr. *lanceola* (PARONA). - DE WEVER (in DE WEVER & THIEBAULT), p. 589, pl. 2, fig. 9.
1981 *Pantanellium squinaboli* (TAN SIN HOK). - NAKASEKO & NISHIMURA, p. 156, pl. 1, figs. 1, 10 (= specimens of Nakaseko *et al.*, 1979, pl. 2, figs. 1, 2).
1981 *Sphaerostylus lanceola* group (PARONA). - SCHAAF, p. 438, pl. 7, fig. 6; pl. 16, figs. 5a-b.
1982 *Sphaerostylus lanceola* (PARONA). - OKAMURA & UTO, pl. 4, figs. 9, 10; pl. 7, fig. 15; pl. 8, figs. 2a-b.
1982 *Pantanellium riedeli* PESSAGNO. - WU & LI, p. 66, pl. 1, fig. 7.
1983 *Pantanellium corriganensis* PESSAGNO. - ORIGLIA-DEVOS, p. 49, pl. 3, figs. 5-7.
non 1983 *Pantanellium lanceola* "forme ancestrale" (PARONA). - ORIGLIA-DEVOS, p. 50, pl. 3, fig. 8.
pars 1983 *Pantanellium lanceola* gr. (PARONA). - ORIGLIA-DEVOS, p. 51, pl. 3, fig. 10; non fig. 9 (= *D. rara* ?).
1983 *Pantanellium* sp. 1. ORIGLIA-DEVOS, p. 52, pl. 3, fig. 11.
1984 *Pantanellium lanceola* (PARONA). - SCHAAF, p. 114-115, text-figs. H (= holotype refigured), 1 (= specimen of Schaaf, 1981, pl. 7, fig. 6), 2-3, 4a-b (= specimens of Schaaf, 1981, pl. 16, figs. 5b-a), 5a-b; p. 152-153, text-figs. 13, 14 (cum syn.).
1984 *Sphaerostylus lanceola* (PARONA). - YAO, pl. 4, fig. 19.
1985 *Sphaerostylus lanceola* SANFILIPPO & RIEDEL, p. 588, text-figs. 4. 4a-b, 4c (= specimen of Pessagno, 1977b, pl. 6, fig. 4); 4d, 4e (= specimen of Okamura & Uto, 1982, pl. 4, fig. 10) (cum syn.).
1986 *Sphaerostylus lanceola* (PARONA). - AITA & OKADA, p. 120, pl. 1, figs. 2, 3.
1986 *Pantanellium* cf. *riedeli* PESSAGNO. - LI, pl. 2, fig. 22.
1986 *Sphaerostylus lanceola* group. (PARONA). - OKAMURA & MATSUGI, pl. 4, figs. 3-5, 7.
1988 *Pantanellium lanceola* (PARONA). - THUROW, p. 403, pl. 9, fig. 14.
1988 *Pantanellium squinaboli* VISHNEVSKAYA, pl. 5, fig. 7.
1988 *Sphaerostulus lanceola* VISHNEVSKAYA, pl. 6, figs. 2, 3.
1989 *Sphaerostylus lanceola* (PARONA). - IWATA & TAJIKA, pl. 4, fig. 7.
1989 *Sphaerostylus lanceola* (PARONA). - KATO & IWATA, pl. 1, fig. 10.
1989 *Sphaerostylus lanceola* (PARONA). - TUMANDA, p. 35, pl. 1, fig. 1.
1990 *Sphaerostylus lanceola* (PARONA). - O'DOGHERTY & MARTINEZ-GALLEGO, pl. 1, fig. 4.
1991 *Pantanellium lanceola* (PARONA). - AGUADO *et al.*, text-fig. 7. 9.
1992 *Pantanellium squinaboli cantuchapai* PESSAGNO and MACLEOD. - BAUMGARTNER, p. 322, pl. 8, fig. 1.
1992 *Pantanellium squinaboli squinaboli* (TAN SIN HOK). - BAUMGARTNER, p. 322, pl. 8, figs. 2, 3.
1992 *Pantanellium lanceola* (PARONA). - OZVOLDOVA & PETERCAKOVA, pl. 1, figs. 7, 12.
1992 *Pantanellium corriganensis* PESSAGNO. - STEIGER, p. 26, pl. 1, figs. 5, 6.
1992 *Pantanellium globulosum* n. sp. STEIGER, p. 26, pl. 1, figs. 7, 8.
1992 *Pantanellium lanceola* (PARONA). - STEIGER, p. 25, pl. 1, figs. 1, 2.
1992 *Pantanellium nodaculeatum* n. sp. STEIGER, p. 25, pl. 1, figs. 3, 4.
1992 *Pantanellium lanceola* (PARONA). - TAKETANI & KANIE, text-figs. 3. 6-7.
1993 *Pantanellium lanceola* (PARONA). - AGUADO *et al.*, pl. 3, fig. 2.
1993 *Pantanellium lanceola* (PARONA). - VISHNEVSKAYA, pl. 8, fig. 3.
1993 *Pantanellium squinaboli* TAN SIN HOK. - VISHNEVSKAYA, pl. 3, fig. 4.
1994 *Pantanellium squinaboli* ((TAN). - JUD, p. 90, pl. 15, figs. 10-12

Holotype: The specimen figured by Parona (1890, pl. 1, fig. 19) may be regarded the holotype. The exact provenance of this specimen is not known. Only an undetermined Neocomian age may be presumed. The holotype seems to be reported from the Maiolica Formation at the Monte Sangiano, near the locality of Cittiglio, Province of Varese (southern Alps, N Italy).

Photographed material: 12 specimens.

Description: Test as with genus, with elliptical to subspherical cortical shell and two primary spines aligned longitudinally. Meshwork comprised of very large hexagonal and pentagonal pore frame having developed nodes at vertices. Bars of pore frames relatively thick. Primary spines are strongly bladed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	85	85	95	80
Length of longest spine	85	116	130	100

Remarks: *P. lanceola* shows a wide range of variability throughout its stratigraphic range. Variation among members of this group is commonly expressed by variation in overall size, density of pores on surface of cortical shell, and length of primary spines. *P. lanceola* is the only species of *Pantanellium* found in the Aptian and represents the terminal species of this genus.

Comparisons: *P. lanceola* is distinguished from *D. rara* by having fewer but larger polygonal pore frames with raised nodes at pore frame vertices. It differs from *P. ventosus* in having a cortical shell with less numerous pore frames, and bigger nodes with more relief. In addition *P. ventosus* generally possesses shorter primary rays.

GENUS **DICROA** FOREMAN, 1975

Type species: *Dicroa periosa* FOREMAN, 1975, by original designation.

Diagnosis: Test as with family. Slender ellipsoidal cortical shell, bearing two long three-bladed polar spines. Cortical shell with somewhat spongy meshwork composed of small hexagonal pore frames, in regular arrangement. Polar spines may be bifurcated.

Remarks: It is likely that *Dicroa* may have evolved from *Pantanellium* in the Early Cretaceous through reduction in size of pore frames and by acquiring a more elliptical and more densely porate cortical shell.

Range: Late Berriasian to earliest Turonian.

Dicroa periosa FOREMAN, 1975

Pl. 49, fig. 25

Species code 383

	1975	*Dicroa periosa* new species FOREMAN, p. 609, pl. 2E, fig. 8; pl. 3, fig. 8.
	1975	*Dicroa* sp. *A*. FOREMAN, p. 609, pl. 2E, figs. 9-11; pl. 3, fig. 11.
	1975	*Dicroa* sp. FOREMAN, pl. 3, fig. 12.
	1977c	*Dicroa* sp. *A*. PESSAGNO, p. 36, pl. 4, figs. 2, 3, 5.
?	1979	*Dicroa perisoa* FOREMAN. - NAKASEKO *et al.*, p. 21, pl. 4, fig. 8.
?	1981	*Dicroa periosa* FOREMAN. - NAKASEKO & NISHIMURA, p. 150, pl. 1, fig. 11 (= specimen of Nakaseko *et al.*, 1979, pl. 4, fig. 8).
	1981	*Dicroa* sp. *A*. FOREMAN. - SCHAAF, p. 433, pl. 16, fig. 8.
	1983	*Dicroa periosa* FOREMAN. - ORIGLIA-DEVOS, p. 40, pl. 1, figs. 6, 7.

1984 *Dicroa* sp. *A*. FOREMAN. - SCHAAF, p. 158-159 text-figs. 6, 10a-b.

1985 *Dicroa* spp. SANFILIPPO & RIEDEL, p. 587, text-figs. 4. 3a-b, 3c (= specimen of Pessagno, 1977c, pl. 4, fig. 3).

1986 Dicroa sp. A. FOREMAN. - LI, pl. 1, figs. 1, 6.

1994 *Dicroa periosa* FOREMAN. - JUD, p. 75, pl. 9, fig. 5.

Holotype: The specimen is figured and described by Foreman (1975) on pl. 3, fig. 8. The holotype was reported from the middle part of Acaeniotyle umbilicata zone (early Aptian) of the North Pacific Ocean (DSDP, Leg 32; Core 306-10-1, 124-125).

Photographed material: 2 specimens and numerous fragments.

Description: Test as with genus, having two moderately long primary spines, bifurcating towards the distal ends. Primary spines and their bifurcations are strongly three-bladed. Termination of spines sharply pointed. Cortical shell ellipsoidal with small hexagonal pore frames having in some cases tiny spines at pore vertices. Cortical shell with numerous pores frames displaying a regular arrangement.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	180	148	180	104
Length of longest spine	218	193	218	169

Remarks: The origin of this species has not been traced in detail, but it is suspected to be a possible phylogenetic link with representatives of *Pantanellium*.

Comparisons: *P. periosa* differs from its probable descendant *P. rara* by possessing bifurcated spines.

Dicroa rara (SQUINABOL, 1904)

Pl. 49, figs. 26-30

Species code 328

1904 *Xiphosphaera rara* n. sp. SQUINABOL, p. 189, pl. 2, fig. 10.

non 1979 *Dicroa* (?) sp. NAKASEKO *et al.*, p. 21, pl. 4, fig. 6.

pars ? 1983 *Pantanellium lanceola* gr. (PARONA). - ORIGLIA-DEVOS, p. 51, pl. 3, fig. 9; non fig. 10 (= *P. lanceola*).

Holotype: The specimen illustrated by Squinabol (1904) on pl. 2, fig. 10 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 22 specimens.

Description: Test as with genus. Cortical shell mostly elliptical. Meshwork comprised of small hexagonal pore frames bearing delicate spines at pore vertices. Primary spines very broad toward its base, elongate and acutely tapered distally. Primary spines strongly bladed, lacking bifurcation at distal ends, and gradually narrowing distally. Otherwise, general shape more or less identical to *D. periosa*.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	142	126	142	108
Length of longest spine	180	201	258	171

Remarks: *D. rara* is tentatively regarded as an offshoot of the earliest *D. periosa*. The only awkward aspect is that the species do not have co-occurring ranges, and there is not connection during a short interval (latest Aptian-earliest Albian). This minor problem may be clarified with a detailed examination of the newest marly-shale samples from Italy.

Comparisons: The stout primary spine, and the permanent absence of bifurcated spines allow us to distinguish *D. rara* from the type species. *D. rara* is distinguished from *P. lanceola* by having more and smaller hexagonal pore frames.

GENUS **HEXAPYRAMIS** SQUINABOL, 1903a

Type species: *Hexapyramis pantanellii* SQUINABOL, 1903b, by monotypy.

Diagnosis: Test as with the family possessing a typical hexapyramidal cortical shell. Cortical shell composed of six pyramidal rays, tapered in a thick, relatively long blade-like spine. Cortical shell with coarse meshwork, somewhat spongy. Meshwork of polygonal pore frames in irregular arrangement.

Remarks: The style and arrangement of both spines and pyramidal rays lead us to regard *Hexapyramis* as a probable derivative of *Pantanellium*, as represented by *P. sexaspinus* (JUD, 1994).

Comparisons: *Hexapyramis* embodies a unique combination of characteristics quite unlike that of any known genera among the wealth of spumellarians ranging through the Cretaceous.

Range: Late Valanginian to latest Cenomanian.

Hexapyramis precedis JUD, 1994

Pl. 50, figs. 1-2
Species code 88

1994 *Hexapyramis (') precedis* n. sp. JUD, p. 79, pl. 11, figs. 4-6.

Holotype: It is the specimen designated by Jud (1994) on pl. 11, figs. 5-6. The holotype comes from locality no. Bo-561.5, early Barremian (Umbria-Marche Apennines, central Italy).

Photographed material: 3 specimens.

Description: Test as with genus. Cortical shell with relatively small size, subspherical to hexapyramidal, composed of very large pentagonal and hexagonal pore frames. Cortical shell having small slightly raised nodes at pore frame vertices. Primary spines, moderately long, straight, and strongly threebladed.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of cortical shell	136	198	261	136
Width of cortical shell	135	158	200	131
Length of primary spines	77	74	81	58

Remarks: This species is close related to representatives of the genus *Pantanellium*, and most likely evolved from a specimen having six perpendicular rays, as illustrated by *P. sexaspinus* (JUD).

Comparisons: The smaller mature size, the largest pore frames, and the less spongy meshwork allow us to make a specific distinction with the type species.

Hexapyramis pantanellii SQUINABOL, 1903b

Pl. 50, figs. 3-7
Species code 82

1903 *Hexapyramis Pantanellii* n. sp. SQUINABOL, p. 114, pl. 10, fig. 5.
1986 *Hexapyramis pantanellii* SQUIN. - KUHNT *et al.*, pl. 7, fig. b.
1988 *Hexapyramis pantanelli* SQUINABOL. - THUROW, p. 401, pl. 6, fig. 5.
1991 *Hexapyramis pantanellii* SQUINABOL. - AGUADO *et al.*, text-fig. 7. 14.
non 1991 *Hexapyramis* (?) *pantanellii* SQUINABOL. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 6 (= *Q. panacea*).
1993 ?*Hexapyramis* sp. BAK, p. 199, pl. 4, fig. 14.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 5 may be considered the holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 39 specimens.

Description: Test as with genus. Cortical shell of very large size, having six very large pyramidal rays perpendicularly disposed. Primary rays are poorly developed, and taper in very long slender spines (approximately equal to width of cortical shell). Spines sharply pointed and strongly three-bladed. Cortical shell densely porate, with meshwork composed of small polygonal pore frames. Meshwork completely spongy and irregular throughout; pore frames of primary rays sometimes display weak linear arrangement.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of cortical shell	312	323	352	305
Width of cortical shell	100	104	120	92
Length of primary spines	75	182	335	64

Remarks: *H. pantanellii* undoubtedly evolved from *H. precedis*, by increasing to a large degree the overall size of the test and by developing very long spines. Stratigraphically, the ranges of the two species suggest very little overlap. Differs from *H. precedis* in having smaller cortical shell, shorter primary rays, and finer spongy meshwork.

FAMILY **LEUGEONIDAE** YANG & WANG, 1990

Type genus: *Leugeo* YANG & WANG, 1990, by original designation.

Actinommaceae with latticed spherical medullary and cortical shell, both interconnected by a variable number of rays. External spines, when they exist, are three-bladed and, as a general rule, these are not co-linearly disposed with internal rays. Cortical wall frequently has nodes or tubercles.

GENUS **ACAENIOTYLE** FOREMAN, 1973b

Type species: *Xiphosphaera umbilicata* RÜST, 1898, by original designation.

Diagnosis: The representatives of this genus have in the center a spherical latticed microsphere connected to the cortical shell by a variable number of rays. The external spines, when present, are to be regarded as secondary spines, and they do not represent the prolongation of internal beams. Cortical shell possesses strongly developed of tubercles throughout its surface. Primary spines strongly bladed, disposed in symmetrical arrangement.

Remarks: Included are all forms possessing two, three, four or six spines and a spherical cortical shell nodose with fine pores, typical of *Acaeniotyle*.

Comparisons: *Acaeniotyle* is distinguished from *Staurosphaeretta* in having always a cortical surface with large porous nodes.

Range: Middle Jurassic (Bajocian) to Late Cretaceous (Campanian).

Acaeniotyle diaphorogona FOREMAN, 1973b

Pl. 50, figs. 8-11
Species code 191

1973b *Acaeniotyle diaphorogona* new species FOREMAN, p. 258, pl. 2, figs. 2-5.
1973b *Acaeniotyle* sp. aff *A. diaphorogona* FOREMAN, pl. 2, figs. 6, 7; pl. 16, fig. 16 ?.
1975 *Acaeniotyle diaphorogona* FOREMAN. - FOREMAN, p. 607, pl. 3, figs. 1, 2; pl. 2F, figs. 1-4; non fig. 5.
? 1975 *Acaeniotyle* sp. cf. *Acaeniotyle diaphorogona* FOREMAN, pl. 1F, fig. 1.
1977 *Acaeniotyle diaphorogona* FOREMAN. - MUZAVOR, p. 34, pl. 1, fig. 1.
1977 *Acaeniotyle tribulosa* FOREMAN. - MUZAVOR, p. 36, pl. 1, fig. 2.
1981 *Acaeniotyle diaphorogona* FOREMAN. - DE WEVER (in DE WEVER & THIEBAULT), p. 582, pl. 2, fig. 7.
? 1981 *Acaeniotyle* sp. aff. *A. diaphorogona* FOREMAN. - EMPSON-MORIN, p. 261, pl. 3, figs. 8a-d.
? 1981 *Acaeniotyle gedrangta* n. sp. EMPSON-MORIN, p. 261, pl. 3, figs. 6, 7.
1981 *Acaeniotyle diaphorogona* FOREMAN. - NAKASEKO & NISHIMURA, p. 141, pl. 1, fig. 12 (= specimen of Nakaseko *et al.*, 1979, pl. 4, fig. 9).
1981 *Acaeniotyle diaphorogona* FOREMAN. - SCHAAF, p. 431, pl. 15, fig. 2.
1983 *Acaeniotyle diaphorogona* FOREMAN. - ORIGLIA-DEVOS, p. 36, pl. 1, figs. 1, 2.
pars 1984b *Acaeniotyle diaphorogona* s. l. FOREMAN. - BAUMGARTNER, p. 753, pl. 1, fig. 1; non fig. 2.
1984 *Acaeniotyle diaphorogona* FOREMAN. - SCHAAF, p. 104-105, text-figs. H (= holotype refigured), 1-2, 3 (= specimen of Schaaf, 1981, pl. 15, fig. 2), 4-5.
1984 *Acaeniotyle* sp. aff. *A. diaphorogona* FOREMAN. - YAO, pl. 3, fig. 24.
1985 *Acaeniotyle* aff. *diaphoropona* FOREMAN. - LI & WU, pl. 2, fig. 19.
1985 *Acaeniotyle diaphorogona* SANFILIPPO & RIEDEL, p. 586, text-figs. 4. 1a-b.
1988 *Acaeniotyle diaphorogona* FOREMAN. - THUROW, p. 396, pl. 9, fig. 8.
non 1988 *Acaeniotyle* sp. cf. *A. diaphorogona* FOREMAN. - THUROW, p. 396, pl. 6, fig. 4 (= *A. tribulosa* ?)
non 1988 *Acaeniotyle diaphorogona* VISHNEVSKAYA, pl. 5, fig. 4.
1989 *Acaeniotyle diaphorogona* FOREMAN. - TUMANDA, p. 33, pl. 1, figs. 2, 3 ?.
? 1992 *Acaeniotyle diaphorogona* FOREMAN. - BAUMGARTNER, p. 317, pl. 3, fig. 1.
1992 *Acaeniotyle diaphorogona* FOREMAN. - OZVOLDOVA & PETERCAKOVA, pl. 1, figs. 13, 16.
1992 *Acaeniotyle diaphorogona* FOREMAN. - STEIGER, p. 28, pl. 2, figs. 1, 2.
1992 *Acaeniotyle diaphorogona* FOREMAN. - TAKETANI & KANIE, text-fig. 3. 1.
1994 *Acaeniotyle diaphorogona* gr. FOREMAN. - JUD, p. 57, pl. 1, figs. 3-4.

Holotype: The specimen is figured and described by Foreman (1973b) on pl. 2, fig. 3. The holotype was reported from the Sethocapsa trachyostraca assemblage (Hauterivian) of the northwest Pacific Ocean (DSDP, Leg 20).

Photographed material: 29 specimens.

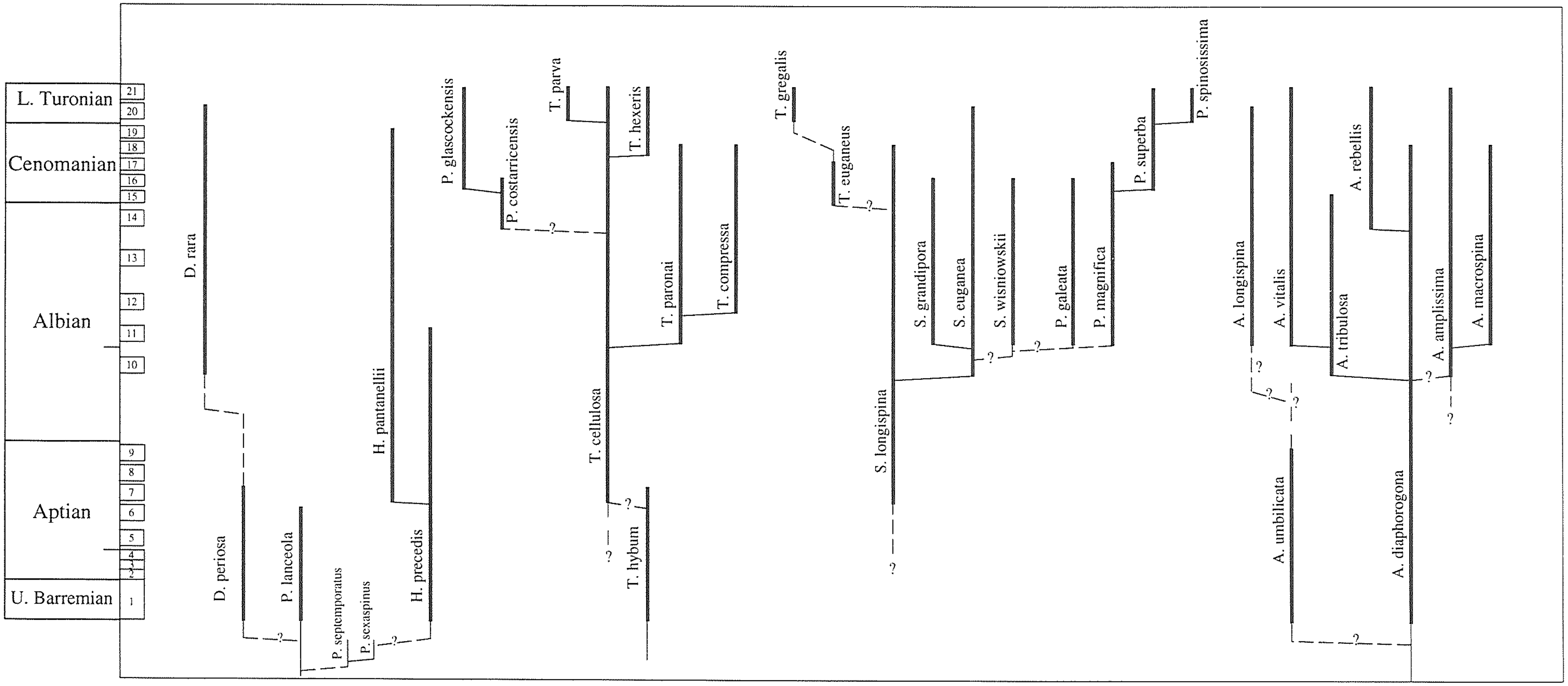

Fig. 29.- Stratigraphic range and possible phyletic relationships of genera and species of the families Pantanelliidae, Leugeonidae, Xiphostylidae and Pyramispongiidae.

Description: Test as with genus, having relatively small cortical shell, but armed with long, solid primary spines, which display only very slight torsion. Spines strongly bladed, sharply pointed and of approximately equal length to diameter of cortical shell. Each spine is composed longitudinally of three broad, rounded ridges and three narrow grooves. Primary spines disposed in the same plane and radiating more or less symmetrically with angles varying from 90 to 130 degrees.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	147	114	115	108
Length of primary spines	107	152	192	131

Remarks: The ancestry of this species has not been recognized, but it gave rise to an important radiation through the Albian-Cenomanian times and several lineages have been recognized (fig. 29). This species shows a wide range of variation through its entire stratigraphic record.

Comparisons: *A. diaphorogona* is closely related to *A. rebellis*, but it is distinguished by having more spherical and smaller cortical shell, and by possessing longer primary spines.

Acaeniotyle tribulosa FOREMAN, 1973b

Pl. 50, figs. 12-19

Species code 184

	1973b	*Acaeniotyle tribulosa* new species FOREMAN, p. 258, pl. 2, fig. 8.
non	1977	*Acaeniotyle tribulosa* FOREMAN. - MUZAVOR, p. 36, pl. 1, fig. 2 (= *A. diaphorogona*).
?	1988	*Acaeniotyle* sp. cf. *A. diaphorogona* FOREMAN. - THUROW, p. 396, pl. 6, fig. 4.

Holotype: The specimen figured and described by Foreman (1973b) on pl. 2, fig. 8. The holotype was reported from the Acaeniotyle tribulosa assemblage (late Aptian-Albian?) of the northwest Pacific Ocean (DSDP, Leg 20).

Photographed material: 45 specimen.

Description: Test as with genus possessing a noticeably large cortical shell with twisted primary spines. Meshwork composed of large and numerous tubercles faintly porate. Spines very thick, strongly three-bladed, with alternating ridges and grooves. Ridges narrow and rounded; grooves about twice the width of ridges. Spines possess very strong sinistral torsion. Length of primary spines equal or shorter than diameter of cortical shell. Primary spines disposed in the same plane and radiating more or less symmetrically with angles varying from 90 to 130 degrees.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	174	221	250	195
Length of primary spines	67	165	210	120

Remarks: This species most likely evolved from *A. diaphorogona* by increasing the overall size of the test a great deal, and by enlarging the pore frame nodes. Furthermore, the spines of most specimens develop strong longitudinal torsion. Range of variation only partially overlaps, but *A. tribulosa* clearly includes forms with larger cortical shell and twisted primary spines, which are generally shorter.

Comparisons: *A. tribulosa* is distinguished from all other congeneric species ranging through Mid-Cretaceous times, by having broad spines with very strong sinistral torsion.

Acaeniotyle vitalis nov. sp.

Pl. 51, figs. 1-4
Species code 215

Holotype: Specimen 5946 (pl. 51, fig. 4). The type-specimen comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *vitalis* -e, meaning relative to the life.

Photographed material: 15 specimens.

Description: Test as with genus possessing large spherical cortical shell and four straight primary spines radiating with tetrahedral symmetry. Primary spines solid, bladed, composed of alternating rounded ridges and wide grooves. Spines tends to be very wide at the base and usually are shorter than the diameter of the cortical shell. Meshwork composed of large, raised tubercles. Primary spines more or less equal in length

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	160	176	190	160
Length of primary spines	114	113	150	87

Remarks: *A. vitalis* seem to have evolved from *A. tribulosa* by increasing the number of spines, which acquire a tetrahedral arrangement. The spines lose the torsion, and become noticeably straight and acutely tapered.

Comparisons: This species is distinguished from all others of the genus by its tetrahedral arrangement of spines and its coarsely tuberculate cortical shell.

Acaeniotyle rebellis nov. sp.

Pl. 51, figs. 5-10
Species code 214

Holotype: Specimen 6203 (pl. 51, fig. 6). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines).

Derivatio nominis: Latin adjective *rebellis* -e, meaning rebel.

Photographed material: 60 specimens.

Description: Test as with genus. Cortical shell subspherical with slightly flattened to convex upper and lower surfaces. Primary spines radiate more or less symmetrically in an equatorial plane with angles varying from 90 to

130 degrees. Cortical shell with nearly vertical sides, displays a hexagonal outline in a view perpendicular to the equatorial plane. Meshwork composed of small tubercles with minute subcircular pore frames.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	150	145	158	120
Length of primary spines	114	127	146	93

Remarks: This species apparently branched off from *A. diaphorogona*. Ranges of variability of *A. rebellis* and *A. diaphorogona* overlap slightly, but *A. rebellis* includes forms with six vertical sides, a hexagonal outline, and a slightly larger cortical shell.

Comparisons: *A. rebellis* is distinguished from *A. tribulosa* by always possessing a nearly hexagonal outline formed of vertical sides and by having straight rather than twisted spines.

Acaeniotyle amplissima (FOREMAN, 1973b)

Pl. 51, figs. 11-14
Species code 201

	1973b	*Staurosphaera amplissima* new species FOREMAN, p. 259, pl. 3, fig. 6.
	1983	*Staurosphaera magnifica* SQUINABOL. - ORIGLIA-DEVOS, p. 112, pl. 14, figs. 22, 23.
non	1985	*Staurosphaera amplissima* FOREMAN. - LI & WU, pl. 1, fig. 12.
	1985	*Staurosphaera glebulosa* FOREMAN. - LI & WU, pl. 1, fig. 9.
	1988	*Acaeniotyle* sp. *A*. THUROW, p. 396, pl. 6, fig. 2.
non	1992	*Staurosphaera amplissima* FOREMAN. - STEIGER, p. 32, pl. 4, fig. 8.

Holotype: The specimen is figured and described by Foreman (1973b) on pl. 3, fig. 6. The holotype has been reported from the Acaeniotyle tribulosa assemblage (late Aptian-Albian ?) of the northwest Pacific Ocean (DSDP, Leg 20, Hole 194).

Photographed material: 42 specimens.

Description: Test as with genus having relatively small cortical shell armed with four primary spines. Meshwork comprised of large, elevated tubercles having small subcircular pore frames. Primary spines radiate in the equatorial plane at right angles. Spines composed longitudinally of thick rounded ridges and very wide, moderately shallow grooves. Spines exhibit slight torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	214	148	160	133
Length of primary spines	187	180	204	158

Remarks: Among the wealth of species assigned to *Acaeniotyle*, this species has many affinities with the oldest species *A. florea* OZVOLDOVA (in Ozvoldova & Petercakova, 1992). This latter species ranges through late Berriasian-early Barremian times and it seems to be an heterochronous homoemorphous of *A. amplissima*. Forms possessing four equatorial primary spines have not been recognized through an important time interval. For this reason its phylogenetic relationship is queried.

Comparisons: *A. amplissima* is distinguished from *A. macrospina* by possessing four instead of six primary spines. Otherwise shape and size of cortical shell almost identical.

Acaeniotyle macrospina (SQUINABOL, 1903b)

Pl. 51, figs. 15-18
Species code 239

	1903b	*Hexastylus macrospina* n. sp. SQUINABOL, p. 112, pl. 8, fig. 7.
	1903b	*Hexastylus microporus* n. sp. SQUINABOL, p. 113, pl. 9, fig. 25.
pars	1983	*Hexastylus uvarius* RÜST. - ORIGLIA-DEVOS, p. 56, pl. 2, fig. 15; non fig. 16.
non	1983	*Hexastylus microporus* SQUINABOL, p. 55, pl. 3, fig. 14 (= *Q. parvipora* ?).
	1985	*Actinomma* (?) *tuberculatum* sp. nov. LI & WU, p. 73, pl. 2, fig. 17.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 7 may be regarded the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 31 specimens.

Description: Test as with genus having a large spherical cortical shell and six primary spines. Four primary spines situated in a equatorial plane and radiating at right angles. Polar spines usually longer than equatorial spines. Meshwork composed of small tubercles finely porate. Primary spines three-bladed composed of alternating ridges and grooves; ridges wide proximally becoming narrow and sharp distally, grooves very wide. Spines very slightly twisted.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	178	182	192	175
Length of primary spines	122	152	175	128

Remarks: This species seems to have evolved from *A. amplissima* by developing two additional primary spines at polar ends. *A. macrospina* seems not to have left descendants.

Comparisons: *A. macrospina* differs from all other congeneric species by possessing six primary spines.

Acaeniotyle umbilicata (RÜST, 1898)

Pl. 51, figs. 19-20
Species code 332

	1898	*Xiphosphaera umbilicata* n. sp. RÜST, p. 7, pl. 1, fig. 9.
	1927	*Xiphosphaera tuberosa* nov. spec. TAN, p. 35, pl. 5, fig. 8.
	1972	*Xiphosphaera umbilicata* RÜST. - DUMITRICA, p. 832, pl. 1, fig. 1.
	1973b	*Acaeniotyle umbilicata* (RÜST). - FOREMAN, p. 258, pl. 1, figs. 12-14, 16.
non	1973b	*Acaeniotyle* sp. aff *A. umbilicata* s. l. (RÜST). - FOREMAN, pl. 1, fig. 15 (= *A. longispina*).
	1974	*Xiphospaera umbilicata* RÜST. - RENZ, p. 799, pl. 2, figs. 9-12; pl. 9, fig. 21.
	1975	*Acaeniotyle umbilicata* (RÜST). - FOREMAN, p. 607, pl. 2E, figs. 14-17, pl. 3, fig. 3.
non	1975	*Acaeniotyle* sp. aff *A. umbilicata* (RÜST). - FOREMAN, p. 609, pl. 2E, fig. 8 (= *A. longispina*).
	1977	*Acaeniotyle umbilicata* (RÜST). - MUZAVOR, p. 36, pl. 1, fig. 3.
?	1979	*Acaeniotyle umbilicata* (RÜST). - NAKASEKO *et al.*, p. 21, pl. 4, fig. 7.

1981 *acaeniotyle umbilicata* (RÜST). - BAUMGARTNER *et al.*, p. 48, pl. 2, fig. 8.

1981 *Acaeniotyle umbilicata* (RÜST). - NAKASEKO & NISHIMURA, p. 141, pl. 1, fig. 7 ? (= specimen of Nakaseko *et al.*, 1979, pl. 4, fig. 7); pl. 14, fig. 2.

1981 *Acaeniotyle umbilicata* (RÜST). - SCHAAF, p. 431, pl. 6, fig. 11; pl. 15, figs. 3a-b.

1983 *Acaeniotyle umbilicata* (RÜST). - ORIGLIA-DEVOS, p, 38, pl. 1, figs. 4 ?, 5.

1984b *Acaeniotyle umbilicata* (RÜST). - BAUMGARTNER, p. 754, pl. 1, fig. 5.

1984 *Acaeniotyle umbilicata* (RÜST). - SCHAAF, p. 148-149, text-figs. H (= holotype refigured), 1 (= specimen of Schaaf, 1981, pl. 6, fig. 11), 2a-b, 3a-b.

? 1984 *Acaeniotyle* sp. cf. *A. umbilicata* (RÜST). - YAO, pl. 4, fig. 21.

non 1985 *Acaeniotyle* aff. *umbilicata* RÜST. - LI & WU, pl. 1, fig. 2 (= *A. longispina*).

1985 *Acaeniotyle umbilicata* SANFILIPPO & RIEDEL, p. 587, text-figs. 4. 2a-c, 2d ?.

1986 *Acaeniotyle umbilicata* (RÜST). - AITA & OKADA, pl. 1, fig. 1.

1986 *Acaeniotyle umbilicata* (RÜST). - OKAMURA & MATSUGI, pl. 4, figs. 6, 9.

1988 *Acaeniotyle umbilicata* (RÜST). - THUROW, p. 396, pl. 9, fig. 7.

1989 *Acaeniotyle umbilicata* (RUST). - KATO & IWATA, pl. 1, fig. 9.

1989 *Acaeniotyle umbilicata* (RÜST). - TUMANDA, p. 33, pl. 1, fig. 4.

non 1992 *Acaeniotyle umbilicata* (RÜST). - BAUMGARTNER, p. 317, pl. 3, fig. 2 (= *A. longispina* ?).

1992 *Acaeniotyle umbilicata* (RÜST). - OZVOLDOVA & PETERCAKOVA, pl. 1, figs. 8, 10.

1992 *Acaeniotyle tuberosa* n. sp. STEIGER, p. 27, pl. 1, figs. 18-20.

1992 *Acaeniotyle umbilicata* (RÜST). - STEIGER, p. 27, pl. 1, figs. 16, 17.

1992 *Acaeniotyle umbilicata* (RÜST). - TAKETANI & KANIE, text-fig. 3. 2.

1993 *Acaeniotyle umbilicata* (RÜST). - AGUADO et al., pl. 3, fig. 8.

1994 *Acaeniotyle umbilicata* (RÜST). - JUD, p. 58, pl. 1, figs. 13-16.

Holotype: The specimen illustrated by Rüst (1898) on pl. 1, fig. 9 may be considered the holotype. This specimen has been reported from the Maiolica Formation (Neocomian) at the locality of Cittiglio, Province of Varese (southern Alps, N Italy).

Photographed material: 2 specimens.

Description: Test as with genus, having a coarsely tuberculate cortical shell and two primary spines longitudinally disposed. Cortical shell approximately spherical, with meshwork composed of hexagonal pore frames. Cortical shell surface covered with large elevated tubercles. Primary spines strongly bladed, composed of alternating thick rounded ridges and narrow grooves, not very deep. Spines somewhat rounded at vertices.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	204	156	192	142
Length of primary spines	265	175	208	140

Remarks: The origin of this species was not directly studied in this research, but unpublished data lead us to tentatively consider this species as branched off from the earliest representatives of *A. diaphorogona*.

Comparisons: *A. diaphorogona* differs from its probable descendant *A. longispina*, by having a spherical shell with a more coarsely tuberculate surface.

Acaeniotyle longispina (SQUINABOL, 1903b)

Pl. 51, figs. 21-25

Species code 331

1903b *Xiphosphaera fossilis* n. sp. SQUINABOL, p. 110, pl. 8, fig. 14

	1903b	*Xiphosphaera longispina* n. sp. SQUINABOL, p. 110, pl. 8, fig. 13
	1973b	*Acaeniotyle* sp. aff *A. umbilicata* s. l. (RÜST). - FOREMAN, pl. 1, fig. 15.
	1975	*Acaeniotyle* sp. aff *A. umbilicata* (RÜST). - FOREMAN, p. 609, pl. 2E, fig. 8.
	1985	*Acaeniotyle* aff. *umbilicata* RÜST. - LI & WU, pl. 1, fig. 2.
?	1985	*Pantanellium multiporis* sp. nov. LI & WU, pl. 1, fig. 8.
?	1992	*Acaeniotyle umbilicata* (RÜST). - BAUMGARTNER, p. 317, pl. 3, fig. 2.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 14 may be considered the holotype. This specimen has been reported from Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 41 specimens.

Description: Test as with genus with two primary polar spines. Cortical shell nearly spherical to slightly ellipsoidal. Spines usually very long, approximately two times diameter of cortical shell. Meshwork composed of small subhexagonal pore frames with weak quincuncial arrangement. Cortical shell develops small tubercles, which are poorly differentiated. Primary spines three-bladed, composed by alternating ridges and grooves; ridges stout and rounded, grooves approximately two or three times the width of ridges. Spines exhibit very slight torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	314	162	190	130
Length of primary spines	700	276	300	210

Remarks: It is suspected that *A. longispina* may have evolved from *A. umbilicata*, as the ornamentation of cortical shell faded and the size of primary spines increased. The only awkward aspect of this interpretation is the fact that a short interval exists between the ancestor and descendant where neither morphotypes is recorded.

Comparisons: *A. longispina* is distinguished from the type species by possessing longer, more stout and acute primary spines. Also *A. longispina* presents weak developed tubercles.

FAMILY **XIPHOSTYLIDAE** HAECKEL, 1881

Type genus: *Xiphostylus* HAECKEL, 1881.

Actinommaceae with only cortical shell, lacking primary radial beams and internal spicule. Cortical shell latticed, formed by a double layer, thicker externally. Cortical shell with or without spines, which are present in variable number, two or more. Spines generally strongly bladed. It probably should be divided into several subfamilies.

GENUS **STAUROSPHAERETTA** SQUINABOL, 1904

Synonym: ? *Pentasphaera* SQUINABOL, 1904.

Type species: *Staurosphaera hindei* SQUINABOL, 1904, by monotypy. This species is considered herein as a synonym of *Staurosphaera longispina* SQUINABOL, 1903b

Diagnosis: Test as with family, with variable number of primary spines; four, six or more spines radiating symmetrically. Spines are usually long, and strongly bladed, and taper distally. Cortical shell relatively large and spherical, with meshwork composed of regular polygonal pore frames.

Comparisons: The representatives of this genus resemble *Acaeniotyle* externally but differ by not having tubercles on their cortical shell and by possessing generally larger test.

Range: Late Aptian to earliest Turonian.

Staurosphaeretta longispina (SQUINABOL, 1903b)

Pl. 52, figs. 6-10
Species code 176

1903b *Staurosphaera longispina* n. sp. SQUINABOL, p. 112, pl. 9, fig. 1.
1904 *Staurosphaera Hindei* n. sp. SQUINABOL, p. 191, pl. 3, fig. 3
1975 *Staurosphaeretta hindei* (SQUINABOL). - FOREMAN, p. 609, pl. 1F, fig. 2; pl. 2F, fig. 8.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 1 may be considered as the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 42 specimens.

Description: *Staurosphaeretta* with relatively small subspherical cortical shell and four slender primary spines radiating in the equatorial plane at angles of approximately 30 and 60 degrees. Cortical shell nearly rectangular in outline with upper and lower surface slightly flattened. Meshwork composed of small hexagonal pore frames. Pores quite uniform in size and shape, displaying regular arrangement. Strongly bladed primary spines composed longitudinally of thick rounded ridges and wide grooves of moderate depth. Primary spines straight, generally about twice the length of the diameter of cortical shell. Spines only occasionally exhibit slight torsion.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	262	113	121	108
Length of primary spines	725	248	258	233

Remarks: This species shows throughout its stratigraphic range a short range of variation. The most variable parameters are the angles between radial spines. The strong resemblance in shape with *Tetracanthellipsis* is probably of phylogenetic significance.

Comparisons: *S longispina* is distinguished from all other described species of *Staurosphaeretta* by having a much smaller cortical shell and by developing the longest primary spines.

Staurosphaeretta euganea (SQUINABOL, 1903b)

Pl. 52, figs. 1-5
Species code 208

1903b *Staurosphaera euganea* n. sp. SQUINABOL, p. 112, pl. 10, fig. 18.

1904 *Staurosphaera veneta* n. sp. SQUINABOL, p. 191, pl. 3, fig. 2.
1973b *Staurosphaera amplissima* n. sp. FOREMAN, p. 259, pl. 3, fig. 6.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 10, fig. 18 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 12 specimens.

Description: Test as with genus possessing a very large spherical cortical shell and four strongly bladed radial spines disposed in a equatorial plane at approximately right angles. Meshwork composed of small hexagonal pore frames. Pores quite uniform in size and shape, showing quincuncial arrangement. Spines composed of three thick rounded ridges that alternate with three very wide, moderately shallow grooves. Spines are generally about the same length as the diameter of cortical shell, and they exhibit slight torsion.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	190	233	250	210
Length of primary spines	580	194	230	170

Remarks: *S. euganea* seems to have evolved from *S. longispina* by further increase in cortical shell size. Although both species could be considered as pertaining to the same continuum, either species range as independent taxa because their morphological differences were fully achieved at the Romanus Subzone. The only variation observed in *S. euganea* is the length of primary spines, which gradually increase as the populations become younger.

Comparisons: This species is distinguished from *S. grandipora* by possessing four instead of six primary spines. *S. euganea* differs from *S. longispina* by having a larger cortical shell and by its more massive primary spines.

Staurosphaeretta grandipora (SQUINABOL, 1903b)

Pl. 52, figs. 11-18
Species code 240

1903b *Hexastylus euganeus* n. sp. SQUINABOL, p. 113, pl. 10, fig. 14 (posterior homonym of *Staurosphaera euganea* SQUINABOL, 1903b).
1903b *Hexastylus grandiporus* n. sp. SQUINABOL, p. 113, pl. 10, fig. 17.
1904 *Hexalonche euganea* n. sp. SQUINABOL, p. 194, pl. 4, fig. 1 (posterior homonym of *Staurosphaera euganea* SQUINABOL, 1903b).
1904 *Hexalonche Ongariana* n. sp. SQUINABOL, p. 194, pl. 3, fig. 4.
1975 *Trochodiscus exaspina* SQUINABOL. - FOREMAN, p. 612, pl. 2F, fig. 11; pl. 4, fig. 11.
1975 *Trochodiscus exaspina* SQUINABOL. - FOREMAN, p. 612, pl. 2F, fig. 11; pl. 4, fig. 11 ?.
? 1985 *Actinomma* (?) *rude* sp. nov. LI & WU, p. 73, pl. 2, fig. 16.
1989 *Hexalonche* sp. TUMANDA, p. 34, pl. 6, fig. 13.

Holotype: Specified type. It is the specimen illustrated by Squinabol (1903b) on pl. 10, fig. 17. The holotype has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 38 specimens.

Description: Test as with genus, having large spherical cortical shell and six massive primary spines. Surface of cortical shell composed of uniform sized, hexagonal pore frames quincuncially arranged. However, the size and number of pores per surface area of cortical shell vary considerably among specimens although they are rather uniform on individual specimens. They vary from small, hexagonal, closely packed and strongly abundant; to large, less numerous, with more irregular shape and surrounded by sharp angular frames. Primary spines tapering, display moderate torsion distally, vary in length from noticeably long (one and half diameter of cortical shell) to relatively short (one half to two-thirds diameter of test). Primary spines strongly bladed. Ridges of spines are wide and rounded proximally, becoming narrow and sharp distally; grooves slightly wider.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	362	254	300	200
Length of primary spines	-	188	260	140

Remarks: *S. grandipora* shows a wide range of variation throughout the succession. Two main extreme morphotypes can be distinguished in a continuum. They are basically distinguished by the density of pores and length of primary spines (see description above). Morphotypes with larger pore may present small pointed nodes at vertices of pore frames and also present slender primary spines. This species seems to have evolved from *S. euganea*, by increasing the number of primary spines.

Comparisons: This species is distinguished from all other congeneric species in always having six primary symmetrical spines; four equatorially disposed, and two, usually longer, at the polar position.

Staurosphaeretta wisniowskii (SQUINABOL, 1903b)

Pl. 53, figs. 1-7
Species code 270

1903b *Acanthosphaera Wisniowskii* n. sp. SQUINABOL, p. 114, pl. 8, fig. 6.
1903b *Heliosphaera Isseli* n. sp. SQUINABOL, p. 115, pl. 8, fig. 8.
1983 *Heilosphaera isseli* SQUINABOL. - ORIGLIA-DEVOS, p. 54, pl. 2, fig. 14.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 6 may be considered the valid holotype. This specimen has been reported from an imprecise locality (Monte sereo or Teòlo) in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 52 specimens.

Description: Test as with genus having a spherical cortical shell and variable number of primary spines; usually twelve straight three-bladed spines. Exceptionally, some specimens are armed with eighteen primary spines. Primary spines display a symmetrical arrangement, two spines situated in a polar position and the remaining spines radiating approximately in an equatorial plane. These spines alternate six downward directed and six upward directed (a good picture of this kind of arrangement is shown on pl. 53, figs. 2-3). Cortical shell becomes subspherical with increasing shell diameter. Meshwork composed of small to moderate large hexagonal pore frames in quincuncial arrangement. Spines variable in length, commonly about one-half to two thirds the diameter of cortical shell. Spines composed of rounded to sharp ridges and wider grooves.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	170	286	310	230
Length of primary spines	100	132	160	90

Remarks: Specimens with elevated number of primary spines, frequently have more slender and tapering spines. It is suspected that *S. wisniowskii* branched off from *S. euganea.*

Comparisons: It must be emphasized that *S. grandipora* and *S. wisniowskii* occur in the same stratigraphic interval and apart from their morphological resemblance, they are probably closely related. Although the latter species might be considered as merely a variant of *S. grandipora,* possessing a major number of primary spines, I prefer to maintain a distinction between both morphotypes, until a more detailed study of the variability among these populations may be undertaken.

GENUS **TETRACANTHELLIPSIS** SQUINABOL, 1903a

Type species: *Tetracanthellipsis euganeus* SQUINABOL, 1903b, by monotypy.

Diagnosis: Test as with family. Elliptical to spherical cortical shell, with relatively spongy meshwork comprised of small polygonal pore frames, more or less irregularly disposed. Cortical shell bearing two pairs of long blade-like spines, either pair disposed symmetrically on two perpendicular planes. Angle between two spine in the same pair approximately 30 degrees.

Remarks: *Tetracanthellipsis* is tentatively regarded as an offshoot of earliest *Staurosphaeretta*, as illustrated by *S. longispina*. The most conspicuous change is shown by modification in the symmetry of primary spines, which tend to be situated in perpendicular planes.

Comparisons: Although the size and arrangement of pore frames on the cortical shell approach those of *Staurosphaeretta* or *Pseudoacanthosphaera*, the diagnostic pattern of the spines permits recognition of the genus.

Range: Cenomanian to early Turonian, insofar as know.

Tetracanthellipsis euganeus SQUINABOL, 1903b

Pl. 53, figs. 8-10
Species code 213

1903b *Tetracanthellipsis euganeus* n. sp. SQUINABOL, p. 117, pl. 8, fig. 9.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 9 may be considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 4 specimens.

Description: Test as with genus having ellipsoidal cortical shell and two pairs of long primary spines disposed in two perpendicular planes. Cortical shell slightly spongy, composed of small irregular polygonal pore frames. Primary spines strongly three-bladed, composed of alternating sharp ridges and wide grooves. Spines slightly longer than diameter of cortical shell and displaying weak torsion distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	145	134	154	112
Length of primary spines	125	144	180	108

Remarks: Because intraspecific variability of the hitherto only illustrated *Tetracanthellipsis* described from the Venetian Alps, in the North of Italy (Squinabol, 1903b) is poorly known, specific identification of the few available specimens is somewhat difficult. Nevertheless, some specimens that apparently occur at a constant stratigraphic level are tentatively assigned to *T. euganeus*.

Comparisons: *T. euganea* is distinguished from *S longispina* by possessing two pairs of primary spines arranged on two perpendicular planes. Furthermore *T. euganea* presents slimmer and shorter primary spines.

Tetracanthellipsis gregalis nov. sp.

Pl. 53, figs. 11-15
Species code 186

Holotype: Specimen 6272 (pl. 53, fig. 13).The holotype comes from locality. no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *gregalis*, -e, meaning communal.

Photographed material: 37 specimens.

Description: Test as with genus possessing subspherical to spherical cortical shell. Test armed with two pairs of primary spines on approximately perpendicular planes. Test with meshwork composed of moderate sized polygonal pore frames. Spines strongly bladed, sharply pointed, and composed of three alternating sharp ridges and three wider grooves (two or three times the width of ridges). Primary spines relatively short (approximately one-half to two-thirds the diameter of cortical shell); ridges of spines slightly ragged distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	127	146	173	127
Length of primary spines	123	129	153	120

Comparisons: *T. gregalis* seems to have evolved from the type species. It differs by possessing a larger cortical shell, much more massive primary spines, and a less perpendicular arrangement of spine pairs.

GENUS **PSEUDOACANTHOSPHAERA** NOV. GEN.

Derivatio nominis: Nominal genus compound for *pseudo* (Latin), meaning false plus *Acanthosphaera*; refers to morphological resemblances with the Recent forms of *Acanthosphaera* EHRENBERG, 1858. Feminine gender.

Type species: *Staurosphaera magnifica* SQUINABOL, 1904.

Diagnosis: Test as with family, possessing a moderately large, subspherical cortical shell and a variable number of primary spines. Usually two, four, or twelve long, strongly bladed primary spines in a symmetrical arrangement. Meshwork composed of irregular polygonal pore frames, slightly variable in size and shape. Pore frames bearing moderate to well developed, delicate secondary spines at pore vertices.

Remarks: Introduction of a new generic name is justified by the presence of a spinose stage upon the cortical shell, a feature hitherto not known among Cretaceous xiphostylids. Shell shape and the arrangement of primary spines otherwise suggest a derivation of *Staurosphaeretta*. Through this lineage there is a steady reduction in the diameter of the cortical shell.

Range: Middle Albian to Campanian- early Maastrichtian?.

Pseudoacanthosphaera galeata nov. sp.

Pl. 53, figs. 16-19
Species code 95

Holotype: Specimen 3302 (pl. 53, fig. 18). This specimen comes from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *galeatus* -a -um, meaning armed with helmet.

Photographed material: 5 specimens.

Description: Test as with genus having subspherical cortical shell and usually armed with twelve long primary spines, which expand slightly at vertices. Primary spines symmetrically arranged, two spines situated at the polar positions, ten spines radiating equatorially, but alternating in inclination; six spines pointing down and six spines pointing up. Meshwork composed of small to median polygonal pore frames, developing sharply pointed spines at pore vertices. Primary spines three-bladed, composed of alternating sharp ridges and wide shallow grooves. Primary spines display moderate to weak torsion distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	253	267	293	252
Length of primary spines	227	287	410	160

Remarks: It seem probable that *P. galeata* may be related to representatives of *Staurosphaeretta*, as illustrated by *S. wisniowskii*. It differs by possessing longer primary spines, and by developing in the meshwork a conspicuous spinose stage at pore frame vertices.

Pseudoacanthosphaera magnifica (SQUINABOL, 1904)

Pl. 54, figs. 1-4
Species code 168

1904 *Staurosphaera magnifica* n. sp. SQUINABOL, p. 191, pl. 3, fig. 1.
non 1981 *Hexastylurus magnificus* (SQUINABOL). - SCHAAF, p. 435, pl. 7, fig. 2; pl. 14, figs. 1a-b.
non 1984 *Hexastylurus magnificus* (SQUINABOL). - SCHAAF, p. 156-157, text- fig. 10 (= specimen of Schaaf, 1981, pl. 7, fig. 2).
non 1983 *Staurosphaera magnifica* SQUINABOL. - ORIGLIA-DEVOS, p. 112, pl. 14, figs. 22-23 (= *A. amplissima*).
non 1988 *Hexatylurus magnificus* (SQUINABOL). - THUROW, p. 401, pl. 9, fig. 16 (= *Q. ombonii*)

Holotype: The specimen illustrated by Squinabol (1904) on pl. 3, fig. 1 may be considered as the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 24 specimens.

Description: Test as with genus having subspherical cortical shell bearing four to six primary spines. Meshwork composed of small hexagonal pore frames, with short spines at pore vertices which are variable in shape and size, and vary from three-bladed to acutely conical. Primary spines are strongly bladed, moderate to quite long, and taper distally. Primary spines are composed of alternating sharp to rounded ridges, and wider, shallow grooves.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	346	277	320	214
Length of primary spines	-	307	453	214

Remarks: This species apparently branched off from *P. galeata*, and seems to have given rise to the lineage *P. superba- P. spinosissima* ranging through the Cenomanian-Turonian interval.

Comparisons: *P. magnifica* is distinguished from *P. galeata* by having only six or four primary spines instead of twelve. In addition the spines of *P. magnifica* are generally longer.

Pseudoacanthosphaera superba (SQUINABOL, 1904)

Pl. 54, figs. 5-10

Species code 342

1904 *Trisphaera superba* n. sp. SQUINABOL, p. 190, pl. 2, fig. 13.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 2, fig. 13 may be considered as the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 65 specimens.

Description: Test as with genus having quite spinose spherical cortical shell armed with six, four or two primary spines. Meshwork composed of very small irregular pore frames with short to moderate long spines at pore vertices. Secondary spines generally faintly three-bladed and bifurcated. Primary spines are usually very long, strongly bladed, and taper distally. They are composed of alternating massive, rounded ridges and much wider, slightly deep, grooves. Occasionally, primary spines display ragged sharp ridges at tips.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	196	198	227	172
Length of primary spines	393	251	427	147

Remarks: *P. superba* evolved from *P magnifica* by strongly increasing the secondary spinose stages, developing secondary bifurcated spines. In addition the cortical shell tends to develop four or two rather than six spines, and it. gradually becomes smaller.

Comparisons: This species is distinguished from *P. magnifica* by possessing well developed secondary spines, which are commonly bifurcated.

Pseudoacanthosphaera spinosissima (SQUINABOL, 1904)

Pl. 54, figs. 11-15
Species code 327

1904 *Xiphosphaera spinosissima* n. sp. SQUINABOL, p. 188, pl. 2, fig. 9.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 2, fig. 9 may be considered as the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 15 specimens.

Description: Test as with genus having a small spinose cortical shell and two moderately long primary spines. Cortical shell with meshwork composed of small irregular sized, hexagonal pore frames; pores are regularly arranged. Small secondary spines are developed at pore vertices. Primary spines are strongly three-bladed, composed of alternating sharp ridges and wide grooves about twice the width of the ridges. Primary spines have longitudinally ragged sharp blades and showing moderate torsion.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	191	125	158	117
Length of primary spines	393	203	233	183

Remarks: This species is regarded as an evolutionary off shoot of *P. superba*. Range of variability of *P. spinosissima* and *P. superba* overlaps slightly , but the former species always has two well-ragged primary spines and a cortical shell with a poorly developed spinose stage.

Comparisons: *P. spinosissima* is distinguished from all other of the genus by possessing only two primary spines with strongly ragged longitudinal sharp ridges.

GENUS **TRIACTOMA** RÜST, 1885

Synonyms: *Staurostylus* HAECKEL, 1881; *Triactis* HAECKEL, 1881; *Tripocyclia* HAECKEL, 1881; ? *Trisphaera* VINASSA, 1900; *Suna* WU, 1986; *Neotripocyclia* PESSAGNO & YANG (in PESSAGNO *et al.*, 1989).

Type species: *Triactoma tithonianum* RÜST, 1885, subsequent designation by Campbell (1954).

Description: Test as with family having spherical, subspherical, or cylindrical cortical shell. Test usually armed with three or four blade-like primary spines. Cortical shell triangular, circular, or hexagonal in outline, and occasionally with upper and lower surfaces only slightly flattened. Spines may be radiating at approximately 120 degrees or are situated tetrahedrally. Meshwork composed of polygonal pore frames, showing regular arrangement. Primary spines have alternating longitudinal ridges and groves.

Remarks: The representatives of this genus are close related to *Staurosphaeretta*. Both genera display the same kind of cortical shell with a more or less identical ornamentation, but the former is distinguished by its cortical shell with a triangular or tetrahedral arrangement of primary spines.

Range: Early Jurassic (Pliensbachian) to Coniacian.

Triactoma hybum FOREMAN, 1975

Pl. 54, figs. 16-18
Species code 297

	1975	*Triactoma hybum* new species FOREMAN, p. 609, pl. 2F, fig. 6, 7 ?; pl. 3, figs. 7, 9.
	1981	*Triactoma hybum* FOREMAN. - SCHAAF, p. 440, pl. 12, fig. 7.
	1983	*Triactoma hybum* FOREMAN. - ORIGLIA-DEVOS, p. 44, pl. 2, figs. 2-5.
	1986	*Triactoma echiodes* FOREMAN. - OKAMURA & MATSUGI, p. 125, pl. 4, fig. 12.
	1986	*Suna geometrica* gen. et sp. nov. WU, p. 357, pl. 2, figs. 12, 13.
	1988	*Triactoma hybum* FOREMAN. - THUROW, p. 407, pl. 9, fig. 11.
	1989	*Triactoma hybum* FOREMAN. - TUMANDA, p. 35, pl. 1, fig. 6.
non	1992	*Triactoma* sp. cf. *T. hybum* FOREMAN. - STEIGER, p. 31, pl. 3, fig. 8.
	1992	*Triactoma hybum* FOREMAN. - TAKETANI & KANIE, text-fig. 3. 8.
	1994	*Suna hybum* (FOREMAN). - JUD, p. 111, pl. 22, figs. 2-3.

Holotype: Is the specimen figured and described by Foreman (1975) on pl. 3, fig. 7. The holotype has been reported from the top of Eucyrtis tenuis zone (early Aptian) of the North Pacific Ocean (DSDP, Leg 32; Core 306-14, CC).

Photographed material: 5 specimens.

Description: *Triactoma* with elevated cylindrical cortical shell bearing three stout primary spines. Upper and lower surfaces of cortical shell with strongly raised central area. Meshwork composed of hexagonal pore frames arranged quincuncially in concentric rings. Primary spines strongly bladed and disposed radially at 120 degrees; spines approximately equal in length to the diameter of the cortical shell. Spines composed of three wide rounded ridges that alternate with three narrow grooves. Ridges and grooves straight, lacking torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	98	122	133	106
Length of primary spines	184	131	147	113

Comparisons: *T. hybum* is distinguished from all other congeneric species by its singular cylindrical cortical shell with slightly raised central area. This species probably evolved from a *Triactoma* with nearly cylindrical cortical shell, as illustrated by *T. echiodes* FOREMAN, 1973b, at early Cretaceous times.

Triactoma cellulosa FOREMAN, 1973b

Pl. 54, figs. 19-23
Species code 175

1973b *Triactoma cellulosa* new species FOREMAN, p. 259, pl. 2, figs. 9, 10; pl. 16, fig. 9.

pars ? 1973b *Triactoma* sp. cf. *T. echiodes* FOREMAN. - FOREMAN, p. 260, pl. 3, fig. 2; non fig. 3.
1983 *Triactoma cellullosa* FOREMAN. - ORIGLIA-DEVOS, p. 41, pl. 1, fig. 11.

Holotype: This is the specimen figured and described by Foreman (1973b) on pl. 2, fig. 9. The holotype has been reported from the Acaeniotyle tribulosa assemblage (late Aptian-Albian ?) of the northwest Pacific Ocean (DSDP, Leg 20).

Photographed material: 35 specimens.

Description: Test as with genus possessing subspherical cortical shell, which varies form subcircular to slightly triangular in outline. Meshwork composed of hexagonal pore frames of very regular size and shape. Cortical shell with meshwork disposed in quincuncial arrangement. Pore frames having well developed sharp nodes at pore frames vertices. Primary spines threebladed; most commonly disposed radially at 120 degrees but the angles may vary slightly. Terminal portion of each spine with crown-like structure, produced by small extensions of ridges. Primary spines slightly twisted.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	143	132	144	123
Length of primary spines	152	121	142	92

Remarks: The origin of this species has not been investigated in detail. It seems probable that a phylogenetic link exists with some Barremian representatives of the genus or arise from *T. hybum*. Through its stratigraphic range the diameter of the cortical shell and the interradial angles of primary spines change moderately. *T. cellulosa* seems to be the common origin of the wealth of species of *Triactoma* ranging through the Mid-Cretaceous.

Comparisons: *T. cellulosa* is distinguished from all other co-occurring species of *Triactoma* by possessing crown-like extensions at the tips. It differs from its descendant *T. parva*, in having only three primary spines radiating equatorially instead of four spines in a tetrahedral arrangement.

Triactoma paronai (SQUINABOL, 1903b)

Pl. 55, figs. 1-8
Species code 192

1903b *Theodiscus Paronai* n. sp. SQUINABOL, p. 119, pl. 8, fig. 19.
? 1983 *Archaeospongoprunum macrostylum* (RÜST). - ORIGLIA-DEVOS, p. 127, pl. 14, fig. 31.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 8, fig. 19 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 27 specimens.

Description: Triactoma having a small cortical shell, circular to subtriangular in outline, and armed with three sturdy, blade-like spines. Cortical shell with slightly flattened upper and lower surfaces. The diameter and shape of the cortical shell varies from small and triangular in outline to relatively large and spherical. The angle between adjacent spines varies, but usually presents two angles of 90 and one angle of 120 degrees. Meshwork composed of very small hexagonal pore frames, showing quincuncial arrangement. Primary spines expand slightly distally. They are strongly three-bladed, composed of narrow, rounded ridges and wider grooves (twice or up to three times the width of ridges). Spines display moderate to weak torsion.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	100	104	150	80
Length of primary spines	315	256	290	230

Remarks: This species shows a wide range of variation throughout its stratigraphic record in shape and size of both cortical shell and primary spines. The interradial angles vary moderately. *T. paronai* apparently branched off from *T. cellulosa,* and it seems to have given rise to *T. compressa* by progressively increasing the flatness of the cortical shell, giving the descendant a cylindrical to discoid, quite spongy, cortical shell. This species should be regarded as a younger homoemorphous of *T. luciae* JUD (1994, p. 115, pl. 23, figs. 8, 9) which existed during Early Cretaceous times. Apart from their strongly morphologic resemblance, *T. luciae* presents a permanently triangular outline, slightly smaller primary spines, and crown-like expansions at tips.

Comparisons: *T. paronai* differs from *T. cellulosa* by having much smaller cortical shell, longer primary spines and by its less regular interradial angles. It usually has two spines at 180 degrees.

Triactoma compressa (SQUINABOL, 1904)

Pl. 55, figs. 9-13
Species code 171

1904 *Spongotripus compressus* n. sp. SQUINABOL, p. 206, pl. 6, fig. 7.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 6, fig. 7 may be considered the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 17 specimens.

Description: Test as with genus possessing a relatively large discoid cortical shell and three primary spines in the same plane radiating from the periphery at approximately 120 degrees. Cortical shell quite spongy, composed of powdery meshwork. Upper and lower surface of cortical shell flat or only slightly convex, having a small raised central area. Diameter of cortical shell quite variable, but regular in height. Test growing preferentially at upper and lower surfaces of cortical shell by addition of meshwork at the periphery, resulting in a wheel rim-like structure. Cortical shell with concave sides. Primary spines, sturdy, three-bladed, composed of alternating sharp ridges and slightly wider grooves. Spines exhibit only weak torsion distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	257	143	167	108
Length of primary spines	157	187	217	150

Remarks: This species seems to have evolved from those representatives of *T. paronai* with the smallest sized cortical shell, by strongly increasing the spongy meshwork radially. *T. compressa* has a heterochronous homoemorphic species ranging through the late Berriasian-Valanginian interval (cf. unpublished specimens from Jud's material), which develops a much wider cortical shell, and possesses vertical sides. *T. compressa* did not leave any known descendants.

Comparisons: *T. compressa* is distinguished from all other congeneric species ranging through the Mid-Cretaceous, by possessing flattened cylindrical cortical shell with concave lateral sides.

Triactoma hexeris nov. sp.

Pl. 55, figs. 14-21
Species code 188

1986 *Triactoma echoides* FORE. - THUROW & KUHNT, text-fig. 9. 19.

Holotype: Specimen 6436 (pl. 55, fig. 16). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *hexeris* -is (f), meaning a boat with six oars on each side.

Photographed material: 151 specimens.

Description: Test as with genus having subspherical cortical shell and three, sturdy, blade-like primary spines. Cortical shell with lateral sides cut off by vertical planes showing a hexagonal outline in a view perpendicular to the equatorial plane. Upper and lower surfaces slightly convex. Meshwork is composed of small hexagonal pore frames and exhibits quincuncial arrangement. Primary spines three-bladed, formed by alternating rounded grooves and narrow, slightly deep, grooves. Spines generally display a more or less regular length, about two-thirds the diameter of the cortical shell.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	217	194	217	183
Length of primary spines	150	137	167	92

Remarks: This species represents an evolutionary off shoot of *T. cellulosa*. Both species present a range of variation slightly superposed, but in late Cenomanian times *T. hexeris* rapidly shows populations with well-pronounced hexagonal outline.

Comparisons: *T. hexeris* is distinguished from all other described species of the genus by always having a hexagonal outlined cortical shell, with three sturdy primary spines radiating at angles of 120 degrees from the middle of straight lateral sides.

Triactoma parva (SQUINABOL, 1903b)

Pl. 54, figs. 24-27
Species code 222

1903b *Theodiscus parvus* n. sp. SQUINABOL, p. 119, pl. 8, fig. 20.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 20 is considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 32 specimens.

Description: Test as with genus possessing spherical cortical shell and armed with four primary spines. Meshwork composed of small to moderate hexagonal pore frames bearing sharply pointed frames. Primary spines equal in length, relatively short, and approximately two-third the diameter of the cortical shell. Primary spines display a tetrahedral arrangement; the spines taper distally, are strongly bladed, and are composed of three alternating wide grooves and three very sharp ridges.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	94	158	171	141
Length of primary spines	97	107	121	83

Remarks: This species seems to have evolved from *T. cellulosa*, by acquiring one additional fourth primary spine, and by changing the arrangement of primary spines from triangular into tetrahedral. Some specimens occasionally show small crown-like expansions at tips.

Comparisons: *T. parva* differs from all other congeneric species in that it has a spherical cortical shell bearing four primary spines radiating with tetrahedral symmetry.

FAMILY **PYRAMISPONGIIDAE** KOZUR & MOSTLER, 1978

Type species: *Pyramispongia* PESSAGNO, 1973.

Tetrahedral spumellarians with very spongy meshwork, having only a tetrahedral cortical shell. This family seems to be monogeneric, so the diagnoses are referred to the genus.

GENUS **PYRAMISPONGIA** PESSAGNO, 1973

Type species: *Pyramispongia magnifica* PESSAGNO, 1973, by original designation. This species is considered here as a synonym of *Pyramispongia glascockensis* PESSAGNO, 1973.

Diagnosis: Spumellarians having tetrahedral symmetry. Test possesses a very thick spongy cortical shell armed with four tetrahedrally radiating primary spines. Size and shape of primary spines very variable.

Remarks: It seems likely that the representatives of *Pyramispongia* are closely related to the genus *Triactoma*. During the Mid-Cretaceous numerous specimens of *Triactoma* have been observed with a marked tendency to modify the general structure of the test. These forms generally present a tetrahedral arrangement of spines or a strongly developed spongy meshwork upon the cortical shell.

Comparisons: *Pyramispongia* is distinguished from all other Cretaceous Spumellarians by possessing a strongly spongy tetrahedral cortical test.

Range: Latest Albian to Coniacian.

Pyramispongia costarricensis (SCHMIDT-EFFING, 1980)

Pl. 55, figs. 22-25
Species code 83

1980 *Obesacapsula costarricensis* n. sp. SCHMIDT-EFFING, p. 249, text-fig. 17.
1983 *Obesacapsula* (?) *costaricaensis* SCHMIDT-EFFING. - ORIGLIA-DEVOS, p. 183, pl. 21, figs. 1, 2.

Holotype: The specimen figured by Schmidt-Effing (1980, on text-fig. 17. The holotype has been reported from the Cenomanian of Capas del Sardinal, Santa Elena peninsula (Costa Rica).

Photographed material: 11 specimens.

Description: Test as with genus having a very thick spongy cortical sell. Test tetrahedron-like, formed by four triangular planiform or slightly convex sides. Test with four short three-bladed spines, each one situated at the vertices of the tetrahedral structure. Vertices of cortical shell slightly rounded. Meshwork of cortical shell quite spongy and comprised of very small pentagonal and hexagonal pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	260	263	300	241
Length of primary spines	167	48	67	42

Remarks: This species apparently evolved from *T. cellulosa* by acquiring a more spongy latticed meshwork and a permanently tetrahedral cortical shell. *P. costarricensis* evolved into *P. glascockensis*.

Comparisons: *P. costarricensis* differs from the type species by having a tetrahedral cortical shell formed by four triangular, quite spongy, sides.

Pyramispongia glascockensis PESSAGNO, 1973

Pl. 56, figs. 1-5
Species code 218

1973 *Pyramispongia glascockensis* n. sp. PESSAGNO, p. 79, pl. 21, figs. 2-5.
1973 *Pyramispongia magnifica* n. sp. PESSAGNO, p. 80, pl. 19, figs. 5-6; pl. 20, figs. 1-6; pl. 21, fig. 1.
1976 *Pyramispongia glascockensis* PESSAGNO. - PESSAGNO, p. 37, pl. 1, fig. 9 (= specimen of Pessagno, 1973, pl. 21, fig. 4).
1976 *Pyramispongia magnifica* PESSAGNO. - PESSAGNO, p. 37, pl. 4, fig. 6 (= specimen of Pessagno, 1973, pl. 19, fig. 5).
1977c *Pyramispongia glascockensis* PESSAGNO. - PESSAGNO, p. 31, pl. 2, fig. 14 (= specimen of Pessagno, 1973, pl. 21, fig. 4).
1980 *Pyramispongia glascockensis* PESSAGNO. - OKAMURA, pl. 21, fig. 11.
1982 *Pyramispongia* sp. *A*. OKAMURA *et al.*, p. 100, pl. 16, figs. 8, 9.
1982 *Pyramispongia glascockensis* PESSAGNO. - TAKETANI, p. 51, pl. 10, fig. 12.
1986a *Pyramispongia* sp. SUYARI, pl. 9, fig. 12; pl. 17, fig. 11.
1986 *Pyramispongia glascockensis* PES. - THUROW & KUHNT, text-fig. 9. 4.
1988 *Pyramispongia glascockensis* PESSAGNO. - THUROW, p. 405, pl. 2, fig. 23.
non 1988 *Pyramispongia glascockensis* PESSAGNO. - TUMANDA, p.39, pl. 6, fig. 11 (= *P. spica*)
1992 *Pyramispongia glascockensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. o.

Holotype: The specimen described and figured by Pessagno (1973) on pl. 21. figs. 2-5. The holotype has been reported from locality NSF 350, early Cenomanian portion of Antelope shale/Fiske Creek Formation, California Coast Ranges.

Photographed material: 108 specimens.

Description: Test as with genus having subpyramidal cortical shell formed by four cupolas in tetrahedral symmetry. Cortical shell with very spongy meshwork comprised of very irregular polygonal pore frames. Base of each cupola strongly inflated, forming bulging rings, which are circular to subtriangular in outline and develop a coarser meshwork with tiny spines at pore vertices. These rings are connected, forming a tetrahedron with curved edges (pl. 56, fig. 3). A sturdy primary spine is situated at the vertices of each cupola. Primary spines are generally long, and strongly three-bladed, they taper and occasionally exhibit slight torsion.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	240	203	217	192
Length of primary spines	70	152	175	125

Remarks: *P. glascockensis* is considered as an evolutionary offshoot of *P. costarricensis*. This species shows a weak range of variability. The most noticeable modifications are related to the development of spongy meshwork and the number of secondary spines that may occur upon the cortical shell.

SUPERFAMILY **PYLONIACEAE** HAECKEL, 1881

This group has been reviewed recently by Dumitrica (1989); the reader is referred to that paper for more detailed information.

FAMILY **CAVASPONGIIDAE** PESSAGNO, 1973

Type genus: *Cavaspongia* PESSAGNO, 1973.

Spumellariina of variable shape, having a latticed medullary shell and a very spongy cortical shell comprised of polygonal pore frames arranged in an indeterminate number of concentric layers. Cortical shell connected by radial beams to the latticed medullary shell. Shape generally varying from triangular to subspherical. Test three-armed in outline, arms equal in length and radiate from the central area in the same plane at approximately 120 degrees. Rays usually terminate in short pointed spines.

GENUS **CYCLASTRUM** RÜST, 1898

Type species: *Cyclastrum infundibuliforme* RÜST, 1898, by monotypy.

Diagnosis: Spumellariina with triangular shape and spongy cortical shell. Delicate three-rayed test having distal ends connected by a thick rounded to subtriangular patagium. Rays equal in length, radiating from the central area, elliptical in cross-section. Patagium composed of very small polygonal pore frames irregularly arranged. Pore frames on rays larger, displaying longitudinal arrangement. Occasionally a faint patagium spreading between interradial angles. Rays terminate in a spine.

Remarks: It seems likely that *Cyclastrum* gave rise to *Cavaspongia* by a strong development of thick rays and dense patagium throughout the interradial angles. The lineage of this genus was well-developed through Early Cretaceous times.

Comparisons: *Cyclastrum* differs from its descendant *Cavaspongia* by possessing a subcircular instead of a three-armed to triangular test in outline. In addition, the patagium is well developed at the periphery connecting the tips and outgrowing inward

Range: Late Berriasian to late Aptian.

Cyclastrum infundibuliforme RÜST, 1898

Pl. 56, fig. 6
Species code 386

1898 *Cyclastrum infundibuliforme* n. sp. RÜST, p. 28, pl. 9, fig. 5.
1916 *Cyclastrum infundibuliforme* RÜST. - FISCHLI, p. 46-47, text-figs. 48-49.
1977 *Cyclastrum infundibuliforme* RÜST. - MUZAVOR, p. 76, pl. 2, figs. 12, 13.
1981 *Cyclastrum infundibuliforme* RÜST. - SCHAAF, p. 433, pl. 14, fig. 8.
1988 *Cyclastrum infundibuliforme* RÜST. - THUROW, p. 400, pl. 9, fig. 21.
1992 *Cyclastrum infundibuliforme* RÜST. - BAUMGARTNER, p. 319, pl. 5, figs. 1, 6.
1994 *Cyclastrum infundibuliforme* RÜST. - JUD, p. 72, pl. 8, figs. 1-3.
1994 *Cyclastrum rarum* (SQUINABOL). - JUD, p. 74, pl. 8, fig. 9.

Holotype: The specimen illustrated by Rüst (1898) on pl. 9, fig. 5 may be regarded the holotype. This specimen has been reported from the Maiolica Formation (Neocomian) at the locality of Cittiglio, Province of Varese (southern Alps, N Italy).

Photographed material: 2 specimens.

Description: Test as with genus, three-rayed with distal terminations connected by a thick triangular to rounded patagium. Usually, a very delicate patagium may cover the entire of the three-rayed structure on both sides. Rays slender, blunt-ended, bearing subspherical tips.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	524	488	524	420

Remarks: This species shows weak variation in the development of patagium at interradial areas. Occasionally the rays may grow out at the tip slightly extending it outside the area limited by the thick rounded patagium.

Comparisons: *C. infundibuliforme* is distinguished from *C. satoi* by possessing large blunt tips and a delicate patagium extending between the interradial areas.

Cyclastrum satoi (TUMANDA, 1989)

Pl. 56, fig. 7
Species code 252

1989 *Orbiculiforma satoi* n. sp. TUMANDA, p. 29, pl. 5, fig. 9; pl. 10, fig. 14.
1994 *Spongotripus* (?) *satoi* (TUMANDA). - JUD, p. 108, pl. 21, fig. 3.

Holotype: The specimen described and figured by Tumanda (1989), on pl. 5, fig. 9. The holotype has been reported from the Furebira formation, Usotan section (Hauterivian-Barremian) in the Esashi Mountain area (Northern Hokkaido, Japan).

Photographed material: 3 specimens.

Description: Test as with genus, having a well-developed patagium throughout. Test subcircular to subtriangular in outline, with marked patagium toward the periphery, slightly more elevated than central area. Three-rayed structure weakly pronounced because of the strong development of the patagium; only the central area slightly raised. Rays taper to a short, massive central spine; auxiliary spines may occur at ray tips.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	370	340	370	315

Remarks: This species seems to have evolved from *C. infundibuliforme* by a strong development of the patagium between interradial angles, and by acquiring tapering spines at tips.

Comparisons: *C. satoi* is distinguished from all other species of *Cyclastrum* by always exhibiting a very thick patagium throughout. It differs from representatives of *Cavaspongia* in not presenting a three-rayed outline, because the patagium is densely developed encircling the periphery and growing inward toward the central area. This centripetal development is characteristic of *Cyclastrum*, whereas in *Cavaspongia* the patagium is developed centrifugally.

GENUS **CAVASPONGIA** PESSAGNO, 1973

Synonym: *Dumitricaia* PESSAGNO, 1976.

Type species: *Cavaspongia antelopensis* PESSAGNO, 1973, by original designation.

Diagnosis: Spumellariina with triangular to three-armed shape having a latticed medullary shell and a spongy cortical shell comprised of polygonal pore frames arranged in an indeterminate number of concentric layers. Test biconvex with a three-rayed cortical shell. Spongy cortical shell connected to the latticed medullary shell by three massive rays which are continuous with central spines at ray tips. Medullary shell also attached to the cortical shell by means of an indeterminate number of thin, radially arranged solid spines. Test may develop a thick patagium between interradial angles.

Remarks: *Cavaspongia* is tentatively regarded as an offshoot of earliest *Cyclastrum*, as illustrated by *C. satoi*. Their common characters are the thick spongy meshwork and presence of patagium. It seems to have evolved by acquiring a three-armed test with a dense patagium closely related to the three-armed central structure. Moreover, the patagium expands evenly interradially. and in a centrifugal manner. On the other hand the patagium of *Cyclastrum* tends to be developed at the periphery connecting the distal ends of each ray and growing toward the central area (centripetal).

Comparisons: This genus differs from its possible ancestor *Cyclastrum* in possessing a three-armed to triangular test rather than one subcircular in outline. In addition, the patagium developed in *Cavaspongia* is much thicker, densely filling the interradial spaces, and developed uniformly centrifugally.

Range: Middle Albian to Campanian.

Cavaspongia euganea (SQUINABOL, 1904)

Pl. 56, figs. 8-14
Species code 142

1904	*Euchitonia euganea* n. sp. SQUINABOL, p. 204, pl. 6, fig. 1.
1976	*Dumitricaia maxwellensis* n. sp. PESSAGNO, p. 38, pl. 4, figs. 10-11.
1978a	Gen. and sp. indet FOREMAN, pl. 1, fig. 4.
1986	*Dumitricaia maxwellensis* PES. - THUROW & KUHNT, text-fig. 9. 23.
1988	*Dumitricaia maxwellensis* PESSAGNO. - THUROW, p. 400, pl. 2, fig. 22.
1991	*Dumitricaia maxwellensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 6.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 6, fig. 1 may be considered the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 53 specimens.

Description: Test as with genus, triangular to subtriangular in outline, having a moderate raised central area. Three-rayed test with a thick patagium strongly developed at interradial angles. Rays taper to a short, massive spine. Rays with meshwork comprised of subrectangular pore frames, showing a weak longitudinal arrangement. Rays expand moderately outside the patagium. Rays elliptical in cross-section.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	243	217	248	192
Diameter of central area	111	105	138	88
Length of primary rays	221	220	250	183

Remarks: The style of sculpture and the thick spongy meshwork lead us to regard this species as a probable derivative of *C. satoi*. However, because of the poor representation of these forms during late Aptian times, the stratigraphic overlap between both morphotypes has not been recognized.

Comparisons: *C. euganea* is distinguished from *C. satoi* by having well-individualized rays and a moderate raised central area. It differs from *C. helice* by possessing cylindrical instead of spatulate rays, and by lacking a well-developed spongy rim at the periphery of the central area.

Cavaspongia cilindrica nov. sp.

Pl. 56, figs. 18-24
Species code 163

Holotype: Specimen 2715 (Pl. 56, fig. 22; fig. 24 lateral view). The holotype comes from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *cilindrus* -i (m), meaning cylinder.

Photographed material: 22 specimens.

Description: Test as with genus, possessing an elevated, cylindrical central area. Three rayed test lacking patagium. Central area possesses small gates at vertical sides between interradial angles. Rays slender, taper distally;

circular to elliptical in cross-section; normally radiate at irregular angles. Rays terminate in acute central spine. Meshwork of rays composed of small rectangular pore frames in linear arrangement; central area formed of finer meshwork and rather spongy. Rays slightly expanded at tips.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	117	108	125	83
Length of primary rays	213	220	242	200

Remarks: The lineage *C. sphaerica-C. contracta* arose from *C. cilindrica* toward the lower stratigraphic range of the latter. During that interval, the ranges of variability of *C. cilindrica* and *C. sphaerica* overlapped only slightly , although *C. sphaerica* rapidly acquired a spherical, yet small, central area. The range of *C. cilindrica* also overlaps slightly with *C. californiaensis*.

Comparisons: *C. cilindrica* is distinguished from all other co-occurring species of *Cavaspongia* by its small cylindrical central area. The general form of rays, and the relatively small central area usually resemble that of its descendant *C. californiaensis,* however *C. cilindrica* possesses a more elevated and well-defined cylindrical central area

Cavaspongia helice nov. sp.

Pl. 56, figs. 15-17

Species code 172

Holotype: Specimen 3771 (pl. 56, fig. 15). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *Helice* (f), the name given to the constellation Ursa Major.

Photographed material: 10 specimens.

Description: Test as with genus, having a large central area triangular in outline. Three-rayed forms that may develop a coarse patagium surrounding the central area. Rays, slender, slightly spatulate at tips, with blunt terminations; rectangular in cross-section. Central area moderate to strong elevated, with a conspicuous spongy ring at the periphery; upper and lower surface slightly convex. Specimens without patagium exhibit gates at vertical sides between rays.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	180	256	300	180
Diameter of central area	130	156	200	130
Length of primary rays	240	237	250	220

Remarks: *C. helice* is species with a short range that evolved from *C. cilindrica* by the development of a spongy rim at the periphery of the central area and the strong expansion of a thick patagium. This species may be considered a terminal form of *C. cilindrica*.

Comparisons: *C. cilindrica* is distinguished from *C. helice* by possessing a well-developed spongy rim at the periphery of its elevated central area, by having more spatulate rays, and by the development of a thick patagium.

Cavaspongia sphaerica nov. sp.

Pl. 57, figs. 1-7
Species code 170

? 1903b F. indet. SQUINABOL, p. 143, pl. 9, fig. 12.

Holotype: Specimen 3712 (pl. 57, fig. 1). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *sphaera* -ae (f), meaning spherical.

Photographed material: 33 specimens.

Description: Test as with genus, possessing a conspicuous, large spherical central area. These are three-rayed forms without patagium and exhibit rays radiating approximately at 120 degrees. Rays are large, circular in cross-section, taper distally and terminate in an acutely conical central spine. Meshwork of rays composed of rectangular pore frames, displaying linear arrangement. Meshwork of central area small, subcircular, spongy, fairly uniform in size and irregularly arranged.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	163	159	175	150
Length of primary rays	208	212	229	202

Remarks: This species evolved directly from *C. cilindrica* by a strong inflation of the central area, which rapidly becomes spherical. Ranges of variation of *C. sphaerica* and *C. contracta* overlap slightly.

Comparisons: *C. sphaerica* is distinguished from all other co-occurring species of *Cavaspongia* by its distinctive and permanently spherical central area.

Cavaspongia contracta nov. sp.

Pl. 57, figs. 8-11
Species code 329

Holotype: Specimen 5710 (pl. 57, fig. 10). The holotype comes from locality no. Gb-84.40, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *contractus* -a -um, meaning tight.

Photographed material: 13 specimens.

Description: Test as with genus, having a poorly differentiated and relatively small central area. Test armed with three rays radiating at angles of approximately 120 degrees. Rays circular in cross-section, acutely conical, and tapering to a sharply pointed central spine. Meshwork of central area and rays small to relatively coarse, spongy, and showing irregular arrangement; sometimes meshwork displays sublinear arrangement on rays.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	108	117	125	108
Length of primary rays	204	207	232	200

Remarks: *C. contracta* is an evolutionary offshoot of *C. sphaerica*. Through much of its stratigraphic range *C. sphaerica* exhibits a very large spherical central area. Nevertheless, at early Cenomanian times a few representatives progressively attain less inflated central area, leading to specimens with a more three-rayed outline and nearly planiform surfaces, a shape typical of *P. contracta*.

Comparisons: *C. contracta* differs from the type species by its less raised central area and by possessing a much finer meshwork on upper and lower surfaces.

Cavaspongia californiaensis PESSAGNO, 1973

Pl. 57, figs. 12-16
Species code 202

1973 *Cavaspongia californiaensis* n. sp. PESSAGNO, p. 77, pl. 19, figs. 2-4.
1976 *Cavaspongia californiaensis* PESSAGNO. - PESSAGNO, p. 37, pl. 4, figs. 2-3 (= holotype refigured).
non 1986 *Cavaspongia californiaensis* PES. - KUHNT *et al.*, pl. 8, fig. 1 (= *C. antelopensis*).
non 1988 *Cavaspongia californiaensis* PESSAGNO. - THUROW, p. 398, pl. 2, fig. 21 (= *C. antelopensis*).
non 1992 *Cavaspongia californiensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. q (= *C. antelopensis*).

Holotype: The specimen described and figured by Pessagno (1973) on pl. 19. figs. 2-3. The holotype was reported from locality NSF 519, early Turonian portion of Antelope shale/Fiske Creek Formation, California Coast Ranges.

Photographed material: 19 specimens.

Description: Test as with genus, having a very small central area from which three ellipsoidal rays. radiate Meshwork comprised of very small polygonal pore frames irregularly arranged. Rays terminate in a short, delicate spine. Numerous tiny spines radiating equatorially at the periphery of rays. Test lacking patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of primary rays	180	201	220	180

Remarks: *C. californiaensis* obviously evolved from *C. cilindrica* by progressive reduction of central area and resorption of spines at ray tips. Throughout its short stratigraphic range *C. californiaensis* shows only weak variations on the degree of inflation of ray and the size of the small central area.

Comparisons: This species is distinguished from co-occurring members of the genus *Cavaspongia* by possessing a strongly reduced central area from which three spongy rays radiate rapidly expanding distally. It differs from the type species by its less raised central area, its ellipsoidal rays slightly rounded at tips, and its much finer meshwork on upper and lower surfaces.

Cavaspongia antelopensis PESSAGNO, 1973

Pl. 57, figs. 17-23
Species code 164

1973 *Cavaspongia antelopensis* n. sp. PESSAGNO, p. 76, pl. 18, figs. 4-6; pl. 19, fig. 1.
1976 *Cavaspongia antelopensis* PESSAGNO. - PESSAGNO, p. 37, pl. 4, figs. 4, 5.
1986 *Cavaspongia californiaensis* PES. - KUHNT *et al.*, pl. 8, fig. 1.
1986 *Cavaspongia antelopensis* PES. - THUROW & KUHNT, text-fig. 9. 3.
1988 *Cavaspongia californiaensis* PESSAGNO. - THUROW, p. 398, pl. 2, fig. 21.
1991 *Cavaspongia antelopensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 7.
1992 *Cavaspongia antelopensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. n.
1992 *Cavaspongia californiensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. q.

Holotype: This is the specimen described and figured by Pessagno (1973) on pl. 18. figs. 4-5. The holotype has been reported from locality NSF 519 early Turonian portion of Antelope shale/Fiske Creek Formation, California Coast Ranges.

Photographed material: 53 specimens.

Description: Test as with genus. Test large with pronounced three-armed outline and having a highly raised central area. Test possesses triangular outline. Rays in lateral view, wedging out from central area to tip. The rapid increase in height of central area produces the occurrence of large gates at interradial vertical sides. Rays taper distally, and terminate in a sharp terminal spine; occasionally rays bear two lateral pairs of lateral spines. Meshwork relatively coarse, composed of irregularly arranged polygonal pore frames throughout. Few small nodes may occur at pore junctions.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of primary rays	187	192	233	167

Remarks: *C. antelopensis* apparently arose from a species slightly convex, like *C. contracta.* Although the meshwork becomes relatively coarser, the most conspicuous modification is shown by the enormous and rapid inflation of the central area of the test. Simultaneous by three gates appear, laterally disposed at interradial sides, which are directly controlled by the rapid growth of the central area.

Comparisons: *C. antelopensis* is distinguished from its ancestor *C. contracta* by its coarser meshwork and its strongly subtriangular central area. A common feature is the presence of large lateral gates.

Cavaspongia tricornis nov. sp.

Pl. 57, figs. 24-28
Species code 187

Holotype: Specimen 7116 (pl. 57, fig. 24). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *tricornis* -e (n), meaning something having three horns.

Photographed material: 48 specimens.

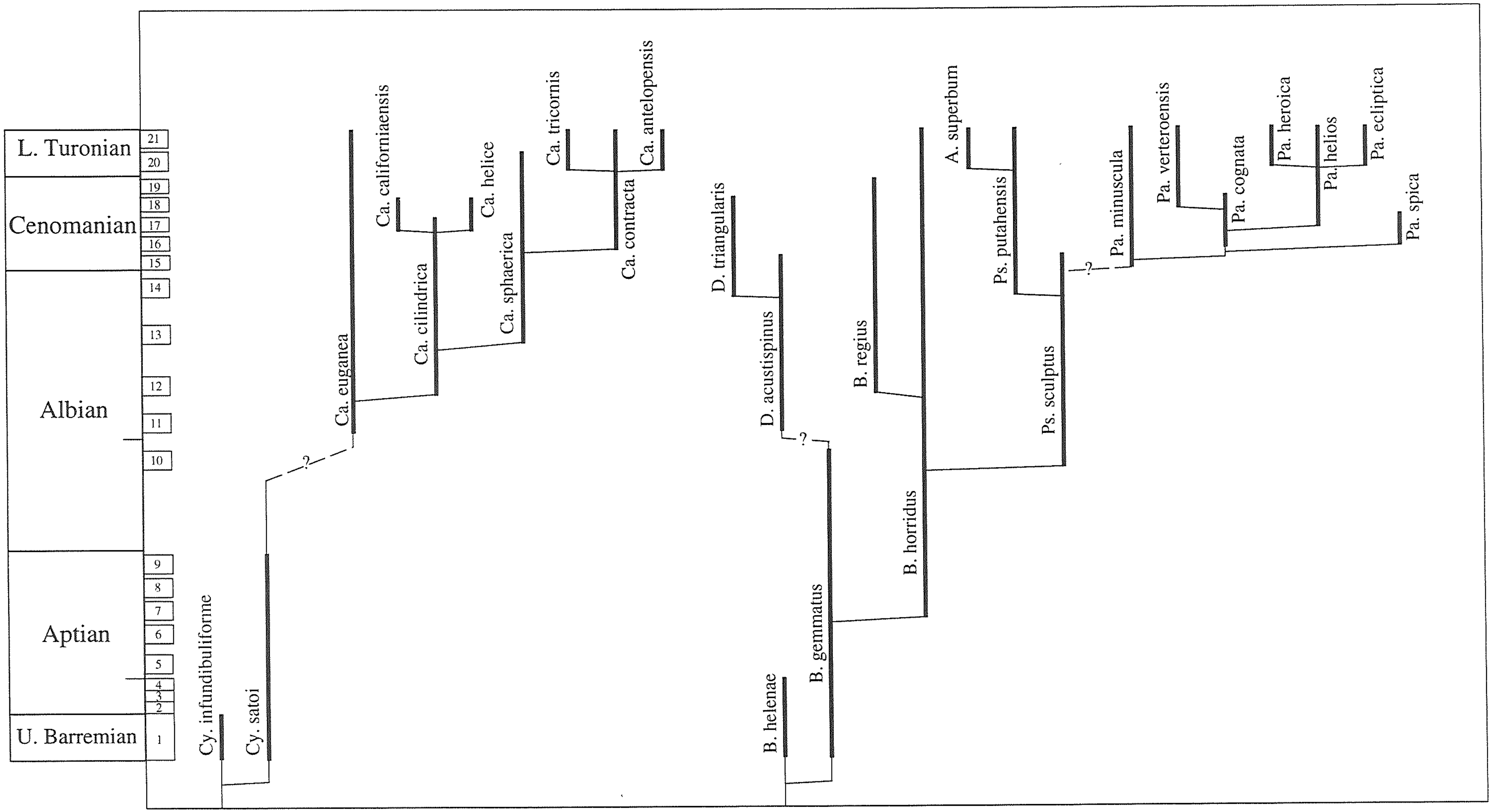

Fig. 30.- Stratigraphic range and possible phyletic relationships of genera and species of the families Cavaspongiidae and Pseudoaulophacidae.

Description: Test as with genus. Test possesses a pronounced three-rayed outline and strongly elevated central area. Rays in lateral view wedging out from central area to tip. Rays equal in length and radiate at approximately 120 degrees. Rays develop strong central three-bladed spine and two pairs of lateral spines. Test gradually develops large gates at interradial vertical sides. Gradual increase in height of central area occurs simultaneously with this change in ornamentation. Meshwork coarse throughout, comprised of polygonal pore frames. Pores exhibit irregular arrangement. Meshwork bearing nodes at pore vertices. Central spines triradiate in cross-section, composed of sharp, narrow ridges and slightly wider grooves. Test lacking patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	138	139	162	115
Length of primary rays	192	188	196	181

Remarks: Intermediate transitional forms indicate that *C. tricornis* evolved directly from *C. contracta*, which it resembles in shape and which also shows an incipient development of tapering spines at tips. *C. tricornis* rapidly develops central and lateral spines at ray tips and its test becomes progressively more elevated in the central area.

Comparisons: *C. tricornis* is distinguished from other members of the lineage (Fig. 30) by its robust long, three-bladed spines, and the regular arrangement of pore frames.

FAMILY **PSEUDOAULOPHACIDAE** RIEDEL, 1967a

Type genus: *Pseudoaulophacus* PESSAGNO, 1963.

Spongy triangular to discoid spumellarians, with all or part of the surface covered by a regular meshwork of equilateral triangular to hexagonal pore frames, which are arranged in noticeably concentric layers. Upper and lower surfaces, planiform, moderate to strongly convex. Test with variable number of spines radiating from the central area in approximately the same plane. The different type of ornamentation (mostly tubercles or spines) that it may develop on either convex side, as well as the number and arrangement of primary spines, are regarded here as distinguishing features at the generic assignment rather than at the specific level.

The first appearance of this group seems to have occurred in the Middle-Late Jurassic. Conti & Marcucci (1991) have recently illustrated some specimens from the Callovian-Oxfordian? of the northern Apennines.

GENUS **BECUS** WU, 1986

Type species: *Becus gemmatus* WU, 1986, by original designation.

Diagnosis: Test lenticular in cross-section, triangular to subcircular in outline. Test armed usually with three sturdy, primary spines, radiating at each corner of the test. Primary spines of variable size and shape, circular or triradiate in cross-section. Numerous secondary spines radiating at the periphery. Test composed of multiple layers of more or less regular, concentrically arranged meshwork. Spongy meshwork composed of small to large polygonal pore frames, bearing small nodes and short spines at pore vertices. Upper and lower surface of the test convex or planiform: it may develop in its center a conspicuous structure of large tubercles and/or massive spines.

Remarks: *Becus* seems to be the older known Cretaceous Pseudoaulophacidae. This genus represents the origin of numerous forms typical of Mid-Late Cretaceous. *Becus* seems to have given rise to *Dispongotripus* and *Pseudoaulophacus*.

Comparisons: *Becus* is distinguished from *Alievium* by possessing strongly developed spines at pore vertices throughout its surface. Additional difference is shown by the central area, which develops large, massive tubercles or sturdy spines.

Range: Late Tithonian to early Turonian.

Becus helenae (SCHAAF, 1981)

Pl. 58, figs. 1-3
Species code 304

?	1899	*Tripodictya elegantissima* n. f. VINASSA, p. 231, pl. 28 [2], fig. 3.
?	1901	*Xyphostylus De Stefanii* n. f. VINASSA, p. 501, pl. 1, fig. 13.
	1973b	*Alievium* sp. FOREMAN, p. 262, pl. 9, figs. 1, 2.
non	1974	*Tripodictya elegantissima* VINASSA. - RENZ, p. 799, pl. 1, figs. 13, 14-15 (= *P. sculptus* ?); pl. 9, fig. 5.
	1975	*Alievium* spp. FOREMAN, p. 613, pl. 2D, figs. 7, 8; pl. 5, fig. 14.
	1977c	*Alievium* sp. *A*. PESSAGNO, p. 29, pl. 3, fig. 10, 18.
?	1979	*Alievium* sp. FOREMAN. - NAKASEKO *et al.*, p. 21, pl. 2, fig. 4
	1980	*alievium helenae* SCHAAF. - BAUMGARTNER *et al.*, p. 49, pl. 1, fig. 8.
?	1981	*Alievium* cf. *helenae* SCHAAF. - NAKASEKO & NISHIMURA, p. 142, pl. 2, fig. 1 (= specimen of Nakaseko *et al.*, 1979, pl. 2, fig. 4).
	1981	*Alievium helenae* n. sp. SCHAAF, p. 431, pl. 7, fig. 9; pl. 10, figs. 2a-b.
	1982	*Alievium helenae* SCHAAF. - OKAMURA & UTO, pl. 4, fig. 6.
	1982	*Alievium* sp. *A*. OKAMURA & UTO, pl. 4, fig. 7.
?	1982	*Alievium* (?) sp. OKAMURA & UTO, pl. 5, figs. 15, 19.
	1982	*Alievium* sp. OKAMURA & UTO, pl. 6, figs. 13, 16.
non	1983	*Alievium helenae* SCHAAF. - ORIGLIA-DEVOS, p. 114, pl. 13, figs. 6, 10; non fig. 7 (= *B. horridus*) and pl. 12, figs. 4-5 (= *D. triangularis*).
	1984b	*Alievum helenae* SCHAAF. - BAUMGARTNER, p. 755, pl. 1, figs. 8-10.
	1984	*Alievium helenae* SCHAAF. - SCHAAF, p. 112-113, text-fig. H (= holotype refigured), 1 (= specimen of Schaaf, 1981 , pl. 7, fig. 9), 2, 3a-b.
non	1984	*Alievium* sp. cf. A. helenae SCHAAF. - YAO, pl. 3, fig. 26 (= *B. gemmatus* ?).
?	1986	*Alievium* sp. AITA & OKADA, pl. 1, fig. 9.
	1988	*Alievium helenae* SCHAAF. - THUROW, p. 397, pl. 9, fig. 9.
non	1988	*Alievium ? helenae* VISHNEVSKAYA, pl. 11, fig. 7.
non	1989	*Alievum* cf. *helenae* SCHAAF - GORKA, p. 335, pl. 10, fig. 11.
	1989	*Alievium helenae* SCHAAF. - TUMANDA, p. 34, pl. 1, fig. 9.
	1992	*Alievium helenae* SCHAAF. - OZVOLDOVA & PETERCAKOVA, pl. 2, figs. 2, 7.
	1992	*Alievium helenae* SCHAAF. - STEIGER, p. 36, pl. 4, figs. 5, 6.
	1992	*Alievium helenae* SCHAAF. - TAKETANI & KANIE, text-fig. 3. 4.
	1993	*Alievium helenae* SCHAAF. - WU, p. 118, pl. 1, fig. 14.
	1994	*Alievium helenae* SCHAAF. - JUD, p. 61, pl. 3, fig. 1.

Holotype: The specimen figured and described by Schaaf (1981) on pl. 10, figs. 2a-b. The holotype has been reported from late Barremian of DSDP Leg 62, Site 463 (Core 90, interval CC), Mid-Pacific Mountains.

Photographed material: 4 specimens.

Description: Test as with genus. Test large with central part triangular in outline; upper and lower surfaces slightly convex. Cortical shell composed of very pronounced, large, triangular pore frames. Meshwork of upper and lower surfaces bearing small, rounded nodes at pore vertices; occasionally relatively long spines may also occurs at pore vertices, although they are more common at the periphery. Primary spines, long, three-bladed, composed of sharp ridges and wide shallow grooves.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	150	-	-	110
Diameter of cortical shell	105	112	125	95

Remarks: *B. helenae* may develop small nodes or even spines at pore vertices, but always possess a regular triangular arrangement of pore frames. *B. helenae* gave rise to the lineage *B. gemmatus-B. horridus*, characterized by a progressive reduction in size of pore frames and an acquisition of a more complex ornamentation.

Comparisons: *B. helenae* is distinguished from *B. gemmatus* in having most clearly triangular pore frames and by lacking large tubercles in the central area.

Becus gemmatus WU, 1986

Pl. 58, figs. 4-8

Species code 320

	1981	*Alievium* sp. SCHAAF , pl. 10, fig. 3.
?	1982	*Patellula* sp. OKAMURA & UTO, pl. 5, fig. 21.
?	1984	*Alievium* sp. cf. *A. helenae* SCHAAF. - YAO, pl. 3, fig. 26.
	1986	*Becus* (?) *barbarus* gen. et sp. nov. WU, p. 356, pl. 1, figs. 14, 17, 18, 21.
	1986	*Becus gemmatus* gen. et sp. nov. WU, p. 356, pl. 1, figs. 11, 13, 23, 24, 26.
	1988	*Pseudoaulophacus* (?) sp. *C.* THUROW, p. 404, pl. 9, fig. 17.

Lectotype: Nominal species described syntypically. I designate as lectotype the specimen illustrated by Wu (1986) on pl. 1, fig. 24. This specimen has been reported from Southern Xizang (Tibet). Wu's presumed early Cenomanian age is regarded here as Aptian.

Photographed material: 18 specimens.

Description: Test as with genus, possessing a slightly raised central area surrounded by a crown of large tubercles, well developed and with strong relief. Test large, subtriangular to nearly circular in outline. Upper and lower surfaces slightly convex. Meshwork of cortical shell composed mostly of very small irregular to subcircular pore frames. Occasionally, tiny spines are slightly developed at pore frame vertices. Primary spines solid, strongly bladed, composed of three alternating ridges and grooves; ridges sharp, grooves wider and deeper. Nine to twelve short, blade-like secondary spines radiate at the periphery.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	162	104	133	80
Diameter of cortical shell	85	177	193	126

Remarks: This species is descended directly from *B. helenae* by development of a crown of tubercles on its central area and a marked tendency to possess a more irregular and spongy meshwork. *B. gemmatus* evolved into *B. horridus* by the development of secondary spines over all its surface. *B. gemmatus* seems to be the origin of the genus *Dispongotripus*.

Comparisons: *B. gemmatus* is distinguished from all others species of the genus *Becus* by its characteristic crown-like arrangement of tubercles around a weakly elevated central area.

Becus horridus (SQUINABOL, 1903b)

Pl. 58, figs. 9-17
Species code 166

	1903b	*Theodiscus horridus* n. sp. SQUINABOL, p. 119, pl. 8, fig. 18.
pars ?	1981	*Alievium antiguum* PESSAGNO. - SCHAAF, p. 431, pl. 7, fig. 10; non pl. 8, fig. 2.
?	1981	Gen. and sp. indet. SCHAAF, pl. 7, fig. 4.
pars	1983	*Alievium helenae* SCHAAF. - ORIGLIA-DEVOS, p. 114, pl. 13, fig. 7; non figs. 6, 10; non pl. 12, figs. 4-5 (= *D. triangularis*).
	1988	*Alievium* sp. *B*. THUROW, p. 397, pl. 5, fig. 16.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 18 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 114 specimens.

Description: Test as with genus, having spinose cortical shell. Test large, subcircular in outline. Upper and lower surfaces moderately convex. Cortical shell composed of very small, massive pore frames, mostly irregular shape. Some small nodes at vertices occur at the central part; nodes irregularly disposed. Primary spines, very long, approximately equal or slightly longer than the diameter of the cortical shell. Primary spines sharply pointed distally, three-bladed, composed of narrow, sharp ridges and slightly wider grooves. Cortical shell covered with numerous secondary spines throughout, which are moderate in length and mostly circular in cross-section.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	220	172	230	66
Diameter of cortical shell	169	169	185	160

Remarks: Range of variability of *B. horridus* and *B. gemmatus* overlap slightly, although their basic differences are rapidly achieved. *B. horridus* seems to have evolved by acquiring long, sturdy secondary spines on upper and lower surfaces, while the large tubercles fade out.

Comparisons: *D. horridus* is distinguished from other congeneric species by the strong development of long secondary spines throughout the test. It differs from *D. regius* by possessing three sturdy primary spines at each corner, which are blade-like instead of conical.

Becus regius nov. sp.

Pl. 58, figs. 18-26
Species code 217

?	1983	*Pseudoaulophacus floresensis* PESSAGNO. - ORIGLIA-DEVOS, p. 117, pl. 15, figs. 4, 6, 7.

Holotype: Specimen 3676 (pl. 58, fig. 20). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *regius* -a -um, meaning royal.

Photographed material: 191 specimens.

Description: Test as with genus. Test large, flattened, subtriangular in outline. Upper and lower surfaces planiform or only slightly convex. Primary spines very long, massive, acutely conical, and circular in cross-section; spines are usually unequal in length and asymmetrically arranged. Test with very variable number of secondary spines radiating at the periphery. Secondary spines, relatively short, sharply pointed, and circular in cross-section.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	250	167	250	80
Diameter of cortical shell	255	232	260	210
Diameter of central area	120	90	120	70

Remarks: The most variable character is the length of primary spines which are irregularly developed among specimens and vary considerably even on individual specimens. There is a marked tendency for a single primary spine to develop preferentially. It becomes larger than the rest, and may even be an isolated spine. Besides these differences, the general outline of the test changes constantly through a single population. *B. regius* seems to have evolved from *B. horridus* by development of sturdy conical primary spines. No descendants have been recognized.

Comparisons: *B. regius* is distinguished from co-occurring species of *Becus* by the presence of acutely conical primary spines with very unequal lengths.

GENUS **PSEUDOAULOPHACUS** PESSAGNO, 1963

Type species: *Pseudoaulophacus floresensis* PESSAGNO, 1963, by original designation.

Diagnosis: Test lenticular in cross-section, triangular to subcircular in outline. Test armed with three sturdy, three-bladed, primary spines, which are located at vertices of triangular or subtriangular test. Variable number of short secondary spines occurs radially at the periphery. Spongy meshwork composed of small polygonal pore frames, bearing small nodes at pore vertices. Upper and lower surface of the test develops a strongly raised area (tholi) at the central part.

Remarks: *Pseudoaulophacus* seems to have evolved from *Becus* by gradually losing the well developed secondary spines at pore vertices, and by developing a strongly raised central area (tholi) on the upper and lower convex surfaces. This elevated central area replaces the conspicuous nodes and/or the spines centrally situated in the test of *Becus*.

Comparisons: *Pseudoaulophacus* is distinguished from *Alievium* by possessing tholi and by having a meshwork with less uniform and much smaller pore frames.

Range: Middle Albian to Campanian.

Pseudoaulophacus sculptus (SQUINABOL, 1904)

Pl. 59, figs. 1-4
Species code 230

1904 *Theodiscus sculptus* n. sp. SQUINABOL, p. 200, pl. 4, fig. 9.
1972 *Alievium antiquum* n. sp. PESSAGNO, p. 298, pl. 24, figs. 1-4.

?	1974	*Spongotripus* sp. cf. *Tripodictya triacummata* LIPMAN. - RENZ, p. 797, pl. 10, fig. 3.
pars ?	1974	*Tripodictya elegantissima* VINASSA. - RENZ, p. 799, pl. 9, fig. 5; pl. 1, fig. 13, non figs. 14-15.
	1977c	*Alievium antiguum* PESSAGNO. - PESSAGNO, p. 29, pl. 3, figs. 14, 17, 21, 22.
?	1981	*Alievium superbum* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 142, pl. 2, fig. 2.
pars	1981	*Alievium antiguum* PESSAGNO. - SCHAAF, p. 431, pl. 8, fig. 2; non pl. 7, fig. 10 (= *B. horridus* ?).
	1981	*Alievium superbum* (SQUINABOL). - SCHMIDT-EFFING, p. 245, text-fig. 14.
	1984	*Alievium antiguum* PESSAGNO. - SCHAAF, p. 156-157, text-fig. 9 (= specimen of Schaaf, 1981, pl. 8, fig. 2).
	1984	*Alievum superbum* (SQUINABOL). - SCHAAF, p. 162-163, text-figs. 4a-b.
non	1986	*Alievium* aff. *antiquum* PESSAGNO. - LI, pl. 1, fig. 18.
	1988	*Alievium superbum* "Cenomanian" form (SQUINABOL). - THUROW, p. 397, pl. 5, fig. 11.
	1988	*Alievium* sp. *A*. THUROW, p. 397, pl. 5, fig. 12.
non	1988	*Alievium antiquum* VISHNEVSKAYA, pl. 4, fig. 1.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 4, fig. 9 may be regarded the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 12 specimens.

Description: Test as with genus. Cortical shell triangular in outline. Upper and lower surfaces slightly convex, with a slightly raised central area. Meshwork of cortical shell composed of small subcircular pore frames having massive raised nodes at pore vertices. Primary spines solid, three-bladed, approximately equal in length. Spines of medium length, approximately one-third to three-quarters the diameter of the test. Primary spines composed of three alternating rounded ridges and narrow grooves.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	155	90	121	54
Diameter of cortical shell	195	175	214	158

Remarks: P. sculptus apparently branched off from the genus *Becus*. It seems to have evolved from *B. horridus* by a gradual inflation of the central area, the loss of secondary spines, and the acquisition of a much finer meshwork.

Comparisons: *P. sculptus* is distinguished from its closely allied *P. putahensis* by its less raised central area and by possessing triangular rather than subcircular outline.

Pseudoaulophacus putahensis PESSAGNO, 1972

Pl. 59, figs. 5-13
Species code 238

?	1900	*Trigonocyclia* sp. α HOLMES, p. 698, pl. 27, fig. 20.
pars	1972	*Pseudoaulophacus praefloresensis* n. sp. PESSAGNO, p. 309, pl. 27, figs. 5, 6; non figs. 2-4.
	1972	*Pseudoaulophacus putahensis* n. sp. PESSAGNO, p. 310, pl. 27, fig. 1.
	1972	*Pseudoaulophacus* sp. *B*. PESSAGNO, p. 312, pl. 30, fig. 5.
?	1975	*Triadiscus terschovensis* sp. n. LOZYNIAK, p. 50, pl. 1, figs. 5a-b.
?	1975	*Triadiscus vialovi* sp. n. LOZYNIAK, p. 49, pl. 1, figs. 1a-4b.
	1976	*Pseudoaulophacus putahensis* PESSAGNO. - PESSAGNO, p. 28, pl. 3, fig. 13 (= holotype refigured).
non	1981	*Pseudoaulophacus putahensis* PESSAGNO. - SCHMIDT-EFFING, p. 246, text-fig. 16 (= *D. silviae*).
?	1983	*Alievium superbum* gr. (SQUINABOL). - ORIGLIA-DEVOS, p.115, pl. 12, fig. 1.
	1986	*Pseudoaulophacus puthahensis* PES. - THUROW & KUHNT, text-fig. 9. 8.
	1988	*Pseudoalophacus putahensis* PESSAGNO. - THUROW, p. 404, pl. 2, fig. 4.

	1989	*Pseudoaulophacus vistulae* sp. n. GORKA, p. 337, pl. 10, figs. 10, 12.
	1991	*Pseudoaulophacus puthaensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 8.
?	1991	*Pseudoaulophacus putahensis* PESSAGNO. - MARCUCCI *et al.*, text-fig. 4. f.
non	1991	*Pseudoaulophacus* cf. *putahensis* PESSAGNO. - MARCUCCI *et al.*, text-fig. 4. c.
non	1991	*Pseudoaulophacus* sp. aff. *Ps. putahensis* PESSAGNO. - MARCUCCI *et al.*, text-fig. 4. e.

Holotype: The specimen figured and described by Pessagno (1972, pl. 27, fig. 1). The holotype has been reported from locality NSF 432-b (Venado Formation), middle Turonian of California Coast Ranges.

Photographed material: 160 specimens.

Description: Test as with genus. Test large, circular to subcircular in outline. Upper and lower surfaces moderately convex. Central area strongly raised with well-developed central tholi. Cortical shell composed of hexagonal and pentagonal pore frames. Nodes at pore frame vertices strongly developed. Primary spines sharply pointed, relatively long and three-bladed. Primary spines triradiate in cross-section, composed of wide rounded ridges and very narrow grooves. Three pairs of small secondary spines occasionally radiate at the periphery.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	58	134	158	65
Diameter of cortical shell	203	198	217	175
Diameter of central area	100	86	108	68

Remarks: The general form of this species is remarkably constant, varying the outline only slightly. Occasionally some delicate secondary spines may occur radiating from the periphery. *P. putahensis* undoubtedly evolved from *P. sculptus*, by acquiring a larger test with subcircular to circular outline, and a more elevated tholi.

Comparisons: *P. putahensis* is distinguished from representatives of *Dispongotripus*, in lacking strongly developed spines in the middle part of each lateral side.

GENUS **ALIEVIUM** PESSAGNO, 1972

Type species: *Theodiscus superbus* SQUINABOL, 1914, by original designation.

Diagnosis: Test lenticular in cross section, triangular to subtriangular in outline. Test consists throughout of a meshwork comprised of triangular pore frames arranged in a series of concentric layers. The meshwork covers all the surface and consists of equilateral triangular pore frames that develop small nodes at pore vertices. Three primary spines occur in the corners of the triangular or subtriangular test. Variable number of secondary spines, may extend to the interior in the equatorial plane and are present along the periphery of the test. These spines have the tendency to be in trigonal symmetry. Test without development of tholi at the central part of either convex side of the test.

Remarks: *Alievium* seems to have evolved from representatives of *Pseudoaulophacus* by acquiring more a uniform meshwork, composed of relatively larger and more regular pore frames.

Comparisons: *Alievium* differs from *Dispongotripus* in possessing three primary spines that occur at the corners of triangular or subtriangular test, instead of being centrally situated on each lateral side.

Range: Turonian to Campanian.

Alievium superbum (SQUINABOL, 1914)

Pl. 59, figs. 14-18
Species code 167

? 1900 *Trigonocyclia* sp. β HOLMES, p. 698, pl. 27, fig. 24.
1914 *Theodiscus superbus* n. f. SQUINABOL, p. 271, pl. 20 [1], fig. 4.
? 1971 *Pseudoaulophacus superbus* (SQUINABOL). - FOREMAN, p. 1675, pl. 2, fig. 5.
1972 *Alievium praegallowayi* n. sp. PESSAGNO, p. 301, pl. 25, figs. 2, 3.
1972 *Alievium superbus* s.s. (SQUINABOL). - PESSAGNO, p. 302, text-fig. 1 (= holotype refigured); pl. 24, figs. 5, 6; pl. 25, fig. 1.
non 1972 *Pseudoaulophacus superbus* (SQUINABOL). - PETRUSHEVSKAYA & KOZLOVA, p. 527, pl. 3, figs. 1-3.
pars 1973b *Alievium* sp. cf. *A. praegallowayi* PESSAGNO. - FOREMAN, p. 262, pl. 14, fig. 15; non fig. 12.
? 1973 *Pseudoaulophacus superbus* (SQUINABOL). - MOORE, p. 825, pl. 12, figs. 4, 5.
? 1974 *Pseudoaulophacus superbus* (SQUINABOL). - RIEDEL & SANFILIPPO, p. 780, pl. 3, figs. 1-3.
1975 *Alievium superbum* (SQUINABOL). - DUMITRICA, text-fig. 2. 42.
1975 *Alievium praegallowayi* PESSAGNO. - FOREMAN, p. 613, pl. 1D, figs. 4 ?, 5; pl. 5, fig. 9..
1976 *Alievium praegallowayi* PESSAGNO. - PESSAGNO, p. 27, pl. 5, fig. 10 (= specimen of Pessagno, 1972, pl. 25, fig. 2).
1976 *Alievium superbum* (SQUINABOL). - PESSAGNO, p. 27, pl. 3, fig. 12 (= specimen of Pessagno, 1972, pl. 25, fig. 1).
? 1979 *Alievium praegallowayi* PESSAGNO. - NAKASEKO *et al.*, p. 21, pl. 8, figs. 5, 6.
? 1979 *Alievium* sp. cf. *A. superbum* (SQUINABOL). - NAKASEKO *et al.*, p. 21, pl. 5, fig. 3.
? 1981 *Alievium* gr. *superbum* (SQUINABOL). - DE WEVER (in DE WEVER & THIEBAULT), p. 584, pl. 2, fig. 8.
non 1981 *Alievium superbum* (SQUINABOL). - NAKASEKO & NISHIMURA, p. 142, pl. 2, fig. 2 (= *P. sculptus* ?).
non 1981 *Alievium superbum* (SQUINABOL). - SCHMIDT-EFFING, p. 245, text-fig. 14 (= *P. sculptus*).
1982 *Alievium praegallowayi* PESSAGNO. - TAKETANI, p. 51, pl. 10, fig. 4.
1982 *Alievium superbum* (SQUINABOL). - TAKETANI, p. 51, pl. 10, fig. 8.
non 1983 *Alievium superbum* gr. (SQUINABOL). - ORIGLIA-DEVOS, p. 115, pl. 12, fig. 1 (= *P. putahensis* ?)
non 1984 *Alievum superbum* (SQUINABOL). - SCHAAF, p. 162-163, text-figs. 4a-b (= *P. sculptus*).
1985 *Alievium superbum* SANFILIPPO & RIEDEL, p. 594, text-fig. 6. 2 (= specimen of Pessagno, 1972, pl. 25, fig. 1)
1986 *Alievum praegallowayi* PES. - KUHNT *et al.*, pl. 7, fig. m.
1986a *Alievium praegallowayi* PESSAGNO. - SUYARI, pl. 11, fig. 12.
? 1986a *Alievium* cf. *praegallowayi* PESSAGNO. - SUYARI, pl. 9, fig. 13.
? 1986 *Alievium* sp. TERAOKA & KURIMOTO, pl. 5, fig. 1.
1986 *Alievum superbum* PES. - THUROW & KUHNT, text-fig. 9. 7.
1988 *Alievium superbum* (SQUINABOL). - THUROW, p. 397, pl. 2, fig. 2.
non 1988 *Alievium superbum* "Cenomanian" form (SQUINABOL). - THUROW, p. 397, pl. 5, fig. 11 (= *P. sculptus*).
? 1988 *Alievium praegallowayi* PESSAGNO. - TUMANDA, p. 34, pl. 9, fig. 1 (= specimen of Tumanda & Sashida, 1988, text-fig. 4. 19).
? 1989 *Alievum praegallowayi* PESSAGNO. - GORKA, p. 335, pl. 10, fig. 9.
? 1989 *Alievium* cf. *gallowayi* (WHITE). - IWATA & TAJIKA, pl. 1, fig. 12.
? 1989 *Alievium praegallowayi* PESSAGNO. - TUMANDA & SASHIDA, text-fig. 4. 19.
1991 *Alievum superbum* (SQUINABOL). - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 2.
1991 *Alievium superbum* (SQUINABOL). - MARCUCCI *et al.*, text-figs. 4. g, h.
? 1992 *Alievium* cf. *A. praegalloway* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 3. k.
? 1992 *Alievium* cf. *A. superbum* (SQUINABOL). - MARCUCCI & GARDIN, text-fig. 3. j; text-fig. 4. d.

Holotype: The single specimen included into the nominal series and illustrated by Squinabol (1914, pl. 20 [1], fig. 4) may be considered the type of the nominal species. This illustration was refigured by Pessagno (1972, text-fig. 1). The holotype was reported from the Late Cretaceous of Novale, Vicentino Province (Venetian Alps, N. Italy).

Photographed material: 127 specimens.

Description: Test as with genus, strongly convex and triangular in outline. Meshwork of cortical shell composed mostly of triangular pore frames. Pores exhibit marked hexagonal arrangement. Meshwork bearing small raised nodes at pore vertices, nodes somewhat spinose. Test armed with three massive primary spines, symmetrically arranged and usually equal in length. Primary spines strongly three-bladed composed of massive rounded ridges and narrow, shallow deep grooves.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	104	107	133	93
Diameter of cortical shell	192	125	167	134

Remarks: It seems likely that *A. superbus* evolved from *P. putahensis* in early Turonian times by acquiring a more uniform meshwork composed of large triangular pore frames.

Comparisons: The large and well defined triangular pore frames, together with the strongly three-bladed primary spines make differentiation from all other congeneric forms possible.

GENUS **DISPONGOTRIPUS** SQUINABOL, 1903a

Type species: *Dispongotripus acutispina* SQUINABOL, 1903b, by monotypy.

Diagnosis: Test lenticular in cross-section, subtriangular to hexagonal in outline. Test armed with six sturdy, three-bladed, primary spines, three of which are located at vertices, and three in the middle of lateral sides. Test with variable number of secondary spines radiating from the periphery. Spongy meshwork composed of small triangular to tetragonal pore frames, bearing minute nodes at pore vertices. Test with well developed tholi on upper and lower surface.

Remarks: *Dispongotripus* appears to have evolved from *Becus*, evolving by the acquisition of primary spines at the middle of each lateral side and by the development of a raised central area (tholi) on the upper and lower surfaces. Also, *Dispongotripus* seems very closely related to the genus *Pseudoaulophacus* in the development of tholi, but it differs in the development of six primary spines.

Comparisons: *Dispongotripus* differs from *Pseudoaulophacus* in possessing primary spines situated in the middle of each lateral side, whereas the latter species only presents primary spines at vertices.

Range: Middle Albian to Cenomanian.

Dispongotripus acutispinus SQUINABOL, 1903b

Pl. 59, figs. 25-27
Species code 322

1903b *Dispongotripus acutispina* n. sp. SQUINABOL, p. 123, pl. 8, fig. 22.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 8, fig. 22 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 7 specimens.

Description: Test as with genus. Test large, hexagonal to subcircular in outline. Upper and lower surface relatively planiform, except central areas, which are strongly raised, hemispherical, and well-differentiated. Cortical shell composed of numerous polygonal pore frames. Meshwork of cortical shell bearing minute nodes at pore vertices. Primary spines of moderate length, one half to three-quarters the diameter of the cortical shell. Primary spines slightly three-bladed, with very narrow ridges and grooves. One secondary spine may occur between two adjacent primary spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	170	153	180	133
Diameter of cortical shell	175	351	373	333
Diameter of central area	-	134	147	120

Remarks: This species may be an evolutionary offshoot of *B. gemmatus*, which introduces new characteristics as the presence of tholi and the development of primary spines on lateral sides.

Comparisons: *D. acutispinus* is distinguished from *D. triangularis* by possessing a subcircular to hexagonal outline, well marked tholi, and primary spines with approximately equal development.

Dispongotripus triangularis (SQUINABOL, 1904)

Pl. 59, figs. 19-24
Species code 209

1904 *Trochodiscus triangularis* n. sp. SQUINABOL, p. 200, pl. 5, fig. 2.
pars 1983 *Alievium helenae* SCHAAF. - ORIGLIA-DEVOS, p. 114, pl. 12, figs. 4-5; non pl. 13, fig. 6, 10; non fig. 7 (= *B. horridus*).
1988 *Pseudoaulophacus* sp. *B*. THUROW, p. 404, pl. 5, fig. 13.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 5, fig. 2 may be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 18 specimens.

Description: Test as with genus. Test large slightly convex, triangular in outline. Upper and lower surface with a strongly raised central area. Meshwork of cortical shell comprised of subhexagonal pore frames. Nodes at pore vertices well-developed, relatively high in relief. Primary spines strongly three-bladed; length of spines approximately equal in diameter to that of the cortical shell. Primary spines composed of alternating wide grooves and narrow rounded ridges. Primary spines situated on lateral sides are much more developed than primary spines at corners. Occasionally, the cortical shell possesses a single secondary spine radiating from between two adjacent primary spines. Secondary spines are variable in shape and size.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	171	124	158	100
Diameter of cortical shell	271	220	258	171
Diameter of central area	100	91	108	75

Remarks: This species is apparently an offshoot of *D. acutispinus*. Both species present a range of variability overlap, although *D. triangularis* tends to develop the primary spines on lateral sides preferentially, whereas the primary spines at the corners are only slightly developed.

Comparisons: *D. triangularis* differs from *P. putahensis* in developing primary spines in the middle part of each lateral side, generally longer than primary spines developed at corners.

GENUS **PATELLULA** KOZLOVA, in PETRUSHEVSKAYA & KOZLOVA, 1972

Synonym: *Pessagnoella* KOZUR & MOSTLER, 1978.

Type species: *Stylospongia planoconvexa* PESSAGNO, 1963, by original designation.

Diagnosis: Test large, with very spongy meshwork, circular to elliptical in cross-section. Test commonly asymmetrical with respect to the equatorial plane. Upper surface generally more convex than lower surface. Upper surface with a large central raised area, which may develop a conspicuous arrangement of nodes and/or spines. Meshwork comprised of tetragonal to hexagonal pore frames Test armed with a variable number of spines that radiate from the equatorial plane. Spines are generally circular in cross section, and taper distally.

Remarks: This genus displays throughout its lineage a gradual increase in on height of the upper convex side, which changes the general shape of the test. The earliest representatives possess a lenticular test, whereas in younger species the test becomes more elevated to strongly conical.

Patellula seems to have evolved from *Pseudoaulophacus* by acquiring a more circular test, increasing the number of radial spines, and by developing a marked asymmetry between upper and lower surfaces.

Comparisons: *Patellula* is distinguished from *Pseudoaulophacus* in having a circular instead of a triangular outline, and unequal upper and lower surfaces.

Range: Cenomanian to Campanian.

Patellula minuscula nov. sp.

Pl. 60, figs. 1-5
Species code 236

Holotype: Specimen 3520 (pl. 60, fig. 2). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *minusculus* -a -um, meaning something minute.

Photographed material: 28 specimens.

Description: Test as with genus, having relatively small size. Test circular to subcircular in outline armed with numerous, very sturdy, massive spines, which radiate approximately at the equatorial plane. Spines circular in cross-section. Upper and lower surfaces slightly convex. Meshwork quite spongy, composed of small polygonal pore frames, developing small nodes at pore vertices.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	93	72	93	60
Diameter of cortical shell	160	181	200	160

Remarks: Rare intermediate forms suggest that *P. minuscula* may have evolved from *P. sculptus*, by development of a more discoid test and by greatly increasing the number of primary spines. *P. minuscula* gave rise to the lineage *P. cognata-P. spica*, which is characterized by a progressive elevation of the upper surface.

Comparisons: *P. minuscula* is distinguished from all other members of this group by its small size and its very similar upper and lower surfaces.

Patellula cognata nov. sp.

Pl. 60, figs. 6-12
Species code 233

? 1900 *Trochodiscus* sp. HOLMES, p. 698, pl. 27, fig. 12.
? 1900 Uncertain HOLMES, p. 698, pl. 27, figs. 13, 14.

Holotype: Specimen 5482 (pl. 60, fig. 6). The holotype comes from locality no. Gb-84.40, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *cognatus*, -a -um, meaning relative.

Photographed material: 41 specimens.

Description: *Patellula* of small sized test having a much elevated upper surface. Test circular in outline with numerous spines radiating at the periphery, which may be pointed up or down. Lower surface moderately convex. Meshwork of cortical shell composed of very small pore frames bearing minute nodes at pore vertices. Upper surface with strongly elevated, hemispherical central area. Meshwork of central area composed of large subcircular pore frames with well-developed nodes at pore vertices.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	67	73	92	58
Diameter of cortical shell	217	236	258	208
Diameter of central area	142	124	142	108
Length of cortical shell	175	164	175	158

Remarks: *P. cognata* evolved from *P. minuscula* by the gradual elevation of the upper surface. As a consequence the test becomes rapidly asymmetrical with respect to the equatorial plane. This species gave rise to *P. spica*.

Comparisons: *P. minuscula* is distinguished from its descendant *P. spica* by having a larger diameter, a less raised upper surface, and spines only in the periphery.

Patellula spica nov. sp.

Pl. 60, figs. 13-18
Species code 84

1988 *Pyramispongia glascockensis* PESSAGNO. - TUMANDA, p. 39, pl. 6, fig. 11.

Holotype: Specimen 3719 (pl. 60, fig. 13). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *spica* -ae (f), meaning spike.

Photographed material: 30 specimens.

Description: Test as with genus. Test broadly conical, with strongly elevated upper surface and slightly convex lower surface. Test bearing robust spines throughout; spines usually of short to medium length, tapering and circular in cross-section. Upper surface conical, greatly elevated, with spines pointing up. Meshwork very spongy and composed of very small irregular pore frames, with small massive nodes at vertices. Spines of equatorial periphery and lower surface generally point down.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	250	178	250	192
Diameter of cortical shell	250	224	250	200
Length of cortical shell	42	58	67	42

Remarks: Throughout its short stratigraphic range this species retains a very constant shape. *P. spica* undoubtedly evolved from *P. cognata* and left no descendant.

Comparisons: *P. spica* is distinguished from the other members of its genus by having a broadly conical test, with a strongly convex upper surface, which possesses numerous spines, usually pointing up.

Patellula helios (SQUINABOL, 1903b)

Pl. 60, figs. 19-24
Species code 234

1903b *Stylotrochus helios* n. sp. SQUINABOL, p. 124, pl. 10, figs. 23, 23a.
1928 *Baculogypsina* (?) *lenticulata* n. sp. WHITE, p. 306, pl. 41, figs. 9, 11a-b.
1962 *Aulophacus lenticulatus* (WHITE). - PESSAGNO, p. 364, pl. 6, figs. 1, 2.
1963 *Pseudoaulophacus lenticulatus* (WHITE). - PESSAGNO, p. 202, pl. 2, figs. 8, 9.
1972 *Pseudoaulophacus lenticulatus* (WHITE). - PESSAGNO, p. 306, pl. 29, figs. 5, 6; pl. 30, figs. 1-3.
? 1973 *Pseudoaulophacus lenticularis* (WHITE). - MOORE, p. 824, pl. 12, fig. 1.
? 1975 *Trochodiscus spasiensis* sp. n. LOZYNIAK, p. 51, pl. 2, figs. 1a-b.
? 1975 *Trochodiscus* sp. LOZYNIAK, pl. 2, figs. 2a-b.
1976 *Pseudoaulophacus lenticulatus* (WHITE). - PESSAGNO, p. , pl. 9, figs. 11, 12 (= specimens of Pessagno, 1972, pl. 30, figs. 1, 3).
? 1981 *Pseudoaulophacus lenticulatus* (WHITE). - DE WEVER (in DE WEVER & THIEBAULT), p. 590, pl. 2, fig. 12.
1981 *Pseudoaulophacus lenticulatus* (WHITE). - NAKASEKO & NISHIMURA, p. 158, pl. 2, figs. 7a-b.
1982 *Pseudoaulophacus lenticulatus* (WHITE). - TAKETANI, p. 51, pl. 10, fig. 11.
1983 *Pseudoaulophacus lenticulatus* (WHITE). - ORIGLIA-DEVOS, p. 118, pl. 13, figs. 11, 12; pl. 15, figs. 1, 5.

non 1984 *Pseudoaulophacus* sp. cf. *P. lenticulatus* (WHITE). - YAO, pl. 5, fig. 30.

1985 *Pseudoaulophacus lenticulatus* SANFILIPPO & RIEDEL, p. 596, text-figs. 6. 4a (= specimen of Pessagno, 1972, pl. 30, fig. 1), 4b.

non 1988 *Pseudoaulophacus lenticulatus* (WHITE). - THUROW, p. 404, pl. 2, fig. 6.

1989 *Pseudoaulophacus lenticulatus* (WHITE). - GORKA, p. 336, pl. 9, fig. 2.

1989 *Pseudoaulophacus sp* GORKA, p. 338, pl. 9, figs. 3, 9.

1991 *Pseudoaulophacus lenticulatus* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 11. 9.

1991 *Pseudoaulophacus lenticulatus* (WHITE). - MARCUCCI *et al.*, text-figs. 4. a, b, d.

1992 *Pseudoaulophacus lenticulatus* (WHITE). - MARCUCCI & GARDIN, text-fig. 3. p.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 23 and 23a (lateral view) may be considered as the valid holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 129 specimens.

Description: Test as with genus. Test very large, circular in outline, lenticular in cross-section. Upper surface convex with moderately raised central area. Central raised area occasionally has a small, slightly depressed pore. Lower surfaces varies from slightly convex to planiform. Very numerous spines radiate approximately in the same equatorial plane; sixteen to twenty moderately long, massive spines taper distally and are circular in cross-section. Meshwork comprised of small subcircular pore frames. Nodes at pore frame vertices slightly developed. Spines exhibit irregular arrangement.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	46	57	67	50
Diameter of cortical shell	300	240	284	208
Diameter of central area	87	102	117	83

Remarks: *P. helios* is obviously related to the lineage *P. minuscula-P. cognata*, which is characterized by a marked tendency to increase the diameter and length of the test. *P. helios* evolved from *P. cognata* as the diameter of the test increased quickly, with only a slight increase in length, becoming more lenticular in cross-section.

Comparisons: *P. helios* differs from its ancestor *P. cognata* in possessing a major diameter and an elevated upper surface, although with a less pronounced central area. *P. helios* also develops a faint depression at the upper part of its raised central area.

Patellula verteroensis (PESSAGNO, 1963)

Pl. 60, figs. 25-26
Species code 321

1963 *Stylospongia (S.) verteroensis* new. species. PESSAGNO, p. 199, pl. 3, figs. 1-3; pl. 6, fig. 2-3; pl. 7, figs. 3, 6.

1972 *Patellula verteroensis* (PESSAGNO). - PETRUSHEVSKAYA & KOZLOVA, p. 527, pl. 3, figs. 8, 9.

1981 *Patellula verteroensis* PESSAGNO. - EMPSON-MORIN, p. 257, pl. 2, figs. 1-4c.

1988 *Patellula verteroensis* (PESSAGNO). - THUROW, p. 403, pl. 2, figs. 19, 20.

1989 *Patelulla verteroensis* PESSAGNO. - TUMANDA, p. 34, pl. 9, figs. 15, 16.

Holotype: The specimen figured and illustrated by Pessagno on pl. 3 figs. 1-3. The holotype has been reported from locality PR 2503 (early Campanian), Parguera Quadrangle (Puerto Rico).

Photographed material: 5 specimens.

Description: Test very large, strongly plane-convex in cross-section, circular in outline. Test lacks whole spines. Upper surface strongly convex, lower surface planiform or slightly convex. Meshwork composed of moderate sized hexagonal and pentagonal pore frames. Nodes at pore frame vertices small, slightly raised, well developed throughout.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	269	314	329	300

Remarks: *P. verteroensis* seems to have evolved from *P. cognata* by acquiring a more convex upper surface and by losing completely its radial spines.

Comparisons: *P. verteroensis* is distinguished from all other congeneric species by its strongly convex upper surface and by the lacking of spines radially disposed at the periphery.

Patellula ecliptica nov. sp.

Pl. 61, figs. 1-5

Species code 382

Holotype: Specimen 6538 (pl. 61, fig. 5). The type-specimen comes from locality. no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *ecliptica* -ae (f), meaning ecliptic line.

Photographed material: 30 specimens.

Description: Test as with genus. Test large, circular in outline, with approximately vertical sides. Upper surface with broad, slightly raised central area; sometimes central area exhibits small depressed pore. Lower surface planiform to slightly convex. Spines long, sharply pointed distally and circular in cross-section. Spines display regular arrangement, radiating in the equatorial plane. Meshwork comprised of pentagonal and hexagonal medium sized pore frames. Nodes at pore frame vertices slightly developed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	77	54	92	46
Diameter of cortical shell	215	219	231	204
Diameter of central area	108	106	123	92

Remarks: *P. ecliptica* appears to have evolved from *P. helios* at the Cenomanian-Turonian boundary. The tendency generally followed by the lineage during the Cenomanian times is now reversed: the test tends to have more planiform surfaces and the spines tend to be arranged in symmetry. These changes are also noticeable in the co-occurring specimens of *P. heroica*.

Comparisons: *P. ecliptica* differs from its ancestor *P. helios* in having a more planiform lower surface, a slightly convex, but larger central area, and a weak symmetric arrangement of radial spines.

Patellula heroica nov. sp.

Pl. 61, figs. 6-11
Species code 325

Holotype: Specimen 6324 (pl. 61, fig. 8). The holotype comes from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *heroicus* -a -um, meaning heroic.

Photographed material: 18 specimens.

Description: Test as with genus, large, flattened, subcircular to hexagonal in outline. Test armed with a strong spine at each corner, showing symmetrical arrangement. Test with elevated vertical sides. Upper and lower surfaces planiform, only slightly convex in the central area. Upper surface usually develops a small to large depressed central area. Meshwork composed mostly of hexagonal pore frames, bearing small nodes at pore vertices. Spines are long and three-bladed; they taper distally and spines radiate in the equatorial plane. Lateral sides are armed with one or two spines, and are generally shorter than spines at vertices.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of longest spine	100	92	110	70
Diameter of cortical shell	260	247	280	220
Diameter of central area	100	96	105	80

Remarks: *P. heroica* seems to have evolved from *P. helios* by the obliteration of the raised central area which is replaced by a faint depression. The whole of the test becomes planiform and exhibits weak hexagonal symmetry.

Comparisons: *P. heroica* is distinguished from all other species of the genus *Patellula* by having planiform surfaces, vertical sides, a hexagonal outline, and a weak depression in the central part of its upper surface.

FAMILY **DACTYLIOSPHAERIDAE** SQUINABOL, 1904

(= Orbiculiformidae PESSAGNO, 1973)

Type genus: *Dactyliodiscus* SQUINABOL, 1903b.

The representatives of this family are characterized by possessing a disc-shaped test with irregular polygonal pore frames arranged in concentric rings. Lower and upper surfaces of the test are equally developed. It exists with or without equatorially radiating spines, and with or without a central cavity. A common characteristic among the representatives of this family is the development of a fine and spongy meshwork throughout the test.

This family includes the following genera: *Dactyliodiscus* SQUINABOL, 1903b; *Godia* WU, 1986; *Dactyliosphaera* SQUINABOL, 1904 and *Quadrigastrum* nov. gen.

GENUS **DACTYLIODISCUS** SQUINABOL, 1903b

Type species: *Dactyliodiscus cayeuxi* SQUINABOL, 1903b, by monotypy.

Diagnosis: Test is disc-shaped and circular in outline, with a variable number of equatorial spines. Test with concentric meshwork throughout. Meshwork spongy with irregularly polygonal pore frames. Poorly defined central raised area generally has numerous small tubercles on the upper and lower surfaces of the test. The test lacks a central cavity on its opposing sides.

Remarks: The ancestry of this genus has not been traced in detail and remains unknown.

Comparisons: *Dactyliodiscus* differs from *Godia* in possessing numerous small tubercles on the upper and lower surfaces of the test, in having longer peripheral spines, and in lacking a central cavity

Range: Late Berriasian to middle-late Cenomanian.

Dactyliodiscus lenticulatus (JUD, 1994)

Pl. 61, figs. 12-15
Species code 138

?	1916	*Odontosphaera echinocatus* FISCHLI, p. 46-47, text-fig. 29.
	1988	*Godia* sp. *C.* THUROW, p. 401, pl. 5, fig. 15.
?	1988	*Orbiculiforma cachensis* VISHNEVSKAYA, pl. 4, fig. 2.
	1994	*Godia lenticulata* n. sp. JUD, p. 78, pl. 10, figs. 10-11.

Holotype: It is the specimen designated by Jud (1994) on pl. 10, fig. 11. The holotype comes from locality no. Bo-566.5, early Barremian (Umbria-Marche Apennines, central Italy).

Photographed material: 16 specimens.

Description: Test as with genus, very large, generally flat or somewhat biconvex. Test with rounded periphery and an undetermined number of moderately long spines. Peripheral spines circular in cross-section and taper distally. Upper and lower surfaces of test covered by numerous small tubercles and minute spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	241	447	480	400
Length of longest spine	26	58	93	26

Comparisons: *D. lenticulatus* is larger than *D. cayeuxi* and further differs from *D. cayeuxi* in having a more circular outline and shorter spines. *D. lenticulatus* is much larger than all other representatives of the genus known thus far.

Dactyliodiscus cayeuxi SQUINABOL, 1903b

Pl. 61, figs. 16-23
Species code 146

	1903b	*Dactyliodiscus Cayeuxi* n. sp. SQUINABOL, p. 120, pl. 9, figs. 18, 18a.
	1983	*Dactyliodiscus* gr. *cayeuxi* SQUINABOL. - ORIGLIA-DEVOS, p. 54, pl. 3, figs. 12, 13, 15.
pars ?	1983	*Heliocryptocapsa neagui* DUMITRICA. - ORIGLIA-DEVOS, p. 210, pl. 24, fig. 19; non fig. 22.
?	1985	*Stylotrochus antiquus* CAMPBELL et CLARK. - LI & WU, pl. 2, fig. 12.
	1988	*Patellula* (?) sp. *B*. THUROW, p. 403, pl. 5, fig. 19.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 18 and 18a (lateral view) is considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 30 specimens.

Description: Test disc-shaped very large and thick, round to subtriangular in outline with rounded periphery and numerous peripheral spines. Spines massive blade-like and radiating at different planes from the periphery. Test has at least three primary spines which are usually longest and radiate from the centre. Upper and lower surfaces of test slightly convex, covered by numerous small tubercles and delicate spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	265	324	440	264
Length of longest spine	58	160	227	107

Remarks: This species seems to have evolved from *D. lenticulatus* through the development of numerous blade-like spines and the acquisition of triangular arrangement of primary spines. This structural arrangement is attained by a progressive development of three primary spines, which are generally bigger than remaining peripheral spines. It is likely that *D. cayeuxi* gave rise to *D. rubus* during middle Albian times.

Comparisons: *D. cayeuxi* is distinguished from the closely allied *D. rubus* by having a greater number peripheral spines and by the triangular arrangement of primary spines.

Dactyliodiscus rubus nov. sp.

Pl. 62, figs. 1-5
Species code 207

Holotype: Specimen 1480 (pl. 62, fig. 2). The holotype comes from locality no. Ap2-12, early Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *rubus* -i (m), meaning bramble.

Photographed material: 34 specimens.

Description: Test disc-shaped, hexagonal in outline with rounded periphery and six long, massive blade-like spines radiating in the same plane from the periphery. Meshwork massive, spongy, composed of polygonal pore frames. Spines disposed in hexagonal arrangement at the corners of the test. Length of spines about same diameter of test. Upper and lower surfaces of test slightly convex and covered with small raised nodes and many minute, spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	158	145	158	133
Length of longest spine	125	150	167	125

Remarks: The small diameter, the flattened nature of the test and the hexagonal arrangement of spines suggest that *D. rubus* and the type species are closely related. It is likely that *D. rubus* evolved from *D. cayeuxi* during the middle Albian and apparently left no descendants.

Comparisons: *D. rubus* differs from all other congeneric species by its smaller size and by possessing six blade-like primary spines radiating from the periphery in hexagonal arrangement.

Dactyliodiscus longispinus (SQUINABOL, 1904)

Pl. 62, figs. 6-11
Species code 235

1904 *Spongolonche diversispina* n. sp. SQUINABOL, p. 206, pl. 6, fig. 6
1904 *Stylotrochus euganeus* n. sp. SQUINABOL, p. 207, pl. 6, fig. 9.
1904 *Stylotrochus longispina* n. sp. SQUINABOL, p. 207, pl. 6, fig. 8.

Holotype: The specimen described and illustrated by Squinabol (1904) on pl. 6, fig. 8 is considered the valid holotype. This specimen was reported from an imprecise locality in the Euganei region (southern Venetian Alps, N Italy).

Photographed material: 50 specimens.

Description: Test disc-shaped, large, nearly circular in outline with an indeterminate number of radially arranged coplanar spines. Test composed of a thick meshwork of minute circular pore frames. Spines long and massive, circular in cross-section and tapered distally. Length and size of spines strongly variable. Upper and lower surfaces convex with rounded periphery and a raised central area. Tubercles not well defined and tend to disappear with progressive development of the meshwork.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	185	278	340	240
Diameter of central area	-	113	130	100
Length of longest spine	95	134	170	100

Remarks: It is quite probable that *D. longispinus* arose from *D. lenticulatus* through an increase in lateral convexity, the complete elimination of tubercles, the development of thick spines, and the development of a raised central area.

Comparisons: *D. longispinus* is distinguished from other members of the lineage (Fig. 31) by its robust circular spines, thicker meshwork, and more convex test surfaces. The latter characteristic together with the absence of tholi enable a generic differentiation from the co-occurring representatives of *Patellula*.

GENUS **GODIA** WU, 1986

Type species: *Godia floreusa* WU, 1986, by original designation. This species is considered in this work as a synonym of *Patellula* (?) *decora* LI & WU, 1985.

Diagnosis: Test disc-shaped, very large, circular to polygonal in outline with short equatorial spines. Test with central cavity and raised central area. This depressed cavity is surrounded by small spiny nods or tubercles. Meshwork with predominantly tetragonal to pentagonal pore frames.

Remarks: A possible phylogenetic link is suspected with the earliest representatives of *Dactyliodiscus* like *D. lenticulatus* by the progressive development of a depressed area (central cavity). Simultaneously peripheral spines become shorter and rapidly disappear. More detailed studies are necessary to support this hypothesis.

Comparisons: This genus is distinguished from its possible ancestor *Dactyliodiscus* by the presence of a central cavity and tubercles. *Godia* differs from its direct descendant *Dactyliosphaera* by having a well marked ring of nodes surrounding the central cavity.

Range: Early Valanginian to middle-late Cenomanian.

Godia concava (LI & WU, 1985)

Pl. 62, figs. 12-15
Species code 149

? 1898 *Astrocyclia sulcata* n. sp. RÜST, p. 21, pl. 7, fig. 2.
pars ? 1971 *Spongodiscid*, gen. and sp. indet. FOREMAN, p. 1681, pl. 5, fig. 2; non figs. 3-7.
? 1979 *Spongodiscus communis* CLARK et CAMPBELL. - OZVOLDOVA, p. 12, pl. 4, fig. 1.
? 1981 *Orbiculiforma chartonae* n. sp. SCHAAF, p. 435, pl. 8, fig. 6; pl. 13, fig. 1.
? 1984 *Orbiculiforma chartonae* SCHAAF. - SCHAAF, p. 96-97, text-fig. 1 (= specimen of Schaaf, 1981, pl. 8, fig. 6), 2, 3.
1985 *Orbiculiforma concave* sp. nov LI & WU, p. 73, pl. 2, fig. 22, 23.
1985 *Orbiculiforma maxima* PESSAGNO. - LI & WU, pl. 2, fig. 18.
1986 *Orbiculiforma depressa* sp. nov. WU, p. 355, pl. 1, figs. 3 ?, 6, 9, 22.
? 1992 *Orbiculiforma railensis* PESSAGNO. - BAUMGARTNER, p. 322, pl. 7, figs. 9, 10.
pars 1992 *Orbiculiforma* spp. BAUMGARTNER, p. 322, pl. 7, fig. 11, non fig. 12.
1992 *Orbiculiforma* sp. A. OZVOLDOVA & PETERCAKOVA, p. 316, pl. 2, figs. 6, 8.
? 1992 *Orbiculiforma* sp. B. OZVOLDOVA & PETERCAKOVA, p. 316, pl. 3, fig. 1.

Holotype: The single specimen illustrated by Li & Wu (1985) on pl. 2, fig. 22. This specimen is from Southern Xizang (Tibet). Li & Wu's presumed early Cenomanian age is regarded here as Aptian-early Albian.

Photographed material: 16 specimens.

Description: Test as with genus, very large, polygonal to circular in outline. Periphery of well-preserved specimens with numerous minute spines. Central cavity large and markedly depressed. Central cavity flanked by a prominent rim of small nodes. Center of the test somewhat raised. Peripheral meshwork massive, comprised of polygonal pore frames. Central cavity deep with somewhat finer meshwork which is denser in the central raised area, forming a spongy bulk.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	263	470	507	400
Diameter of central area	69	268	320	213

Remarks: *G. depressa* appears to be the earliest representative of *Godia* and may give rise to the first representatives of *Dactyliosphaera* during late Aptian time.

Comparisons: *G. depressa* is distinguished from *G. coronata* by possessing more polygonal rather than circular outline and in having wider central cavities.

Godia coronata (TUMANDA, 1989)

Pl. 62, figs. 16-18
Species code 141

?	1981	*Patellula planoconvexa* (PESSAGNO). - SCHAAF, p. 436, pl. 8, fig. 9.
	1986	*Patellula* sp. OKAMURA & MATSUGI, pl. 4, fig. 11.
?	1986	*Orbiculiforma unica* sp. nov. WU, p. 355, pl. 1, figs. 7, 8.
	1988	*Godia* (?) sp. *A*. THUROW, p. 401, pl. 5, fig. 20.
	1988	*Godia* (?) sp. *B*. THUROW, p. 401, pl. 5, fig. 17.
?	1988	*Godia* (?) sp. *D*. THUROW, p. 401, pl. 9, fig. 15.
	1988	*Godia* (?) sp. *F*. THUROW, p. 401, pl. 9, fig. 23.
	1989	*Orbiculiforma coronata* n. sp. TUMANDA, p. 29, pl. 5, figs. 12-14; pl. 10, figs. 2 and 5 ?.
pars ?	1989	*Orbiculiforma igoi* n. sp. TUMANDA, p. 29, pl. 5, fig. 11; non pl. 10, fig. 8.
	1989	*Pseudoaulaphacus lenticulatus* (WHITE). - TUMANDA, p. 35, pl. 9, fig. 9.
?	1992	*Orbiculiforma coronata* TUMANDA. - OZVOLDOVA & PETERCAKOVA, pl. 2, fig. 13.
	1994	*Pseudoaulophacus* (?) *florealis* n. sp. JUD, p. 95, pl. 17, figs. 6-8.

Holotype: The specimen described and figured by Tumanda (1989), on pl. 5, fig. 14. The holotype is from the Furebira Formation, Usotan section (Hauterivian-Barremian) in the Esashi Mountain area (Northern Hokkaido, Japan).

Photographed material: 22 specimens.

Description: Test disc-shaped, round in outline, with short peripheral spines. Upper and lower surfaces of the test strongly convex. Periphery rounded with flattened triangular spines radiating in the same plane. Central area relatively wide, slightly dome-shaped, somewhat nodose and surrounded by a conspicuous ring of small circular nodes. Meshwork of central cavity finer than that of surrounding rim.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	327	395	413	373
Diameter of central area	127	169	187	147
Length of longest spine	-	80	93	67

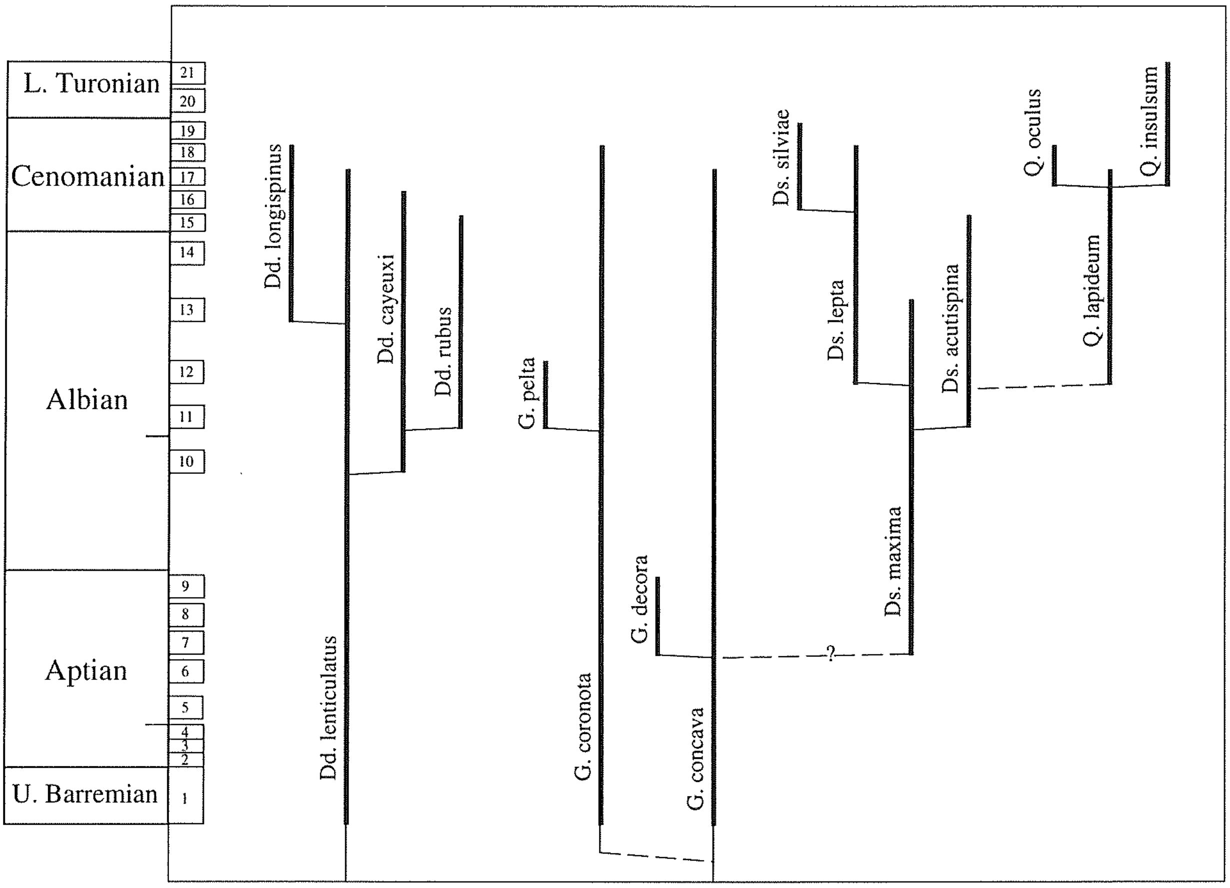

Fig. 31.- Stratigraphic range and possible phyletic relationships of genera and species of the family Dactyliosphaeridae.

Remarks: Spongy meshwork surrounding the ring of nodes is quite delicate. Most commonly a portion of the central cavity is missing (pl. 62, fig. 16). As a consequence, the central area is attached to the outer rim by fine and delicate bars. This species seems to have evolved from *G. depressa* in late Hauterivian time (cf. Jud's material) and gave rise to *G. decora* in the late Aptian by a gradual decrease of test convexity together with resorption of peripheral spines and displacement of nodes towards the periphery.

Comparisons: The more circular shape, more convex surfaces, the conspicuous ring of nodes, and the development of peripheral spines enable specific distinction with the type species. *G. coronata* is distinguished from *G. pelta* by having both surfaces of test convex, instead of an upper convex and a lower concave as represented by the latter species.

Godia decora LI & WU, 1985

Pl. 63, figs. 1-4
Species code 148

? 1981 *Pseudoaulophacus ? sulcatus* (RÜST). - SCHAAF, p. 436, pl. 14, figs. 3a-b.
1985 *Patellula* (?) *decora* sp. nov. LI & WU, p. 73, pl. 2, fig. 13.

pars 1986 *Godia floreusa* gen. et sp. nov. WU, p. 356, pl. 2, figs. 11, 16, 24; figs. 3?, 8?.
1986 *Godia nodosa* gen. et sp. nov. WU, p. 356, pl. 2, figs. 1, 2, 6, 10.
1986 *Godia ornata* gen. et sp. nov. WU, p. 356, pl. 2, figs. 4, 5, 9, 17, 25.
pars ? 1988 *Orbiculiforma railensis* PESSAGNO. - THUROW, p. 403, pl. 9, fig. 20; non pl. 5, fig. 18 (= *O. maxima*).

Holotype: The single specimen illustrated by Li & Wu (1985) on pl. 2, fig. 13. This specimen is from Southern Xizang (Tibet). Li & Wu's presumed early Cenomanian age is regarded here as Aptian-early Albian.

Photographed material: 9 specimens.

Description: Test disc-shaped, polygonal to subcircular in outline, having a rounded periphery. Lower and upper surface nearly flat. Central area raised, somewhat dome-shaped and surrounded by large circular to elliptical nodes. Nodular surface not well defined, but occupying at least one half diameter of test.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	296	265	287	253
Diameter of central area	64	73	80	60

Remarks: This species appears to have evolved from *G. depressa* by reduction of the central cavity with the central surface more thick and nodose. *G. decora* apparently left no descendants.

Comparisons: *G. decora* differs from *G. coronata* in having flatter surfaces and in lacking a well defined ring of nodes and peripheral spines.

Godia pelta nov. sp.

Pl. 62, figs. 19-21
Species code 147

? 1983 *Orbiculiforma monticelloensis* PESSAGNO. - ORIGLIA-DEVOS, p. 119, pl. 15, figs. 8, 11.

Holotype: Specimen 224 (pl. 62, fig. 20) reported from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin *pelta* -ae (f), meaning little shield.

Photographed material: 3 specimens.

Description: Test disc-shaped, large and thick, elliptical to circular in outline. Upper surface convex with minute spines radiating from the periphery in different planes. Lower surface concave with fragile bars radiating from the central part toward periphery, usually terminating in acute peripheral spines. Upper surface may develop spiny nodes surrounding the central area. Periphery rounded with meshwork comprised of massive square and triangular pore frames. Meshwork of lower surface finer and denser than upper surface.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	350	350	370	330
Diameter of central area	190	160	190	110
Length of longest spine	40	33	40	30

Remarks: *G. pelta* embodies a combination of characters that would seemingly justify introduction of a new generic name. However, such a distinction should preferably be based on more rich populations rather than just the few specimens from Central Italy. *G. pelta* is an evolutionary offshoot from *G. coronata* and there are no known descendants. This species seems to have evolved by gradual loss of the convexity of the lower surface of test.

Comparisons: *G. pelta* is distinguishable from all other congeneric species by having an upper convex surface and a lower concave surface.

GENUS **DACTYLIOSPHAERA** SQUINABOL, 1904

Synonyms: *Orbiculiforma* PESSAGNO, 1973; *Orbiculiformella* KOZUR & MOSTLER, 1978.

Type species: *Dactyliosphaera silviae* SQUINABOL, 1904, by monotypy.

Diagnosis: Test disc-shaped, circular to elliptical in outline, with a variable number of peripheral spines. Test may develop spongy arms. Test with concentric meshwork throughout and central cavities on opposing sides of the test. Central cavity frequently possesses a raised central area.

Remarks: *Dactyliosphaera* appears to have evolved from *Godia* during late Aptian by acquiring more spongy meshwork, more biconvex sides, and by loss of nodes or prominent rim surrounding the central cavity. *Dactyliosphaera* may have given rise to *Quadrigastrum* by the rapid development of four long robust spines, which make the whole of the test appear more square in outline.

Comparisons: *Dactyliosphaera* differs from representatives of the genus *Orbiculiforma* PESSAGNO, 1973 because the latter (see type-species *Orbiculiforma quadrata* PESSAGNO, 1973) possesses four rays arranged along two axes at right angles. These rays are somewhat hidden by a strong development of spongy meshwork. Otherwise the shell structure and ornamentation of *Orbiculiforma* suggests derivation from late Turonian representatives of *Quadrigastrum*.

Range: Late Aptian to Cenomanian.

Dactyliosphaera maxima (PESSAGNO, 1976)

Pl. 63, figs. 5-8
Species code 145

? 1904 *Porodiscus crebriporus* n. sp SQUINABOL, p. 202, pl. 5, fig. 4.
1976 *Orbiculiforma maxima* n. sp. PESSAGNO, p. 34, pl. 1, figs. 14, 16.
1977c *Orbiculiforma maxima* PESSAGNO. - PESSAGNO, p. 27, pl. 1, figs. 15 (= holotype refigured), 16.
? 1977c *Orbiculiforma multangula* n. sp. PESSAGNO, p. 27, pl. 1, fig. 20.
1977c *Orbiculiforma nevadaensis* n. sp. PESSAGNO, p. 28, pl. 1, fig. 22; pl. 12, fig. 3.
1977c *Orbiculiforma* sp. *A*. PESSAGNO, p. 28, pl. 1, figs. 19.
1979 *Coccodiscus holmesi* CAMPBELL et CLARK. - OZVOLDOVA, p. 7, pl. 5, fig. 2.
1981 *Spongodiscus americanus* KOZLOVA. - SCHAAF, p. 438, pl. 8, fig. 10.
1981 *Spongodiscus renillaeformis* CAMPBELL and CLARK. - SCHAAF, p. 438, pl. 8, figs. 4, 5, 8; pl. 13, fig. 9; pl. 15, fig. 1 ?.
1981 *Orbiculiforma* cf. *persenex* PESSAGNO. - SCHMIDT-EFFING, p. 246, text-fig. 13.
1984 *Spongodiscus renillaeformis* CAMPBELL et CLARK. - SCHAAF, p. 160-161, text-fig. 1 (= specimen of Schaaf, pl. 8, fig. 4).
non 1985 *Orbiculiforma maxima* PESSAGNO. - LI & WU, pl. 2, fig. 18 (= *G. depressa*).
1986 *Orbiculiforma belliatula* sp. nov. WU, p. 355. pl. 1, figs. 12, 16, 20, 27.

pars 1988 *Orbiculiforma railensis* PESSAGNO. - THUROW, p. 403, pl. 5, fig. 18; non pl. 9, fig. 20 (= *G. decora* ?).

Holotype: The specimen described and figured by Pessagno (1976) on pl. 1. fig. 14. The holotype is from locality NSF 350 early Cenomanian portion of Antelope shale/Fiske Creek Formation, California Coast Ranges.

Photographed material: 14 specimens.

Description: Test very large, massive, disc-shaped, with angular periphery and having a deep central cavity. Test circular to polygonal in outline. Test sloping away from central cavity toward periphery. Central part of the cavity raised. Very fine meshwork, composed of minute circular to hexagonal pore frames concentrically arranged. Periphery with indeterminate number of minute spines (only in very well preserved specimens).

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	600	403	430	390
Diameter of central area	323	178	210	130

Remarks: This species appears to be an important evolutionary offshoot from the lineage connecting *G. depressa* and *G. decora*. It is probable that *D. maxima* represents an early stock for *Dactyliosphaera*.

Comparisons: *D. maxima* differs from *D. acutispina* by its larger diameter and by lacking long spines. *D. maxima* is distinguished from *G. decora* by possessing a larger central cavity without surface nodes.

Dactyliosphaera acutispina (SQUINABOL, 1904)

Pl. 63, figs. 9-12
Species code 324

1904 *Heliodiscus acutispina* n. sp. SQUINABOL, p. 202, pl. 5, fig. 3.
1976 *Orbiculiforma cachensis* n. sp. PESSAGNO, p. 34, pl. 1, figs. 13, 15.
? 1977c *Orbiculiforma railensis* n. sp. PESSAGNO, p. 28, pl. 1, figs. 14, 21; pl. 12, fig. 5.
? 1979 *Septinastrum* sp. OZVOLDOVA, p. 13, pl. 5, fig. 1.
1979 *Stylospongia* cf. *excavata* nov. comb. (RÜST). - OZVOLDOVA, p. 12, pl. 4, fig. 2.
1983 *Stylotrochus octocanthus* ? LIPMAN. - ORIGLIA-DEVOS, p. 122, pl. 15, fig. 14.
1985 *Orbiculiforma cachensis* PESSAGNO. - LI & WU, pl. 2, fig. 14.
non 1986 *Orbiculiforma cachensis* PES. - KUHNT *et al.*, pl. 8, fig. j.
non 1988 *Orbiculiforma railensis* PESSAGNO. - THUROW, p. 403, pl. 5, fig. 18 (= *O. maxima*), pl. 9, fig. 20 (= *G. decora* ?).
non 1988 *Orbiculiforma cachensis* VISHNEVSKAYA, pl. 4, fig. 2 (= *D. lenticulatus* ?).
non 1992 *Orbiculiforma railensis* PESSAGNO. - BAUMGARTNER, p. 322, pl. 7, figs. 9-10 (= *G. depressa* ?).

Holotype: The specimen described and illustrated by Squinabol (1904) on pl. 5, fig. 3 is considered the valid holotype. This specimen was reported from an imprecise locality in the Colli Euganei region (southern Venetian Alps, N Italy).

Photographed material: 17 specimens.

Description: Massive test, polygonal in outline with nine long peripheral threebladed spines. Central cavity, circular, moderately narrow and deep. Spongy meshwork fine and dense in the central cavity. Pore frames large, predominantly circular to hexagonal in outer rim.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	235	223	260	180
Diameter of central area	58	65	70	55
Length of longest spine	138	128	150	90

Remarks: Diameter of central cavity strongly variable, and controlled by the development of the spongy meshwork. In some specimens this area may be completely covered by spongy meshwork. It is probable that *D. maxima* gave rise to *D. acutispina* during middle Albian time through the acquisition of long peripheral spines and the reduction of test diameter.

Comparisons: *D. acutispina* is distinguished from its possible ancestor *D. maxima* by its smaller size and by the long blade-like peripheral spines.

Dactyliosphaera lepta (FOREMAN, 1978a)

Pl. 63, figs. 13-21

Species code 81

1969b *Spongodiscacea* PESSAGNO, pl. 7, fig. A.
1978a *Amphibrachium leptum* new species FOREMAN, p. 841, pl. 1, figs. 8, 9.
1981 ? *Spongodruppa cocos* RÜST. - SCHAAF, p. 439, pl. 6, fig. 13; pl. 15, figs. 4a-b.
1984 *Spongodruppa cocos* RÜST. - SCHAAF, p. 160-161, text-fig. 3 (= specimen of Schaaf, pl. 6, fig. 13).

Holotype: The specimen described and figured by Foreman (1978a) on pl. 1, figs. 8, 9 (fig. 8 side view). The holotype is from eastern South Atlantic (DSDP, Leg. 40, Site 364, interval 26-6, 56-58), latest Albian-Cenomanian.

Photographed material: 39 specimens.

Description: Test large, circular in outline with two large spongy arms. Spongy meshwork very fine and dense. Central cavity very wide, shallow to relatively deep, with finer meshwork. The central area of this cavity is moderate to well raised. Spongy arms always radiating at 180 degrees in the same plane from periphery of central disc. Arms taper distally and terminate in short spines.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	256	264	330	200
Diameter of central area	94	107	130	80
Length of longest ray	133	256	320	260

Remarks: *D. lepta* seems to have evolved from *D. maxima*; a wide spectrum of transitional forms has been observed in the middle Albian. Both species show a range of variability that partially overlaps.

Comparisons: *D. lepta* differs from all others species of *Dactyliosphaera* by possessing two long spongy arms that radiate from the perimeter of disc and by having a more dense spongy meshwork.

Dactyliosphaera silviae SQUINABOL, 1904

Pl. 63, figs. 22-26
Species code 140

1903b Gen. sp. nov. SQUINABOL, p. 121, pl. 9, fig. 21.
1904 *Dactyliosphaera Silviae* n. sp. SQUINABOL, p. 196, pl. 4, fig. 3.
1904 *Dactyliosphaera Saturnia* n. sp. SQUINABOL, p. 196.
1975 *Dactyliosphaera silviae* SQUINABOL. -DUMITRICA, text-fig. 2. 14.
1981 *Pseudoaulophacus putahensis* PESSAGNO. - SCHMIDT-EFFING, p. 246, text-fig. 16.
1983 *Orbiculiforma* sp. aff. *sacramentoensis* PESSAGNO. - ORIGLIA-DEVOS, p. 120, pl. 14, figs. 27, 28; pl. 15, figs. 9, 12.
1988 *Pseudoaulophacus* (?) sp. *D*. THUROW, p. 404, pl. 5, figs. 14a-b.

Holotype: The specimen illustrated by Squinabol (1904) on pl. 4, fig. 3 is be considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 140 specimens.

Description: Test large circular in outline, having ten to twelve very short spines radiating in the same plane from periphery of the disc. Meshwork coarse, consisting predominantly of pentagonal to circular pore frames. Upper and lower surfaces of shell convex. Central part of the test large (approximately half test diameter) and strongly raised. Central convex area surrounded by a narrow deep groove. Periphery somewhat keeled. Spines flat, somewhat rectangular and taper distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	265	273	283	262
Diameter of central area	140	128	146	108
Length of longest spine	32	36	54	33

Remarks: Intermediate transitional forms indicate that *D. silviae* arose from *D. lepta* and seems to have left no descendants. This transition is accomplished by the resorption of spongy rays and by rapid loss of spongy meshwork which is replaced with larger pentagonal pore frames bearing minute nodes at their vertices.

Comparisons: *D. silviae* differs from all other species of *Dactyliosphaera* in having very short flat spines and by possessing a wide, strongly raised central area.

GENUS **QUADRIGASTRUM** NOV. GEN.

Derivatio nominis: The new generic name is a compound of *quadriga* (Latin), meaning chariot with four horses, plus *astrum* (Latin) meaning star. Neuter gender.

Type species: *Quadrigastrum oculus* nov. sp.

Diagnosis: Test disc-shaped, circular to nearly square in outline, with four solid primary spines radiating in the same plane from approximately the periphery of the central disc. Test has four spongy rays arranged along two axes at right angles to one another. Rays are more or less visible externally depending of the development of meshwork. Rays taper distally and terminate in strong blade-like spines. Test having central cavity on opposing sides of the test. Central part of the cavity raised to well inflated; it is thicker, more densely porate and biconvex. Test with an indeterminate number of short peripheral spines. Meshwork very fine, dense and quite spongy.

Remarks: This genus seems to have evolved from late Albian representatives of *Dactyliosphaera* by developing four primary spines and acquiring a test with more tetragonal symmetry (e.i., pl. 64, figs. 5-10). The representatives of *Quadrigastrum* may have given rise to *Orbiculiforma* PESSAGNO 1973 by reduction of primary spines and by acquiring a more delicate and spongy meshwork at late Turonian-early Coniacian times.

Comparisons: *Quadrigastrum* differs from *Dactyliosphaera* by possessing four well differentiated long primary spines radiating from the periphery.

Range: Middle-late Albian to early Coniacian, as far as know.

Quadrigastrum lapideum nov. sp.

Pl. 64, figs. 1-4
Species code 143

Holotype: Specimen 3561 (pl. 64, fig. 1). The holotype is from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *lapideus* -a -um, meaning made of stone.

Photographed material: 8 specimens.

Description: Test disc-shaped, round in outline, with four solid primary spines radiating in the same plane from approximately the periphery and arranged along two axes at right angles. Rays are not well defined externally due to the strong development of meshwork. Rays terminate in a strong blade-like spines. Test has a central cavity on opposing sides. Central cavity wide, about one-half diameter of test, well defined and shallow with central area raised. Test may develop an indeterminate number of secondary peripheral spines. Meshwork very fine, dense and quite spongy throughout.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	242	246	258	242
Diameter of central area	108	117	125	108
Length of longest spine	133	108	133	75

Remarks: A possible origin is suspected from representatives of *Dactyliosphaera* which may develop (*D. acutispina*) threebladed peripheral spines and also exhibit gross sculptural resemblance. *Q. lapideum* differs from other congeneric species by its more circular periphery.

Quadrigastrum oculus nov. sp.

Pl. 64, figs. 5-10
Species code 185

Holotype: Specimen 3532 (pl. 64, fig. 9). The holotype is from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *oculus* -i (m), meaning eye.

Photographed material: 15 specimens.

Description: Test disc-shaped, nearly square in outline, with four solid primary spines. Test having four spongy rays arranged along two axes at right angles to one another. This arrangement is more or less visible externally depending of the development of the meshwork. Rays taper distally and terminate in strong blade-like spines. Test has pronounced central cavity on opposing sides. Central cavity very narrow and deep, surrounded by a very thick ring of spongy meshwork (slightly resembles a lacuna structure). Test may develop delicate peripheral spines. Meshwork very fine, dense and quite spongy.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	135	158	180	125
Maximum width of rays	125	148	190	110
Diameter of central area	120	138	160	115
Length of longest spine	100	100	110	80

Remarks: Range of variability of *Q. oculus* and *Q. insulsum* slightly overlap, but the type species differs from *Q. insulsum* by its deep and well defined central cavity and by possessing well developed spongy arms. This species shows a wide range of variation through its stratigraphic range. Some specimens have a nearly square outline whereas other individuals possess an authentic cross-shaped test.

Q. oculus seems to have evolved from *Q. lapideum* by acquiring more quadrate outline and by developing meshwork which is denser and more spongy along the two axes forming a cross.

Comparisons: *Q oculus* differs from other congeneric species by developing four well differentiated spongy rays. *Q. oculus* more closely resembles *Q. insulsum* in outline, but is distinguished by its distinctive central cavity and spongy rays.

Quadrigastrum insulsum nov. sp.

Pl. 64, figs. 11-13
Species code 232

Holotype: Specimen 3692 (pl. 64, fig. 13). The holotype is from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *insulsus* -a -um, meaning insipid.

Photographed material: 9 specimens.

Description: Test disc-shaped, square in outline, with four solid primary blade-like spines radiating in the same plane from the periphery and arranged along two axes at right angles. Rays are weakly defined externally, and visible only where the meshwork tends to be denser along the two axes in line with primary spines. Central cavity completely covered by dense meshwork, only the central area is slightly raised. Test may develop an indeterminate number of delicate spines. Periphery rounded with very fine and dense meshwork.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of cortical shell	270	247	270	230
Length of longest spine	160	143	160	130

Remarks: *Q. insulsum* is undoubtedly allied to *Q. oculus* (see remarks under the latter species). Both species seem to have evolved from the common ancestor *Q. lapideum*. *Q. insulsum* seems to be the only representatives of *Quadrigastrum* that survives the Cenomanian-Turonian crisis, and could be the origin for Late Cretaceous *Orbiculiforma*.

Comparisons: This species is distinguished from *Q. lapideum* by having not a depressed central cavity on its test and by possessing permanently a square outline.

FAMILY **HAGIASTRIDAE** RIEDEL, 1971

(= Patulibracchiidae PESSAGNO, 1971a)

Type genus: *Hagiastrum* Haeckel, 1881. *Tetratrabs* BAUMGARTNER, 1980 seems to be a junior synonym of this genus.

The family Patulibracchiidae is not interpreted in the sense of Baumgartner (1980), and include in this family all genera previously placed by Baumgartner in the families Hagiastridae RIEDEL, 1971 and Patulibracchiidae PESSAGNO, 1971a. In recently publications (De Wever, 1981b; Nagai 1985; Kito & De Wever 1990, Kito & De Wever 1992) numerous cross-sections of rays of Patulibracchiidae were analyzed and illustrated. These figures undoubtedly show that the genera classified as Patulibracchiidae possess the structure of the Hagiastridae, which is typically composed of longitudinal canals. This paper, the Patulibracchiidae includes forms with two or more rays radiating in the same plane, composed of uniform spongy meshwork, which develops inner concentric shells and longitudinal canals. Ray surfaces have linear, sublinear or irregularly arranged of pore frames that externally are sometimes composed of external beams and tiny transversal bars. Cross section of rays, variable, circular elliptic or rectangular. Test may develop a bracchiopyle and patagium. It must be emphasized that the family Hagiastridae could be divided into several subfamilies, but any division considering only the symmetry seems artificial. A true classification can be realized only after a detailed stratigraphic study with special attention paid to the phylogenetic relationships among representatives of the Hagiastridae.

GENUS **DEVIATUS** LI, 1986

Synonym: *Foremanella* MUZAVOR, 1977 (nomen nudum); *Noviforemanella* PESSAGNO, BLOME & HULL, in Pessagno *et al.*, 1993 (objective junior synonym).

Type species: *Paronaella* (?) *diamphidia* FOREMAN, 1973b, by original designation.

Diagnosis: Hagiastrid having a test shaped as a tuning-fork. Test with two asymmetrical rays pointed at the ends, forming a horseshoe-shaped structure. Approximately perpendicular to this structure a third beam protrudes. Test with uniform spongy meshwork. Curved arms with or without a bracchiopyle.

Remarks: *Deviatus* is apparently a monospecific taxon.

Comparisons: *Deviatus* embodies an unique combination of characters that enable the differentiation from other patulibracchiids. The genus *Paronaella* is distinguished from *Deviatus* by having three rays of approximately equal length and structure, placed at near equal angles.

Range: Late Jurassic (Oxfordian) to late Aptian.

Deviatus diamphidius (FOREMAN, 1973b)

Pl. 64, fig. 14
Species code 203

1973b *Paronaella* (?) *diamphidia* new species FOREMAN, p. 262, pl. 8, figs. 3, 4.
1973b *Paronaella* (?) sp. aff. *P. diamphidia* FOREMAN. - FOREMAN, pl. 8, figs. 5.
1974 Spongy form resembling *Paronaella* (?) *diamphidia* FOREMAN. - RIEDEL & SANFILIPPO, pl. 12, fig. 4.
1975 *Paronaella* (?) *diamphidia* FOREMAN. - FOREMAN, p. 612, pl. 5, figs. 4, 5 ?.
1975 *Paronaella* (?) *hipposidericus* new species FOREMAN, p. 612, pl. 2E, figs. 1, 2; pl. 5, figs. 3, 7, 10.
1977 *Foremanella alpina* n. sp. MUZAVOR, p. 67, pl. 3, fig. 8.
1978b *Paronaella* (?) *diamphidia* FOREMAN. - FOREMAN, p. 744, pl. 1, figs. 5, 6.
1980 *Paronaella* (?) *diamphidia* FOREMAN. - BAUMGARTNER, p. 302, pl. 4, fig. 4.
1980 *Paronaella* (?) *hipposidericus* FOREMAN. - BAUMGARTNER, p. 302, pl. 4, figs. 1-2, 3 (= specimen of Baumgartner *et al.*, 1980, pl. 2, fig. 4).
1980 *paronaella* (?) *hipposidericus* FOREMAN. - BAUMGARTNER *et al.*, p. 57, pl. 2, fig. 4.
1981 *Paronaella* ? *diamphidia* FOREMAN. - SCHAAF, p. 436, pl. 13, fig. 4.
non 1982 *Paronaella* (?) cf. *hipposidericus* FOREMAN. - OKAMURA & UTO, pl. 7, fig. 18.
1983 *Paronaella* (?) *hipposidericus* FOREMAN. - ORIGLIA-DEVOS, p. 98, pl. 13, fig. 1.
1984b *Foremanella diamphidia* (FOREMAN). - BAUMGARTNER, p. 765, pl. 6, fig. 18.
1984b *Foremanella hipposidericus* (FOREMAN). - BAUMGARTNER, p. 765, pl. 6, fig. 19 (= specimen of Baumgartner, 1980, pl. 4, fig. 2).
1984 *Paronaella* (?) sp. YAO, pl. 3, fig. 25.
1985 *Foremanella diamphidia* SANFILIPPO & RIEDEL, p. 593, text-figs. 5. 4a-b.
1985 *Foremanella hipposidericus* SANFILIPPO & RIEDEL, p. 593, text-fig. 5. 3.
1986 *Deviatus hipposidericus* (FOREMAN). - LI, pl. 1, fig. 12.
1986 *Deviatus selliformis* sp. nov. LI, p. 312, pl. 1, fig. 13.
1992 *Foremanella diamphidia diamphidia* (FOREMAN). - BAUMGARTNER, p. 321, pl. 7, fig. 1.
non 1992 *Foremanella diamphidia hipposidericus* (FOREMAN). - BAUMGARTNER, p. 321, pl. 7, fig. 5 (= *Angulobracchia* sp.)
1992 *Foremanella diamphidia* (FOREMAN). - STEIGER, p. 46, pl. 10, figs. 13, 14.
? 1992 *Foremanella hipposidericus* (FOREMAN). - STEIGER, p. 46, pl. 10, fig. 15.
1992 *Foremanella* sp. *A*. STEIGER, p. 46, pl. 10, fig. 16.
1992 *Foremanella* sp. *B*. STEIGER, p. 46, pl. 10, fig. 17.
? 1993 *Noviforemanella* sp. aff. *N. hipposiderica* (FOREMAN). - PESSAGNO, BLOME & HULL (in Pessagno *et al.*, 1993), p. 123, pl. 2, figs. 8-9, 22-23.
1994 *Foremanella diamphidia* (FOREMAN). - JUD, p. 77, pl. 10, figs. 7-9.

Holotype: The specimen illustrated and described by Foreman (1973b) on pl. 8, fig. 3. The holotype is reported from the Sethocapsa trachyostraca assemblage (late Valanginian-Barremian?) of the north-west Pacific Ocean (DSDP, Leg 20).

Photographed material: 6 specimens.

Description: Test as with genus, having a horseshoe-shaped spongy structure. Test possesses a third unpaired arm, which is perpendicular or oblique to the horseshoe.

Remarks: This species shows a wide range of variation through all its stratigraphic range. These variation are particularly noticeable on size and position of the unpaired arm. The classical pair *diamphidius-hipposidericus* is considered as pertaining to the same morphological continuum.

GENUS **ANGULOBRACCHIA** BAUMGARTNER, 1980

Synonym: ? *Cavabracchia* KITO & DE WEVER, 1992.

Type species: *Paronaella* (?) *purisimaensis* PESSAGNO, 1977b, by original designation.

Diagnosis: Patulibracchiidae having three rays with prominent lateral external beams. Upper and lower surfaces with two prominent solid lateral external beams. Lateral sides with three or more regular horizontal rows of circular pores. Cross-section of rays normally rectangular. Inner structure spongy layered as indicated in Baumgartner (1980). Test generally, lenticular in horizontal view, showing a strongly central area. Rays without a true bracchiopyle.

Remarks: *Angulobracchia* usually does not possess a bracchiopyle, although in latest representatives of the genus frequently develops a tubular bracchiopyle-like extension at ray tips.

Comparisons: *Angulobracchia* is distinguished from *Halesium* by having less regular rows of pore frames on the rays instead of parallel arrangement of pores and nodes. Furthermore Angulobracchia possesses only two lateral external beams on each surface. Both genera may possess a bracchiopyle on their primary rays. *Angulobracchia* seems to be the direct ancestor of *Halesium.*

Range: Middle Jurassic (Bajocian) to late Aptian.

Angulobracchia portmanni BAUMGARTNER, 1984b

Pl. 64, figs. 15-16
Species code 388

pars 1973b Hagiastrids Gen. and sp. indet. FOREMAN, pl. 7, figs. 1-5, 6 ?, 7; non pl. 5, figs. 6-8; non pl. 6, figs. 2, 5 and 6 (= *H. crassum*), 1, 3, 4.
1979 *Rhopalastrum retusum* RÜST. - OZVOLDOVA, p. 11, pl. 3, fig. 1.
1981 *Paronaella* sp. SCHAAF, p. 436, pl. 8, fig. 7.
1983 *Halesium* sp. *1.* ORIGLIA-DEVOS, p. 92, pl. 11, figs. 7, 9-11.
? 1983 *Halesium* sp. (*Angulobracchia* sp. *B.* BAUMGARTNER). - ORIGLIA-DEVOS, p. 91, pl. 11, fig. 8.
1984b *Angulobracchia* (?) *portmanni* n. sp. BAUMGARTNER, p. 757, pl. 2, figs. 1-3.
pars 1988 *Angulobracchia* (?) *portmanni* BAUMGARTNER. - THUROW, p. 397, pl. 10, fig. 13; non fig. 15.
1989 *Angulobracchia* (?) *portmani* BAUMGARTNER. - TUMANDA, p. 34, pl. 2, figs. 8, 9.
1992 *Angulobracchia* (?) *portmanni* BAUMGARTNER. - STEIGER, p. 50, pl. 12, figs. 7-13.
1992 *Angulobracchia* sp. *C.* BAUMGARTNER. - STEIGER, p. 50, pl. 13, figs. 1, 2.
1994 *Angulobracchia portmanni* gr. BAUMGARTNER. - JUD, p. 61, pl. 3, figs. 2-6.
1994 *Angulobracchia* (?) *portmanni portmanni* BAUMGARTNER. - JUD, p. 61, pl. 3, fig. 7.

Holotype: The specimen described and figured by Baumgartner (1984b) on pl. 2, fig. 1. The holotype is reported from the late Tithonian-Berriasian (Maiolica Formation), locality POB-1330, Breggia Gorge, (Southern Switzerland).

Photographed material: 6 specimens.

Description: Three-rayed hagiastrid with a highly raised central area. Rays in lateral view rapidly wedging out from central area to tip. Upper and lower surfaces of central area covered with minute pores and coarse irregular nodes. Rays have irregular rows of pores with nodes at vertices of pore frames, showing some linearity distally; pores irregular in size. Nodes on rays finer than on central area. Ray tips generally develop tubular bracchiopyle-like extension. Lateral beams weakly marked externally in ancient populations; this ornamental feature tends to disappear with time and is completely lacking in newer populations. Gradual increase in height of central area occurs simultaneously with this change in ornamentation.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	135-185	183-205	200-217	183-205
Width of rays at base	41	52	58	45
Maximum width of ray tips	63	72	76	66

Remarks: *A. portmanni* is probably the last representative of the genus *Angulobracchia* and gives rise to *Halesium* at Early Cretaceous time (early Valanginian). *A. portmanni* embodies a combination of characters that could be utilized to classify it under *Halesium* but the less regular arrangement of pores on the rays herein justify the assignment to *Angulobracchia.*

Comparisons: *A. portmanni* differs from all other congeneric species by its highly raised central area, less marked lateral beams and the flattened ray tips.

GENUS **HALESIUM** PESSAGNO, 1971a

Synonym: *Patulibracchium* PESSAGNO, 1971a.

Type species: *Halesium sexangulum* PESSAGNO, 1971a, by original designation. This species is considered herein as a synonym of *Dictyastrum amissum* SQUINABOL, 1914.

Diagnosis: Three-rayed hagiastrid possessing two parallel rows of triangular and/or rectangular pore frames, which are disposed in single or double longitudinal rows. Rays rectangular in cross-section. Upper and lower surfaces with two prominent lateral external beams and a solid median beam; small nodes may be developed along the beams. Median and lateral beams connected by diagonal bars. Lateral sides with three or more regular horizontal rows of circular pores. Central area flat or slightly raised. Ray tips expanded to wedge-shaped with well developed central and lateral spines. Rays with cylindrical hollow bracchiopyle. Test rays generally equal in length and interradial angles are quite constant. Test has a spongy layered inner structure and frequently develops a patagium.

Remarks: *Halesium* seems to have evolved from *Angulobracchia* in the Early Cretaceous by acquiring two well-differentiated rows of pore frames and by developing an additional median lateral beam.

Comparisons: *Halesium* differs from *Pessagnobrachia* by possessing more uniform meshwork; pore frames are arranged in two (single or double) rows that are separated by a median beam. *Halesium* is distinguished from *Angulobracchia* by having the upper and lower surfaces of rays with three external beams instead of two.

Range: Early Valanginian to Turonian.

Halesium crassum (OZVOLDOVA, 1979)

Pl. 64, figs. 17-18
Species code 204

pars 1973b Hagiastrids Gen. and sp. indet. FOREMAN, pl. 6, figs. 2, 5 and 6; non figs. 1, 3, 4; non pl. 7, figs. 1-5, 6 ?, 7 (= *A. portmanni*); non pl. 5, figs. 6-8.
1979 *Dictyastrum crassum* n. sp. OZVOLDOVA, p. 10, pl. 2, fig. 1, 3.
? 1986 *Patulibracchium* sp. OKAMURA & MATSUGI, pl. 4, fig. 8.
? 1989 *Paronaella* sp. IWATA & TAJIKA, pl. 4, fig. 10.
1992 ? *Angulobracchia crassa* nov. comb. (OZVOLDOVA). - OZVOLDOVA & PETERCAKOVA, p. 315, pl. 2, figs. 3, 4.
1992 *Angulobracchia* (?) *media* STEIGER. - BAUMGARTNER, p. 318, pl. 3, fig. 4.
1992 *Angulobracchia* spp. BAUMGARTNER, p. 318, pl. 3, figs. 5, 6.
1992 *Angulobracchia media* n. sp. STEIGER, p. 49, pl. 11, figs. 12, 13.

Holotype: The specimen figured by Ozvoldova (1979a) on pl. 2, fig. 1. The holotype is from the Albian of Brodno, Klippen belt (West Carpathians).

Photographed material: 5 specimens and numerous fragmentary material.

Description: Test as with genus, with greatly expanded ray tips, composed of a coarse tetragonal meshwork. Central area strongly raised. Upper and lower surfaces of rays with well developed median and lateral beams. Nodes better developed on lateral beams. The slightly nodose median beam separates two double rows of triangular pore frames. A pattern of alternating (or zigzag) diagonal bars occurs between the median and lateral beams forming the double row of pores. Rays moderately slender with large wedge or club-shaped ray tips. Two small and thick, lateral spines occur at tips. Rays tips with a noticeable long tubular bracchiopyle which is tapered distally.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	145	223	229	216
Width of rays at base	35	63	75	50
Maximum width of ray tips	80	93	96	92

Remarks: This species appears to be transitional between *Angulobracchia* and *Halesium*. Generic attribution to *Halesium* results from the characteristic pattern of rows of pore frames on the rays. Both genera co-occur in the Turbocapsula zone but their morphological differentiation is already fully achieved.

Comparisons: *H. crassum* differs from all the other congeneric species by possessing a strongly raised central area, a stoutly developed bracchiopyle, and a more lenticular test in cross-section. *H. crassum* shows patent affinities with *A. portmanni* but the presence of a median beam justifies the generic designation herein.

Halesium nevianii (SQUINABOL, 1903b)

Pl. 64, figs. 19-24
Species code 178

1903b *Rhopalastrum Nevianii* n. sp. SQUINABOL, p. 122, pl. 10, fig. 6.
1971a *Patulibracchium davisi* n. sp. PESSAGNO, p. 30, pl. 1, figs. 1-4.
1971a *Patulibracchium woodlandensis* n. sp. PESSAGNO, p. 45, pl. 5, figs. 2-6.
? 1973 *Paronaella* sp. *A*. MOORE, p. 825, pl. 15, fig. 4.

1976 *Patulibracchium davisi* PESSAGNO. - PESSAGNO, p. 30, pl. 1, fig. 7 (= specimen of Pessagno, 1971a, pl. 1, fig. 1).

1976 *Patulibracchium woodlandensis* PESSAGNO. - PESSAGNO, p. 31, pl. 1, fig. 8 (= specimen of Pessagno, 1971a, pl. 5, fig. 2).

non 1977 *Patulibracchium* cf. *woodlandensis* PESSAGNO. - MUZAVOR, p. 65, pl. 2, fig. 7; pl. 3, fig. 2.

1977c *Paronaella* sp. cf. *P. solanoensis* PESSAGNO. - PESSAGNO, p. 27, pl. 1, fig. 2.

? 1977c *Patulibracchium obesum* n. sp. PESSAGNO, p. 27, pl. 1, figs. 17, 18; pl. 12, fig. 2.

? 1983 *Paronaella torvitatis* (PESSAGNO). - ORIGLIA-DEVOS, p. 102, pl. 13. fig. 3.

non 1983 *Paronaella woodlandsis* (PESSAGNO). - ORIGLIA-DEVOS, p. 103, pl. 13, fig. 5 (= *G. fabianii*).

non 1986 *Patulibracchium* cf. *davisi* PES. - KUHNT *et al.*, pl. 7, fig. g (= *P. irregularis*).

1986 *Patulibracchium davisi* PES. - THUROW & KUHNT, text-fig. 9. 17.

1988 *Patulibracchium* sp. cf. *P. davisi* PESSAGNO. - THUROW, p. 403, pl. 6, fig. 6.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 10, fig. 6 is considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 34 specimens.

Description: Test as with genus with quite expanded rays, which are flattened slightly near the tips; rays expanded distally by the addition of a lateral patagium. Rays with well developed blade-like lateral and central spines. Upper and lower surface of rays usually with two double rows of triangular pore frames which are separated by a prominent median beam. Lateral and median beams nodose and well-marked. Median beam connected to lateral beams by means of thin diagonal bars. Central area most commonly flat or sometimes slightly raised. Rays rectangular to slightly ellipsoidal in cross-section.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	206	222	234	212
Width of rays at base	37	66	78	50
Maximum width of ray tips	75	130	175	112

Remarks: This species appears to have evolved from *H. crassum* by a reduction in the height of the central area, the loss of parallelism on lateral external beams, and by developing more strongly expanded ray tips. In addition lateral and central spines become stoutly developed.

Comparisons: *H. nevianii* differs from the closely allied *H. diacanthum*, by possessing longer central and lateral spines and by having larger rays that are strongly expanded distally and lack bulbous tips.

Halesium diacanthum (SQUINABOL, 1914)

Pl. 65, figs. 1-8

Species code 181

1914 *Dictyastrum diacanthos* n. f. SQUINABOL, p. 274, pl. 21 [2], fig. 3.

1971a *Halesium quadratum* n. sp. PESSAGNO, p. 23, pl. 3, figs. 1-6; pl. 4, figs. 1, 2.

1976 *Halesium quadratum* PESSAGNO. - PESSAGNO, p. 29, pl. 1, fig. 5 (= specimen of Pessagno, 1971a, pl. 3, fig. 1).

non 1983 ? *Halesium* (?) *quadratum* PESSAGNO. - ORIGLIA-DEVOS, p. 90, pl. 11, figs. 1-2 (= *P. grapevinensis* ?), 3.

non 1986 *Halesium quadratum* PESSAGNO. - THUROW & KUHNT, text-fig. 9. 16 (= *H. triacanthum*).

non 1988 *Halesium quadratum* PESSAGNO. - THUROW, p. 401, pl. 2, fig. 10 (= *H. triacanthum* ?)

Holotype: The specimen illustrated by Squinabol (1914) on pl. 21 [2], fig. 3 is considered the valid holotype. This specimen was reported from the locality of Novale Vicentino Province (Venetian Alps, N Italy).

Photographed material: 69 specimens.

Description: Test as with genus always with well rounded ray tips. Ray tips composed of polygonal pore frames with small circular pores. Test usually with two single rows of rectangular pore frames per ray. Lateral and median beams strongly nodose and well marked. Perpendicular thin bars connect median with lateral beams. Central and lateral spines strong. Rays rectangular in cross-section. A thick patagium is occasionally developed on the test.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	252-258	262-284	313-338	213-225
Width of rays at base	39-52	63	125	43
Maximum width of ray tips	138	106	150	88

Remarks: This species undoubtedly evolved from *H. nevianii* by the development of bulbous ray tips. The range of variation overlaps, but *H. diacanthum* always includes slender forms having bulbous ray tips with weakly central and lateral spines. In addition *H. diacanthum* possesses two single rows rather than two double rows of pore frames between beams.

Comparisons: *H. diacanthum* is compared with *H. triacanthum* and *H. amissum* which co-occurs during early-middle Cenomanian times. *H. diacanthum* has a similar but weaker ornamentation on the rays, however differs mainly by constantly possessing well developed bulbous, finely porate, ray tips.

Halesium triacanthum (SQUINABOL, 1903b)

Pl. 65, figs. 9-14

Species code 183

	1903b	*Dictyastrum triacanthos* n. sp. SQUINABOL, p. 121, pl. 9, fig. 28.
	1986	*Halesium quadratum* PESSAGNO. - THUROW & KUHNT, text-fig. 9. 16.
?	1988	*Halesium quadratum* PESSAGNO. - THUROW, p. 401, pl. 2, fig. 10.
	1991	*Halesium* (?) *sexangulum* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 7.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 28 is considered as the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 45 specimens.

Description: Test as with the genus, relatively large form composed of three long rays. Rays comprised externally of two strong lateral beams and one weak median beam, all possessing nodes. Beams connected by small perpendicular bars. Median beam separates two single rows of rectangular pore frames. Width of rays quite uniform along the axis, expanded distally at ray tips. Rays with strong lateral and central spines. Lateral spines frequently longer than the central spine, which usually has a bracchiopyle. Rays square to rectangular in cross-section. Patagium rarely observed among studied populations.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	344	298	350	250
Width of rays at base	34	52	75	37
Maximum width of ray tips	50	73	100	50

Remarks: *H. triacanthum* seems to have evolved from *H. diacanthum*. The range of variability among older populations slightly overlaps, but in younger populations specific distinction between morphotypes is wholly achieved. During this transition bulbous ray tips gradually become diminished. *H. triacanthum* is enhanced by definitive obliteration of bulging tips and noticeable increase in the length of axial rays.

Comparisons: The larger size, the longer rays, and the less massive lateral spines of *H. triacantha* enable making a specific distinction with *H. amissum*.

Halesium amissum (SQUINABOL, 1914)

Pl. 65, figs. 15-23
Species code 182

	1914	*Dictyastrum amissum* n. f. SQUINABOL, p. 273, pl. 21 [2], fig. 2.
	1971a	*Halesium sexangulum* n. sp. PESSAGNO, p. 25, pl. 1, figs. 5, 6; pl. 2, figs. 1-6.
?	1973	*Patulibracchium* cf. *P. ungulae* PESSAGNO.- MOORE, p. 825, pl. 15, fig. 3.
	1976	*Halesium sexangulum* PESSAGNO. - PESSAGNO, p. 29, pl. 1, fig. 6 (= specimen of Pessagno, 1971a, pl. 1, fig. 5).
	1983	*Halesium sexangulum* PESSAGNO. - ORIGLIA-DEVOS, p. 91, pl. 11, figs. 4, 5.
	1986	*Halesium* cf. *sexangulum* PES. - KUHNT *et al.*, pl. 7, fig. e.
	1986	*Halesium sexangulum* PES. - THUROW & KUHNT, text-fig. 9. 15.
?	1988	*Halesium sexangulum* PESSAGNO. - THUROW, p. 401, pl. 6, fig. 3.
non	1989	*Halesium* cf. *H. sexagulum* PESSAGNO. - TUMANDA, p. 34, pl. 2, fig. 11.
non	1990	? *Halesium sexangulum* PESSAGNO. - OZVOLDOVA, p. 141, pl. 5, fig. 3.
non	1991	*Halesium* (?) *sexangulum* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 7 (= *H. triacanthum*).
non	1992	*Halesium sexangulum* PESSAGNO. - STEIGER, p. 47, pl. 11, figs. 1, 2.

Holotype: The specimen illustrated by Squinabol (1914) on pl. 21 [2], fig. 2 is considered the valid holotype. This specimen was reported from the locality of Novale Vicentino Province (Venetian Alps, N Italy).

Photographed material: 134 specimens.

Description: Test as with genus, forms of small size with relatively thick rays. External median and lateral beams, solid and strongly nodose. Rays relatively short, very thick and quite expanded distally. Upper and lower sides of rays have two double rows of alternating triangular pore frames separated by a median beam. Lateral beams connected to the median beam by small diagonal bars. Ray tips large wedge-shaped, with coarser meshwork of tetragonal pore frames. Rays rectangular in cross-section. Test in a lateral view showing quite flat surfaces on rays wedging out toward the ray tips. Ray tips share frequently a bracchiopyle. Test frequently develops a strong patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	215	194	220	175
Width of rays at base	60-62	68	80	45
Maximum width of ray tips	123	90	120	70

Remarks: Range of variability overlaps that of *H. diacanthum*, but *H. amissum* undoubtedly evolved from *H. diacanthum* in early Cenomanian time by acquiring a more robust test with smaller rays and by developing coarser meshwork.

Comparisons: *H. amissum* differs from all other congeneric species by its smaller size and robust rays. Also, *H. amissum* is further distinguished from *H. diacanthum* by its more robust rays, coarser meshwork, and by lacking bulbous ray tips.

GENUS **PARONAELLA** PESSAGNO, 1971a

Synonym: *Sontonaella* YEH, 1987.

Type species: *Paronaella solanoensis* PESSAGNO, 1971a, by original designation.

Diagnosis: Three-rayed hagiastrid without bracchiopyle. Test usually three-rayed in outline, but some species have a marked tendency to attain a triangular shape. Rays equal or unequal in length lacking prominent lateral external beams; circular to elliptical in cross-section. Test may develop lateral and central spines at ray tips. Pore frames comprised of bars connected to weakly developed nodes. Surface of rays with linear, sublinear or irregular arrangement of pores and nodes. Short spines occasionally radiate from lateral sides of rays. Ray tips, highly variable, bulbous or smooth.

Remarks: *Paronaella* is regarded as a polyphyletic genus. The repeated problem of recurrent heterochronous homoeomorphs makes it very difficult to distinguish genera or subgenera among this group. Only after a major stratigraphic-paleontological revision of this genus, from the Triassic on, could be realistic a division into different genera or subgenera be made from among the wide morphological spectrum shown by the representatives of *Paronaella*. In this paper *Paronaella* groups a wide range of morphologies including forms with bulbous or expanded ray tips, as others authors have previously mentioned (Baumgartner, 1980; Carter, 1993; Pessagno *et al.*, 1993). It becomes difficult at this time, to recognize a single phyletic thread through the disjointed record, and a more complicated pattern of phylogenetic divisions than may one day emerge.

Comparisons: *Paronaella* is distinguished from *Pessagnobrachia* by lacking a bracchiopyle and by sometimes possessing lateral spines that radiate laterally from the rays.

Range: Late Triassic to Campanian.

Paronaella grapevinensis (PESSAGNO, 1977c)

Pl. 66, figs. 1-8

Species code 227

	1977c	*Patulibracchium grapevinensis* n. sp. PESSAGNO, p. 24, pl. 1, figs. 1, 5, 10-12; pl. 12, fig. 1.
?	1982	*Paronaella* sp. *A*. TAKETANI, p. 50, pl. 9, fig. 18.
pars ?	1983	? *Halesium* (?) *quadratum* PESSAGNO. - ORIGLIA-DEVOS, p. 90, pl. 11, figs. 1, 2; non fig. 3.
?	1988	*Paronaella* sp. *A*. THUROW, p. 403, pl. 6, fig. 7.

Holotype: The specimen described and figured by Pessagno (1977c) on pl. 1. figs. 1, 10, 10, 11, 12 (figs. 10-12. holotype's close view). The holotype is from locality NSF 884, late Albian portion of the Great Valley Sequence, California Coast Ranges.

Photographed material: 28 specimens.

Description: Three-rayed form with small central area. Test may develop a delicate patagium between the rays. Two or three pairs of lateral spines per ray radiate more or less at the same plane. Rays composed of polygonal to circular pore frames which tend to be aligned in two or three longitudinal rows. Rays increase in width distally. Lateral spines about equal in size to the central spine. Although intraspecific variability is relatively high, rays laterally becomes quite spinose. When the patagium becomes rather spongy, rays may develop an incipient bracchiopyle-like extension.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	380	243	270	220
Width of rays at base	60	62	100	30
Maximum width of ray tips	144	83	130	70

Remarks: This species shows a wide range of variation through its entire stratigraphic range. Variability is induced by the development of a patagium and the unequal development of pairs of spines radiating from the lateral sides of rays. *P. grapevinensis* seems to be the common ancestor of all species of *Paronaella* described herein.

Comparisons: *P. grapevinensis* is distinguished from all other Cretaceous congeneric species by possessing two or three pairs of lateral spines per ray and by having a smaller central area.

Paronaella communis (SQUINABOL, 1903b)

Pl. 66, figs. 9-16
Species code 369

	1903b	*Spongotripus communis* n. sp.	SQUINABOL, p. 123, pl. 9, fig. 7.
?	1982	*Spongotripus morenoensis*	CAMPBELL and CLARK. - TAKETANI, p. 49, pl. 9, fig. 11.
	1989	*Pseudoaulophacus polonicus*	sp. n. GORKA, p. 337, pl. 10, figs. 1-4.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 9, fig. 7 is considered the valid holotype. This specimen was reported from an imprecise locality in the Colli Euganei area (southern Venetian Alps, N Italy).

Photographed material: 18 specimens.

Description: Small three-rayed forms having a strongly developed patagium which gives a triangular outline to the test. Rays terminate in a long three-bladed central spine. Upper and lower surface planiform or slightly convex. Test relatively flattened, with concave lateral sides. In some older specimens (pl. 66, fig. 9) test develops lateral spines, that are usually equal in length to the central spines. Meshwork quite spongy, comprised of circular to polygonal pore frames irregularly arranged.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	170	204	225	187
Width of rays at base	56	98	125	54

Remarks: As the phylogeny progresses lateral spines tend to disappear and the triangular test becomes progressively smaller and three-rayed. It is likely that *P. communis* evolved from more spongy representatives of *P. grapevinensis*, by the progressive loss of lateral spines and by acquiring more triangular test.

Comparisons: This species appears closely related to *P. acuta*; it differs by having convex lateral sides and longer blade-like central spines.

Paronaella acuta nov. sp.

Pl. 66, figs. 17-18
Species code 312

Holotype: Specimen 6511 (pl. 66, fig. 17). The holotype is from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *acutus* -a -um, meaning pointed.

Photographed material: 2 specimens.

Description: *Paronaella* with triangular test in outline. Distal ends of rays with vertex cut off by a vertical plane, from which a central spine extends. Central spines mostly short and circular in cross-section, in some specimens they are slightly three-bladed at the base. Upper and lower surfaces planiform with a depressed central area. Lateral sides somewhat convex in outline.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	208	200	213	188
Width of ray tips	58	54	58	50

Remarks: *P. acuta* seems to have evolved from *P. communis* by acquiring a thick test with convex lateral sides, by developing a depressed central area, and by reduction of the central blade-like spines. While phylogeny progresses, spines become circular in outline.

Comparisons: Among the wealth of the Cretaceous species assigned to *Paronaella*, *P. acuta* shows patent affinities with *P. communis*. Both nominal species have a range of variability that slightly overlaps during the early Turonian, but *P. acuta* distinctly includes forms with thicker spongy meshwork, a truncated vertex at the base of each central spine, convex lateral sides, and a depressed central area.

Paronaella solanoensis PESSAGNO, 1971a

Pl. 66, figs. 19-24
Species code 179

	1971a	*Paronaella* sp. *A*. PESSAGNO, p. 51, pl. 17, fig. 2.
	1971a	*Paronaella solanoensis* n. sp. PESSAGNO, p. 48, pl. 10, figs. 2, 3.
pars	1971a	*Patulibracchium lawsoni* n. sp. PESSAGNO, p. 35, pl. 14, fig. 1; non pl. 13, figs. 4-6.
	1971a	*Patulibracchium torvitatis* n. sp. PESSAGNO, p. 42, pl. 6, figs. 4-6; pl. 7, figs. 1-2.

non 1977c *Paronaella* sp. cf. *P. solanoensis* PESSAGNO. - PESSAGNO, p. 27, pl. 1, fig. 2 (= *H. nevianii*).
non 1983 *Paronaella torvitatis* (PESSAGNO). - ORIGLIA-DEVOS, p. 102, pl. 13. fig. 3 (= *H. nevianii* ?).
1986 *Paronella salonensis* PES. - THUROW & KUHNT, text-fig. 9. 18.

Holotype: The specimen described and figured by Pessagno (1971a) on pl. 10. fig. 2. The holotype was reported from locality NSF 483 (Yolo Formation) late Turonian-Coniacian of the California Coast Ranges.

Photographed material: 23 specimens.

Description: Three-rayed hagiastrid with coarse hexagonal and tetragonal pore frames. Rays relatively wide and elliptical in cross-section having two robust lateral spines and one prominent central spine at rays tips. Central and lateral spines well-developed and blade-like. Lateral spines somewhat flattened axially. Central area wide, about the same width as rays. In younger specimens a small pair of spines on the lateral sides of rays has been irregularly observed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	110-120	149	175	134
Width of rays at base	53	55	75	42
Maximum width of ray tips	71	85	100	66

Remarks: Specimens referred to here as *P. solanoensis* appear to be restricted stratigraphically to the Superbum zone. They differ from co-occurring individuals of *P. grapevinensis* by possessing more massive lateral spines and a larger central area. Nevertheless, the range of variability of *P. grapevinensis* slightly overlaps with the type species and with coexisting *P. californiaensis,* but the latter species always includes specimens with more bulbous ray tips and with a strongly raised central area.

Comparisons: *P. solanoensis* is distinguished from the closely allied *P. grapevinensis*, by having a more robust test, a well developed pair of lateral spines on each ray, a thicker central area, and coarser meshwork. The type species differs from *P. californiaensis* by the presence of well-developed blade-like lateral and central spines at ray tips.

Paronaella californiaensis PESSAGNO, 1971a

Pl. 67, figs. 1-7
Species code 180

1971a *Patulibracchium californiaensis* n. sp. PESSAGNO, p. 29, pl. 11, fig. 6; pl. 12, figs. 1, 2.
1976 *Patulibracchium californiaensis* PESSAGNO. - PESSAGNO, p. 30, pl. 10, fig. 13 (= specimen of Pessagno , 1971a, pl. 12, fig. 2).
? 1988 *Patulibracchium californensis* PESSAGNO. - THUROW, p. 403, pl. 2, fig. 9.

Holotype: The specimen described and figured by Pessagno (1971a) on pl. 11. fig. 6. The holotype was reported from locality NSF 32-B (Forbes Formation, "Dobin Shale" Member) early Campanian of the California Coast Ranges.

Photographed material: 34 specimens.

Description: Three-rayed forms composed of short and broad rays strongly expanded at tips. Test has coarse to medium meshwork with hexagonal to tetragonal pore frames. Rays short, equal to subequal in length, gradually expanding and flattening slightly near the tips. Rays with two lateral spines and one prominent central spine at rays tips. Tips rounded to wedge-shaped. Toward the middle part of each ray test sometimes develops one pair of long lateral spines that are usually longer than the lateral spines situated at ray tips. Lateral spines circular in cross-section. Central area large has the tendency to develop a conspicuous raised promontory. In more spongy specimens, interradial sides are permanently concave.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	156	151	175	125
Width of rays at base	106	87	117	75
Maximum width of ray tips	144	121	150	92

Remarks: Range of variability of *P. californiaensis* and *P. solanoensis* somewhat superposed. The most conspicuous change is shown by the enormous enlargement of central area. *P. californiaensis* evolves from *P. solanoensis* and undoubtedly gave rise to *P. pseudoaulophacoides*.

Comparisons: *P. californiaensis* is closely allied to the type species (*P. solanoensis*), but differs in having more expanded ray tips and a sturdy raised central area.

Paronaella pseudoaulophacoides nov. sp.

Pl. 67, figs. 8-9
Species code 144

? 1988 *Patulibracchium petroleumensis* PESSAGNO. - THUROW, p. 403, pl. 2, fig. 11.

Holotype: Specimen 6627 (pl. 67, fig. 8). The holotype is from locality no. Asv-5-43, early Turonian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Specific name is formed by the addition of the suffix *-oides* to *Pseudoaulophacus*, meaning with form of *Pseudoaulophacus*.

Photographed material: 8 specimens.

Description: Three-rayed hagiastrid with a conspicuous triangular test. Rays short, approximately equal in length, with a sturdy three-bladed central spine at each tip. Central area strongly raised with a characteristic triangular shape. Pore frames irregular to sublinearly aligned, more or less uniform in size, mostly tetragonal. Interradial sides convex, usually with four acute spines on each side. These spines correspond to the prolongation of two pairs of lateral spines per ray. In horizontal view, shell has a lenticular shape with a enormous raised central area.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	175	163	175	154
Length of longest spine	100	92	100	84
Diameter of central area	50	52	58	42

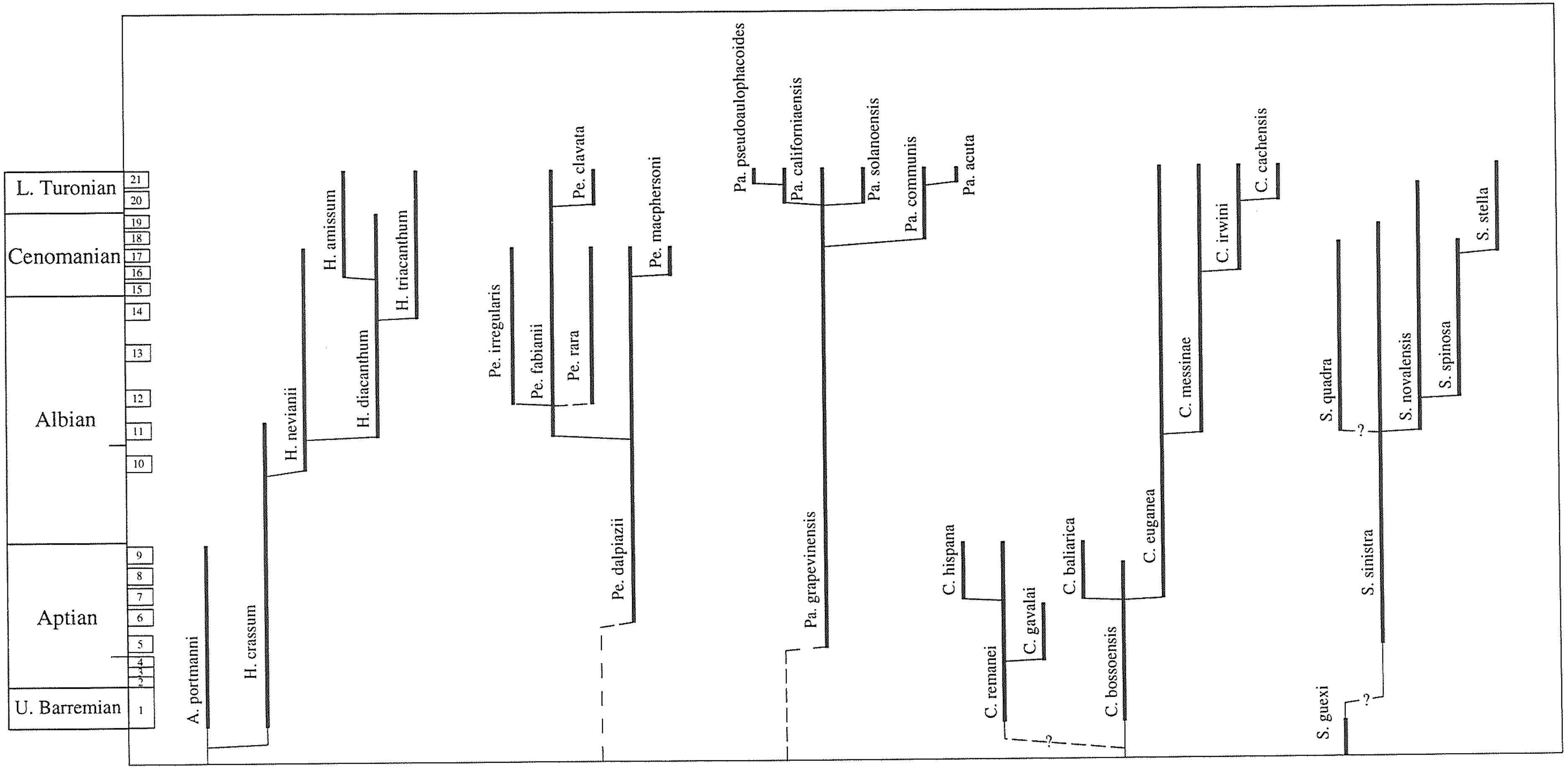

Fig. 32.- Stratigraphic range and possible phyletic relationships of genera and species of the family Patulibracchiidae.

Remarks: *P. pseudoaulophacoides* evolves from *P. californiaensis* by developing a thick interradial patagium, giving to the three-rayed shell a triangular shape (hugely resembling the common test of the genus *Pseudoaulophacus* PESSAGNO). In *P. pseudoaulophacoides* the shape of the test appears to be directly related to the evolutionary transition of *Paronaella* during the Mid-Cretaceous. A good pictorial sequence showing how the shape of the cortical shell changes from *P. californiaensis* to *P. pseudoaulophacoides* is shown on pl. 67, figs. 1-9.

Comparisons: *P. pseudoaulophacoides* embodies an unlike combination of characters among the representatives of the genus. Generic attribution to *Paronaella* is supported by the clearly evolutionary progression between representatives of the genus. *P. pseudoaulophacoides* closely resembles *P. californiaensis* in shape and raised central area, but is distinguished by its convex lateral sides.

GENUS **PESSAGNOBRACHIA** KOZUR & MOSTLER, 1978.

Type species: *Patulibracchium teslaensis* PESSAGNO 1971a, by original designation.

Diagnosis: Spongy three-rayed hagiastrid with irregular to regular arrangement of pores on rays. Length of rays quite variable with species, with or without central and lateral spines at ray tips. Rays are frequently of unequal length. Ray tips expanded, bulbous or wedge-shaped. Rays frequently develop bracchiopyle. Thickness of the central area generally equal to thickness of rays. Test may develop a patagium.

Remarks: Kozur & Mostler (1978, p. 142) introduced the new generic name *Pessagnobrachia* to include those species of *Patulibracchium* without a patagium. Simultaneously, these authors synonymized *Patulibracchium* with *Halesium*, based on the presence of a poorly developed patagium in *Patulibracchium davisi*, the type species of *Patulibracchium*, as was indicated by Baumgartner (1980). In accord with the latter, the presence or absence of a patagium is not considered to be a criterion of taxonomic classification at the generic level, or even the specific or subspecific level. Nevertheless, the genus name *Pessagnobrachia* is retained here, because among the wealth of species originally included by Pessagno (1971a) in the heterogeneous type series of *Patulibracchium*, the type species shows patent affinities with *Halesium*, and it is not possible to differentiate these at·generic level. Consequently *P. davisi* has been synonymized under *Halesium nevianii* and the generic name *Pessagnobrachia* is utilized as a valid name for most remaining species similar to the type series of *Patulibracchium*.

Comparisons: Representatives of *Pessagnobrachia* have affinities with *Paronaella* but differ by having more spongy meshwork and a bracchiopyle. *Pessagnobrachia* is distinguished from *Halesium* by lacking lateral external beams on the upper and lower surfaces and by lacking parallel arrangement of pores on the rays.

Range: Berriasian to Coniacian, as far as know.

Pessagnobrachia dalpiazii (SQUINABOL, 1914)

Pl. 67, figs. 10-16
Species code 161

1914 *Rhopalastrum dal Piazii* n. f. SQUINABOL, p. 277, pl. 21 [2], fig. 6.
1914 *Euchitonia novalensis* n. f. SQUINABOL, p. 277, pl. 21 [2], fig. 7.

Holotype: The specimen illustrated by Squinabol (1914) on pl. 21 [2], fig. 6 is considered the holotype. This specimen was reported from the locality of Novale, Vicentino Province (Venetian Alps, N Italy).

Photographed material: 35 specimens.

Description: Stout three-rayed forms with cylindrical to subcylindrical rays having large inflated ray tips without spines. Rays short, approximately equal in length, rapidly expanding and gradually flattening at the tips. Spongy meshwork of rays is strongly developed. Rays with circular to rectangular pores; sometimes weak linearity of pore frames is exhibited distally. Large central area, raised, flat or slightly depressed. Test generally slightly flattened on upper and lower surfaces. Test develops bracchiopyle at ray tips.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	215-262	216	235	195
Width of rays at base	46	63	90	40
Maximum width of ray tips	69	131	170	100

Remarks: *P. dalpiazii* ranges through Albian and Cenomanian time giving rise to the main phylogenetic lineage of the genus *Pessagnobrachia.* The origin of this species has not been traced in detail. Throughout the stratigraphic range of this species, the most noticeable change is in the central area of the shell. Older representatives of *P. dalpiazii* have a large, raised central area which becomes progressively smaller and flat through time, eventually attaining a depressed central surface. Among the older population of *P. dalpiazii* the central area may become strongly raised.

Comparisons: *P. dalpiazii* differs from all other congeneric species by possessing a flat central area which may become slightly depressed, and by having large inflated ray tips.

Pessagnobrachia fabianii (SQUINABOL, 1914)

Pl. 67, figs. 17-25
Species code 189

1914	*Rhopalastrum Fabianii* n. f. SQUINABOL, p. 274, pl. 21 [2], fig. 4.
1983	*Paronaella woodlandsis* (PESSAGNO). - ORIGLIA-DEVOS, p. 103, pl. 13, fig. 5.
1992	*Patulibracchium* cf. *P. teslaensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 4. j.

Holotype: The specimen illustrated by Squinabol (1914) on pl. 21 [2], fig. 4 is considered the holotype. This specimen was reported from the locality of Novale, Vicentino Province (Venetian Alps, N Italy).

Photographed material: 42 specimens.

Description: Three-rayed hagiastrid with incipient development of the bracchiopyle at ray tips. Central area generally planiform with dense meshwork composed by small pores and minute nodes. Rays relatively equal in length, circular in cross-section, and showing a faint linear arrangement of the subcircular pore frames. Width of rays regular along the axis, expanding only at tips. Pore frames irregularly shaped, composed of thin bars with fine nodes at vertices. Ray tips with uniform spongy meshwork and circular pore frames. Rays may be surrounded by a robust patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	260-307	297	338	250
Width of rays at base	107	87	150	50
Maximum width of ray tips	126	119	163	100

Remarks: *P. fabianii* is probably closely related to *P. dalpiazii* and both co-occurs in the Spoletoensis zone. Compared to *P. dalpiazii*, *P. fabianii* differs by possessing longer rays, less bulbous ray tips and by showing a better arrangement of pores at rays. The central area is also simplified and becomes smaller by loss of the depressed area on both upper and lower surfaces. *P. fabianii* undoubtedly gave rise to *P. clavata* by loss of the linear arrangement of pores and by simultaneously acquiring numerous tiny spines. Through the greatest part of its stratigraphic range, the most variable features of *P. fabianii* are the length of rays and development of a patagium.

Comparisons: This species is distinguished from *P irregularis* by possessing rays with a constant interradial angle and equal length, and by lacking a well developed system of external beams on the rays. *P. fabianii* differs from its ancestor *P. dalpiazii*, by having more slender rays of constant width with ray tips only slightly thicker than the width of rays.

Pessagnobrachia irregularis (SQUINABOL, 1903b)

Pl. 68, figs. 1-8
Species code 210

	1903b	*Rhopalastrum irregulare* n. sp. SQUINABOL, p. 122, pl. 9, fig. 10.
	1914	*Rhopalastrum deperditum* n. f. SQUINABOL, p. 276, pl. 21 [2], fig. 5.
	1971a	*Patulibracchium inaequalum* n. sp. PESSAGNO, p. 33, pl. 4, figs. 3-6; pl. 5, fig. 1.
	1976	*Patulinracchium inaequalum* PESSAGNO. - PESSAGNO, p. 30, pl. 1, fig. 2 (= specimen of Pessagno, 1971a, pl. 4, fig. 4).
	1983	*Paronaella arbucklensis* (PESSAGNO). - ORIGLIA-DEVOS, p. 96, pl. 12, figs. 12, 13.
	1986	*Patulibracchium* cf. *davisi* PES. - KUHNT *et al.*, pl. 7, fig. g.
	1989	*Patulibrachium delvallensis* PESSAGNO. - GORKA, p. 332, pl. 11, fig. 8.
non	1994	*Homoeoparonaella* sp. aff. *H. irregularis* (SQUINABOL). - JUD, p. 80, pl. 11, figs. 7-8.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 10 is considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 15 specimens.

Description: Three-rayed hagiastrid with rays composed of numerous longitudinal external beams connected by fragile bars placed in oblique transverse rows to form small rectangular pore frames. Distally, longitudinal beams tend to be oriented obliquely with respect to the ray axis, causing the rays to appear left-twisted. Central area relatively small. Interradial angles between rays strongly unequal and variable. Rays very long, always unequal in length, with expanded ellipsoidal tips. Rays circular in cross-section and composed cortically of six to eight longitudinal beams. Ray tips composed of polygonal pore frames with circular pores. Some specimens show weakly developed central and lateral spines on ray tips.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	225-344	302-378	362-463	262-337
Width of rays at base	50	56	75	44
Maximum width of ray tips	85	110	125	81

Remarks: *P. irregularis* undoubtedly evolved from *P. fabianii* by rapidly acquiring a more regular arrangement of pores, which seem to be directly controlled by the development of external longitudinal beams on the rays. The study of successive populations of *P fabianii* and *P. irregularis* recognize the gradual transition between these morphotypes in the middle Albian (base of Missilis subzone).

Comparisons: In addition to its much bigger size, *P. irregularis* differs from *P. fabianii* by the markedly unlike length of its rays and by having distinct, obliquely running longitudinal beams producing left-twisted rays distally.

Pessagnobrachia rara (SQUINABOL, 1914)

Pl. 68, figs. 9-13
Species code 174

	1914	*Dictyocoryne rara* n. f. SQUINABOL, p. 279, pl. 21 [2], fig. 8.
?	1988	*Paronaella* sp. *B*. THUROW, p. 403, pl. 6, fig. 8.
non	1994	*Cyclastrum rarum* (SQUINABOL). - JUD, p. 74, pl. 8, fig. 9 (= *C. infundibuliforme*).

Holotype: The specimen illustrated by Squinabol (1914) on pl. 21 [2], fig. 8 is considered the holotype. This specimen has been reported from the locality of Novale, Vicentino Province (Venetian Alps, N Italy).

Photographed material: 12 specimens.

Description: Three-rayed forms, with a well developed patagium spreading between the rays; rays terminate in a smooth tapered central spine flanked by a pair of small lateral spines. Central area quite small. Rays of equal (occasionally unequal) length with expanded ellipsoidal tips. Rays composed cortically of six to eight longitudinal beams. External beams connected by transverse rows of short delicate bars to form small rectangular pore frames. Rays slightly flattened, showing three to four parallel pore rows per side. Pores of patagium irregularly distributed and generally smaller than pores on rays.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	205	322	362	287
Maximum width of ray tips	96	128	138	125

Remarks: It is likely that *P. rara* corresponds to extremes morphotypes of *P. irregularis* that have more constant length of rays, more constant interradial angles between rays and, in addition, develop a robust patagium. Both morphospecies have a similar stratigraphic range. *P. rara* seems to have evolved from *P. fabianii* by progressively acquiring a more regular arrangement of pores, and by developing external longitudinal beams on the rays. This species apparently left no descendants.

Comparisons: *P. rara* differs from the closely allied *P. fabianii* by possessing central and lateral spines at ray tips and by possessing external longitudinal beams on the rays. *P. rara* differs from *P. irregularis* by developing a patagium and by having the longitudinal beams oriented parallel to the axis instead of on oblique orientation.

Pessagnobrachia macphersoni nov. sp.

Pl. 68, figs. 14-20
Species code 169

Holotype: Specimen 3767 (pl. 68, fig. 18). The holotype is from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: This genus is named in honour of J. MacPherson for his early contribution to the regional geology of the western Betic Cordillera.

Photographed material: 20 specimens.

Description: Three-rayed hagiastrid with conspicuous wedge-shaped ray tips. Rays nearly equal in length strongly widened laterally at tips with relatively fine, irregular meshwork. Ray tips widely expanded and wedge-shaped; meshwork coarser with large circular pore frames. Ray tips quite inflated axially in the center and flattened toward the periphery. Cross section of rays rectangular to nearly hexagonal. Test possesses a strongly raised central area. In terminal forms test may develop a strong patagium, acquiring an almost triangular shape in outline. Distal end of rays without spines but have a faintly developed bracchiopyle.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	220	213	220	200
Width of rays at base	45	63	90	45
Maximum width of ray tips	190	194	225	160

Remarks: This species undoubtedly branched off from *P. dalpiazii,* and seems to be the original stock (together with the latter) of all Late Cretaceous species of *Pessagnobrachia*. The range of variability of *P. macphersoni* and *P. dalpiazii* slightly overlap, but the former has wedge-shaped ray tips and a noticeably raised central area

Comparisons: *P. macphersoni* is distinguished from *P. dalpiazii* by its narrow strongly raised central area and large wedge-shaped rays tips.

Pessagnobrachia clavata (SQUINABOL, 1903b)

Pl. 68, figs. 21-26

Species code 190

1903b *Rhopalastrum clavatum* n. sp. SQUINABOL, p. 122, pl. 9, fig. 23.
1986 *Paronella* sp. *A*. KUHNT *et al.*, pl. 7, fig. f.

Holotype: The specimen illustrated by Squinabol (1903b) on pl. 9, fig. 23 is considered the holotype. This specimen has been reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 20 specimens.

Description: Slender three-rayed hagiastrid with cylindrical rays having numerous tiny spines. Rays possess relatively fine, irregular meshwork with circular or elongate pores which may show a faint linear arrangement. When linearly arranged, rays become slightly left-twisted. Ray tips with finer spongy meshwork than rays. Bracchiopyle faintly developed. Some specimens have moderately long weakly developed central and lateral spines.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Axial length of rays	187-212	293	321	256
Width of rays at base	56	79	100	62
Maximum width of ray tips	69	122	138	100

Remarks: *P. clavata* is regarded as an evolutionary offshoot of *P. fabianii*.

Comparisons: Distinguished from the otherwise comparable *P. fabianii* by the presence of numerous tiny spines and by the weak development of lateral and central spines.

GENUS **CRUCELLA** PESSAGNO, 1971a

Synonym: ? *Pseudocrucella* BAUMGARTNER, 1980.

Type species: *Crucella messinae* PESSAGNO, 1971a, by original designation.

Diagnosis: Four-rayed hagiastrid without bracchiopyle. Rays equal in length, sharply pointed distally; either with a single central spine at tip or with central and lateral spines. Central spine solid and blade-like. Rays rectangular to circular in cross-section. Rays possess meshwork arranged on regular or irregular rows axially. Nodes may occur at pore junctions. Central area faintly raised, occasionally with a large central depression (lacuna). Test may develop a patagium.

Remarks: According to Baumgartner (1980), the genus *Crucella* include forms that may develop two lateral spines at ray tips.

Comparisons: *Crucella* is distinguished from *Savaryella* by having prominent blade-like spines at the tip of each rays.

Range: Late Triassic to Late Cretaceous.

Crucella bossoensis JUD, 1994.

Pl. 69, figs. 1-6
Species code 384

pars ? 1973 *Crucella espartoensis* PESSAGNO. - MOORE, p. 790, pl. 9, fig. 4; pl. 1, fig. 11; non fig. 12.
pars 1975 *Crucella* sp. FOREMAN, p. 612, pl. 2D fig. 10; non figs. 9 (= C. *messinae* ?), 11; non pl. 1D, fig. 7 (= C. *messinae* ?).
1983 *Crucella plana* PESSAGNO. - ORIGLIA-DEVOS, p. 95, pl. 12, figs. 9.
1988 *Pseudocrucella* sp. *A*. THUROW, p. 404, pl. 10, fig. 9.
? 1991 *Crucella cachensis* PESSAGNO. - GORKA, p. 42, pl. 2, figs. 7, 8.
1992 *Crucella cachensis* PESSAGNO. - BAUMGARTNER, p. 319, pl. 4, figs. 2, 3.
1994 *Crucella bossoensis* n. sp. JUD, p. 70, pl. 6, figs. 7-10.

Holotype: The specimen designated by Jud (1994) on pl. 6, figs. 7-8. The holotype is from locality no. Bo-566.5, early Barremian (Umbria-Marche Apennines, central Italy).

Photographed material: 23 specimens.

Description: Test as with genus, four-rayed, large and cruciform. Test possesses an elevated central area with well developed lacuna. Meshwork composed of large tetragonal pore frames. Lacuna possess a border slightly raised and a central part cover of dense spongy meshwork. Central spines blade-like and relatively long. Interradial areas with weak developed patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	160-175	206	300	160
Maximum width of rays	40	61	80	50
Length of longest spine	23	50	70	37
Diameter of central area	50	56	70	46

Remarks: *C. bossoensis* probably evolved from some early Cretaceous *Crucella* without a lacuna such as *Stauralastrum gracile* RÜST (1898), p. 29, pl. 9, fig. 9. *C. bossoensis* (Valanginian to late Aptian) is identical in sculpture to the homoemorphic *C. cachensis* (Turonian-Coniacian), but the unconnected ranges enable a specific distinction.

Comparisons: *C. bossoensis* differs from all other early Cretaceous congeneric species by possessing a well-developed lacuna.

Crucella remanei JUD, 1994

Pl. 69, figs. 7-10
Species code 219

	1981	*Crucella* sp. cf. *C. cachensis* PESSAGNO. - SCHAAF, p. 433, pl. 8, fig. 3.
	1988	*Pseudocrucella* (?) sp. *B*. THUROW, p. 404, pl. 10, fig. 7.
?	1989	*Crucella theokaftensis* BAUMGARTNER. - TUMANDA, p. 34, pl. 2, fig. 1.
	1989	*Crucella* sp. TUMANDA, pl. 2, fig. 2.
	1989	*Pseudocrucella* sp. TUMANDA, pl. 2, fig. 3.
?	1991	*Crucella* cf. *cachensis* PESSAGNO. - GORKA, p. 42, pl. 2, fig. 10.
	1994	*Crucella remanei* n. sp. JUD, p. 72, pl. 7, fig. 9-12.

Holotype: The specimen designated by Jud (1994) on pl. 7, figs. 10-11. The holotype is from locality no. Ru-135.50 (early Barremian) from the Rusconi quarry near the locality of Cittiglio, Province of Varese (southern Alps, N Italy)

Photographed material: 12 specimens.

Description: Four-rayed hagiastrid with an elevated nearly cylindrical central area. Rays relatively short, equal in length tapering to a long solid triradiate central spine. Rays near circular in cross-section. Lower and upper surfaces of central area develop a faint ring of small nodes around the periphery. Central part of central area slightly raised. Meshwork spongy, composed of very small circular pore frames. Test develops a slight patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	214	181	187	173
Maximum width of rays	50	72	93	60
Length of longest spine	107	65	78	57
Diameter of central area	95	108	120	93

Remarks: The origin of this species has not been traced, but a possible origin is suspected from *C. bossoensis*, with which it co-occurs through the Hauterivian-Aptian interval. *C. remanei* evolved into *C. gavalai* and may also have given rise to *C. hispana*.

Comparisons: *C. remanei* is distinguished from *C. gavalai* by its finer meshwork, shorter rays, and by lacking large tubercles on the central area.

Crucella gavalai nov. sp.

Pl. 69, figs. 11-21
Species code 205

Holotype: Specimen 9835 (pl. 69, fig. 21). The holotype is from locality. no. Mc-268b, middle Aptian, Carbonero Formation (Valdepeñas de Jaén, Betic Cordillera, S Spain).

Derivatio nominis: This species is named in honour of J. Gavala y Laborde for his early contribution towards understanding the regional geology of the western Betic Cordillera. Masculine gender.

Photographed material: 65 specimens.

Description: Four-rayed hagiastrid with a conspicuous tubercular central area. Test cruciform with medium to long rays terminated by long central spines. Rays uniform in width, more or less equal in length and diverging abruptly from the central area. Rays near circular in cross-section. Central area cylindrical and strongly elevated. Central area possesses a ring of large rounded tubercles at the periphery. Central area has a large rounded tubercle at its center. Test possesses coarse meshwork composed of large tetragonal pore frames. Meshwork bears large rounded nodes at vertices of pore frames. Central spine strongly bladed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	135	153	193	120
Maximum width of rays	65	57	65	50
Length of longest spine	-	48	55	40
Diameter of central area	68	69	80	55

Remarks: *C. gavalai* seems to have evolved from *C. remanei* by developing strong tubercles on the central area. Concomitantly, the meshwork becomes coarser, and develops nodes at pore junctions. *C. remanei* left no descendants

Comparisons: *C. gavalai* is distinguished from all other congeneric species by the distinctive pattern of nodes on the central area, and by possessing well-developed nodes at pore junctions.

Crucella hispana nov. sp.

Pl. 70, figs. 1-5
Species code 220

? 1981 *Crucella* sp. indet. SCHAAF, pl. 11, fig. 3.

pars 1981 *Histiastrum aster* LIPMAN. - SCHAAF, p. 435, pl. 8, fig. 1; non pl. 11, fig. 5 (= *S. novalensis* ?).
1984 *Histiastrum aster* LIPMAN. - SCHAAF, p. 160-161, text-fig. 2 (= specimen of Schaaf, 1981, pl. 8, fig. 1).

Holotype: Specimen 10958 (pl. 70, fig. 1). The holotype is from locality no. Pan-1, late Aptian, near of Vélez Blanco Province of Almería (Betic Cordillera, SE Spain).

Derivatio nominis: *hispanus* -a -um, Latin adjective of Spain.

Photographed material: 18 specimens.

Description: Test as with genus composed of four large conical rays arranged obliquely. Test has a large central area that is slightly to moderately elevated. Rays massive, very thick near the central area. Rays circular to elliptical in cross-section terminating in a short blade-like spine. Rays located in the same axis, although slightly displaced laterally. Meshwork formed of coarse tetragonal pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	160-173	153-181	167-200	133-167
Maximum width of rays	100	98	107	80
Diameter of central area	143-150	119-159	114-180	107-133

Remarks: Although only rare transitional forms have been found, it appears that *C. hispana* arose from *C. remanei*.. The most conspicuous change is shown by the central area, which seems to control the growth of rays. Throughout its stratigraphic range, the most variable characteristics are the diameter of the rays, the inflation of the central area and the size of the interradial angles. No descendants have been recognized.

Comparisons: Distinguished from all other congeneric species in having a massive test, thick conical rays and by having an enormous central area. *C. hispana* has affinities with *C. baliarica,* but the former species includes robust forms with large conical rays. These morphologies are acquired in parallel lineages.

Crucella baliarica nov. sp.

Pl. 70, figs. 6-9
Species code 224

Holotype: Specimen 10898 (pl. 70, fig. 6). The holotype comes from locality no. Pan-1 (late Aptian) near Vélez Blanco (Betic Cordillera, SE Spain).

Derivatio nominis: *Baliaricus* a- um- Latin adjective relative to the Balearic sea on the western Mediterranean.

Photographed material: 20 specimens.

Description: Test as with genus, cruciform with a faintly depressed lacuna-like central area. Rays long, tapering to strong bladed central spines. Ray tips have two small massive thorns spines. Rays almost rectangular in cross-section. Central area strongly elevated and may have a variably sized area in the center. Rays usually at 90 degrees but sometimes they are slightly displaced laterally. Meshwork formed of coarse tetragonal pore frames, showing a regular arrangement of pore rows on top and bottom surfaces. Meshwork has small rounded nodes at pore junctions. Patagium may be present but poorly developed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	250	198	250	175
Maximum width of rays	92	91	100	75
Length of longest spine	75	-	-	-
Diameter of central area	133-158	136-175	192-208	133-133

Remarks: This species seems to have evolved from *C. bossoensis* by strong increase of the central area, which is accompanied by a variation on the interradial angle of rays; the rays further develop two thick lateral spines at ray tips. *C. baliarica* apparently left no descendants.

Comparisons: *C. baliarica* is distinguished from other coexisting *Crucella* by having well-developed lateral spines and by possessing a strongly elevated central area.

Crucella euganea (SQUINABOL, 1903b)

Pl. 70, figs. 10-20
Species code 196

1903b *Stauralastrum euganeum* n. sp. SQUINABOL, p. 123, pl. 9, fig. 19.
non 1972 *Hagiastrum* sp. aff. *Stauralastrum euganea* SQUINABOL. - PETRUSHEVSKAYA & KOZLOVA, p. 527, pl. 6, figs. 4, 5.
pars 1973 *Crucella* sp. *A*. MOORE, p. 825, pl. 15, fig. 2; non fig. 1 (= *S. novalensis* ?).
non 1981 *Hagiastrum* ? *euganeum* (SQUINABOL). - SCHAAF, p. 434, pl. 11, figs. 1a-b.
1983 *Crucella messinae* PESSAGNO. - ORIGLIA-DEVOS, p. 94, pl. 12, figs. 6-8.
1983 *Higumastra* sp. aff. *inflata* BAUMGARTNER. - ORIGLIA-DEVOS, p. 74, pl. 7, figs. 5, 6.
1986 *Pseudocrucella* (?) sp. KUHNT *et al.*, pl. 7, fig. 1.
1988 *Crucella* (?) sp. *D*. THUROW, p. 399, pl. 5, fig. 23.

Holotype: The specimen described and illustrated by Squinabol (1903b) on pl. 9, fig. 19 is considered the holotype. This specimen was reported from an imprecise locality in the Colli Euganei area (southern Venetian Alps, N Italy).

Photographed material: 186 specimens.

Description: Test as with genus, with large central area. Test cruciform and slightly inflated in the central area. Rays with very large tetragonal to pentagonal pore frames linearly arranged. Test develops large rounded nodes at pore junctions. Rays very long, circular to rectangular in cross-section with long blade-like spines. Test may develop a slight patagium.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	200	195	231	169
Maximum width of rays	43	59	73	46
Length of longest spine	56	95	131	73
Diameter of central area	75	98	115	84

Remarks: *C. euganea* probably evolved from *C. bossoensis* and through the late Albian-Early Turonian gave rise to the *C. messinae* - *C. irwini* - *C. cachensis* lineage.

Comparisons: Range of variability of *C. euganea* and *C. messinae* partially overlap, but *C. euganea* includes more robust forms with longer threebladed spines.

Crucella messinae PESSAGNO, 1971a

Pl. 70, figs. 21-24; Pl. 71, figs. 1-6
Species code 223

?	1900	*Stauralastrum venustum* sp. nov. HOLMES, p. 700, pl. 38, fig. 1.
	1971a	*Crucella messinae* n. sp. PESSAGNO, p. 56, pl. 6, figs. 1-3.
?	1975	*Crucella messinae* PESSAGNO. - FOREMAN, p. 612, pl. 1D, figs. 8, 9; pl. 5, fig. 2.
pars ?	1975	*Crucella* sp. FOREMAN, p. 612, pl. 1D, fig. 7, pl. 2D, fig. 9, non figs. 10 (= *C. bossoensis*), 11.
	1976	*Crucella messinae* PESSAGNO. - PESSAGNO, p. 32, pl. 1, fig. 4 (= holotype refigured).
	1977	*Crucella messinae* PESSAGNO. - MUZAVOR, p. 61, pl. 3, fig. 4.
	1977c	*Crucella messinae* PESSAGNO. - PESSAGNO, p. 27, pl. 1, figs. 3, 4, 13.
non	1982	*Crucella messinae* PESSAGNO. - TAKETANI, p. 50, pl. 9, fig. 17 (= *C. irwini*).
non	1983	*Crucella messinae* PESSAGNO. - ORIGLIA-DEVOS, p. 94, pl. 12, figs. 6-8 (= C. *euganea*).
	1986	*Crucella messinae* PES. - KUHNT *et al.*, pl. 7, fig. d.
	1988	*Crucella messinae* PESSAGNO. - THUROW, p. 399, pl. 5, fig. 22.
?	1988	*Crucella* sp. *B*. THUROW, p. 399, pl. 2, fig. 15.
non	1989	*Crucella messinae* PESSAGNO, p. 34, pl. 2, fig. 4.

Holotype: The specimen described and figured by Pessagno (1971a) on pl. 6. fig. 1. The holotype was reported from locality NSF 350, early Cenomanian portion of "Fiske Creek" Formation "Antelope shale", California Coast Ranges.

Photographed material: 212 specimens.

Description: Test as with genus, large with relatively long rays. Central area moderate to strongly inflated. Rays thick approximately equal in length, and taper to a central spine. Rays with tetragonal to pentagonal pore frames, sublinearly arranged. Very small rounded nodes occur at pore frames junctions. Rays rectangular to ellipsoidal in cross-section. Central spines relatively long, threebladed to acutely conical. Test may develop a thick patagium, which causes the central area to become larger and more inflated.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	179	263	300	233
Maximum width of rays	64	77	92	58
Length of longest spine	79	85	125	50
Diameter of central area	100	118	150	92

Remarks: *C. messinae* evolved from *C. euganea*, which accompanies it for much of its range, and gave rise to *C. irwini*. Throughout its stratigraphic range are the size of the central area and the width of rays.

Comparisons: This species is distinguished from its closely allied *C. euganea* by having irregular arrangement of pore frames, smaller and less marked nodes at pore junctions and by possessing thicker and longer rays. In addition the meshwork is composed of much smaller pore frames.

Crucella irwini PESSAGNO, 1971a

Pl. 71, figs. 7-14

Species code 229

	1900	*Stauralastrum* sp. HOLMES, p. 700, pl. 38, fig. 2.
	1971a	*Crucella irwini* n. sp. PESSAGNO, p. 55, pl. 9, figs. 4-6.
	1971a	*Crucella plana* n. sp. PESSAGNO, p. 56, pl. 8, figs. 5, 6.
?	1975	*Crucella irwini* PESSAGNO. - FOREMAN, p. 612, pl. 1D, fig. 6 and pl. 5, fig. 1 (= *C. cachensis* ?)
	1976	*Crucella irwini* PESSAGNO. - PESSAGNO, p. 32, pl. 3, fig. 16.
	1976	*Crucella plana* PESSAGNO. - PESSAGNO, p. 32, pl. 7, fig. 9 (= specimen of Pessagno, 1971a, pl. 8, fig. 6).
?	1977	*Hagiastrum crux* LIPMAN. - SALAJ & SAMUEL, pl. 46, fig. 6.
	1982	*Crucella espartoensis* PESSAGNO. - TAKETANI, p. 50, pl. 9, fig. 15.
	1982	*Crucella messinae* PESSAGNO. - TAKETANI, p. 50, pl. 9, fig. 17.
non	1983	*Crucella irwini* PESSAGNO. - ORIGLIA-DEVOS, p. 93, pl. 12, figs. 2, 3.
non	1983	*Crucella plana* PESSAGNO. - ORIGLIA-DEVOS, p. 95, pl. 12, figs. 9 (= *C. bossoensis*)
	1986	*Crucella* cf. *irwini* PES. - KUHNT *et al.*, pl. 8, fig. p.
	1988	*Crucella espartoensis* PESSAGNO. - THUROW, p. 399, pl. 2, fig. 14.
	1993	*Crucella irwini* PESSAGNO. - VISHNEVSKAYA, pl. 5, fig. 8.
pars ?	1993	*Crucella membraniferum* (LIPMAN). - VISHNEVSKAYA, pl. 5, fig. 4; non fig. 5.
?	1993	*Spongodiscus multus* KOZLOVA. - VISHNEVSKAYA, pl. 5, fig. 6.

Holotype: The specimen described and figured by Pessagno (1971a) on pl. 9. fig. 4. The holotype has been reported from locality NSF 705B, middle Turonian portion of Marsh Creek Formation, California Coast Ranges.

Photographed material: 44 specimens.

Description: Test cruciform with elevated central area, showing a well-developed patagium spread between the rays. Central area may present a shallow lacuna. Rays of more or less equal length, diverging abruptly from the central area. Rays slender and conical, with circular to elliptical cross-section. Rays tapered in long central spines which tend to be circular in distal cross-sections. Rays and central area with tetragonal to pentagonal pore frames, showing an axial sublinear to irregular arrangement of pores. Rays possess small rounded nodes at pore junctions.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	243	245	292	225
Length of longest spine	22	57	79	37
Diameter of central area plus patagium	226	194	234	158

Remarks: Through the Cenomanian the more variable features are the inflation of both rays and central area. It must be emphasized that during the late Cenomanian-early Turonian an incipient development of lacuna has been observed among the representatives of *C. irwini* . Range of variation overlaps slightly those of *C. messinae* and *C. cachensis*. However specific distinctions are based on the moderately elevated central area, its well-developed patagium at interradial angles, and the noticeable inflation of rays. *C. irwini* undoubtedly evolved from *C. messinae* and seems to have given rise to *C. cachensis* by a progressive acquisition of a cylindrical central area with a well-developed lacuna. In addition, the rays become less inflated and cylindrical in the descendant, as a consequence of central area modifications.

Comparisons: *C. irwini* is distinguished from the type-species by having a slightly depressed rather than a raised central area, by the coarser and less regular pore frames, by its well-developed patagium, and by the central spines, which are circular rather than triradiate in cross-section.

Crucella cachensis PESSAGNO, 1971a

Pl. 71, figs. 15-22
Species code 221

1971a *Crucella cachensis* n. sp. PESSAGNO, p. 53, pl. 9, figs. 1-3.
1975 *Crucella cachensis* PESSAGNO. - FOREMAN, p. 612, pl. 5, fig. 6.
? 1975 *Crucella irwini* PESSAGNO. - FOREMAN, p. 612, pl. 1D, fig. 6; pl. 5, fig. 1.
1976 *Crucella cachensis* PESSAGNO. - PESSAGNO, p. 31, pl. 3, figs. 14, 15 (= holotype refigured).
non 1981 *Crucella* sp. cf. *C. cachensis* PESSAGNO. - SCHAAF, p. 433, pl. 8, fig. 3 (= *C. remanei*).
1982 *Crucella* cf. *espartoensis* PESSAGNO. - OKAMURA *et al.*, pl. 15, fig. 10.
1982 *Crucella cachensis* PESSAGNO. - TAKETANI, p. 50, pl. 9, fig. 16.
1986 *Crucella cachensis* PES. - KUHNT *et al.*, pl. 6, fig. j.
1986 *Crucella* aff. *cachensis* PES. - KUHNT *et al.*, pl. 6, fig. k.
1986 *Crucella cachensis* PES. - THUROW & KUHNT, text-figs. 9. 5-6.
1988 *Crucella cachensis* PESSAGNO. - THUROW, p. 399, pl. 2, fig. 13.
pars ? 1989 *Crucella cachensis* PESSAGNO. - GORKA, p. 331, pl. 11, fig. 3, non fig. 4 (= *C. espartoensis* ?).
non 1991 *Crucella cachensis* PESSAGNO. - GORKA, p. 42, pl. 2, figs. 7, 8 (= *C. bossoensis* ?).
non 1991 *Crucella* cf. *cachensis* PESSAGNO. - GORKA, p. 42, pl. 2, fig. 10 (= *C. remanei* ?).
1991 *Crucella cachensis* PESSAGNO. - HERNANDEZ-MOLINA *et al.*, text-fig. 12. 2.
1991 *Crucella cachensis* PESSAGNO. - MARCUCCI *et al.*, text-figs. 4, j-l.
non 1992 *Crucella cachensis* PESSAGNO. - BAUMGARTNER, p. 319, pl. 4, figs. 2, 3 (= *C. bossoensis*).
1992 *Crucella cachensis cachensis* PESSAGNO. - MARCUCCI & GARDIN, text-fig. 4. m.
1992 *Crucella cachensis tolfaensis* n. subsp. MARCUCCI & GARDIN, p. 563, text-figs. 4. l, n.
non 1993 *Crucella cachensis* PESSAGNO. - VISHNEVSKAYA, pl. 10, fig. 4 (= *C. espartoensis* ?).

Holotype: The specimen described and figured by Pessagno (1971a) on pl. 9. fig. 1. The holotype has been reported from locality NSF 697, middle Turonian portion of Venado Formation, California Coast Ranges.

Photographed material: 221 specimens.

Description: Four or five-rayed hagiastrid possessing a cylindrical central area with a well-developed lacuna. Central area markedly elevated and quite thick. Diameter of central area about equal to the length of the rays. Central depressed area covered by delicate meshwork. Rays terminate in a moderately long, massive central spine with a circular cross-section. Rays are relatively short, slender, and cylindrical. Test with coarse meshwork of pentagonal to subcircular pore frames. Nodes at pore junctions are only weakly developed. Development of patagium was never observed.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	225	221	250	200
Maximum width of rays	69	60	75	50
Diameter of central area	109	138	167	108

Remarks: Range of variability of *C. cachensis* and *C. irwini* overlaps partially, but *C. cachensis* distinctly includes robust forms with less inflated rays, a cylindrical central area, and a strongly depressed lacuna. Specimens identical in sculpture but bearing an additional fifth ray seem to be relatively frequent. Shell shape and arrangement of pores otherwise suggest derivation from *C. irwini.*

Comparisons: *C. cachensis* embodies a singular combination of characteristics on its test making it easy to differentiate among other *Crucella. C. cachensis* is undoubtedly regarded as heterochronous homoemorphous of *C. bossoensis* (pl. 69. figs. 1-6) which ranges during the early Cretaceous. Nevertheless the late Cretaceous forms can be distinguished by a more stout, more elevated, and cylindrical central area. The recurrence of a well-developed lacuna through time seems to be related to forms at the end of the lineage.

GENUS **SAVARYELLA** JUD, 1994

Type species: *Savaryella guexi* JUD, 1994, by original designation.

Diagnosis: Hagiastrid with four to five stout spongy rays. Rays without spines, occasionally with either only a small central spine at the tip or with central and lateral spines. Rays very long, elliptical, rounded rectangular to circular in cross-section. Rays may possess spongy meshwork with linear to sublinear arrangement of pores. Rays of about equal length, with right or variable interradial angles. Central rays are relatively large and frequently flattened. Test may develop a patagium. Rays expanded distally, with rounded, bulbous, or wedge-shaped ray tips. Rays without bracchiopyle.

Remarks: The phylogenetic relationship for this genus has not been traced in detail, and it is difficult to determine actually its derivation.

Comparisons: *Savaryella* is distinguished from *Crucella* by its more spongy meshwork, less regular arrangement of pores, more massive rays, and its rounded instead of sharply pointed ray tips.

Range: Berriasian to Turonian, as far as know.

Savaryella sinistra nov. sp.

Pl. 73, figs. 9-12
Species code 195

Holotype: Specimen 2742 (pl. 73, fig. 9). The holotype comes from locality no. Bo-685.20, late Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective sinistra -ae (f), meaning sinister.

Photographed material: 8 specimens.

Description: Test as with genus, composed of four rays with equal angles lacking patagium. Test with slender elongate rays of equal length and small central area. Rays having expanded ellipsoidal tips. Meshwork comprised of rectangular pore frames. Rays cylindrical with regular longitudinal arrangement of pores. Rays with somewhat obliquely-running longitudinal rows of pores, producing weakly left-twisted rays. Nodes at vertices of pore junctions slightly developed. Ray tips composed of polygonal to circular pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	270	305	360	270
Maximum width of rays	60	70	90	50
Diameter of central area	100	112	140	100

Remarks: *S. sinistra* seems to have given rise to *S. novalensis* by acquiring a more massive and more flattened test, by the development of wedge-shaped ray tips, and by the progressive loss of the linear arrangement of pores.

Comparisons: *S. sinistra* is distinguished from *S novalensis* by possessing slender rays with noticeable bulbous ray tips and left-twisted rays weakly-developed.

Savaryella quadra (FOREMAN, 1978a)

Pl. 72, figs. 1-11
Species code 193

1978a *Crucella quadra* new species FOREMAN, p. 841, pl. 1, fig. 10.

Holotype: The specimen figured by Foreman (1978a) on pl. 1, fig. 10. The holotype has been reported from latest Albian-Cenomanian, eastern South Atlantic (DSDP, Leg. 40, Site 364, interval 26-6, 56-58).

Photographed material: 26 specimens.

Description: Four-rayed hagiastrid possessing a small central area with slightly expanding distal rays. Test may exhibit a well-developed patagium, spreading between the rays. Rays slender, very long, terminating in a relatively long, tapered, smooth central spine. Rays may present two or three pair of small lateral spines. Central and lateral spines are circular in cross-section. Rays axially flattened showing four to five parallel pore rows on each side. Meshwork composed of large hexagonal to subcircular pore frames. Size of pores gradually increasing towards the tips. Rays elliptical in cross-section. Test usually flattened, although somewhat raised in the central area. When the patagium is strongly developed the test may exhibit a square outline. Occasionally patagium may grow on ray intersections, with a noticeable elevation of the central area.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	316	246	342	183
Maximum width of rays	-	52	58	42
Length of longest spine	38	41	60	25
Diameter of central area plus patagium	436	203	320	92

Remarks: This species probably evolved from *S. sinistra*. But the ancestry of this species remains queried because intermediate forms have been observed only rarely during early-middle Albian times.

Comparisons: *S. quadra* differs from all other congeneric species in possessing a well-arranged row of pores in the rays and by possessing a delicate patagium.

Savaryella novalensis (SQUINABOL, 1914)

Pl. 72, figs. 12-19
Species code 206

1914 *X-Astrum novalenses* n. f. SQUINABOL, p. 278, pl. 20 [1], fig. 7.
pars ? 1973 *Crucella* sp. *A*. MOORE, p. 825, pl. 15, fig. 1; non fig. 2 (= *C. euganea*).

pars ? 1981 *Histiastrum aster* LIPMAN. - SCHAAF, p. 435, pl. 11, fig. 5; non pl. 8, fig. 1 (= *C. hispana*).
1988 *Crucella* (?) sp. *C.* THUROW, p. 399, pl. 5, fig. 21.

Holotype: The specimen illustrated by Squinabol (1914) on pl. 20 [1], fig. 7 may be considered the holotype. This specimen has been reported from the locality of Novale in the Vicentino Province (Venetian Alps, N Italy).

Photographed material: 27 specimens.

Description: Test large with four long, spongy rays. Rays subequal in length, strongly expanding at tips. Cross-section of rays ellipsoidal to rectangular. Ray tips rounded to wedge-shaped. Central area relatively large. Meshwork spongy, with pore frames irregular to sublinearly aligned, uniform in size, mostly tetragonal. Rays and central area axially flattened. Rays may develop a massive, short central spine. Two small lateral expansions occasionally occur at ray tips, which may terminate in a minute spine.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	222	238	290	210
Maximum width of rays	40	69	80	55
Length of longest spine	-	28	45	20
Diameter of central area	83	121	160	100

Remarks: Range of variability of *S. novalensis* and *S. spinosa* overlap slight, but *S novalensis* distinctly includes robust forms without differentiation between rays and central area. Also *S. novalensis* possesses large wedge-shaped expansion at tips. *S. novalensis* apparently branched off from *S. sinistra* and gave rise to *S. spinosa*. The development of central spines is evident in almost all specimens.

Comparisons: This species is distinguished from its closely allied *S. spinosa* in lacking a well-differentiated central area and in possessing rays expanded strongly at tips. *S. novalensis* differs from *S. stella* by possessing a small rather than a strongly raised central area.

Savaryella spinosa nov. sp.

Pl. 73, figs. 1-8
Species code 194

Holotype: Specimen 3796 (pl. 73, fig. 5). The holotype comes from locality no. Gc-1073.94, middle Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin adjective *spinosus* -a -um, meaning prickly.

Photographed material: 33 specimens.

Description: Test as with genus with well differentiated central area of variable size. Rays increase strongly in width distally and are elliptical cross-section. They have a coarse meshwork of large, mostly tetragonal pore frames which increase in size toward the tips. The pore frames are sometimes in a weakly linear arrangement. The rays terminate in a relatively long central spine with a circular cross-section. Numerous minute, fine spines extend from the ray tips. Central area with massive spongy meshwork. Patagium grows upon ray intersections, with a noticeable increase of central area.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	242	230	250	200
Maximum width of rays	50	68	108	42
Length of longest spine	25	29	42	22
Diameter of central area plus patagium	108	131	200	75

Remarks: This species seems to have evolved from *S. novalensis* by acquiring a well-differentiated central area, which becomes larger in younger populations. *S. spinosa* shows throughout its stratigraphic record a wide range of variation. These changes affect principally the rays and central area, which varies from small to large. Central area probably enlarged as the patagium developed around the intersections of the rays.

Comparisons: *S. spinosa* differs from *S. novalensis* in having a much larger and well-differentiated central area. In addition numerous tiny spines occur at ray tips.

Savaryella stella nov. sp.

Pl. 73, figs. 13-17
Species code 199

Holotype: Specimen 7436 (pl. 73, fig. 13). The holotype comes from locality no. Gb-108.60, middle-late Cenomanian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin noun *stella* -ae (f), meaning star.

Photographed material: 25 specimens.

Description: Test as with genus, having four to five rays radiating from a strongly elevated central area. Rays of uniform width, with tips slightly rounded at the periphery. Rays rectangular to square in cross-section, and slightly flattened near tips. Central area rectangular or pentagonal in outline, with flat upper and lower surfaces. Meshwork composed of large pore frames more or less uniform in size, except at the central area where they are generally smaller and more spongy.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Length of rays	187	169	187	153
Maximum width of rays	63	57	63	47
Diameter of central area	123	118	123	113

Remarks: Through its short stratigraphic range the only variations observed are the degree of inflation of the central area and its outline, which is controlled by the number of rays. It seems that *S. stella* evolved from *S. novalensis* by way of *S. spinosa* *S. stella* seems to have left no descendants.

Comparisons: Distinguished from all other congeneric species in having a strongly raised central area with flat surfaces at both sides of the test. The representatives of *S. stella* usually may develop an additional fifth ray.

SPUMELLARIINA INCERTAE SEDIS

GENUS **ARCHAEOCENOSPHAERA** PESSAGNO & YANG in PESSAGNO *et al.*, 1989

Type species: *Archaeocenosphaera ruesti* PESSAGNO & YANG, in PESSAGNO *et al.*, 1989, by original designation.

Diagnosis: Spumellarians without medullary shell. Cortical shell spherical, lacking spines, consisting of two fused latticed layers with symmetrical polygonal pore frames

Remarks: *Archaeocenosphaera* differs from *Cenosphaera* EHRENBERG (1854) by having a thick cortical shell with two fused latticed layers and by usually having symmetrical polygonal pore frames.

Range: Triassic to Late Cretaceous.

Archaeocenosphaera ? mellifera nov. sp.

Pl. 74, figs. 1-5
Species code 124

? 1977 *Cenosphaera* sp. SALAJ & SAMUEL, pl. 45, fig. 5.
1977 *Liosphaera* sp. SALAJ & SAMUEL, pl. 44, fig. 5, pl. 45, figs. 2-4.
1983 *Hemicryptocapsa polyhedra* DUMITRICA. - ORIGLIA-DEVOS, p. 206, pl. 24, figs. 17, 20, 21.
? 1984 *Cenosphaera* ? sp. *A*. EMPSON-MORIN, pl. 1, fig. 6.
1986 *Hemicryptocapsa* (?) sp. TERAOKA & KURIMOTO, pl. 3, fig. 3.
1986 *Hemicryptocapsa polyhedra* DUM. - THUROW & KHUNT, text-fig. 9. 21.
1988 *Hemicryptocapsa polyhedra* DUMITRICA. - THUROW, p. 401, pl. 1, fig. 1.
1988 *Hemicryptocapsa* sp. cf. *H. polyhedra* DUMITRICA. - THUROW, p. 401, pl. 5, fig. 2.
1991 *Hemicryptocapsa* sp. HERNANDEZ-MOLINA, text-fig. 11. 1.
1991 *Williriedellum* sp. aff. *W. gilkey* DUMITRICA. - MARCUCCI *et al.*, text-fig. 4. n.
1992 *Hemicryptocapsa* sp. A. MARCUCCI & GARDIN, text- fig. 3. l.

Holotype: Specimen 138, (pl. 74, fig. 4). The holotype comes from loc. no. Ap2 (-7.78), late Albian (Umbria-Marche Apennines, central Italy)

Derivatio nominis: Latin adjective *mellifer* -era -erum , meaning who produce honey, refers to the honeycomb-like surface.

Photographed material: 45 specimens.

Description: Cortical shell very large, spherical with symmetrical meshwork and a polygonal surface. Test with surface divided into large polygonal areas which are limited by sharp, elevated, winglet-like frames. Pores are circular, of regular size, and arranged in regular rows.

Measurements: (μm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of shell	320	296	320	280

Remarks: Generic assignment queried because the phylogenetic relationship with other representatives of this genus are poorly known. This specie has been frequently classified under the suborder Nassellariina, usually belonging to the genus *Hemicryptocapsa* TAN, 1927. However the lack of aperture, sutural pore, or cephalic depression, justifies exclusion in the latter genus. Furthermore, numerous thin sections have never shown some relict structures of the cephalo-thorax portion in specimens of this species (Dumitrica, personal communication).

Comparisons: This species differs from all other Cretaceous species assignable to *Archaeocenosphaera* by possessing a spherical test covered entirely by an irregular network of polygonal facets.

GENUS **MALLANITES** NOV. GEN.

Derivatio nominis: The genus is dedicated to P. Mallan (University Lausanne), as homage to her activity in diffusing the practical use of the deterministic methods (Unitary Associations) on biostratigraphy. Masculine gender.

Type species: *Mallanites romanus* nov. sp.

Diagnosis: Spherical cortical shell, without spines. Cortical shell presents a latticed layer of small polygonal pore frames. Shell usually very large, bearing a conspicuous ornamentation formed by a system of crests. Each one is situated upon the spherical shell at the edge of a tetrahedron formed by four curved planes.

Remarks: *Mallanites* embodies a unique combination of characteristics quite unlike that of any previously known Cretaceous genera. Its size suggests affinity with *Archaeocenosphaera*, but the rest of the test is so profoundly altered that it justifies introduction of a new genus. Magne & Sigal (1954) illustrated some forms undoubtedly belonging to this new genus (loc. cit. fig. 2.30).

Range: Middle Albian to earliest Cenomanian, insofar as know.

Mallanites romanus nov. sp.

Pl. 74, figs. 6-9
Species code 121

Holotype: Specimen 24 (pl. 74, fig. 6). The holotype comes from locality no. Ap2 (-7.78), middle Albian (Umbria-Marche Apennines, central Italy).

Derivatio nominis: Latin substantive *romanus* -a -um (m), meaning roman citizen.

Photographed material: 6 specimens.

Description: Test as with genus, with hexagonal pores. Ornamentation composed of solid, sharply pointed crest, lacking teeth. Meshwork composed of small hexagonal pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of shell	250	258	267	250
Maximum width of crest	75	73	75	67

Remarks: Specimens assigned to *M. triquetrus* probably represent more dentate and stout ornamented variants of *M. romanus*. However, the number of available specimens is not suitable to demonstrate such a continuous variation. In addition both species always occur at distinct stratigraphic intervals.

Mallanites triquetrus (SQUINABOL, 1904)

Pl. 74, figs. 10-16
Species code 122

1904 *Cenosphaera triquetra* n. sp. SQUINABOL, p. 185, pl. 2, fig. 2.

Holotype: The single specimen figured and described by Squinabol (1904) on pl. 2, fig. 2, is considered the valid holotype. This specimen was reported from the locality of Teòlo in the Colli Euganei (southern Venetian Alps, N Italy).

Photographed material: 24 specimens.

Description: Test as with genus, very large. Cortical shell possesses a system of ragged crests, with four to five strong triangular teeth on each edge. Test with more or less marked small hexagonal pore frames.

Measurements: (µm)

	Holotype	*Mean*	*Max.*	*Min.*
Diameter of shell	140	300	342	267
Maximum width of crest	15	71	100	58

Remarks: This species evolved from *M. romanus* by rapid acquisition of ragged crests and no descendants have been recognized. Transitional forms with the type species have never been observed.

Comparisons: *M. triquetrus* is distinguished from *M. romanus* by its ragged crests composed of triangular teeth.

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VI. APPENDIX

Radiolarian fauna inventory of the samples selected and that were treated in constructing the range chart (protoreferential). Each taxon is represented by a numerical code (three digit number) to enable computer treatment of data by BioGraph program (Savary & Guex, 1991)

"MIDDLE CRETACEOUS DATABASE"

SECTION 1: BOTTOM 1, TOP 12

< 12 {GC-1096.50}: 14, 35, 42, 44, 46, 49, 50, 63, 64, 82, 85, 96, 98, 103, 106, 117, 120, 124, 125, 132, 142, 156, 157, 158, 164, 166, 167, 170, 179, 180, 182, 183, 186, 187, 188, 189, 190, 196, 201, 206, 208, 214, 215, 218, 221, 222, 223, 227, 229, 232, 234, 236, 238, 273, 281, 283, 287, 290, 293, 299, 314, 321, 325, 327, 328, 329, 331, 338, 340, 341, 342, 347, 349, 350, 351, 352, 354, 355, 356, 361, 362, 368, 369, 370, 372, 374, 375, 377, 379, 380, 382

< 11 {GC-1094.48}: 6, 13, 30, 31, 35, 38, 39, 44, 45, 47, 54, 64, 78, 82, 86, 87, 91, 93, 98, 101, 124, 132, 140, 150, 152, 155, 181, 182, 217, 223, 234, 238, 271, 273, 294, 314, 328, 361, 362, 363, 365, 368, 370, 372

< 10 {GC-1073.94}: 3, 4, 6, 7, 13, 28, 30, 31, 32, 35, 36, 38, 39, 41, 45, 49, 51, 52, 54, 56, 58, 59, 61, 62, 63, 64, 78, 81, 82, 84, 86, 87, 90, 91, 97, 117, 118, 124, 132, 138, 140, 141, 142, 143, 149, 150, 151, 156, 161, 163, 166, 168, 169, 170, 171, 172, 174, 175, 176, 178, 181, 182, 183, 185, 189, 191, 193, 194, 196, 199, 201, 202, 206, 208, 209, 210, 213, 214, 215, 217, 218, 223, 227, 229, 232, 233, 234, 235, 236, 238, 239, 245, 271, 273, 281, 288, 314, 328, 331, 338, 355, 358, 359, 361, 362, 363, 365, 367, 377, 379, 380

< 9 {GC-1035.10}: 1, 3, 4, 7, 8, 9, 10, 11, 13, 15, 16, 24, 30, 31, 35, 36, 37, 39, 41, 45, 48, 49, 51, 53, 54, 56, 58, 61, 64, 66, 77, 78, 82, 83, 86, 90, 92, 95, 97, 99, 101, 110, 111, 114, 118, 122, 129, 132, 141, 142, 143, 146, 149, 156, 157, 160, 166, 168, 170, 171, 174, 175, 176, 178, 181, 183, 184, 189, 191, 192, 194, 195, 196, 201, 207, 209, 214, 217, 223, 226, 227, 230, 235, 238, 239, 240, 244, 245, 270, 273, 288, 291, 292, 294, 303, 305, 314, 322, 324, 331, 338, 345, 346, 350, 355, 358, 359, 367, 377, 380

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< 4 {CA1-22.30}: 18, 19, 21, 27, 66, 68, 69, 74, 76, 79, 126, 127, 128, 133, 138, 141, 149, 191, 204, 205, 219, 241, 246, 247, 248, 249, 252, 253, 254, 255, 259, 260, 261, 264, 265, 267, 269, 279, 280, 294, 297, 300, 304, 305, 307, 308, 311, 313, 320, 326, 332, 357, 384, 388, 391

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Index of genera and species arranged by ascending order of numerical codes. All these taxa have been used in constructing the range chart by means of an automatic treatment (see Chapter III.2 for details).

1	*Spongostichomitra indomita* nov. sp.
2	*Hsuum ? cataphracta* nov. sp.
3	*Dictyomitra pulchra* (SQUINABOL)
4	*Crolanium triangulare* (ALIEV)
6	*Crolanium pulchrum* (SQUINABOL)
7	*Crolanium cuneatum* (SMIRNOVA & ALIEV)
8	*Spongostichomitra phalanga* nov. sp.
9	*Stichomitra tosaensis* NAKASEKO & NISHIMURA
10	*Thanarla spoletoensis* nov. sp.
11	*Anachoreta sagitta* nov. sp.
13	*Xitus mclaughlini* PESSAGNO
14	*Eostichomitra bonum* (KOZLOVA)
15	*Phalangites calamus* nov. sp.
16	*Crolanium spineum* (PESSAGNO)
17	*Dictyomitra magnifica* (PESSAGNO)
18	*Pseudoeucyrtis apochrypha* nov. sp.
19	*Hsuum pectorale* nov. sp.
21	*Parvicingula usotanensis* TUMANDA
24	*Tugurium pagoda* (SQUINABOL)
27	*Pseudoeucyrtis hanni* (TAN)
28	*Dictyomitra turritum* (SQUINABOL)
29	*Thanarla carboneroensis* nov. sp.
30	*Thanarla veneta* (SQUINABOL)
31	*Thanarla pulchra* (SQUINABOL)
32	*Tubilustrium transmontanum* nov. sp.
34	*Tubilustrium iracundum* nov. sp.

35 *Stichomitra communis* SQUINABOL
36 *Stichomitra magna* SQUINABOL
37 *Pseudodictyomitra paronai* (ALIEV)
38 *Pseudodictyomitra tiara* (HOLMES)
39 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL)
41 *Distylocapsa micropora* (SQUINABOL)
42 *Dictyomitra undata* SQUINABOL
43 *Dictyomitra multicostata* ZITTEL
44 *Pseudoeucyrtis pulchra* (SQUINABOL)
45 *Pseudoeucyrtis spinosa* (SQUINABOL)
46 *Phalangites hastatus* nov. sp.
47 *Dictyomitra crassispina* (SQUINABOL)
48 *Pseudodictyomitra languida* nov. sp.
49 *Phalangites telum* nov. sp.
50 *Distylocapsa squama* nov. sp.
51 *Obeliscoites vinassai* (SQUINABOL)
52 *Obeliscoites maximus* (SQUINABOL)
53 *Obeliscoites giganteus* (ALIEV)
54 *Obeliscoites perspicuus* (SQUINABOL)
56 *Obeliscoites turris* (SQUINABOL)
57 *Mirifusus chenodes* (RENZ)
58 *Xitus spinosus* (SQUINABOL)
59 *Distylocapsa veneta* (SQUINABOL)
61 *Dictyomitra gracilis* (SQUINABOL)
62 *Spongostichomitra elatica* (ALIEV)
63 *Dictyomitra crebrisulcata* (SQUINABOL)
64 *Rhopalosyringium euganeum* (SQUINABOL)
66 *Crolanium puga* (SCHAAF)
68 *Xitus clava* (PARONA)
69 *Xitus elegans* (SQUINABOL)
70 *Torculum bastetani* nov. sp.
74 *Pseudoeucyrtis ? columbaria* (RENZ)
76 *Podobursa tytthopora* (FOREMAN)
77 *Eribotrys ?* sp. *1*
78 *Xitus spicularius* (ALIEV)
79 *Thanarla lacrimula* (FOREMAN)
80 *Turbocapsula costata* (WU)
81 *Dactyliosphaera lepta* (FOREMAN)
82 *Hexapyramis pantanellii* SQUINABOL
83 *Pyramispongia costarricensis* (SCHMIDT-EFFING)
84 *Patellula spica* nov. sp.
85 *Pogonias incallidus* nov. sp.
86 *Quinquecapsularia ombonii* (SQUINABOL)
87 *Pogonias ? hirsutus* (SQUINABOL)
88 *Hexapyramis precedis* JUD
90 *Diacanthocapsa fossilis* (SQUINABOL)
91 *Guttacapsa gutta* (SQUINABOL)
92 *Stichomitra navalis* nov. sp.
93 *Rhopalosyringium adriaticum* nov. sp.
95 *Pseudoacanthosphaera galeata* nov. sp.
96 *Quinquecapsularia grandiloqua* nov. sp.
97 *Dorypyle ovoidea* (SQUINABOL)
98 *Diacanthocapsa brevithorax* DUMITRICA
99 *Dorypyle communis* (SQUINABOL)
100 *Pogonias prodromus* nov. sp.
101 *Rhopalosyringium mosquense* (SMIRNOVA & ALIEV)
102 *Rhopalosyringium perforaculum* nov. sp.
103 *Pseudotheocampe tina* (FOREMAN)
106 *Rhopalosyringium scissum* nov. sp.
108 *Rhopalosyringium radiosum* nov. sp.
109 *Rhopalosyringium solivagum* nov. sp.
110 *Trimulus fossilis* (SQUINABOL)
111 *Dorypyle ? anisa* (FOREMAN)
113 *Afens liriodes* RIEDEL & SANFILIPPO
114 *Pogonias harpago* nov. sp.
115 *Pogonias missilis* nov. sp.
116 *Eribotrys ?* sp. *2*
117 *Dictyodedalus acuticephalus* (SQUINABOL)
118 *Rhopalosyringium petilum* (FOREMAN)
120 *Dictyodedalus hesperis* nov. sp.
121 *Mallanites romanus* nov. sp.
122 *Mallanites triquetrus* (SQUINABOL)
124 *Archaeocenosphaera ? mellifera* nov. sp.
125 *Hemicryptocapsa polyhedra* DUMITRICA
126 *Cryptamphorella crepida* nov. sp.
127 *Cryptamphorella gilkeyi* (DUMITRICA)
128 *Hiscocapsa verbeeki* (TAN)
129 *Trisyringium echitonicum* (ALIEV)
132 *Squinabollum fossile* (SQUINABOL)
133 *Hiscocapsa uterculus* (PARONA)
134 *Dorypyle elliptica* SQUINABOL
138 *Dactyliodiscus lenticulatus* (JUD)
140 *Dactyliosphaera silviae* SQUINABOL
141 *Godia coronata* (TUMANDA)
142 *Cavaspongia euganea* (SQUINABOL)
143 *Quadrigastrum lapideum* nov. sp.
144 *Paronaella pseudoaulophacoides* nov. sp.
145 *Dactyliosphaera maxima* (PESSAGNO)
146 *Dactyliodiscus cayeuxi* SQUINABOL
147 *Godia pelta* nov. sp.
148 *Godia decora* (LI & WU)
149 *Godia concava* (LI & WU)
150 *Diacanthocapsa euganea* SQUINABOL
151 *Diacanthocapsa rara* SQUINABOL
152 *Diacanthocapsa matsumotoi* (TAKETANI)
153 *Sciadiocapsa hibrida* nov. sp.
154 *Sciadiocapsa elegans* (SQUINABOL)
155 *Sciadiocapsa pertica* nov. sp.
156 *Sciadiocapsa speciosa* (SQUINABOL)
157 *Sciadiocapsa euganea* SQUINABOL
158 *Sciadiocapsa monticelloensis* (PESSAGNO)
160 *Thanarla cucurbita* nov. sp.
161 *Pessagnobrachia dalpiazii* (SQUINABOL)
163 *Cavaspongia cilindrica* nov. sp.
164 *Cavaspongia antelopensis* PESSAGNO
166 *Becus horridus* (SQUINABOL)

167 *Alievium superbum* (SQUINABOL)
168 *Pseudoacanthosphaera magnifica* (SQUINABOL)
169 *Pessagnobrachia macphersoni* nov. sp.
170 *Cavaspongia sphaerica* nov. sp.
171 *Triactoma compressa* (SQUINABOL)
172 *Cavaspongia helice* nov. sp.
174 *Pessagnobrachia rara* (SQUINABOL)
175 *Triactoma cellulosa* FOREMAN
176 *Staurosphaeretta longispina* (SQUINABOL)
178 *Halesium nevianii* (SQUINABOL)
179 *Paronaella solanoensis* PESSAGNO
180 *Paronaella californiaensis* PESSAGNO
181 *Halesium diacanthum* (SQUINABOL)
182 *Halesium amissum* (SQUINABOL)
183 *Halesium triacanthum* (SQUINABOL)
184 *Acaeniotyle tribulosa* FOREMAN
185 *Quadrigastrum oculus* nov. sp.
186 *Tetracanthellipsis gregalis* nov. sp.
187 *Cavaspongia tricornis* nov. sp.
188 *Triactoma hexeris* nov. sp.
189 *Pessagnobrachia fabianii* (SQUINABOL)
190 *Pessagnobrachia clavata* (SQUINABOL)
191 *Acaeniotyle diaphorogona* FOREMAN
192 *Triactoma paronai* (SQUINABOL)
193 *Savaryella quadra* (FOREMAN)
194 *Savaryella spinosa* nov. sp.
195 *Savaryella sinistra* nov. sp.
196 *Crucella euganea* (SQUINABOL)
199 *Savaryella stella* nov. sp.
201 *Acaeniotyle amplissima* (FOREMAN)
202 *Cavaspongia californiaensis* PESSAGNO
203 *Deviatus diamphidius* (FOREMAN)
204 *Halesium crassum* (OZVOLDOVA)
205 *Crucella gavalai* nov. sp.
206 *Savaryella novalensis* (SQUINABOL)
207 *Dactyliodiscus rubus* nov. sp.
208 *Staurosphaeretta euganea* (SQUINABOL)
209 *Dispongotripus triangularis* (SQUINABOL)
210 *Pessagnobrachia irregularis* (SQUINABOL)
213 *Tetracanthellipsis euganeus* SQUINABOL
214 *Acaeniotyle rebellis* nov. sp.
215 *Acaeniotyle vitalis* nov. sp.
217 *Becus regius* nov. sp.
218 *Pyramispongia glascockensis* PESSAGNO
219 *Crucella remanei* JUD
220 *Crucella hispana* nov. sp.
221 *Crucella cachensis* PESSAGNO
222 *Triactoma parva* (SQUINABOL)
223 *Crucella messinae* PESSAGNO
224 *Crucella baliarica* nov. sp.
226 *Falsocromyodrymus mirabilis* (SQUINABOL)
227 *Paronaella grapevinensis* (PESSAGNO)
229 *Crucella irwini* PESSAGNO
230 *Pseudoaulophacus sculptus* (SQUINABOL)
232 *Quadrigastrum insulsum* nov. sp.
233 *Patellula cognata* nov. sp.
234 *Patellula helios* (SQUINABOL)
235 *Dactyliodiscus longispinus* (SQUINABOL)
236 *Patellula minuscula* nov. sp.
238 *Pseudoaulophacus putahensis* PESSAGNO
239 *Acaeniotyle macrospina* (SQUINABOL)
240 *Staurosphaeretta grandipora* (SQUINABOL)
241 *Parvicingula boesii* (PARONA)
242 *Phalangites perspicuus* (SQUINABOL)
244 *Torculum dengoi* (SCHMIDT-EFFING)
245 *Torculum coronatum* (SQUINABOL)
246 *Thanarla pseudodecora* (TAN)
247 *Turbocapsula fugitiva* nov. sp.
248 *Turbocapsula giennensis* nov. sp.
249 *Holocryptocapsa fallax* (TAN)
252 *Cyclastrum satoi* (TUMANDA)
253 *Hiscocapsa grutterinki* (TAN)
254 *Holocryptocapsa hindei* TAN
255 *Cryptamphorella clivosa* (ALIEV)
257 *Dictyomitra obesa* (SQUINABOL)
258 *Dictyomitra excellens* (TAN)
259 *Thanarla brouweri* (TAN)
260 *Thanarla pacifica* NAKASEKO & NISHIMURA
261 *Hiscocapsa asseni* (TAN)
264 *Trisyringium capellinii* VINASSA
265 *Pseudodictyomitra carpatica* (LOZYNIAK)
267 *Pseudodictyomitra nuda* (SCHAAF)
269 *Dictyomitra communis* (SQUINABOL)
270 *Staurosphaeretta wisniowskii* (SQUINABOL)
271 *Pseudodictyomitra pentacolaensis* PESSAGNO
273 *Dictyomitra formosa* SQUINABOL
275 *Thanarla conica* (SQUINABOL)
279 *Pseudodictyomitra lodogaensis* PESSAGNO
280 *Pseudodictyomitra hornatissima* (SQUINABOL)
281 *Sciadiocapsa radiata* (SQUINABOL)
283 *Sciadiocapsa multiradiata* nom. nov.
285 *Rotaforma volatilis* nov. sp.
286 *Rotaforma haeckeli* (SQUINABOL)
287 *Falsocromyodrymus ? nebulosus* nov. sp.
288 *Rotaforma mirabilis* PESSAGNO
290 *Ultranapora cretacea* (SQUINABOL)
291 *Ultranapora durhami* PESSAGNO
292 *Ultranapora crassispina* (SQUINABOL)
293 *Ultranapora dendroacanthos* (SQUINABOL)
294 *Ultranapora praespinifera* PESSAGNO
295 *Saitoum ? mercuriale* nov. sp.
297 *Triactoma hybum* FOREMAN
299 *Rhopalosyringium hispidum* nov. sp.
300 *Stichomitra simplex* (SMIRNOVA & ALIEV)
303 *Falsocromyodrymus ? fragosus* nov. sp.
304 *Becus helenae* (SCHAAF)

305 *Stichomitra mediocris* (TAN)
307 *Rhopalosyringium fossile* (SQUINABOL)
308 *Trimulus parmatus* nov. sp.
311 *Diacanthocapsa betica* nov. sp.
312 *Paronaella acuta* nov. sp.
313 *Stichomitra japonica* (NAKASEKO & NISHIMURA)
314 *Dictyomitra montisserei* (SQUINABOL)
320 *Becus gemmatus* WU
321 *Patellula verteroensis* (PESSAGNO)
322 *Dispongotripus acutispinus* SQUINABOL
324 *Dactyliosphaera acutispina* (SQUINABOL)
325 *Patellula heroica* nov. sp.
326 *Pantanellium lanceola* (PARONA)
327 *Pseudoacanthosphaera spinosissima* (SQUINABOL)
328 *Dicroa rara* (SQUINABOL)
329 *Cavaspongia contracta* nov. sp.
331 *Acaeniotyle longispina* (SQUINABOL)
332 *Acaeniotyle umbilicata* (RÜST)
336 *Protoxiphotractus ventosus* nov. sp.
337 *Vitorfus morini* EMPSON-MORIN
338 *Vitorfus minimus* (SQUINABOL)
340 *Acanthocircus hueyi* (PESSAGNO)
341 *Acanthocircus euganeus* (SQUINABOL)
342 *Pseudoacanthosphaera superba* (SQUINABOL)
345 *Acanthocircus angustus* DONOFRIO & MOSTLER
346 *Acanthocircus multidentatus* (SQUINABOL)
347 *Acanthocircus tympanum* nov. sp.
348 *Acanthocircus ellipticus* (SQUINABOL)
349 *Acanthocircus floridus* nov. sp.
350 *Acanthocircus impolitus* nov. sp.
351 *Vitorfus campbelli* PESSAGNO
352 *Falsocromyodrymus noxiosus* nov. sp.
353 *Acanthocircus subquadratus* (DONOFRIO & MOSTLER)
354 *Acanthocircus nanus* nov. sp.
355 *Acanthocircus venetus* (SQUINABOL)
356 *Acanthocircus bestiarius* nov. sp.
357 *Dicerosaturnalis amissus* (SQUINABOL)
358 *Acanthocircus horridus* SQUINABOL
359 *Acanthocircus dendroacanthos* SQUINABOL
360 *Acanthocircus levis* (DONOFRIO & MOSTLER)
361 *Diacanthocapsa ovoidea* DUMITRICA
362 *Hemicryptocapsa prepolyhedra* DUMITRICA
363 *Guttacapsa biacuta* (SQUINABOL)
365 *Rhopalosyringium elegans* (SQUINABOL)
367 *Acanthocircus irregularis* SQUINABOL
368 *Diacanthocapsa antiqua* (SQUINABOL)
369 *Paronaella communis* (SQUINABOL)
370 *Stichomitra stocki* (CAMPBELL & CLARK)
372 *Distylocapsa nova* SQUINABOL
374 *Protoxiphotractus machinosus* nov. sp.
375 *Quinquecapsularia panacea* nov. sp.
376 *Dictyodedalus cretaceus* (TAKETANI)
377 *Quinquecapsularia parvipora* (SQUINABOL)
379 *Vitorfus brustolensis* (SQUINABOL)
380 *Falsocromyodrymus cardulus* nov. sp.
382 *Patellula ecliptica* nov. sp.
383 *Dicroa periosa* FOREMAN
384 *Crucella bossoensis* JUD
385 *Xitus alievi* (FOREMAN)
386 *Cyclastrum infundibuliforme* RÜST
388 *Angulobracchia portmanni* BAUMGARTNER
389 *Crolanium bipodium* (PARONA)
391 *Podobursa typica* (RÜST)
392 *Aurisaturnalis carinatus* (FOREMAN)
393 *Sciadiocapsa patera* nov. sp.

Index of genera and species arranged by alphabetical order. All these taxa have been used in constructing the range chart by means of an automatic treatment (see Chapter III.2 for details).

201 *Acaeniotyle amplissima* (FOREMAN)
191 *Acaeniotyle diaphorogona* FOREMAN
331 *Acaeniotyle longispina* (SQUINABOL)
239 *Acaeniotyle macrospina* (SQUINABOL)
214 *Acaeniotyle rebellis* nov. sp.
184 *Acaeniotyle tribulosa* FOREMAN
332 *Acaeniotyle umbilicata* (RÜST)
215 *Acaeniotyle vitalis* nov. sp.
345 *Acanthocircus angustus* DONOFRIO & MOSTLER
356 *Acanthocircus bestiarius* nov. sp.
359 *Acanthocircus dendroacanthos* SQUINABOL
348 *Acanthocircus ellipticus* (SQUINABOL)
341 *Acanthocircus euganeus* (SQUINABOL)
349 *Acanthocircus floridus* nov. sp.
358 *Acanthocircus horridus* SQUINABOL
340 *Acanthocircus hueyi* (PESSAGNO)
350 *Acanthocircus impolitus* nov. sp.
367 *Acanthocircus irregularis* SQUINABOL
360 *Acanthocircus levis* (DONOFRIO & MOSTLER)
346 *Acanthocircus multidentatus* (SQUINABOL)
354 *Acanthocircus nanus* nov. sp.
353 *Acanthocircus subquadratus* (DONOFRIO & MOSTLER)
347 *Acanthocircus tympanum* nov. sp.
355 *Acanthocircus venetus* (SQUINABOL)
113 *Afens liriodes* RIEDEL & SANFILIPPO
167 *Alievium superbum* (SQUINABOL)
11 *Anachoreta sagitta* nov. sp.
388 *Angulobracchia portmanni* BAUMGARTNER
124 *Archaeocenosphaera ? mellifera* nov. sp.
392 *Aurisaturnalis carinatus* (FOREMAN)

320 *Becus gemmatus* WU
304 *Becus helenae* (SCHAAF)
166 *Becus horridus* (SQUINABOL)
217 *Becus regius* nov. sp.
164 *Cavaspongia antelopensis* PESSAGNO
202 *Cavaspongia californiaensis* PESSAGNO
163 *Cavaspongia cilindrica* nov. sp.
329 *Cavaspongia contracta* nov. sp.
142 *Cavaspongia euganea* (SQUINABOL)
172 *Cavaspongia helice* nov. sp.
170 *Cavaspongia sphaerica* nov. sp.
187 *Cavaspongia tricornis* nov. sp.
389 *Crolanium bipodium* (PARONA)
7 *Crolanium cuneatum* (SMIRNOVA & ALIEV)
66 *Crolanium puga* (SCHAAF)
6 *Crolanium pulchrum* (SQUINABOL)
16 *Crolanium spineum* (PESSAGNO)
4 *Crolanium triangulare* (ALIEV)
224 *Crucella baliarica* nov. sp.
384 *Crucella bossoensis* JUD
221 *Crucella cachensis* PESSAGNO
196 *Crucella euganea* (SQUINABOL)
205 *Crucella gavalai* nov. sp.
220 *Crucella hispana* nov. sp.
229 *Crucella irwini* PESSAGNO
223 *Crucella messinae* PESSAGNO
219 *Crucella remanei* JUD
255 *Cryptamphorella clivosa* (ALIEV)
126 *Cryptamphorella crepida* nov. sp.
127 *Cryptamphorella gilkeyi* (DUMITRICA)
386 *Cyclastrum infundibuliforme* RÜST
252 *Cyclastrum satoi* (TUMANDA)
146 *Dactyliodiscus cayeuxi* SQUINABOL
138 *Dactyliodiscus lenticulatus* (JUD)
235 *Dactyliodiscus longispinus* (SQUINABOL)
207 *Dactyliodiscus rubus* nov. sp.
324 *Dactyliosphaera acutispina* (SQUINABOL)
81 *Dactyliosphaera lepta* (FOREMAN)
145 *Dactyliosphaera maxima* (PESSAGNO)
140 *Dactyliosphaera silviae* SQUINABOL
203 *Deviatus diamphidius* (FOREMAN)
368 *Diacanthocapsa antiqua* (SQUINABOL)
311 *Diacanthocapsa betica* nov. sp.
98 *Diacanthocapsa brevithorax* DUMITRICA
150 *Diacanthocapsa euganea* SQUINABOL
90 *Diacanthocapsa fossilis* (SQUINABOL)
152 *Diacanthocapsa matsumotoi* (TAKETANI)
361 *Diacanthocapsa ovoidea* DUMITRICA
151 *Diacanthocapsa rara* SQUINABOL
357 *Dicerosaturnalis amissus* (SQUINABOL)
383 *Dicroa periosa* FOREMAN
328 *Dicroa rara* (SQUINABOL)
117 *Dictyodedalus acuticephalus* (SQUINABOL)
376 *Dictyodedalus cretaceus* (TAKETANI)
120 *Dictyodedalus hesperis* nov. sp.
269 *Dictyomitra communis* (SQUINABOL)
47 *Dictyomitra crassispina* (SQUINABOL)
63 *Dictyomitra crebrisulcata* (SQUINABOL)
258 *Dictyomitra excellens* (TAN)
273 *Dictyomitra formosa* SQUINABOL
61 *Dictyomitra gracilis* (SQUINABOL)
17 *Dictyomitra magnifica* (PESSAGNO)
314 *Dictyomitra montisserei* (SQUINABOL)
43 *Dictyomitra multicostata* ZITTEL
257 *Dictyomitra obesa* (SQUINABOL)
3 *Dictyomitra pulchra* (SQUINABOL)
28 *Dictyomitra turritum* (SQUINABOL)
42 *Dictyomitra undata* SQUINABOL
322 *Dispongotripus acutispinus* SQUINABOL
209 *Dispongotripus triangularis* (SQUINABOL)
41 *Distylocapsa micropora* (SQUINABOL)
372 *Distylocapsa nova* SQUINABOL
50 *Distylocapsa squama* nov. sp.
59 *Distylocapsa veneta* (SQUINABOL)
111 *Dorypyle ? anisa* (FOREMAN)
99 *Dorypyle communis* (SQUINABOL)
134 *Dorypyle elliptica* SQUINABOL
97 *Dorypyle ovoidea* (SQUINABOL)
14 *Eostichomitra bonum* (KOZLOVA)
77 *Eribotrys* ? sp. *1*
116 *Eribotrys* ? sp. 2
303 *Falsocromyodrymus ? fragosus* nov. sp.
287 *Falsocromyodrymus ? nebulosus* nov. sp.
380 *Falsocromyodrymus cardulus* nov. sp.
226 *Falsocromyodrymus mirabilis* (SQUINABOL)
352 *Falsocromyodrymus noxiosus* nov. sp.
141 *Godia coronata* (TUMANDA)
148 *Godia decora* (LI & WU)
149 *Godia concava* (LI & WU)
147 *Godia pelta* nov. sp.
363 *Guttacapsa biacuta* (SQUINABOL)
91 *Guttacapsa gutta* (SQUINABOL)
182 *Halesium amissum* (SQUINABOL)
204 *Halesium crassum* (OZVOLDOVA)
181 *Halesium diacanthum* (SQUINABOL)
178 *Halesium nevianii* (SQUINABOL)
183 *Halesium triacanthum* (SQUINABOL)
125 *Hemicryptocapsa polyhedra* DUMITRICA
362 *Hemicryptocapsa prepolyhedra* DUMITRICA
82 *Hexapyramis pantanellii* SQUINABOL
88 *Hexapyramis precedis* JUD
261 *Hiscocapsa asseni* (TAN)
253 *Hiscocapsa grutterinki* (TAN)
133 *Hiscocapsa uterculus* (PARONA)
128 *Hiscocapsa verbeeki* (TAN)
249 *Holocryptocapsa fallax* (TAN)

254 *Holocryptocapsa hindei* TAN
2 *Hsuum ? cataphracta* nov. sp.
19 *Hsuum pectorale* nov. sp.
121 *Mallanites romanus* nov. sp.
122 *Mallanites triquetrus* (SQUINABOL)
57 *Mirifusus chenodes* (RENZ)
53 *Obeliscoites giganteus* (ALIEV)
52 *Obeliscoites maximus* (SQUINABOL)
54 *Obeliscoites perspicuus* (SQUINABOL)
56 *Obeliscoites turris* (SQUINABOL)
51 *Obeliscoites vinassai* (SQUINABOL)
326 *Pantanellium lanceola* (PARONA)
312 *Paronaella acuta* nov. sp.
180 *Paronaella californiaensis* PESSAGNO
369 *Paronaella communis* (SQUINABOL)
227 *Paronaella grapevinensis* (PESSAGNO)
144 *Paronaella pseudoaulophacoides* nov. sp.
179 *Paronaella solanoensis* PESSAGNO
241 *Parvicingula boesii* (PARONA)
21 *Parvicingula usotanensis* TUMANDA
233 *Patellula cognata* nov. sp.
382 *Patellula ecliptica* nov. sp.
234 *Patellula helios* (SQUINABOL)
325 *Patellula heroica* nov. sp.
236 *Patellula minuscula* nov. sp.
84 *Patellula spica* nov. sp.
321 *Patellula verteroensis* (PESSAGNO)
190 *Pessagnobrachia clavata* (SQUINABOL)
161 *Pessagnobrachia dalpiazii* (SQUINABOL)
189 *Pessagnobrachia fabianii* (SQUINABOL)
210 *Pessagnobrachia irregularis* (SQUINABOL)
169 *Pessagnobrachia macphersoni* nov. sp.
174 *Pessagnobrachia rara* (SQUINABOL)
15 *Phalangites calamus* nov. sp.
46 *Phalangites hastatus* nov. sp.
242 *Phalangites perspicuus* (SQUINABOL)
49 *Phalangites telum* nov. sp.
391 *Podobursa typica* (RÜST)
76 *Podobursa tytthopora* (FOREMAN)
87 *Pogonias ? hirsutus* (SQUINABOL)
114 *Pogonias harpago* nov. sp.
85 *Pogonias incallidus* nov. sp.
115 *Pogonias missilis* nov. sp.
100 *Pogonias prodromus* nov. sp.
374 *Protoxiphotractus machinosus* nov. sp.
336 *Protoxiphotractus ventosus* nov. sp.
95 *Pseudoacanthosphaera galeata* nov. sp.
168 *Pseudoacanthosphaera magnifica* (SQUINABOL)
327 *Pseudoacanthosphaera spinosissima* (SQUINABOL)
342 *Pseudoacanthosphaera superba* (SQUINABOL)
238 *Pseudoaulophacus putahensis* PESSAGNO
230 *Pseudoaulophacus sculptus* (SQUINABOL)
265 *Pseudodictyomitra carpatica* (LOZYNIAK)
280 *Pseudodictyomitra hornatissima* (SQUINABOL)
48 *Pseudodictyomitra languida* nov. sp.
279 *Pseudodictyomitra lodogaensis* PESSAGNO
267 *Pseudodictyomitra nuda* (SCHAAF)
37 *Pseudodictyomitra paronai* (ALIEV)
271 *Pseudodictyomitra pentacolaensis* PESSAGNO
39 *Pseudodictyomitra pseudomacrocephala* (SQUINABOL)
38 *Pseudodictyomitra tiara* (HOLMES)
74 *Pseudoeucyrtis ? columbaria* (RENZ)
18 *Pseudoeucyrtis apochrypha* nov. sp.
27 *Pseudoeucyrtis hanni* (TAN)
44 *Pseudoeucyrtis pulchra* (SQUINABOL)
45 *Pseudoeucyrtis spinosa* (SQUINABOL)
103 *Pseudotheocampe tina* (FOREMAN)
83 *Pyramispongia costarricensis* (SCHMIDT-EFFING)
218 *Pyramispongia glascockensis* PESSAGNO
232 *Quadrigastrum insulsum* nov. sp.
143 *Quadrigastrum lapideum* nov. sp.
185 *Quadrigastrum oculus* nov. sp.
96 *Quinquecapsularia grandiloqua* nov. sp.
86 *Quinquecapsularia ombonii* (SQUINABOL)
375 *Quinquecapsularia panacea* nov. sp.
377 *Quinquecapsularia parvipora* (SQUINABOL)
93 *Rhopalosyringium adriaticum* nov. sp.
365 *Rhopalosyringium elegans* (SQUINABOL)
64 *Rhopalosyringium euganeum* (SQUINABOL)
307 *Rhopalosyringium fossile* (SQUINABOL)
299 *Rhopalosyringium hispidum* nov. sp.
101 *Rhopalosyringium mosquense* (SMIRNOVA & ALIEV)
102 *Rhopalosyringium perforaculum* nov. sp.
118 *Rhopalosyringium petilum* (FOREMAN)
108 *Rhopalosyringium radiosum* nov. sp.
106 *Rhopalosyringium scissum* nov. sp.
109 *Rhopalosyringium solivagum* nov. sp.
286 *Rotaforma haeckeli* (SQUINABOL)
288 *Rotaforma mirabilis* PESSAGNO
285 *Rotaforma volatilis* nov. sp.
295 *Saitoum ? mercuriale* nov. sp.
206 *Savaryella novalensis* (SQUINABOL)
193 *Savaryella quadra* (FOREMAN)
195 *Savaryella sinistra* nov. sp.
194 *Savaryella spinosa* nov. sp.
199 *Savaryella stella* nov. sp.
154 *Sciadiocapsa elegans* (SQUINABOL)
157 *Sciadiocapsa euganea* SQUINABOL
153 *Sciadiocapsa hibrida* nov. sp.
158 *Sciadiocapsa monticelloensis* (PESSAGNO)
283 *Sciadiocapsa multiradiata* nom. nov.
393 *Sciadiocapsa patera* nov. sp.
155 *Sciadiocapsa pertica* nov. sp.
281 *Sciadiocapsa radiata* (SQUINABOL)
156 *Sciadiocapsa speciosa* (SQUINABOL)
62 *Spongostichomitra elatica* (ALIEV)

1	*Spongostichomitra indomita* nov. sp.
8	*Spongostichomitra phalanga* nov. sp.
132	*Squinabollum fossile* (SQUINABOL)
208	*Staurosphaeretta euganea* (SQUINABOL)
240	*Staurosphaeretta grandipora* (SQUINABOL)
176	*Staurosphaeretta longispina* (SQUINABOL)
270	*Staurosphaeretta wisniowskii* (SQUINABOL)
35	*Stichomitra communis* SQUINABOL
313	*Stichomitra japonica* (NAKASEKO & NISHIMURA)
36	*Stichomitra magna* SQUINABOL
305	*Stichomitra mediocris* (TAN)
92	*Stichomitra navalis* nov. sp.
300	*Stichomitra simplex* (SMIRNOVA & ALIEV)
370	*Stichomitra stocki* (CAMPBELL & CLARK)
9	*Stichomitra tosaensis* NAKASEKO & NISHIMURA
213	*Tetracanthellipsis euganeus* SQUINABOL
186	*Tetracanthellipsis gregalis* nov. sp.
259	*Thanarla brouweri* (TAN)
29	*Thanarla carboneroensis* nov. sp.
275	*Thanarla conica* (SQUINABOL)
160	*Thanarla cucurbita* nov. sp.
79	*Thanarla lacrimula* (FOREMAN)
260	*Thanarla pacifica* NAKASEKO & NISHIMURA
246	*Thanarla pseudodecora* (TAN)
31	*Thanarla pulchra* (SQUINABOL)
10	*Thanarla spoletoensis* nov. sp.
30	*Thanarla veneta* (SQUINABOL)
70	*Torculum bastetani* nov. sp.
245	*Torculum coronatum* (SQUINABOL)
244	*Torculum dengoi* (SCHMIDT-EFFING)
175	*Triactoma cellulosa* FOREMAN
171	*Triactoma compressa* (SQUINABOL)
188	*Triactoma hexeris* nov. sp.
297	*Triactoma hybum* FOREMAN
192	*Triactoma paronai* (SQUINABOL)
222	*Triactoma parva* (SQUINABOL)
110	*Trimulus fossilis* (SQUINABOL)
308	*Trimulus parmatus* nov. sp.
264	*Trisyringium capellinii* VINASSA
129	*Trisyringium echitonicum* (ALIEV)
34	*Tubilustrium iracundum* nov. sp.
32	*Tubilustrium transmontanum* nov. sp.
24	*Tugurium pagoda* (SQUINABOL)
80	*Turbocapsula costata* (WU)
247	*Turbocapsula fugitiva* nov. sp.
248	*Turbocapsula giennensis* nov. sp.
292	*Ultranapora crassispina* (SQUINABOL)
290	*Ultranapora cretacea* (SQUINABOL)
293	*Ultranapora dendroacanthos* (SQUINABOL)
291	*Ultranapora durhami* PESSAGNO
294	*Ultranapora praespinifera* PESSAGNO
379	*Vitorfus brustolensis* (SQUINABOL)
351	*Vitorfus campbelli* PESSAGNO
338	*Vitorfus minimus* (SQUINABOL)
337	*Vitorfus morini* EMPSON-MORIN
385	*Xitus alievi* (FOREMAN)
68	*Xitus clava* (PARONA)
69	*Xitus elegans* (SQUINABOL)
13	*Xitus mclaughlini* PESSAGNO
78	*Xitus spicularius* (ALIEV)
58	*Xitus spinosus* (SQUINABOL)

VII. PLATES

PLATE 1

Figures 1-2 **Dictyomitra excellens** (TAN) x200 .... p. 70

1) R-34, from loc. no. Bo-566.50, early Barremian.
2) 9749, from loc. no. Ca1-9.70, late Barremian.

Figures 3-11 **Dictyomitra communis** (SQUINABOL) x150 .... p. 71

3) 10377, from loc. no. Pan-1, late Aptian.
4) 10453, from loc. no. Pan-1, late Aptian.
5) 10561, from loc. no. Pan-1, late Aptian.
6) 10494, from loc. no. Pan-1, late Aptian.
7) 10670, from loc. no. Pan-1, late Aptian.
8) 10438, from loc. no. Pan-1, late Aptian.
9) 10364, from loc. no. Pan-1, late Aptian.
10) 10354, from loc. no. Pan-1, late Aptian.
11) 10335, from loc. no. Pan-1, late Aptian.

Figures 12-25 **Dictyomitra gracilis** (SQUINABOL) x120 .... p. 73

12) 2373, from loc. no. Gc-1035.10, late Albian.
13) 3269, from loc. no. Bo-685.20, late Albian.
14) 2866, from loc. no. Bo-685.20, late Albian.
15) 839, from loc. no. Gc-1027.10, middle Albian.
16) 404.1, from loc. no. Ap2 (-7.78), middle Albian.
17) 404.2, from loc. no. Ap2 (-7.78), middle Albian.
18) 2861, from loc. no. Bo-685.20, late Albian.
19) 403.1, from loc. no. Ap2 (-7.78), middle Albian.
20) 526, from loc. no. Ap2 (-7.78), middle Albian.
21) 103, from loc. no. Ap2 (-7.78), middle Albian.
22) 401, from loc. no. Ap2 (-7.78), middle Albian.
23) 390.2, from loc. no. Ap2 (-7.78), middle Albian.
24) 403.2, from loc. no. Ap2 (-7.78), middle Albian.
25) 390.1, from loc. no. Ap2 (-7.78), middle Albian.

Plate 1

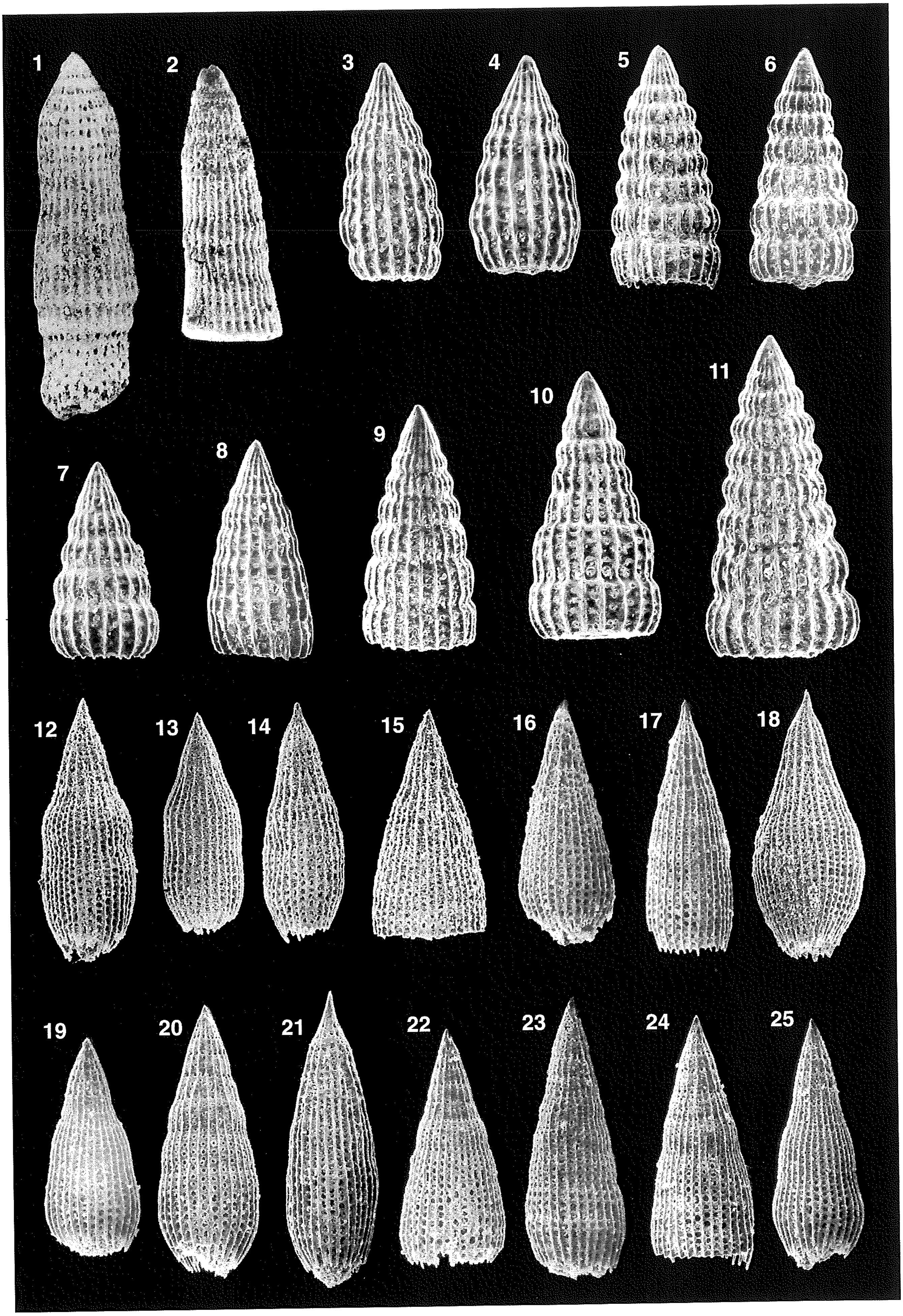

PLATE 2

Figures 1-6 **Dictyomitra obesa** (SQUINABOL) x150 .... p. 74

1) 5350, from loc. no. Gb-84.40, early Cenomanian.
2) 3291, from loc. no. Bo-685.20, late Albian.
3) 3263, from loc. no. Bo-685.20, late Albian.
4) 2766, from loc. no. Bo-685.20, late Albian.
5) 3271, from loc. no. Bo-685.20, late Albian.
6) 838, from loc. no. Gc-1027.10, middle Albian.

Figures 7-11 **Dictyomitra turritum** (SQUINABOL) x100 .... p. 74

7) 3314, from loc. no. Gc-1073.94, middle Cenomanian.
8) 3316, from loc. no. Gc-1073.94, middle Cenomanian.
9) 5248, from loc. no. Gb-84.40, early Cenomanian.
10) 3969, from loc. no. Gc-1073.94, middle Cenomanian.
11) 7888, from loc. no. Gb-108.60, late Cenomanian.

Figures 12-17 **Dictyomitra crebrisulcata** (SQUINABOL) x120 .... p. 75

12) 4055, from loc. no. Gc-1073.94, middle Cenomanian.
13) 7205, from loc. no. Gb-108.60, late Cenomanian.
14) 7571, from loc. no. Gb-108.60, late Cenomanian.
15) 7826, from loc. no. Gb-108.60, late Cenomanian.
16) 4078, from loc. no. Gc-1073.94, middle Cenomanian.
17) 4028, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 18-24 **Dictyomitra pulchra** (SQUINABOL) x75 .... p. 76

18) 2585, from loc. no. Bo-685.20, late Albian.
19) 2575, from loc. no. Bo-685.20, late Albian.
20) 2572, from loc. no. Bo-685.20, late Albian.
21) 2565, from loc. no. Bo-685.20, late Albian.
22) 3217, from loc. no. Bo-685.20, late Albian.
23) 2586, from loc. no. Bo-685.20, late Albian.
24) 2577, from loc. no. Bo-685.20, late Albian.

Plate 2

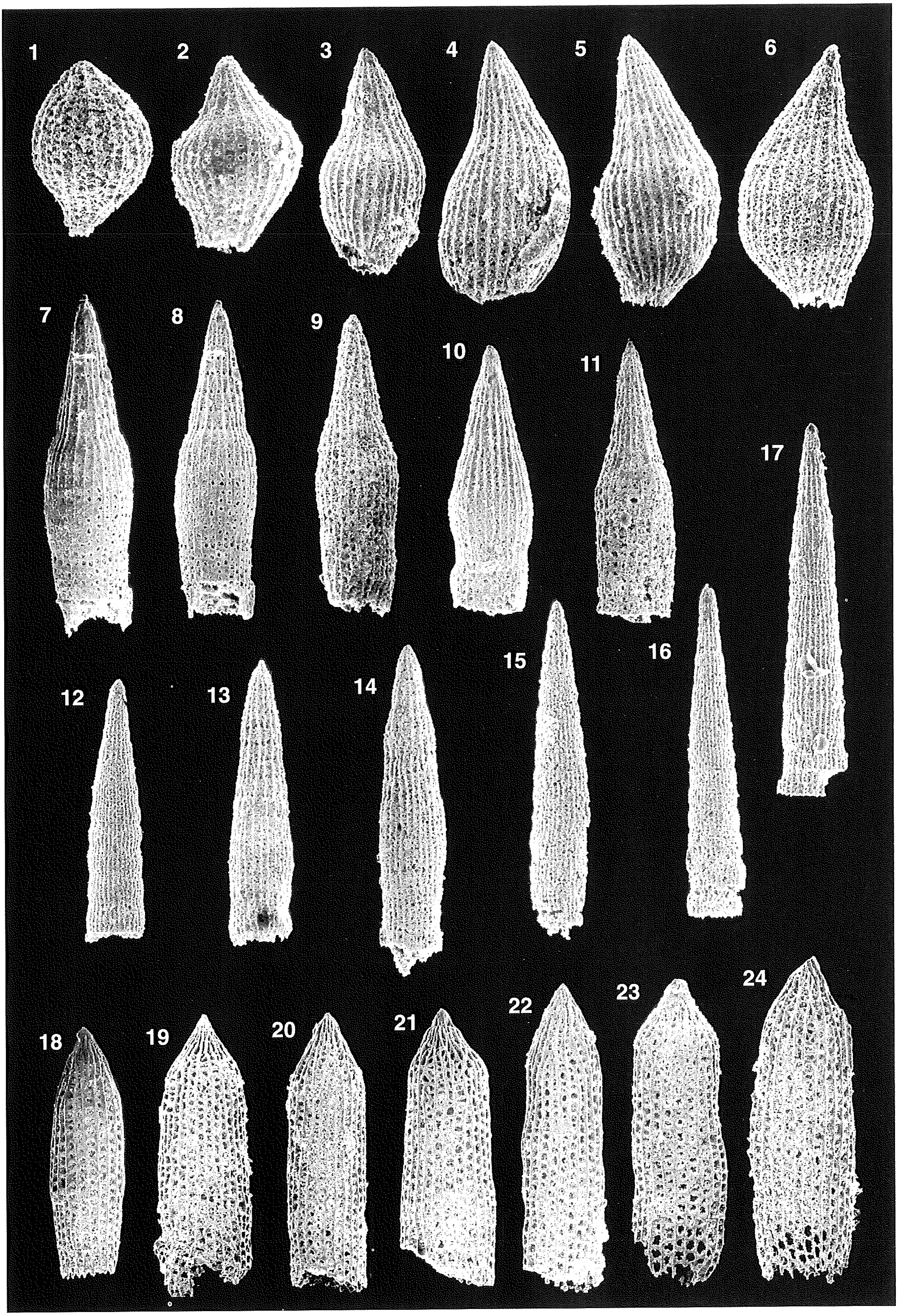

PLATE 3

Figures 1-29 **Dictyomitra montisserei** (SQUINABOL) x120 .... p. 77

1) 340.2, from loc. no. Ap2 (-7.78), middle Albian.
2) 342.2, from loc. no. Ap2 (-7.78), middle Albian.
3) 338, from loc. no. Ap2 (-7.78), middle Albian.
4) 379, from loc. no. Ap2 (-7.78), middle Albian.
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6) 383.2, from loc. no. Ap2 (-7.78), middle Albian.
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9) 381.1, from loc. no. Ap2 (-7.78), middle Albian.
10) 374, from loc. no. Ap2 (-7.78), middle Albian.
11) 367, from loc. no. Ap2 (-7.78), middle Albian.
12) 358, from loc. no. Ap2 (-7.78), middle Albian.
13) 383.1, from loc. no. Ap2 (-7.78), middle Albian.
14) 353, from loc. no. Ap2 (-7.78), middle Albian.
15) 382.1, from loc. no. Ap2 (-7.78), middle Albian.
16) 351, from loc. no. Ap2 (-7.78), middle Albian.
17) 350, from loc. no. Ap2 (-7.78), middle Albian.
18) 65, from loc. no. Ap2 (-7.78), middle Albian.
19) 355.2, from loc. no. Ap2 (-7.78), middle Albian.
20) 366, from loc. no. Ap2 (-7.78), middle Albian.
21) 384.1, from loc. no. Ap2 (-7.78), middle Albian.
22) 337, from loc. no. Ap2 (-7.78), middle Albian.
23) 341.2, from loc. no. Ap2 (-7.78), middle Albian.
24) 340.1, from loc. no. Ap2 (-7.78), middle Albian.
25) 384.2, from loc. no. Ap2 (-7.78), middle Albian.
26) 341.1, from loc. no. Ap2 (-7.78), middle Albian.
27) 356.2, from loc. no. Ap2 (-7.78), middle Albian.
28) 373, from loc. no. Ap2 (-7.78), middle Albian.
29) 381.2, from loc. no. Ap2 (-7.78), middle Albian.

Plate 3

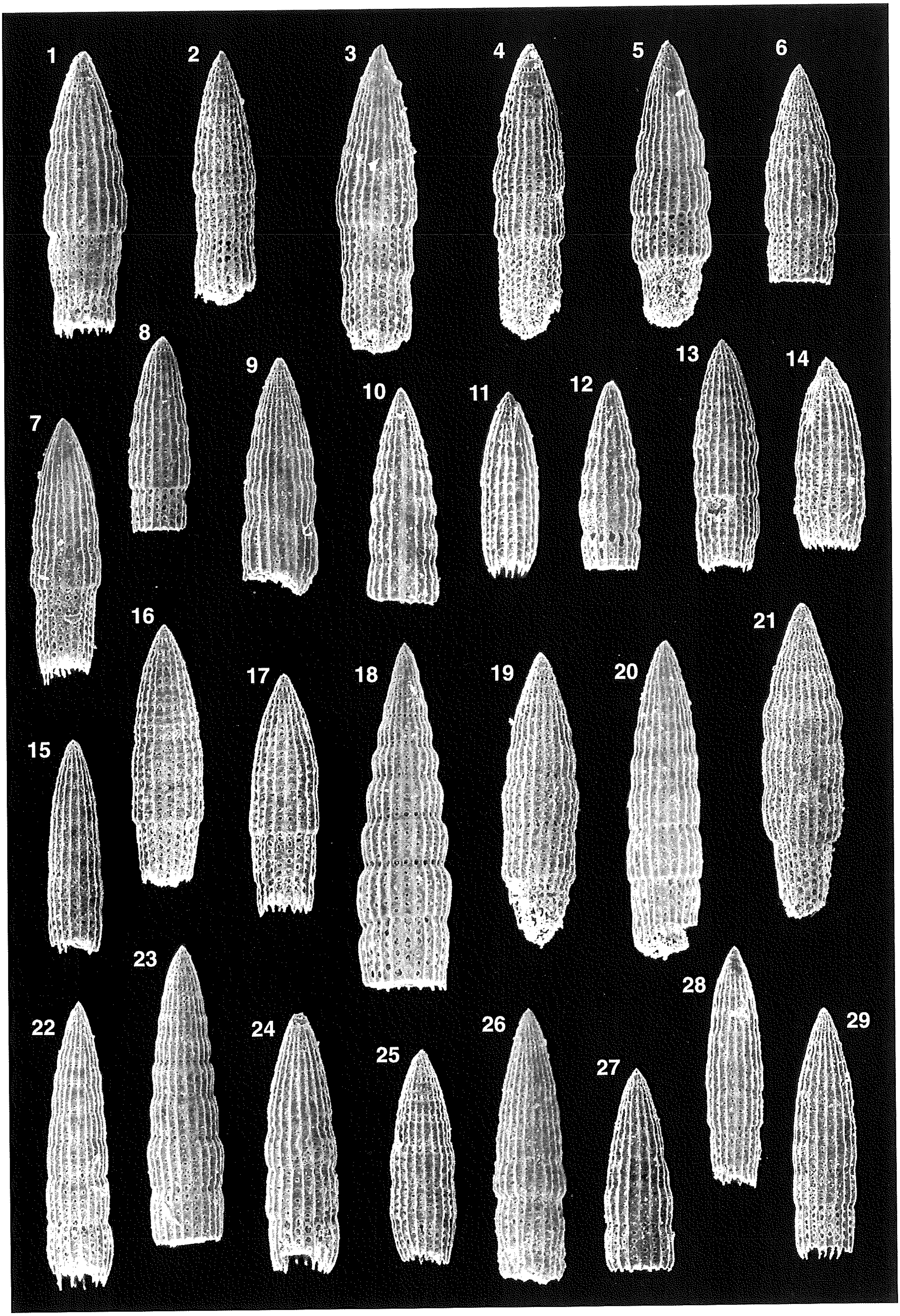

PLATE 4

Figure 1 **Dictyomitra magnifica** (PESSAGNO) x120 .... p. 79

1) 270, from loc. no. Ap2 (-7.78), middle Albian.

Figures 2-7 **Dictyomitra crassispina** (SQUINABOL) x120 .... p. 79

2) 7587, from loc. no. Gb-108.60, late Cenomanian.
3) 7710, from loc. no. Gb-108.60, late Cenomanian.
4) 7415, from loc. no. Gb-108.60, late Cenomanian.
5) 7796, from loc. no. Gb-108.60, late Cenomanian.
6) 7896, from loc. no. Gb-108.60, late Cenomanian.
7) 7521, from loc. no. Gb-108.60, late Cenomanian.

Figures 8-12 **Dictyomitra formosa** SQUINABOL x150 .... p. 80

8) 4302, from loc. no. Gc-1094.48, late Cenomanian.
9) 7825, from loc. no. Gb-108.60, late Cenomanian.
10) 2255, from loc. no. Gc-1035.10, late Albian.
11) 4190, from loc. no. Gc-1094.48, late Cenomanian.
12) 6962, from loc. no. Asv-5-43, early Turonian.

Figures 13-16 **Dictyomitra undata** SQUINABOL x150 .... p. 81

13) 5029, from loc. no. Gc-1096.50, early Turonian.
14) 5051, from loc. no. Gc-1096.50, early Turonian.
15) 6486, from loc. no. Asv-5-43, early Turonian.
16) 5012, from loc. no. Gc-1096.50, early Turonian.

Figures 17-19 **Dictyomitra multicostata** ZITTEL x150 .... p. 82

17) 7143, from loc. no. Asv-5-43, early Turonian.
18) 5724, from loc. no. Asv-5-43, early Turonian.
19) 5722, from loc. no. Asv-5-43, early Turonian.

Figures 20-24 **Thanarla pacifica** NAKASEKO & NISHIMURA x150 .... p. 84

20) 8131, from loc. no. Ca1-22.30, early Aptian.
21) 9669, from loc. no. Ca1-9.70, late Barremian.
22) 10216, from loc. no. Mc-268b, middle Aptian.
23) 8041, from loc. no. Ca1-22.30, early Aptian.
24) 9392, from loc. no. Ca1-26.05, early Aptian.

Figures 25-29 **Thanarla carboneroensis** nov. sp. x120 .... p. 85

25) 9736 (holotype), from loc. no. Ca1-9.70, late Barremian.
26) 9662, from loc. no. Ca1-9.70, late Barremian.
27) 9735, from loc. no. Ca1-9.70, late Barremian.
28) 9713, from loc. no. Ca1-9.70, late Barremian.
29) 9720, from loc. no. Ca1-9.70, late Barremian.

Plate 4

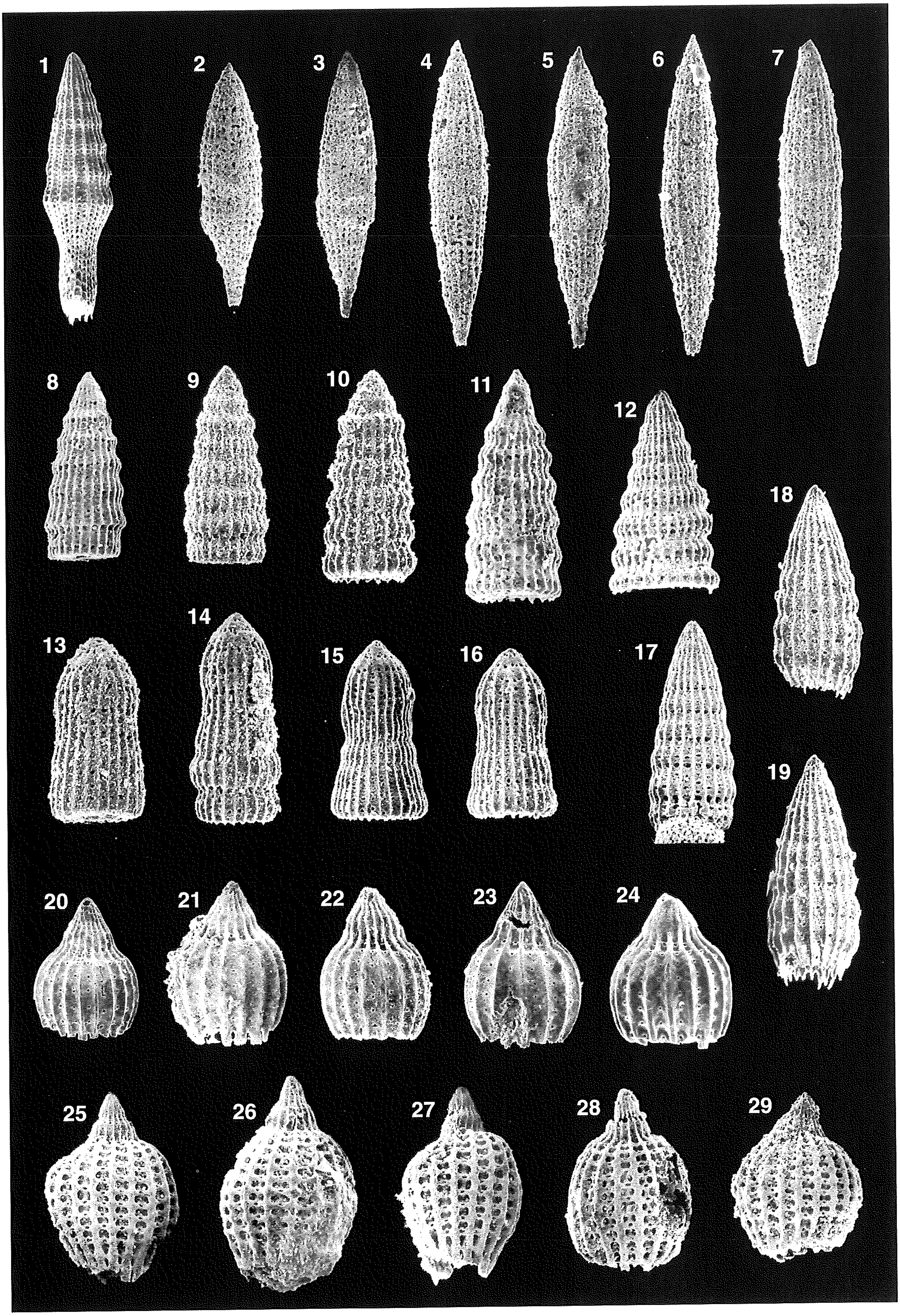

PLATE 5

Figures 1-12 **Thanarla brouweri** (TAN) x150 .... p. 86

1) 454, from loc. no. Ap2 (-7.78), middle Albian.
2) 7983, from loc. no. Ca1-22.30, early Aptian.
3) 434, from loc. no. Ap2 (-7.78), middle Albian.
4) 141, from loc. no. Ap2 (-7.78), middle Albian.
5) 473, from loc. no. Ap2 (-7.78), middle Albian.
6) 430, from loc. no. Ap2 (-7.78), middle Albian.
7) 7987, from loc. no. Ca1-22.30, early Aptian.
8) 8142, from loc. no. Ca1-22.30, early Aptian.
9) 8174, from loc. no. Ca1-22.30, early Aptian.
10) 9028, from loc. no. Ca1-22.30, early Aptian.
11) 8339, from loc. no. Ca1-22.30, early Aptian.
12) 444, from loc. no. Ap2 (-7.78), middle Albian.

Figures 13-16 **Thanarla lacrimula** (FOREMAN) x150 .... p. 88

13) 8209, from loc. no. Ca1-22.30, early Aptian.
14) 7993, from loc. no. Ca1-22.30, early Aptian.
15) 8052, from loc. no. Ca1-22.30, early Aptian.
16) 8088, from loc. no. Ca1-22.30, early Aptian.

Figures 17-22 **Thanarla pseudodecora** (TAN) x150 .... p. 89

17) 8585, from loc. no. Ca1-22.30, early Aptian.
18) 8354, from loc. no. Ca1-22.30, early Aptian.
19) 7984, from loc. no. Ca1-22.30, early Aptian.
20) 8043, from loc. no. Ca1-22.30, early Aptian.
21) 9710, from loc. no. Ca1-9.70, late Barremian.
22) 9417, from loc. no. Ca1-26.05, early Aptian.

Figures 23-27 **Thanarla conica** (SQUINABOL) x200 .... p. 90
except fig. 25 x300

23) 427.2, from loc. no. Ap2 (-7.78), middle Albian.
24) 429, from loc. no. Ap2 (-7.78), middle Albian.
25) 10121, from loc. no. Mc-268b, middle Aptian.
26) 446, from loc. no. Ap2 (-7.78), middle Albian.
27) 427.1, from loc. no. Ap2 (-7.78), middle Albian.

Figures 28-33 **Thanarla pulchra** (SQUINABOL) x150 .... p. 91

28) 104, from loc. no. Ap2 (-7.78), middle Albian.
29) 433, from loc. no. Ap2 (-7.78), middle Albian.
30) 3446, from loc. no. Gc-1073.94, middle Cenomanian.
31) 436, from loc. no. Ap2 (-7.78), middle Albian.
32) 4198, from loc. no. Gc-1094.48, late Cenomanian.
33) 4186, from loc. no. Gc-1094.48, late Cenomanian.

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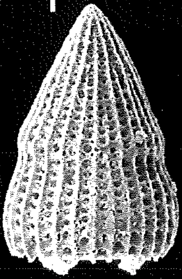

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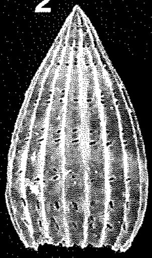

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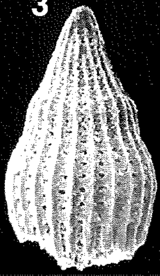

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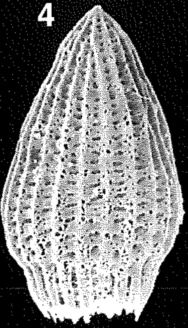

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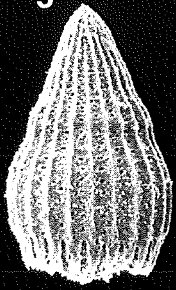

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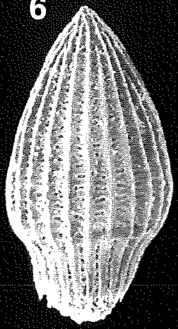

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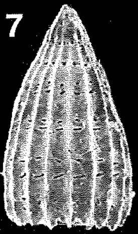

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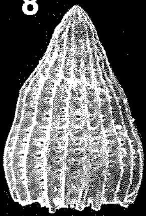

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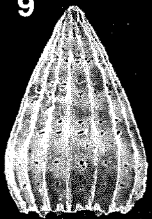

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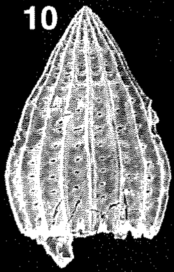

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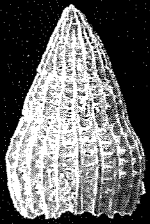

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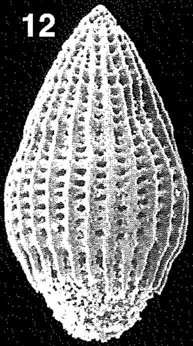

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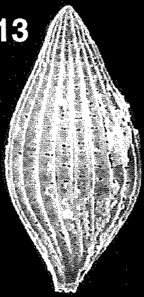

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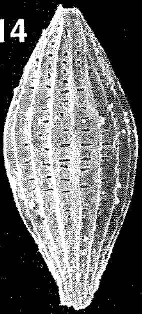

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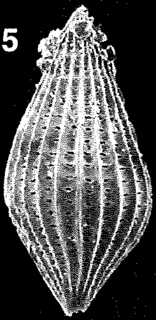

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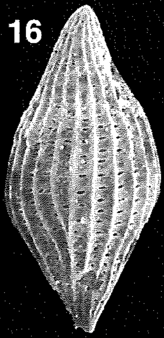

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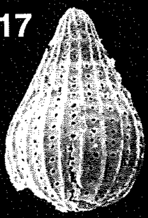

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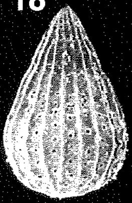

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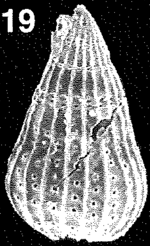

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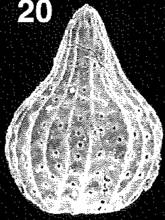

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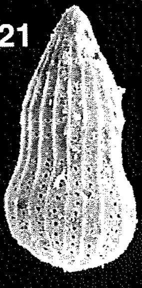

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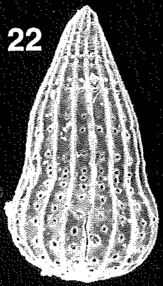

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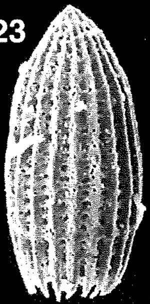

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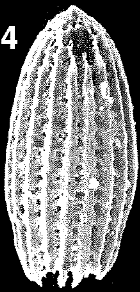

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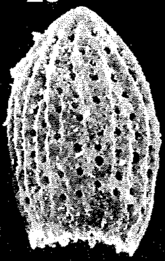

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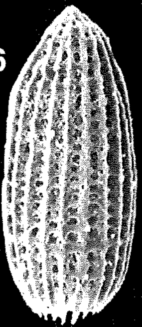

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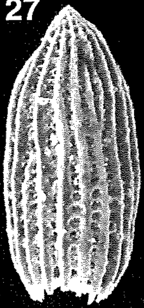

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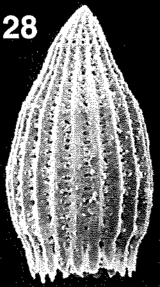

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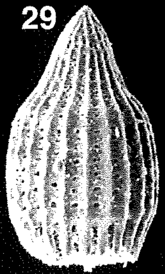

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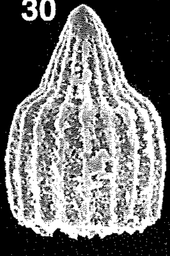

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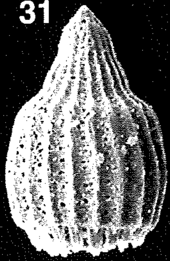

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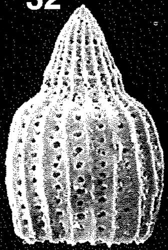

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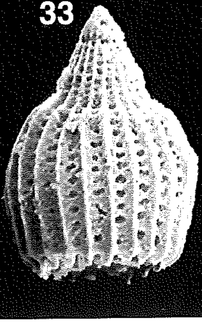

PLATE 6

Figures 1-4 **Thanarla veneta** (SQUINABOL) x 200 .... p. 92

1) 1796, from loc. no. Ap2-12, early Cenomanian.
2) 3429, from loc. no. Gc-1073.94, middle Cenomanian.
3) 7247, from loc. no. Gb-108.60, late Cenomanian.
4) 4211, from loc. no. Gc-1094.48, late Cenomanian.

Figures 5-12 **Thanarla spoletoensis** nov. sp. x120 .... p. 95

5) 93, from loc. no. Ap2 (-7.78), middle Albian.
6) 81, from loc. no. Ap2 (-7.78), middle Albian.
7) 4 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
8) 416, from loc. no. Ap2 (-7.78), middle Albian.
9) 2740, from loc. no. Bo-685.20, late Albian.
10) 425, from loc. no. Ap2 (-7.78), middle Albian.
11) 107, from loc. no. Ap2 (-7.78), middle Albian.
12) 2942, from loc. no. Bo-685.20, late Albian.

Figures 13-15 **Thanarla cucurbita** nov. sp. x120 .... p. 95

13) 12180, from loc. no. Gc-1035.10, late Albian.
14) 12179, from loc. no. Ap2-12, early Cenomanian.
15) 12178 (holotype), from loc. no. Ap2-12, early Cenomanian.

Figures 16-20 **Hsuum ? cataphracta** nov. sp. x120 .... p. 97

16) 875, from loc. no. Gc-1027.10, middle Albian.
17) 885, from loc. no. Gc-1027.10, middle Albian.
18) 3225, from loc. no. Bo-685.20, late Albian.
19) 888 (holotype), from loc. no. Gc-1027.10, middle Albian.
20) 2699, from loc. no. Bo-685.20, late Albian.

Figures 21-23 **Hsuum pectorale** nov. sp. x150 .... p. 97

21) 9477, from loc. no. Ca1-26.05, early Aptian.
22) 9502, from loc. no. Ca1-26.05, early Aptian.
23) 7956 (holotype), from loc. no. Ca1-22.30, early Aptian.

Figures 24-27 **Pseudodictyomitra nuda** (SCHAAF) x200 .... p. 102

24) 8026, from loc. no. Ca1-22.30, early Aptian.
25) 8071, from loc. no. Ca1-22.30, early Aptian.
26) 8213, from loc. no. Ca1-22.30, early Aptian.
27) 9388, from loc. no. Ca1-26.05, early Aptian.

Plate 6

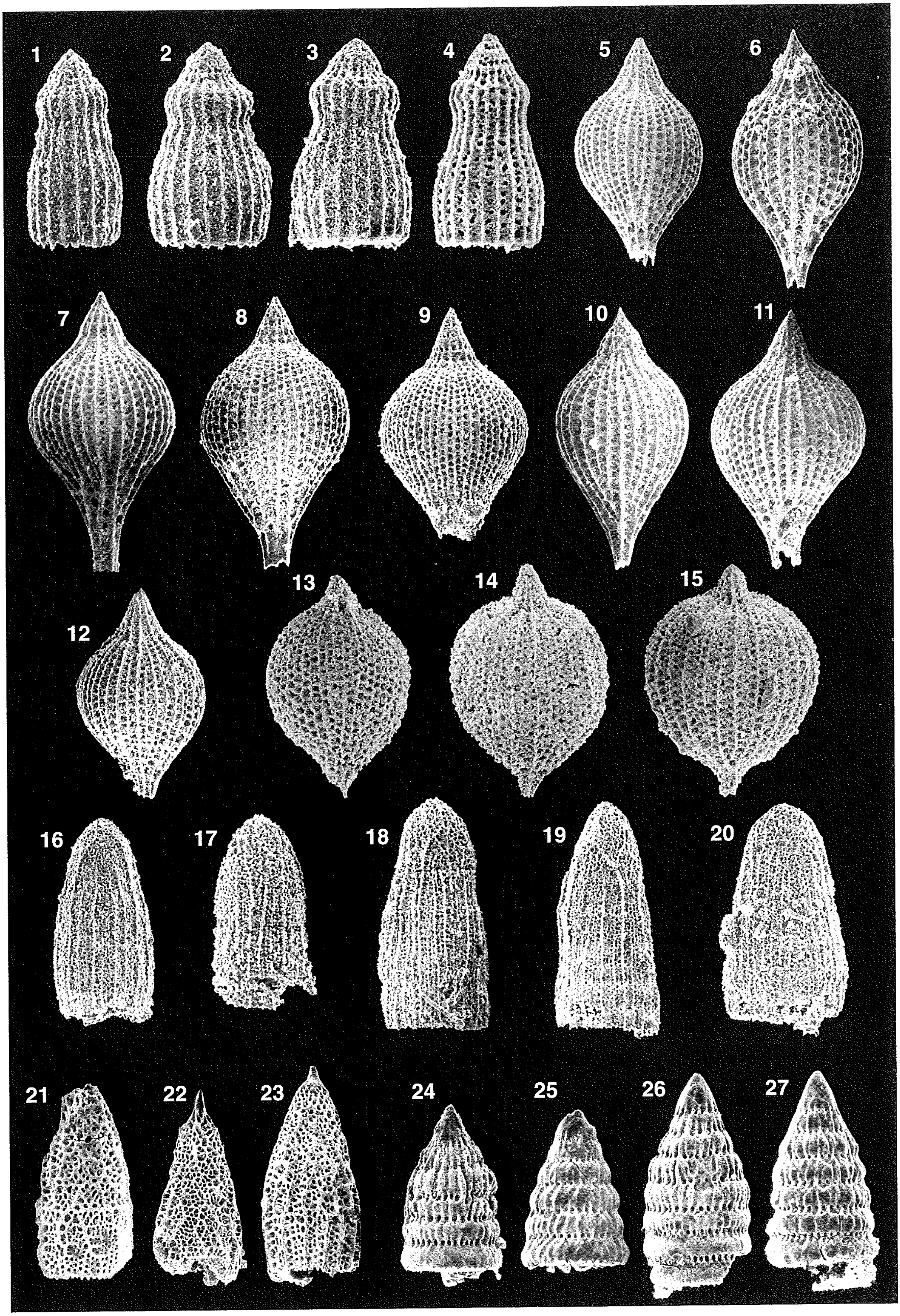

PLATE 7

Figures 1-5 **Pseudodictyomitra carpatica** (LOZYNIAK) x150 .... p. 99

1) 8121, from loc. no. Ca1-22.30, early Aptian.
2) 8341, from loc. no. Ca1-22.30, early Aptian.
3) 8340, from loc. no. Ca1-22.30, early Aptian.
4) 7969, from loc. no. Ca1-22.30, early Aptian.
5) 9308, from loc. no. Ca1-22.30, early Aptian.

Figures 6-17 **Pseudodictyomitra hornatissima** (SQUINABOL) x200 .... p. 101

6) 8276, from loc. no. Ca1-22.30, early Aptian.
7) 10776, from loc. no. Pan-1, late Aptian.
8) 8188, from loc. no. Ca1-22.30, early Aptian.
9) 9335, from loc. no. Ca1-22.30, early Aptian.
10) 9457, from loc. no. Ca1-22.30, early Aptian.
11) 8010, from loc. no. Ca1-22.30, early Aptian.
12) 8023, from loc. no. Ca1-22.30, early Aptian.
13) 8386, from loc. no. Ca1-22.30, early Aptian.
14) 10472, from loc. no. Pan-1, late Aptian.
15 11080, from loc. no. Pan-2, late Aptian.
16) 10462, from loc. no. Pan-1, late Aptian.
17) 10487, from loc. no. Pan-1, late Aptian.

Figures 18-21 **Pseudodictyomitra lodogaensis** PESSAGNO x200 .... p. 103

18) 11097, from loc. no. Pan-2, late Aptian.
19) 11095, from loc. no. Pan-2, late Aptian.
20) 9447, from loc. no. Ca1-26.05, early Aptian.
21) 11057, from loc. no. Pan-2, late Aptian.

Figures 22-28 **Pseudodictyomitra paronai** (ALIEV) x120 .... p. 106

22) 815, from loc. no. Gc-1027.10, middle Albian.
23) 494.1, from loc. no. Ap2 (-7.78), middle Albian.
24) 493, from loc. no. Ap2 (-7.78), middle Albian.
25) 464, from loc. no. Ap2 (-7.78), middle Albian.
26) 465, from loc. no. Ap2 (-7.78), middle Albian.
27) 2667, from loc. no. Bo-685.20, late Albian.
28) 494.2, from loc. no. Ap2 (-7.78), middle Albian.

Figures 29-32 **Pseudodictyomitra pentacolaensis** PESSAGNO x150 .... p. 104

29) 119, from loc. no. Ap2 (-7.78), middle Albian.
30) 4218, from loc. no. Gc-1094.48, late Cenomanian.
31) 3903, from loc. no. Gc-1073.94, middle Cenomanian.
32) 7174, from loc. no. Gb-108.60, late Cenomanian.

Plate 7

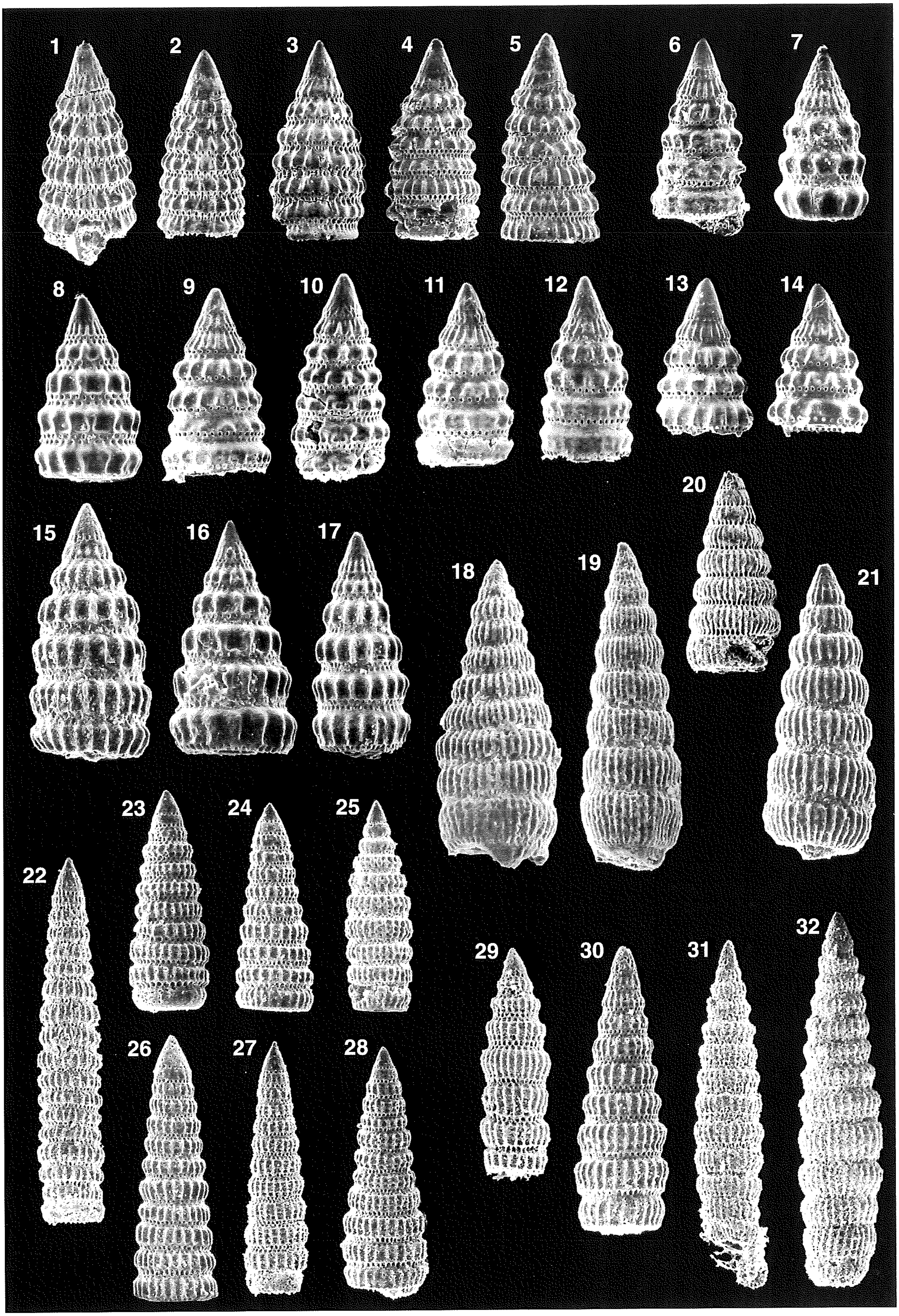
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PLATE 8

Figures 1-4 **Pseudodictyomitra languida** nov. sp x120 .... p. 107

1) 2269, from loc. no. Gc-1035.10, late Albian.
2) 2668 (holotype), from loc. no. Bo-685.20, late Albian.
3) 2669, from loc. no. Bo-685.20, late Albian.
4) 2799, from loc. no. Bo-685.20, late Albian.

Figures 5-8 **Pseudodictyomitra pseudomacrocephala** (SQUINABOL) x120 .... p. 108

5) 3160, from loc. no. Bo-685.20, late Albian.
6) 5048, from loc. no. Gc-1096.50, early Turonian.
7) 3152, from loc. no. Bo-685.20, late Albian.
8) 3380, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 9-11 **Pseudodictyomitra tiara** (HOLMES) x120 .... p. 109

9) 4160, from loc. no. Gc-1094.48, late Cenomanian.
10) 4238, from loc. no. Gc-1094.48, late Cenomanian.
11) 4193, from loc. no. Gc-1094.48, late Cenomanian.

Figures 12-15 **Parvicingula usotanensis** TUMANDA x150 .... p. 113

12) 7959, from loc. no. Ca1-22.30, early Aptian.
13) 8205, from loc. no. Ca1-22.30, early Aptian.
14) 7912, from loc. no. Ca1-22.30, early Aptian.
15) 7973, from loc. no. Ca1-22.30, early Aptian.

Figure 16 **Parvicingula boesii** (PARONA) x150 .... p. 111

16) 8089, from loc. no. Ca1-22.30, early Aptian.

Figures 17-19 **Mirifusus chenodes** (RENZ) x120 .... p. 114

17) R-302, from loc. no. Bo-566.50, early Barremian.
18) R-67, from loc. no. Bo-566.50, early Barremian.
19) R-536, from loc. no. Bo-566.50, early Barremian.

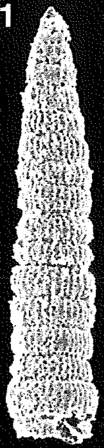
Figures 20-21 **Crolanium bipodium** (PARONA) x150 .... p. 117

20) 9725, from loc. no. Ca1-9.70, late Barremian.
21) 9664, from loc. no. Ca1-9.70, late Barremian.

Figures 22-28 **Crolanium puga** (SCHAAF) x150 .... p. 116

22) 8160, from loc. no. Ca1-22.30, early Aptian.
23) 8272, from loc. no. Ca1-22.30, early Aptian.
24) 8293, from loc. no. Ca1-22.30, early Aptian.
25) 10994, from loc. no. Pan-1, late Aptian.
26) 8025, from loc. no. Ca1-22.30, early Aptian.
27) 9303, from loc. no. Ca1-22.30, early Aptian.
28) 9667, from loc. no. Ca1-9.70, late Barremian.

Plate 8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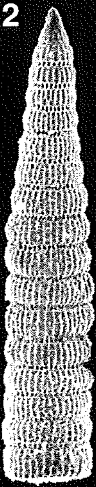
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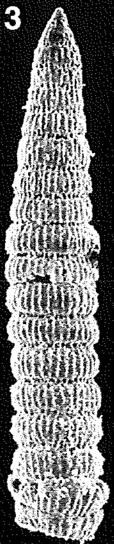
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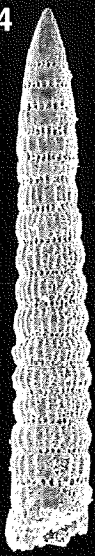
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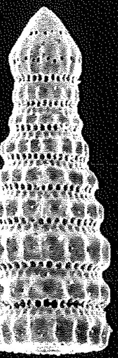
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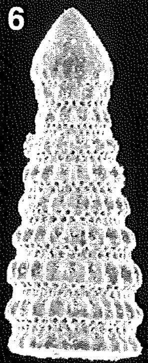
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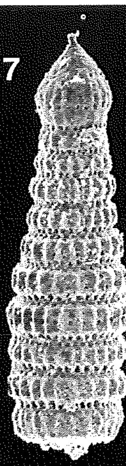
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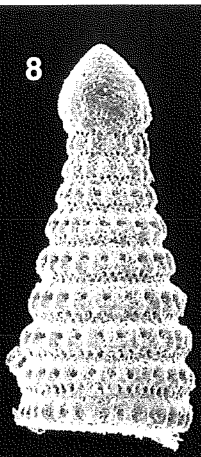
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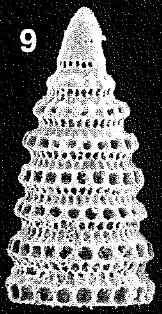
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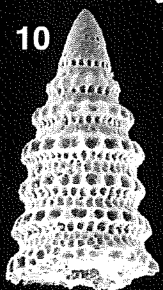
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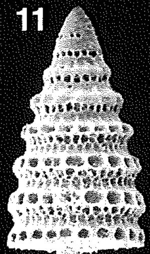
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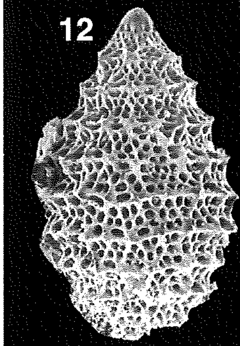
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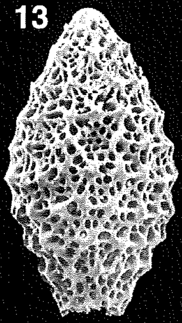
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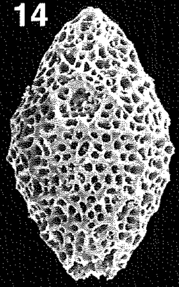
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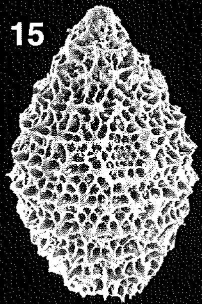
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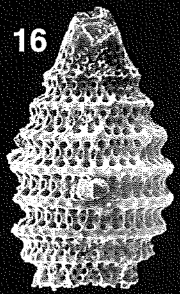
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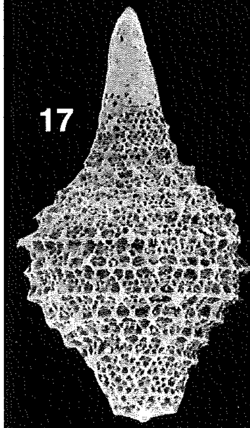
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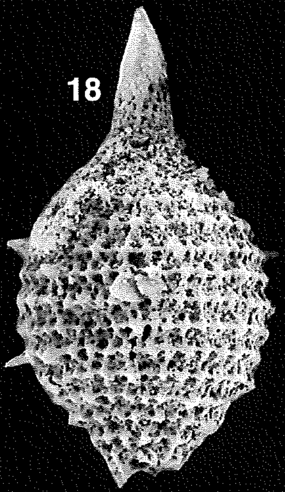
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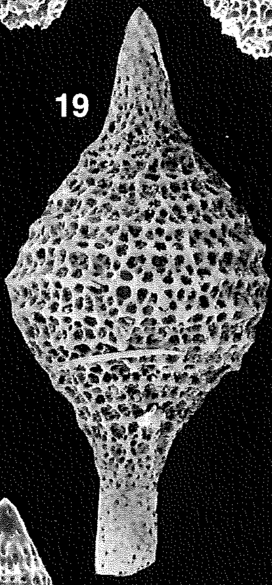
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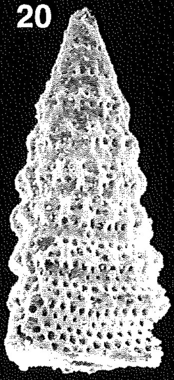
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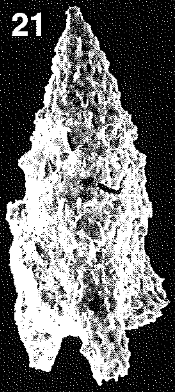
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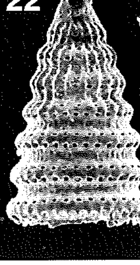
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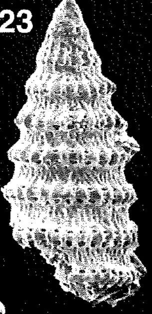
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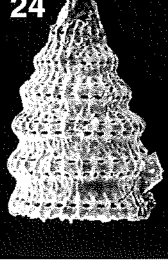
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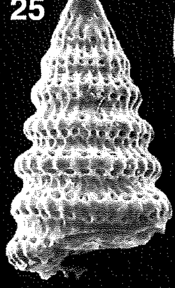
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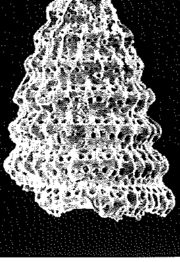
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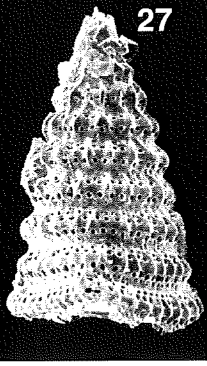
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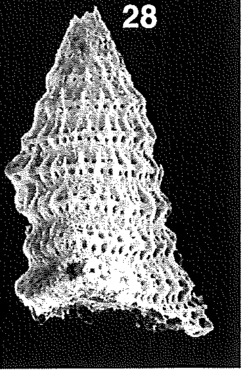
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PLATE 9

Figures 1-6 **Crolanium spineum** (PESSAGNO) x120 .... p. 118

1) 2628, from loc. no. Gc-1035.10, late Albian.
2) 826, from loc. no. Gc-1027.10, middle Albian.
3) 2653, from loc. no. Bo-685.20, late Albian.
4) 1897, from loc. no. Gc-1035.10, late Albian.
5) 803, from loc. no. Gc-1027.10, middle Albian.
6) 1630, from loc. no. Ap2-12, early Cenomanian.

Figures 7-14 **Crolanium cuneatum** (SMIRNOVA & ALIEV) x100 .... p. 119

7) 787, from loc. no. Gc-1027.10, middle Albian.
8) 3362, from loc. no. Gc-1073.94, middle Cenomanian.
9) 3136, from loc. no. Bo-685.20, late Albian.
10) 2627, from loc. no. Bo-685.20, late Albian.
11) 3054, from loc. no. Bo-685.20, late Albian.
12) 3197, from loc. no. Bo-685.20, late Albian.
13) 1894, from loc. no. Gc-1035.10, late Albian.
14) 2788, from loc. no. Bo-685.20, late Albian.

Plate 9

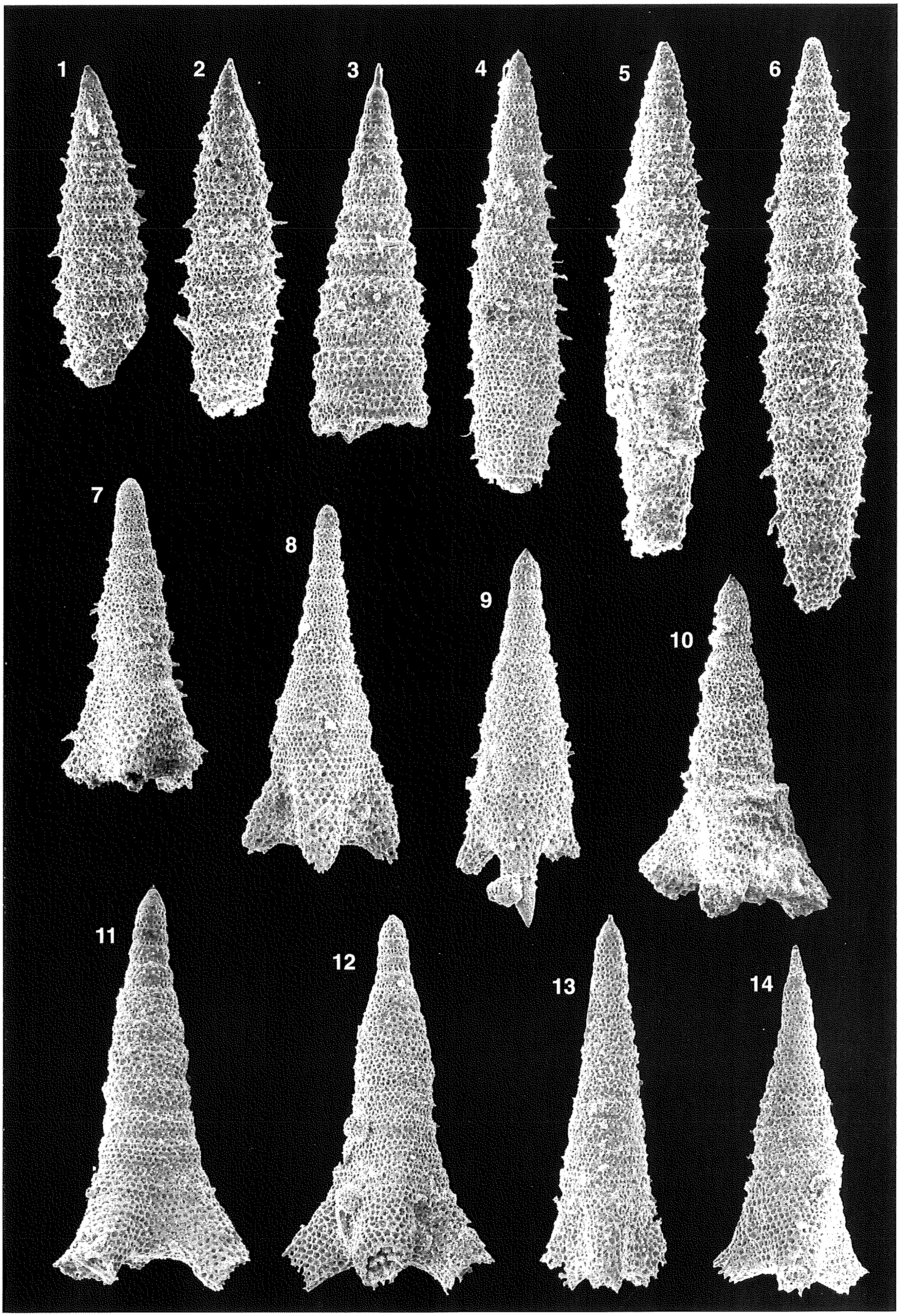

PLATE 10

Figures 1-7 **Crolanium triangulare** (ALIEV) x150 .... p. 120

1) 3394, from loc. no. Gc-1073.94, middle Cenomanian.
2) 1993, from loc. no. Gc-1035.10, late Albian.
3) 3344, from loc. no. Gc-1073.94, middle Cenomanian.
4) 3368, from loc. no. Gc-1073.94, middle Cenomanian.
5) 2651, from loc. no. Bo-685.20, late Albian.
6) 306, from loc. no. Ap2 (-7.78), middle Albian.
7) 2731, from loc. no. Bo-685.20, late Albian.

Figures 8-14 **Crolanium pulchrum** (SQUINABOL) x120 .... p. 120

8) 5308, from loc. no. Gb-84.40, early Cenomanian.
9) 7464, from loc. no. Gb-108.60, late Cenomanian.
10) 3322, from loc. no. Gc-1073.94, middle Cenomanian.
11) 3323, from loc. no. Gc-1073.94, middle Cenomanian.
12) 5336, from loc. no. Gb-84.40, early Cenomanian.
13) 7453, from loc. no. Gb-108.60, late Cenomanian.
14) 3309, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 15-21 **Tugurium pagoda** (SQUINABOL) x130 .... p. 123

15) 2728, from loc. no. Bo-685.20, late Albian.
16) 2867, from loc. no. Bo-685.20, late Albian.
17) 3009, from loc. no. Bo-685.20, late Albian.
18) 2655, from loc. no. Bo-685.20, late Albian.
19) 2898, from loc. no. Bo-685.20, late Albian.
20) 874, from loc. no. Gc-1027.10, middle Albian.
21) 2985, from loc. no. Bo-685.20, late Albian.

Plate 10

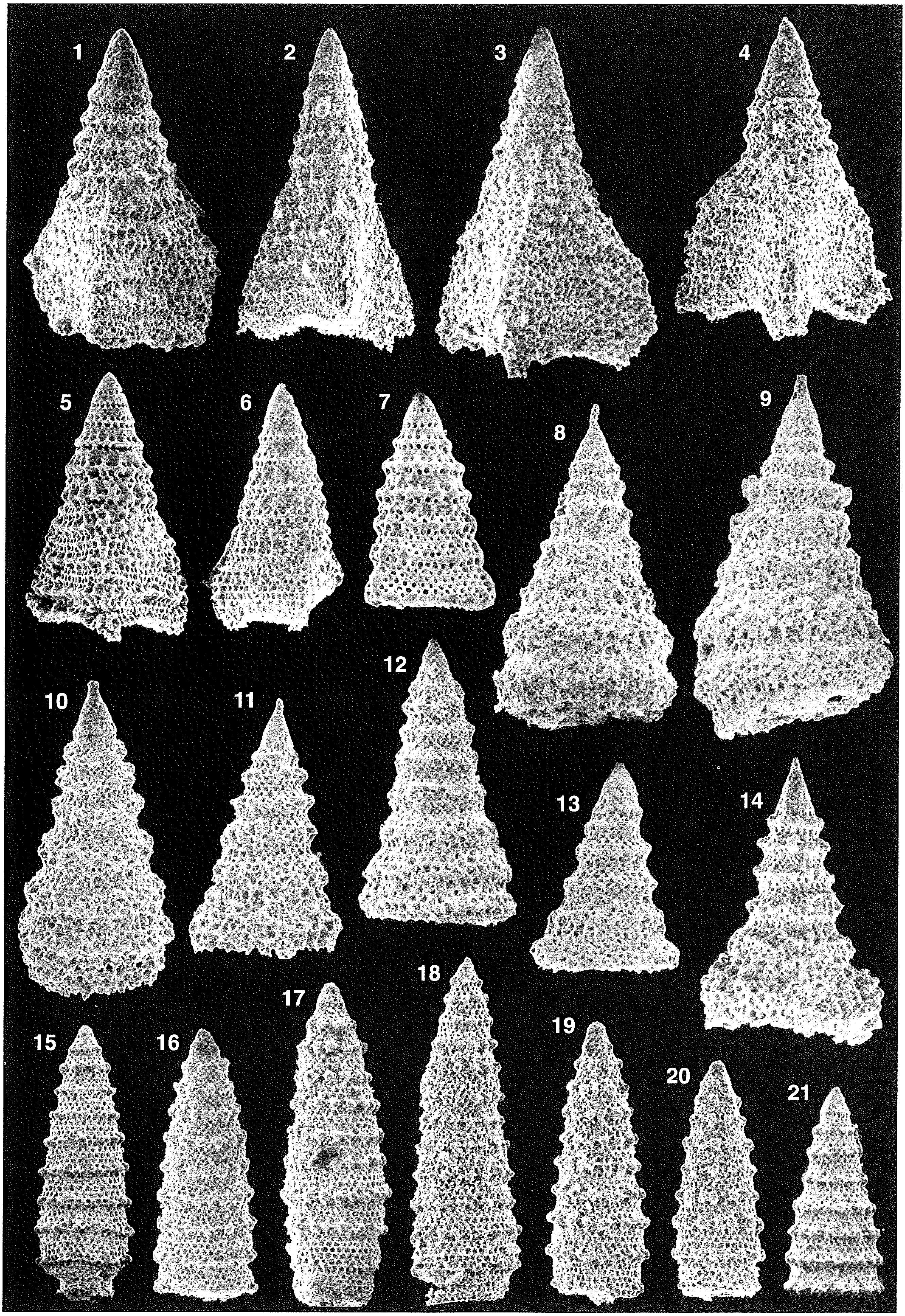

PLATE 11

Figures 1-8 **Xitus clava** (PARONA) x150 .... p. 124

1) 10610, from loc. no. Pan-1, late Aptian.
2) 8042, from loc. no. Ca1-22.30, early Aptian.
3) 9293, from loc. no. Ca1-22.30, early Aptian.
4) 7924, from loc. no. Ca1-22.30, early Aptian.
5) 8078, from loc. no. Ca1-22.30, early Aptian.
6) 8256, from loc. no. Ca1-22.30, early Aptian.
7) 7921, from loc. no. Ca1-22.30, early Aptian.
8) 8167, from loc. no. Ca1-22.30, early Aptian.

Figures 9-14 **Xitus elegans** (SQUINABOL) x200 .... p. 126

9) 8319, from loc. no. Ca1-22.30, early Aptian.
10) 9606, from loc. no. Ca1-26.05, early Aptian.
11) 8285, from loc. no. Ca1-22.30, early Aptian.
12) 9364, from loc. no. Ca1-22.30, early Aptian.
13) 7933, from loc. no. Ca1-22.30, early Aptian.
14) 9485, from loc. no. Ca1-26.05, early Aptian.

Figures 15-16 **Xitus alievi** (FOREMAN) x150 .... p. 126

15) R-22, from loc. no. Bo-569.60, early Barremian.
16) 9674, from loc. no. Ca1-9.70, late Barremian.

Figures 17-31 **Xitus spicularius** (ALIEV) x120 .... p. 127

17) 1948, from loc. no. Gc-1035.10, late Albian.
18) 218, from loc. no. Ap2 (-7.78), middle Albian.
19) 321, from loc. no. Ap2 (-7.78), middle Albian.
20) 315, from loc. no. Ap2 (-7.78), middle Albian.
21) 307, from loc. no. Ap2 (-7.78), middle Albian.
22) 310, from loc. no. Ap2 (-7.78), middle Albian.
23) 316, from loc. no. Ap2 (-7.78), middle Albian.
24) 314, from loc. no. Ap2 (-7.78), middle Albian.
25) 310.2, from loc. no. Ap2 (-7.78), middle Albian.
26) 313, from loc. no. Ap2 (-7.78), middle Albian.
27) 121, from loc. no. Ap2 (-7.78), middle Albian.
28) 2411, from loc. no. Gc-1035.10, late Albian.
29) 312, from loc. no. Ap2 (-7.78), middle Albian.
30) 307, from loc. no. Ap2 (-7.78), middle Albian.
31) 317, from loc. no. Ap2 (-7.78), middle Albian.

Plate 11

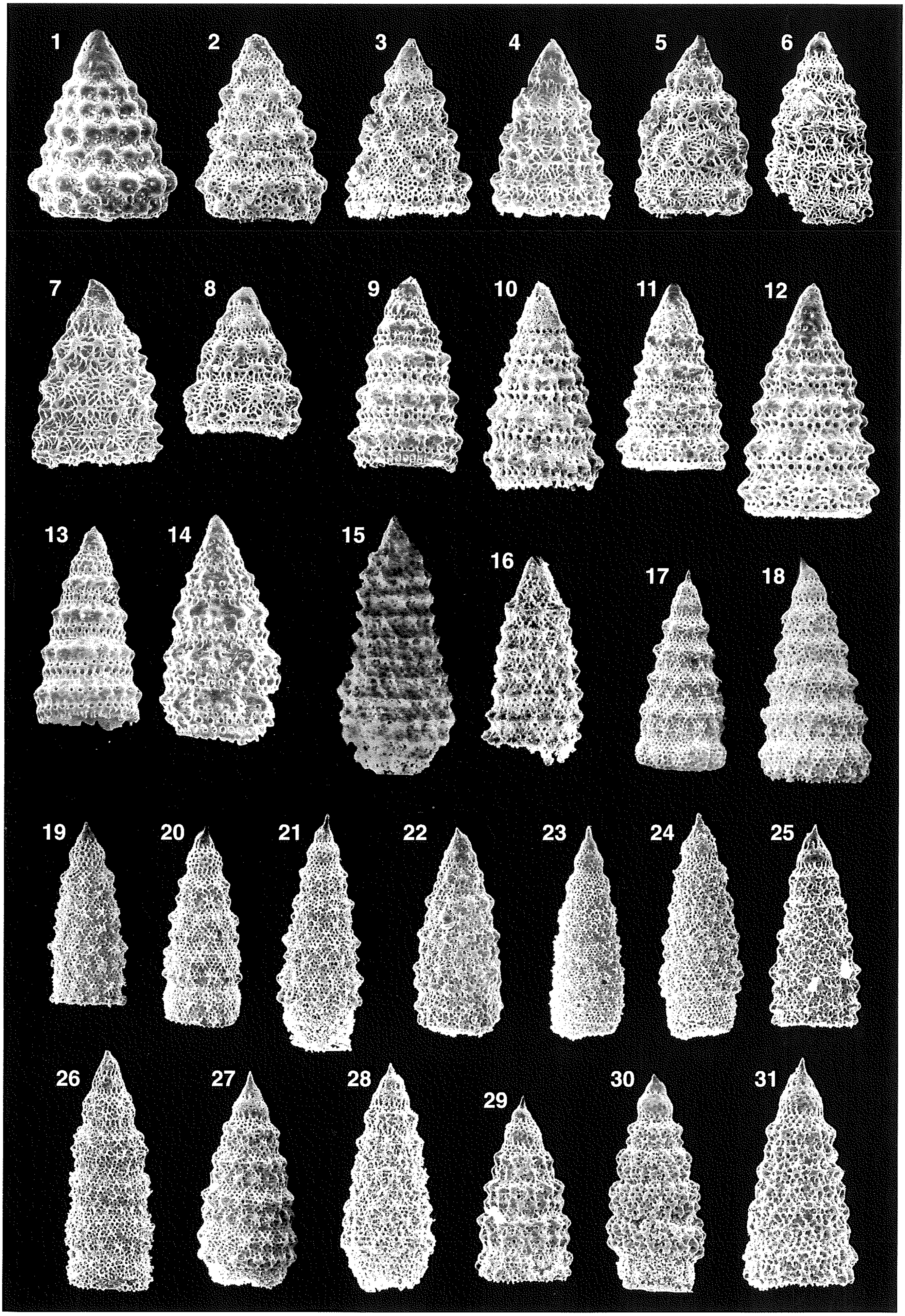
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PLATE 12

Figures 1-13 **Xitus spinosus** (SQUINABOL) x150 .... p. 129

1) 294, from loc. no. Ap2 (-7.78), middle Albian.
2) 295, from loc. no. Ap2 (-7.78), middle Albian.
3) 299, from loc. no. Ap2 (-7.78), middle Albian.
4) 297, from loc. no. Ap2 (-7.78), middle Albian.
5) 298, from loc. no. Ap2 (-7.78), middle Albian.
6) 305, from loc. no. Ap2 (-7.78), middle Albian.
7) 300, from loc. no. Ap2 (-7.78), middle Albian.
8) 193, from loc. no. Ap2 (-7.78), middle Albian.
9) 285, from loc. no. Ap2 (-7.78), middle Albian.
10) 172, from loc. no. Ap2 (-7.78), middle Albian.
11) 296, from loc. no. Ap2 (-7.78), middle Albian.
12) 1629, from loc. no. Ap2-12, early Cenomanian.
13) 170, from loc. no. Ap2 (-7.78), middle Albian.

Figures 14-21 **Xitus mclaughlini** PESSAGNO x120 .... p. 130

14) 3354, from loc. no. Gc-1073.94, middle Cenomanian.
15) 2875, from loc. no. Bo-685.20, late Albian.
16) 4237, from loc. no. Gc-1094.48, late Cenomanian.
17) 2877, from loc. no. Bo-685.20, late Albian.
18) 1617, from loc. no. Ap2-12, early Cenomanian.
19) 2381, from loc. no. Gc-1035.10, late Albian.
20) 7728, from loc. no. Gb-108.60, late Cenomanian.
21) 3312, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 22-26 **Torculum bastetani** nov. sp. x150 .... p. 133

22) 10572, from loc. no. Pan-1, late Aptian.
23) 10567, from loc. no. Pan-1, late Aptian.
24) 10613, from loc. no. Pan-1, late Aptian.
25) 10606 (holotype), from loc. no. Pan-1, late Aptian.
26) 10609, from loc. no. Pan-1, late Aptian.

Figures 27-28 **Torculum coronatum** (SQUINABOL) x100 .... p. 133

27) 277, from loc. no. Ap2 (-7.78), middle Albian.
28) 1674, from loc. no. Ap2-12, early Cenomanian.

Plate 12

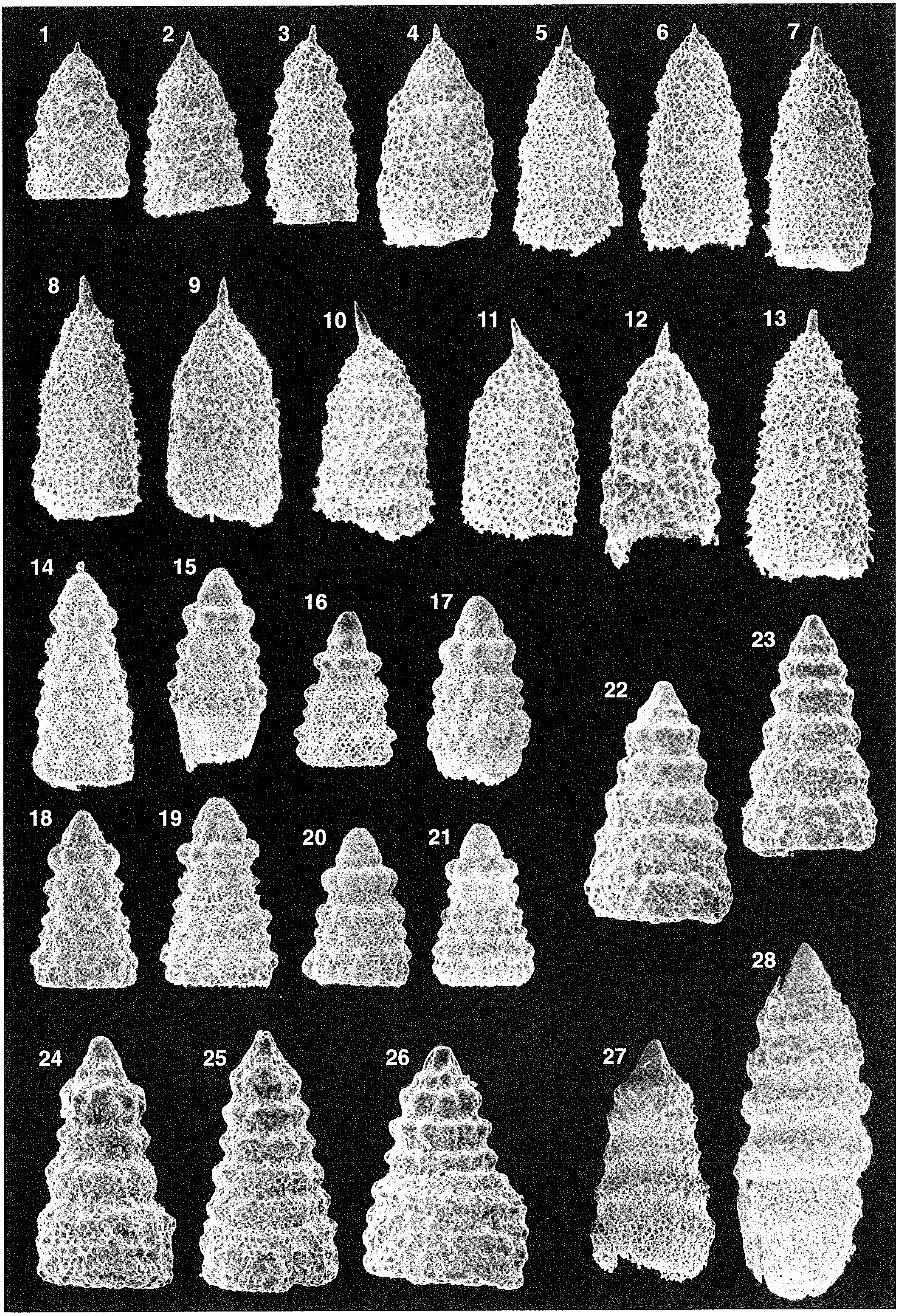


PLATE 14

Figures 1-29 **Torculum coronatum** (SQUINABOL) x100 .... p. 133

1) 2683, from loc. no. Bo-685.20, late Albian.
2) 254, from loc. no. Ap2 (-7.78), middle Albian.
3) 243, from loc. no. Ap2 (-7.78), middle Albian.
4) 143, from loc. no. Ap2 (-7.78), middle Albian.
5) 140, from loc. no. Ap2 (-7.78), middle Albian.
6) 234, from loc. no. Ap2 (-7.78), middle Albian.
7) 272, from loc. no. Ap2 (-7.78), middle Albian.
8) 256, from loc. no. Ap2 (-7.78), middle Albian.
9) 245, from loc. no. Ap2 (-7.78), middle Albian.
10) 252, from loc. no. Ap2 (-7.78), middle Albian.
11) 271, from loc. no. Ap2 (-7.78), middle Albian.
12) 251, from loc. no. Ap2 (-7.78), middle Albian.
13) 248, from loc. no. Ap2 (-7.78), middle Albian.
14) 235, from loc. no. Ap2 (-7.78), middle Albian.
15) 236, from loc. no. Ap2 (-7.78), middle Albian.
16) 2903, from loc. no. Bo-685.20, late Albian.
17) 250, from loc. no. Ap2 (-7.78), middle Albian.
18) 2921, from loc. no. Bo-685.20, late Albian.
19) 2893, from loc. no. Bo-685.20, late Albian.
20) 2894, from loc. no. Bo-685.20, late Albian.
21) 2929, from loc. no. Bo-685.20, late Albian.
22) 2890, from loc. no. Bo-685.20, late Albian.
23) 263, from loc. no. Ap2 (-7.78), middle Albian.
24) 3327, from loc. no. Gc-1073.94, middle Cenomanian.
25) 3358, from loc. no. Gc-1073.94, middle Cenomanian.
26) 7487, from loc. no. Gb-108.60, late Cenomanian.
27) 7562, from loc. no. Gb-108.60, late Cenomanian.
28) 2265, from loc. no. Gc-1035.10, late Albian.
29) 261, from loc. no. Ap2 (-7.78), middle Albian.

Plate 14

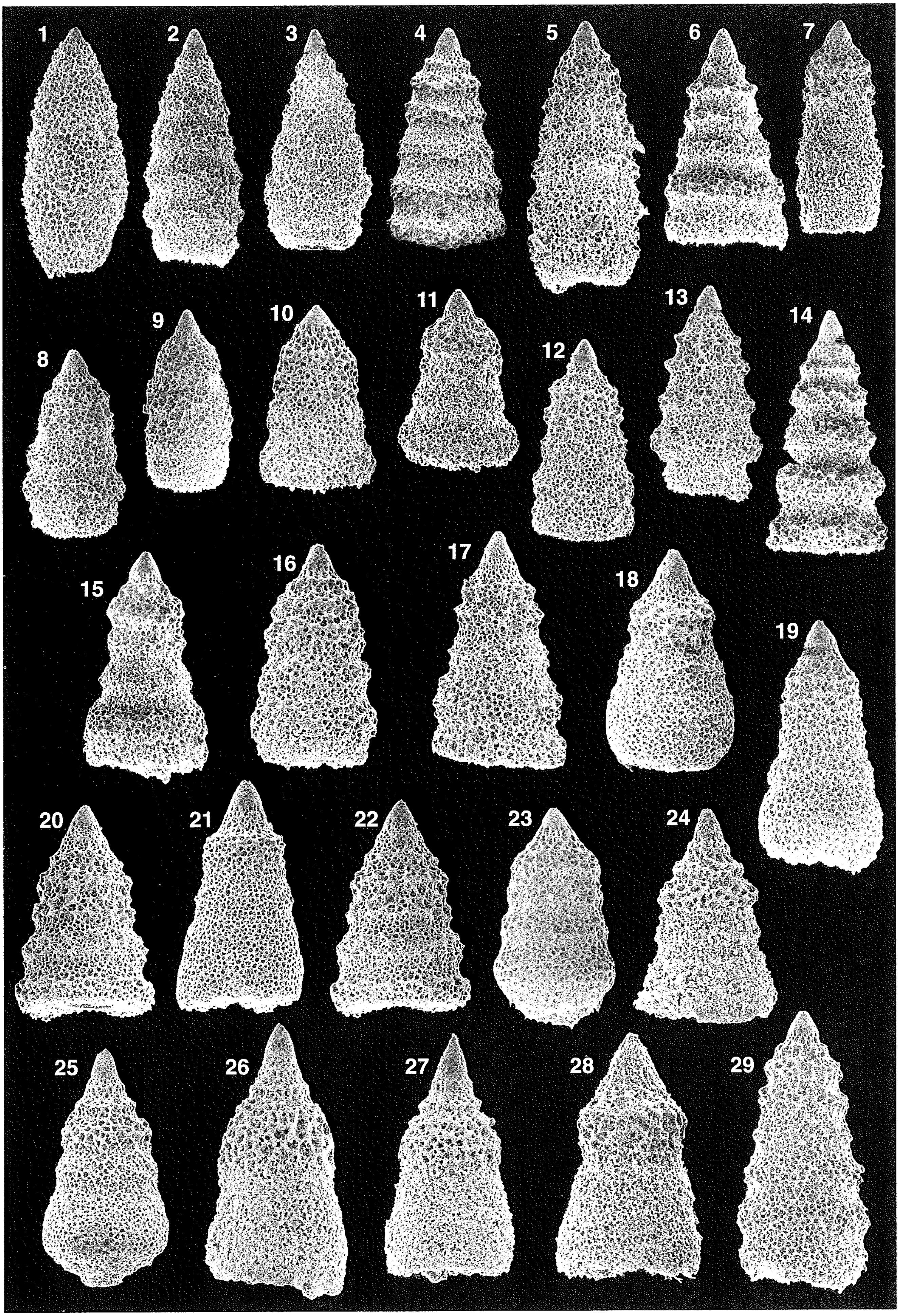


PLATE 15

Figures 1-4 **Torculum dengoi** (SCHMIDT-EFFING) x120 .... p. 135

1) 5316, from loc. no. Gb-84.40, early Cenomanian.
2) 5706, from loc. no. Gb-84.40, early Cenomanian.
3) 1959, from loc. no. Gc-1035.10, late Albian.
4) 5385, from loc. no. Gb-84.40, early Cenomanian.

Figures 5-8 **Tubilustrium iracundum** nov. sp. x150 .... p. 136

5) 304, from loc. no. Ap2 (-7.78), middle Albian.
6) 283 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
7) 901, from loc. no. Gc-1027.10, middle Albian.
8) 284, from loc. no. Ap2 (-7.78), middle Albian.

Figures 9-19 **Tubilustrium transmontanum** nov. sp. x120 .... p. 137

9) 2981, from loc. no. Bo-685.20, late Albian.
10) 2821, from loc. no. Bo-685.20, late Albian.
11) 162, from loc. no. Ap2 (-7.78), middle Albian.
12) 3119, from loc. no. Bo-685.20, late Albian.
13) 2838, from loc. no. Bo-685.20, late Albian.
14) 2883, from loc. no. Bo-685.20, late Albian.
15) 3391, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3280 (holotype), from loc. no. Bo-685.20, late Albian.
17) 2761, from loc. no. Bo-685.20, late Albian.
18) 927, from loc. no. Gc-1027.10, middle Albian.
19) 2703, from loc. no. Bo-685.20, late Albian.

Figures 20-26 **Anachoreta sagitta** nov. sp. x100 .... p. 138

20) 5279, from loc. no. Gb-84.40, early Cenomanian.
21) 7534, from loc. no. Gb-108.60, late Cenomanian.
22) 12181, from loc. no. Gc-1035.10, late Albian.
23) 5324, from loc. no. Gb-84.40, early Cenomanian.
24) 5295, from loc. no. Gb-84.40, early Cenomanian.
25) 5319, from loc. no. Gb-84.40, early Cenomanian.
26) 5284 (holotype), from loc. no. Gb-84.40, early Cenomanian.

Plate 15

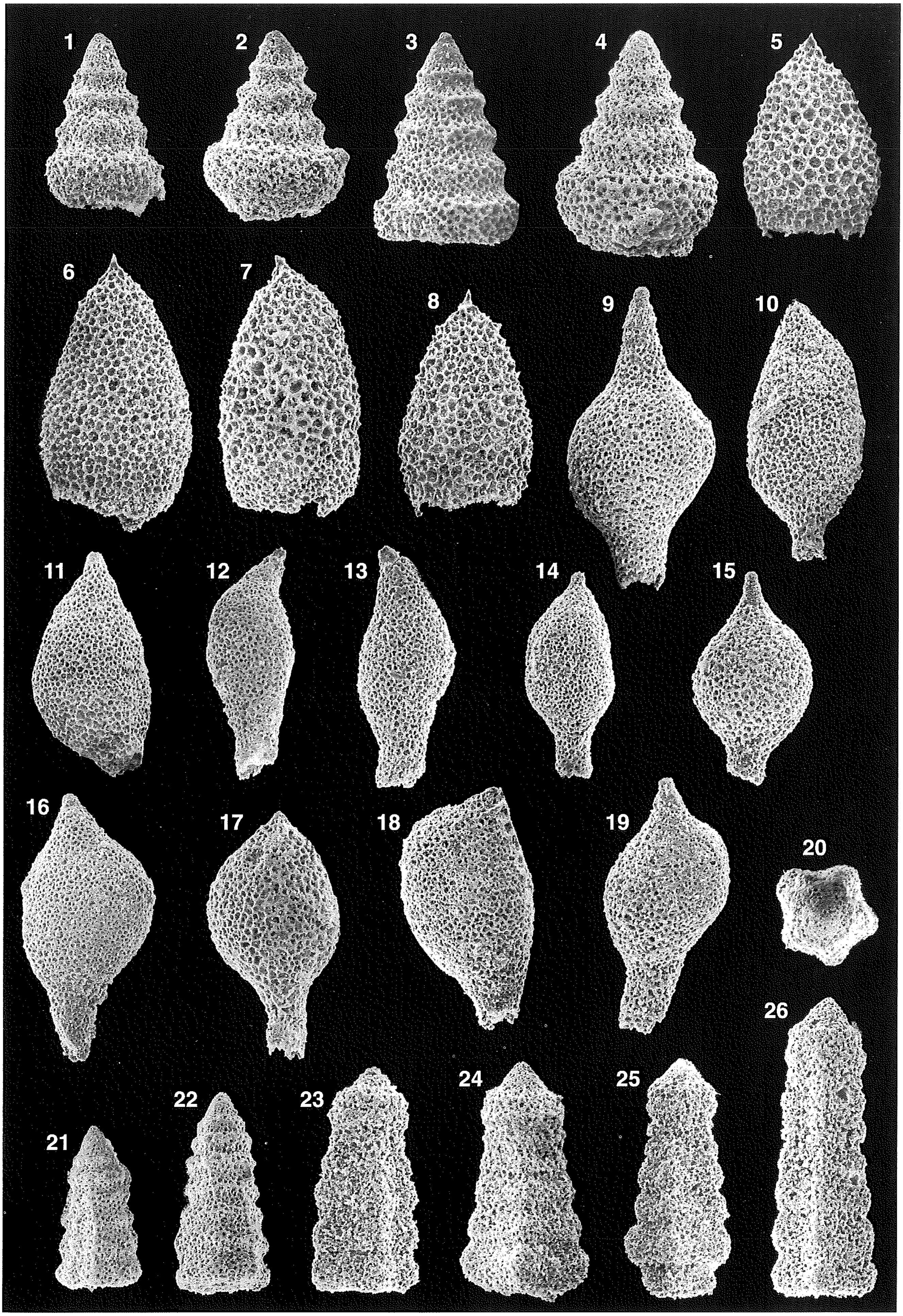


PLATE 16

Figures 1-6 **Stichomitra japonica** (NAKASEKO & NISHIMURA) x200 .... p. 139

1) 8890, from loc. no. Cal-22.30, early Aptian.
2) 8560, from loc. no. Cal-22.30, early Aptian.
3) 8448, from loc. no. Cal-22.30, early Aptian.
4) 8029, from loc. no. Cal-22.30, early Aptian.
5) 8520, from loc. no. Cal-22.30, early Aptian.
6) 8176, from loc. no. Cal-22.30, early Aptian.

Figures 7-12 **Stichomitra simplex** (SMIRNOVA & ALIEV) x200 .... p. 141

7) 8112, from loc. no. Cal-22.30, early Aptian.
8) 8035, from loc. no. Cal-22.30, early Aptian.
9) 9552, from loc. no. Cal-26.05, early Aptian.
10) 11194, from loc. no. Pan-2, late Aptian.
11) 10866, from loc. no. Pan-1, late Aptian.
12) 10826, from loc. no. Pan-1, late Aptian.

Figures 13-17 **Stichomitra navalis** nov. sp. x150 .... p. 141

13) 105, from loc. no. Ap2 (-7.78), middle Albian.
14) 3187, from loc. no. Bo-685.20, late Albian.
15) 132 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
16) 2694, from loc. no. Bo-685.20, late Albian.
17) 3137, from loc. no. Bo-685.20, late Albian.

Figures 18-24 **Stichomitra mediocris** (TAN) x200 .... p. 142

18) 11071, from loc. no. Pan-2, late Aptian.
19) 186, from loc. no. Ap2 (-7.78), middle Albian.
20) 475.1, from loc. no. Ap2 (-7.78), middle Albian.
21) 10775, from loc. no. Pan-1, late Aptian.
22) 475.2, from loc. no. Ap2 (-7.78), middle Albian.
23) 479, from loc. no. Ap2 (-7.78), middle Albian.
24) 11082, from loc. no. Pan-2, late Aptian.

Plate 16

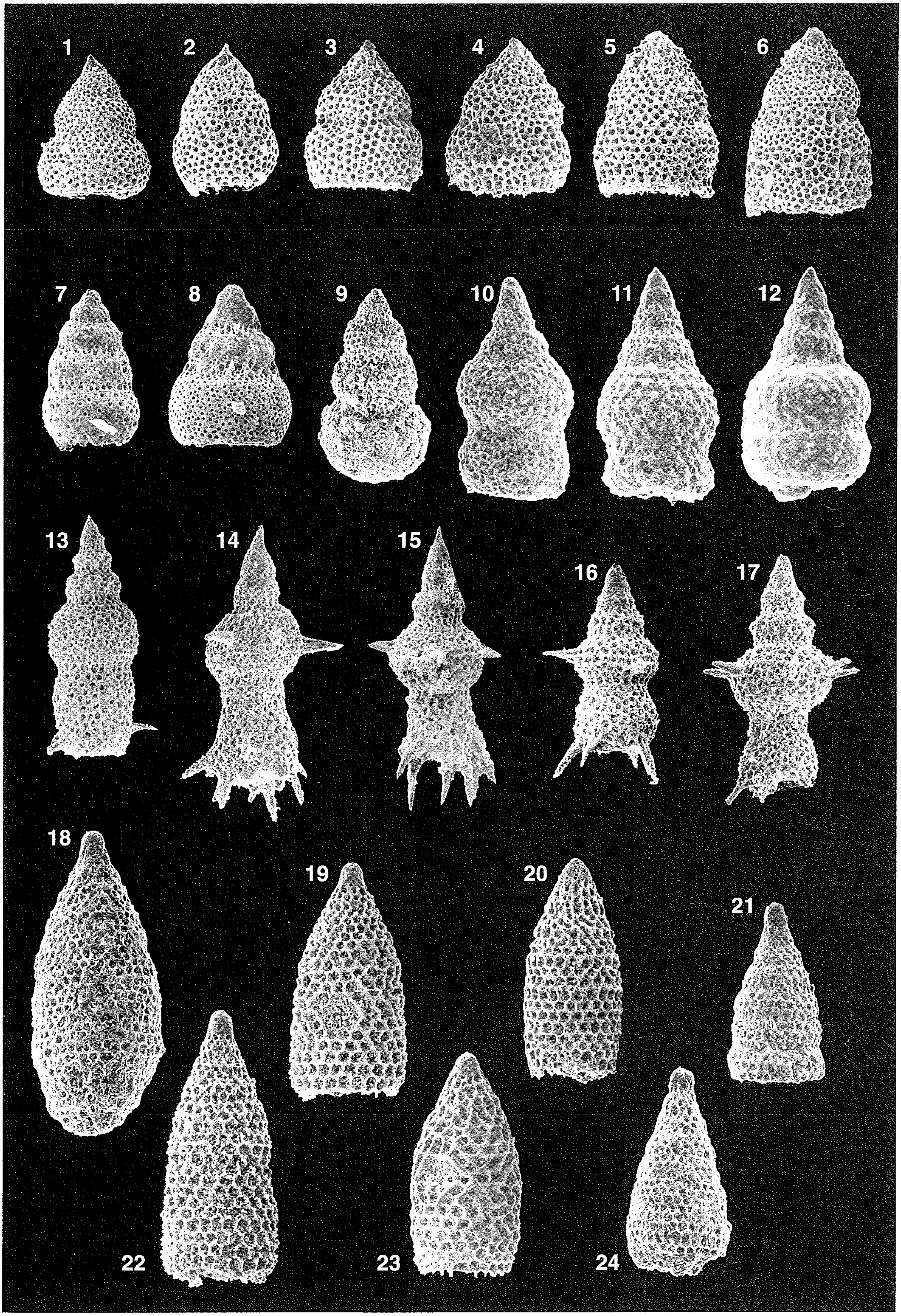


PLATE 17

Figures 1-5 **Stichomitra mediocris** (TAN) x200 .... p. 142

1) 478, from loc. no. Ap2 (-7.78), middle Albian.
2) 7916, from loc. no. Ca1-22.30, early Aptian.
3) 8311, from loc. no. Ca1-22.30, early Aptian.
4) 8392, from loc. no. Ca1-22.30, early Aptian.
5) 8327, from loc. no. Ca1-22.30, early Aptian.

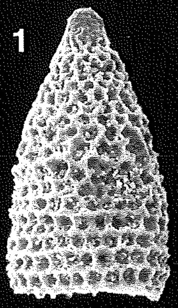
Figures 6-16 **Stichomitra communis** SQUINABOL x120 .... p. 144

6) 267, from loc. no. Ap2 (-7.78), middle Albian.
7) 846, from loc. no. Gc-1027.10, middle Albian.
8) 269, from loc. no. Ap2 (-7.78), middle Albian.
9) 268, from loc. no. Ap2 (-7.78), middle Albian.
10) 3916, from loc. no. Gc-1073.94, middle Cenomanian.
11) 2028, from loc. no. Gc-1035.10, late Albian.
12) 850, from loc. no. Gc-1027.10, middle Albian.
13) 851, from loc. no. Gc-1027.10, middle Albian.
14) 1640, from loc. no. Ap2-12, early Cenomanian.
15) 265, from loc. no. Ap2 (-7.78), middle Albian.
16) 849, from loc. no. Gc-1027.10, middle Albian.

Figures 17-21 **Stichomitra magna** SQUINABOL x100 .... p. 146

17) 3950, from loc. no. Gc-1073.94, middle Cenomanian.
18) 3332, from loc. no. Gc-1073.94, middle Cenomanian.
19) 3915, from loc. no. Gc-1073.94, middle Cenomanian.
20) 4076, from loc. no. Gc-1073.94, middle Cenomanian.
21) 3389, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 17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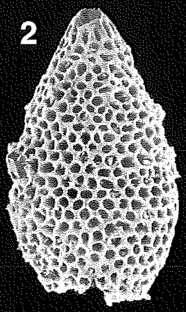
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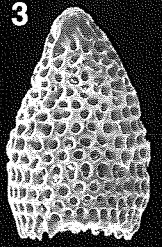
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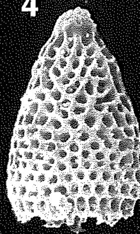
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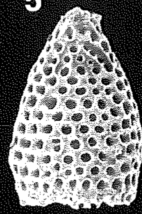
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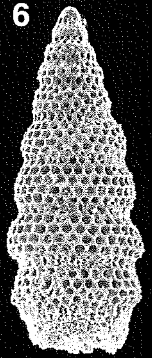
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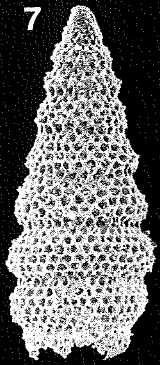
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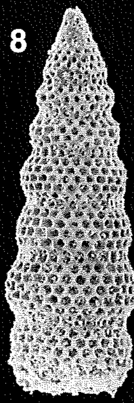
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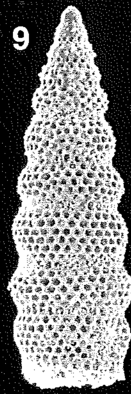
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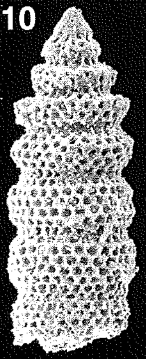
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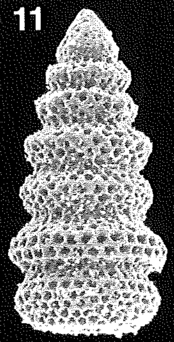
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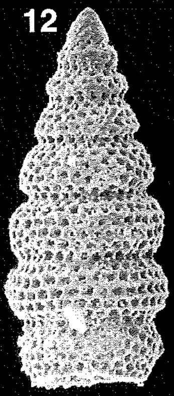
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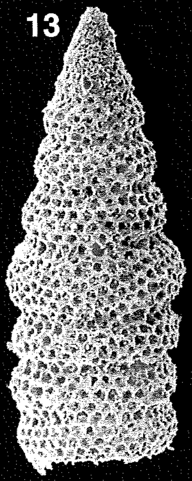
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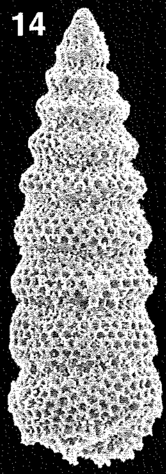
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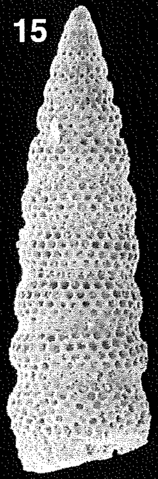
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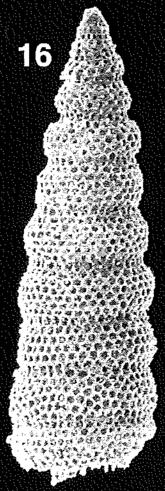
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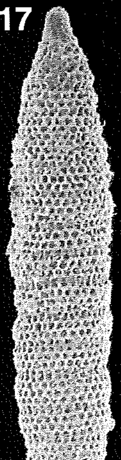
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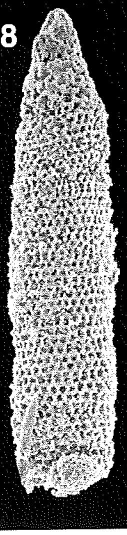
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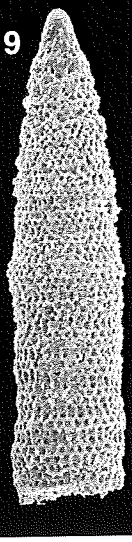
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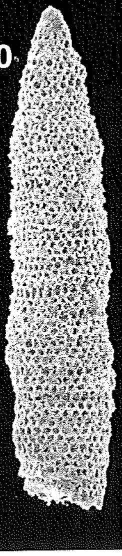
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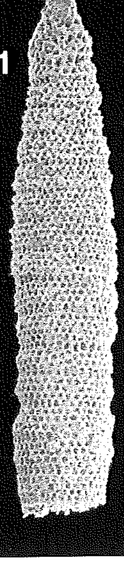
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PLATE 18

Figures 1-8 **Stichomitra tosaensis** NAKASEKO & NISHIMURA x130 .... p. 146

1) 1189, from loc. no. Gc-1027.10, middle Albian.
2) 935, from loc. no. Gc-1027.10, middle Albian.
3) 1652, from loc. no. Ap2-12, early Cenomanian.
4) 1654, from loc. no. Ap2-12, early Cenomanian.
5) 2383, from loc. no. Gc-1035.10, late Albian.
6) 1679, from loc. no. Ap2-12, early Cenomanian.
7) 288, from loc. no. Ap2 (-7.78), middle Albian.
8) 115, from loc. no. Ap2 (-7.78), middle Albian.

Figures 9-15 **Stichomitra stocki** (CAMPBELL & CLARK) x200 .... p. 147

9) 6608, from loc. no. Asv-5-43, early Turonian.
10) 5748, from loc. no. Asv-5-43, early Turonian.
11) 6905, from loc. no. Asv-5-43, early Turonian.
12) 5018, from loc. no. Gc-1096.50, early Turonian.
13) 4296, from loc. no. Gc-1094.48, late Cenomanian.
14) 6899, from loc. no. Asv-5-43, early Turonian.
15) 5910, from loc. no. Asv-5-43, early Turonian.

Figures 16-24 **Eostichomitra bonum** (KOZLOVA) x150 .... p. 151

16) 6941, from loc. no. Asv-5-43, early Turonian.
17) 6384, from loc. no. Asv-5-43, early Turonian.
18) 5003, from loc. no. Gc-1096.50, early Turonian.
19) 5755, from loc. no. Asv-5-43, early Turonian.
20) 6564, from loc. no. Asv-5-43, early Turonian.
21) 6548, from loc. no. Asv-5-43, early Turonian.
22) 6631, from loc. no. Asv-5-43, early Turonian.
23) 5082, from loc. no. Gc-1096.50, early Turonian.
24) 6880, from loc. no. Asv-5-43, early Turonian.

Figures 25-28 **Spongostichomitra elatica** (ALIEV) x100 .... p. 152
except figs. 25-26 x50

25) 12183, from loc. no. Gc-947.50, early Albian.
26) 12182, from loc. no. Gc-947.50, early Albian.
27) 3345, from loc. no. Gc-1073.94, middle Cenomanian.
28) 2689, from loc. no. Bo-685.20, late Albian.

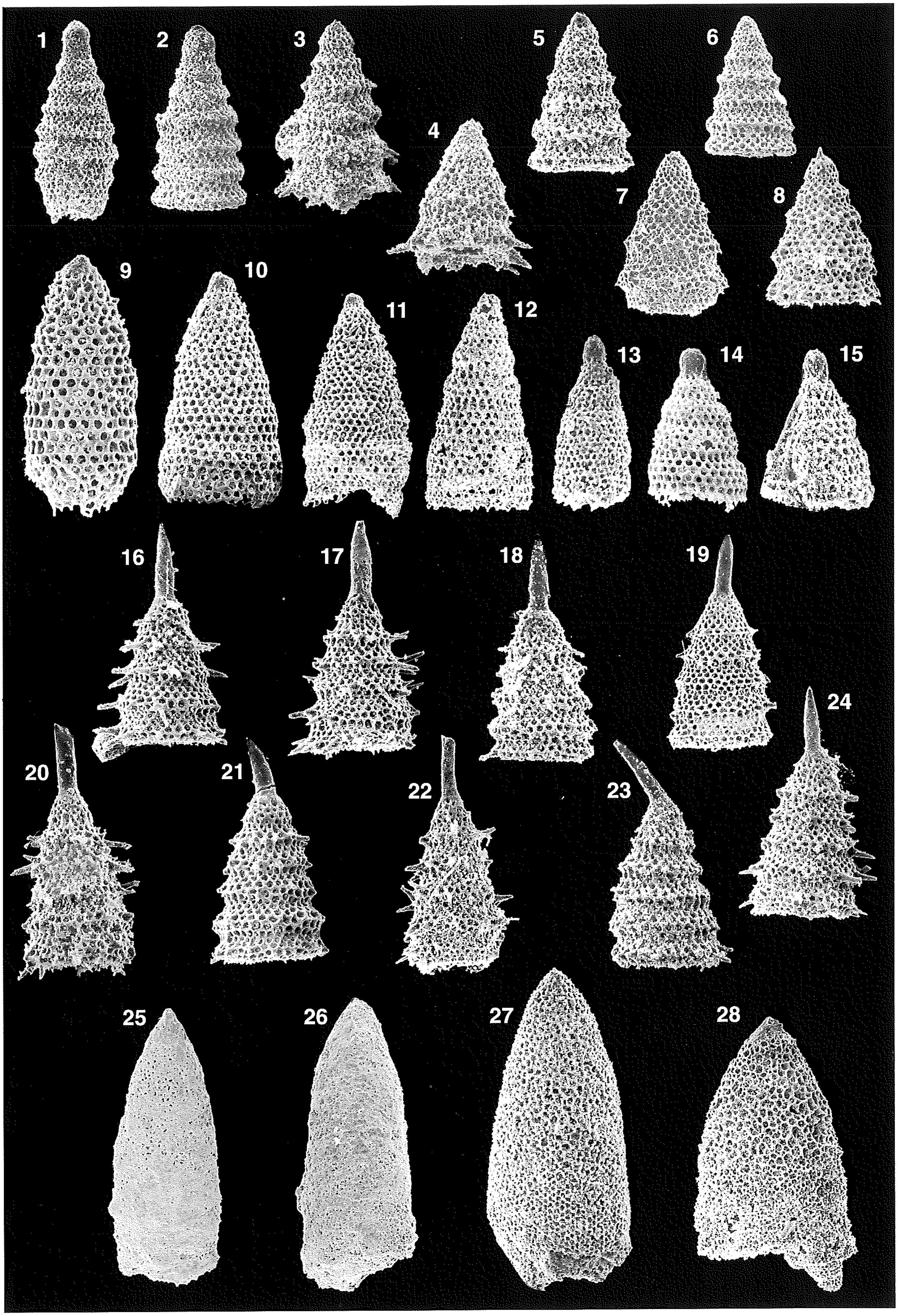
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PLATE 19

Figures 1-11 **Spongostichomitra phalanga** nov. sp. x 75 .... p. 153
except figs. 1, 2, 3, 5, 6, 11 x50

1) 5213 (holotype), from loc. no. Gb-84.40, early Cenomanian.
2) 3021, from loc. no. Bo-685.20, late Albian.
3) 1903, from loc. no. Gc-1035.10, late Albian.
4) 1901, from loc. no. Gc-1035.10, late Albian.
5) 813, from loc. no. Gc-1027.10, middle Albian.
6) 3026, from loc. no. Bo-685.20, late Albian.
7) 5422, from loc. no. Gb-84.40, early Cenomanian.
8) 2662, from loc. no. Bo-685.20, late Albian.
9) 3023, from loc. no. Bo-685.20, late Albian.
10) 811, from loc. no. Gc-1027.10, middle Albian.
11) 832, from loc. no. Gc-1027.10, middle Albian.

Figures 12-21 **Spongostichomitra indomita** nov. sp. x75 .... p. 154

12) 2061 (holotype), from loc. no. Gc-1035.10, late Albian.
13) 3057, from loc. no. Bo-685.20, late Albian.
14) 1898, from loc. no. Gc-1035.10, late Albian.
15) 1939, from loc. no. Gc-1035.10, late Albian.
16) 3215, from loc. no. Bo-685.20, late Albian.
17) 1987, from loc. no. Gc-1035.10, late Albian.
18) 1672, from loc. no. Ap2-12, early Cenomanian.
19) 1931, from loc. no. Gc-1035.10, late Albian.
20) 1932, from loc. no. Gc-1035.10, late Albian.
21) 1942, from loc. no. Gc-1035.10, late Albian.

Plate 19

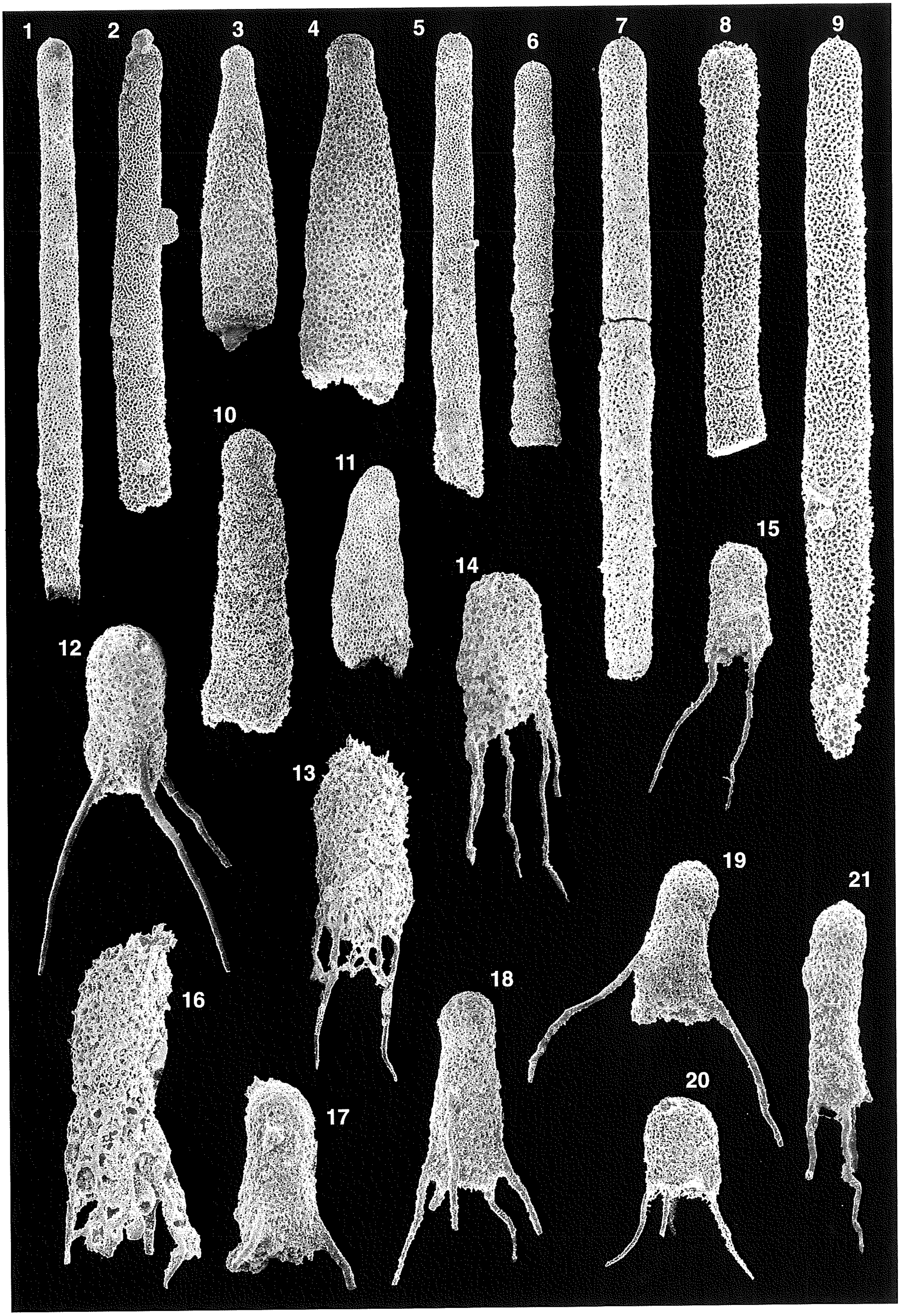

PLATE 20

Figures 1-6 **Phalangites perspicuus** (SQUINABOL) x200 .... p. 155

1) 2674, from loc. no. Gc-1035.10, late Albian.
2) 1165, from loc. no. Gc-1027.10, middle Albian.
3) 1227, from loc. no. Gc-1027.10, middle Albian.
4) 926, from loc. no. Gc-1027.10, middle Albian.
5) 472, from loc. no. Ap2 (-7.78), middle Albian.
6) 471, from loc. no. Ap2 (-7.78), middle Albian.

Figures 7-15 **Phalangites calamus** nov. sp. x150 .... p. 156

7) 2370 (holotype), from loc. no. Ap2-12, early Cenomanian.
8) 3275, from loc. no. Bo-685.20, late Albian.
9) 943, from loc. no. Gc-1027.10, middle Albian.
10) 1670, from loc. no. Ap2-12, early Cenomanian.
11) 2675), from loc. no. Bo-685.20, late Albian.
12) 2437, from loc. no. Gc-1035.10, late Albian.
13) 2823, from loc. no. Bo-685.20, late Albian.
14) 2686, from loc. no. Bo-685.20, late Albian.
15) 2684, from loc. no. Bo-685.20, late Albian.

Figures 16-23 **Phalangites telum** nov. sp. x130 .... p. 157

16) 3258, from loc. no. Bo-685.20, late Albian.
17) 2934, from loc. no. Bo-685.20, late Albian.
18) 3395, from loc. no. Gc-1073.94, middle Cenomanian.
19) 2057 (holotype), from loc. no. Gc-1035.10, late Albian.
20) 6853, from loc. no. Asv-5-43, early Turonian.
21) 2941, from loc. no. Bo-685.20, late Albian.
22) 2984, from loc. no. Bo-685.20, late Albian.
23) 5887, from loc. no. Asv-5-43, early Turonian.

Plate 20

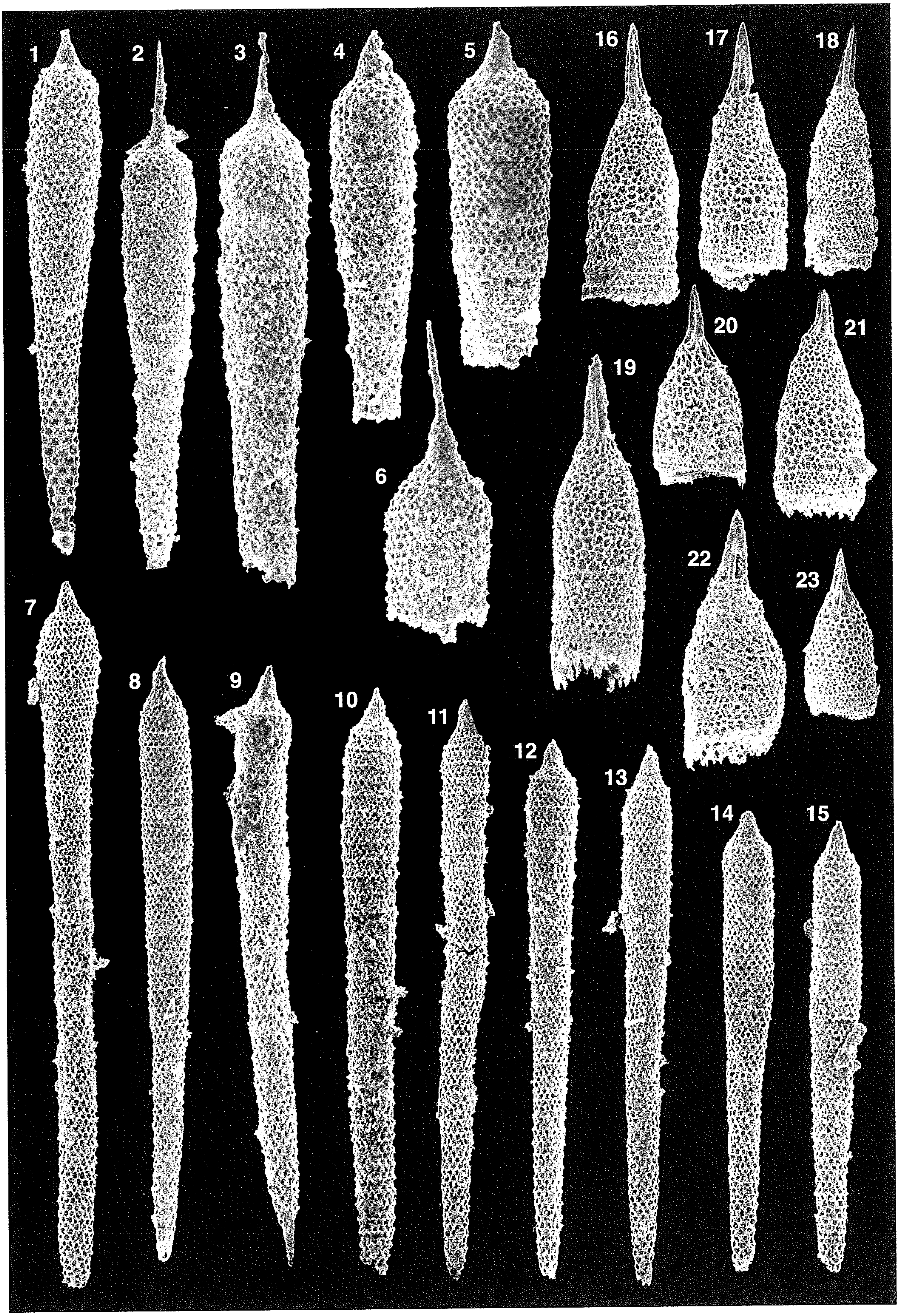

PLATE 21

Figures 1-6 **Phalangites hastatus** nov. sp. x150 .... p. 158

1) 5772, from loc. no. Asv-5-43, early Turonian.
2) 6549, from loc. no. Asv-5-43, early Turonian.
3) 5820 (holotype), from loc. no. Asv-5-43, early Turonian.
4) 6852, from loc. no. Asv-5-43, early Turonian.
5) 6834, from loc. no. Asv-5-43, early Turonian.
6) 7036, from loc. no. Asv-5-43, early Turonian.

Figures 7-12 **Trimulus parmatus** nov. sp. x250 .... p. 159

7) 9464, from loc. no. Ca1-22.30, early Aptian.
8) 9474, from loc. no. Ca1-26.05, early Aptian.
9) 9643, (holotype), from loc. no. Ca1-26.05, early Aptian.
10) 9425, from loc. no. Ca1-26.05, early Aptian.
11) 8368, from loc. no. Ca1-22.30, early Aptian.
12) 8422, from loc. no. Ca1-22.30, early Aptian.

Figures 13-17 **Trimulus fossilis** (SQUINABOL, 1904) x150 .... p. 160

13) 10752, from loc. no. Pan-1, late Aptian.
14) 3177, from loc. no. Bo-685.20, late Albian.
15) 723, from loc. no. Ap2 (-7.78), middle Albian.
16) 2082, from loc. no. Gc-1035.10, late Albian.
17) 2849, from loc. no. Bo-685.20, late Albian.

Figures 18-22 **Rhopalosyringium fossile** (SQUINABOL) x250 .... p. 161

18) 8495, from loc. no. Ca1-22.30, early Aptian.
19) 8862, from loc. no. Ca1-22.30, early Aptian.
20) 946, from loc. no. Gc-1027.10, middle Albian.
21) 192, from loc. no. Ap2 (-7.78), middle Albian.
22) 8532, from loc. no. Ca1-22.30, early Aptian.

Figures 23-24 **Rhopalosyringium solivagum** nov. sp. x150 .... p. 163

23) 1132, from loc. no. Gc-1027.10, middle Albian.
24) 79 (holotype), from loc. no. Ap2 (-7.78), middle Albian.

Figures 25-27 **Rhopalosyringium perforaculum** nov. sp. x300 .... p. 166

25) 2727 (holotype), from loc. no. Bo-685.20, late Albian.
26) 575, from loc. no. Ap2 (-7.78), middle Albian.
27) 577, from loc. no. Ap2 (-7.78), middle Albian.

Plate 21

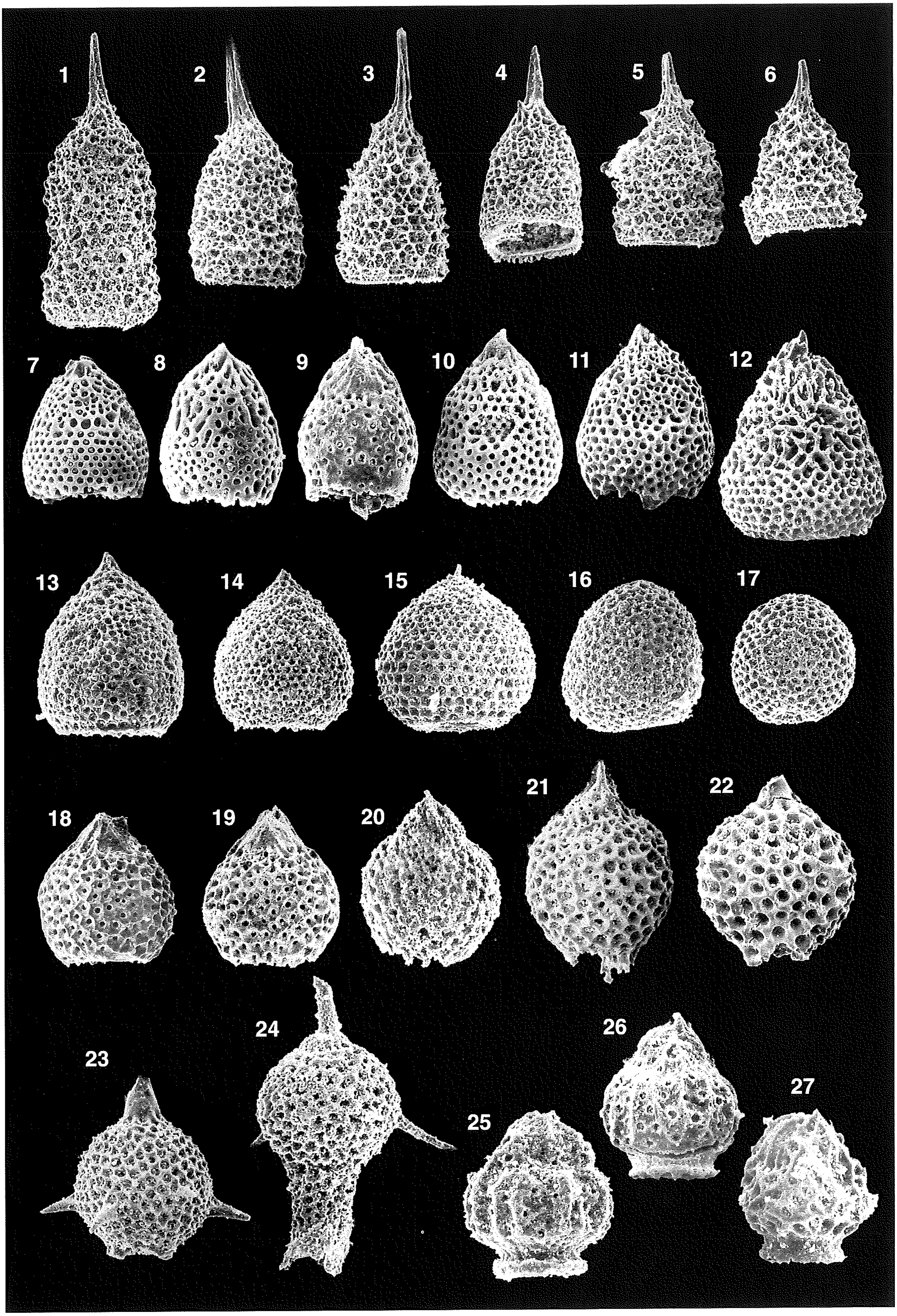

PLATE 22

Figures 1-6 **Rhopalosyringium mosquense** (SMIRNOVA & ALIEV) x200 .... p. 165

1) 544, from loc. no. Ap2 (-7.78), middle Albian.
2) 2037, from loc. no. Gc-1035.10, late Albian.
3) 551, from loc. no. Ap2 (-7.78), middle Albian.
4) 69, from loc. no. Ap2 (-7.78), middle Albian.
5) 2700, from loc. no. Bo-685.20, late Albian.
6) 2785, from loc. no. Bo-685.20, late Albian.

Figures 7-13 **Rhopalosyringium euganeum** (SQUINABOL) x120 .... p. 162

7) 2043, from loc. no. Gc-1035.10, late Albian.
8) 102, from loc. no. Ap2 (-7.78), middle Albian.
9) 78, from loc. no. Ap2 (-7.78), middle Albian.
10) 560, from loc. no. Ap2 (-7.78), middle Albian.
11) 1090, from loc. no. Gc-1027.10, middle Albian.
12) 2056, from loc. no. Gc-1035.10, late Albian.
13) 7423, from loc. no. Gb-108.60, late Cenomanian.

Figures 14-18 **Rhopalosyringium petilum** (FOREMAN) x150 .... p. 164

14) 1740, from loc. no. Ap2-12, early Cenomanian.
15) 7459, from loc. no. Gb-108.60, late Cenomanian.
16) 3464, from loc. no. Gc-1073.94, middle Cenomanian.
17) 7418, from loc. no. Gb-108.60, late Cenomanian.
18) 3431, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 22

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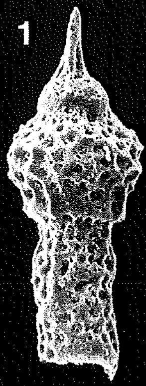

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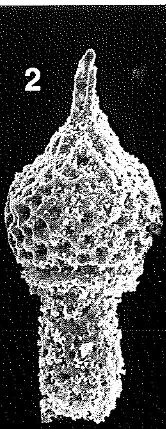

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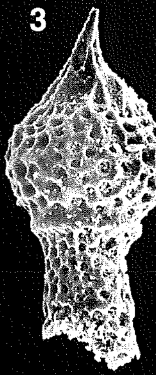

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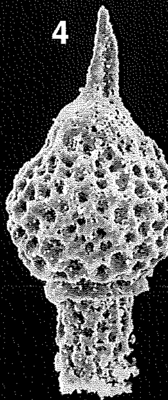

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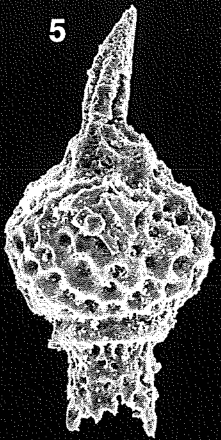

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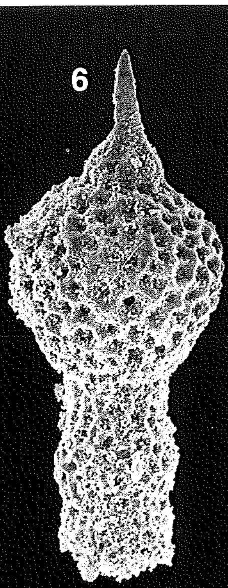

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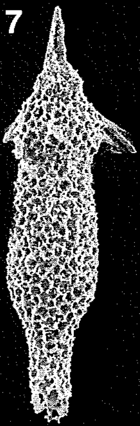

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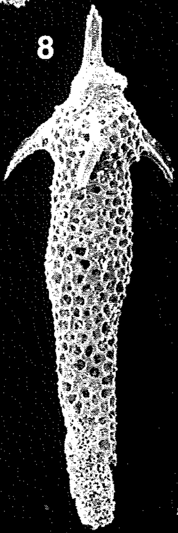

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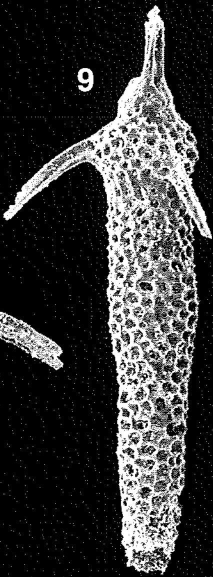

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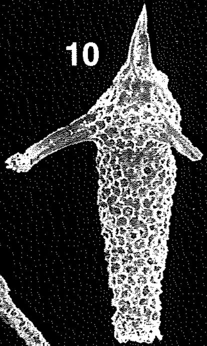

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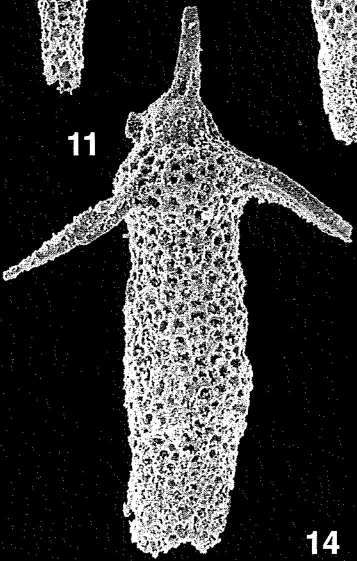

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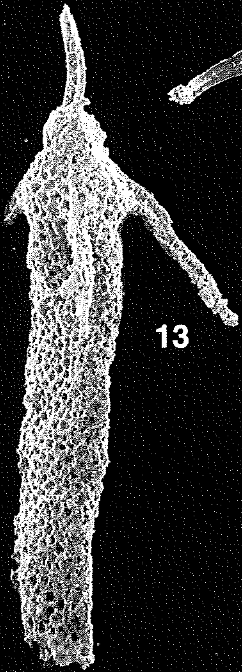

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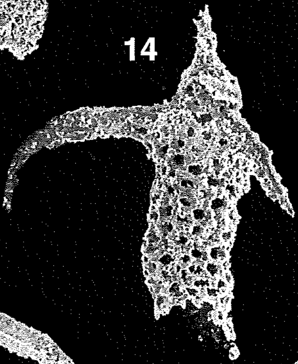

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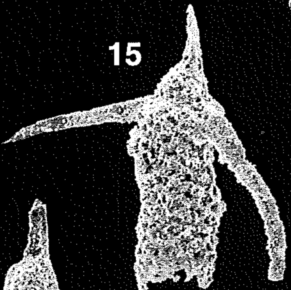

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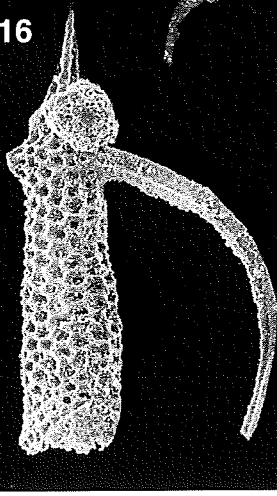

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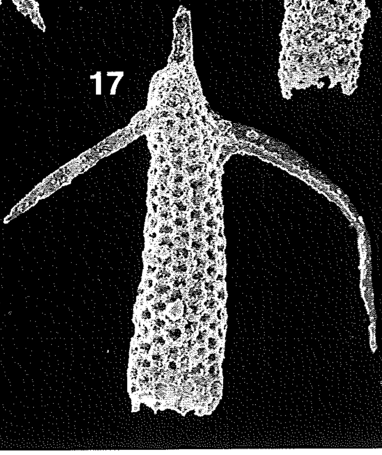

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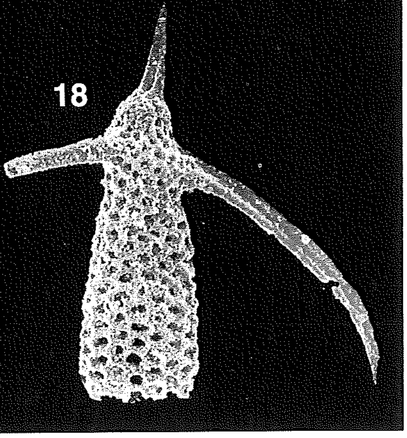

PLATE 23

Figures 1-6 **Rhopalosyringium elegans** (SQUINABOL) x250 .... p. 166

1) 7715, from loc. no. Gb-108.60, late Cenomanian.
2) 7429, from loc. no. Gb-108.60, late Cenomanian.
3) 7505, from loc. no. Gb-108.60, late Cenomanian.
4) 7866, from loc. no. Gb-108.60, late Cenomanian.
5) 4128, from loc. no. Gc-1094.48, late Cenomanian.
6) 4109, from loc. no. Gc-1094.48, late Cenomanian.

Figures 7-11 **Rhopalosyringium hispidum** nov. sp. x250 .... p. 167

7) 6262, from loc. no. Asv-5-43, early Turonian.
8) 7002 (holotype), from loc. no. Asv-5-43, early Turonian.
9) 5943, from loc. no. Asv-5-43, early Turonian.
10) 5827, from loc. no. Asv-5-43, early Turonian.
11) 5073, from loc. no. Gc-1096.50, early Turonian.

Figures 12-16 **Rhopalosyringium scissum** nov. sp. x250 .... p. 168

12) 6618, from loc. no. Asv-5-43, early Turonian.
13) 6768 (holotype), from loc. no. Asv-5-43, early Turonian.
14) 6710, from loc. no. Asv-5-43, early Turonian.
15) 5190, from loc. no. Gc-1096.50, early Turonian.
16) 11442, from loc. no. E-12, early Turonian.

Figures 17-20 **Rhopalosyringium radiosum** nov. sp. x200 .... p. 169

17) 5971, from loc. no. Asv-5-43, early Turonian.
18) 5819, from loc. no. Asv-5-43, early Turonian.
19) 5972 (holotype), from loc. no. Asv-5-43, early Turonian.
20) 5826, from loc. no. Asv-5-43, early Turonian.

Plate 23

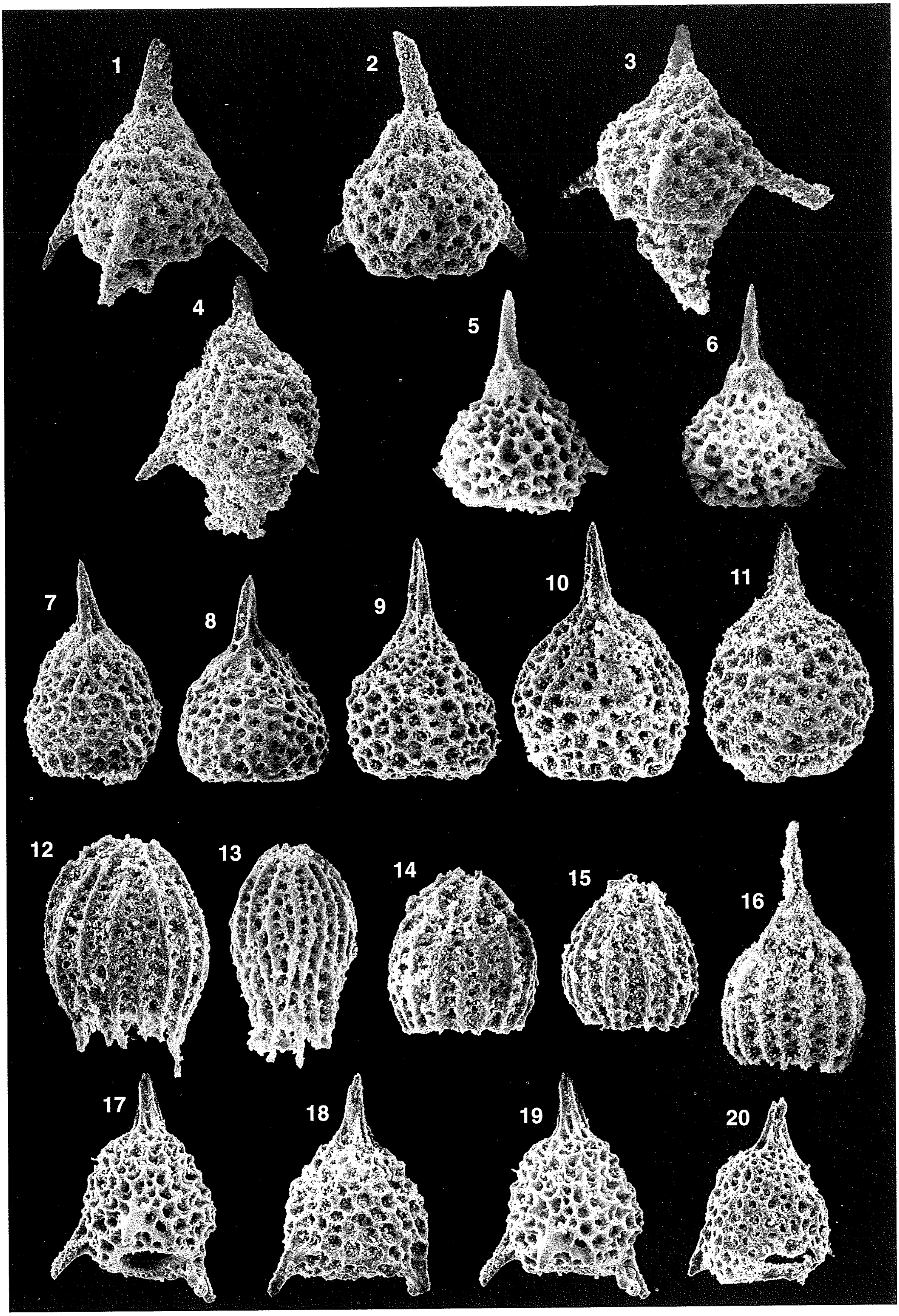

PLATE 24

Figures 1-2 **Rhopalosyringium adriaticum** nov. sp. x300 .... p. 169

1) 4266 (holotype), from loc. no. Gc-1094.48, late Cenomanian.
2) 576, from loc. no. Ap2 (-7.78), middle Albian.

Figures 3-5 **Pseudotheocampe tina** (FOREMAN) x300 .... p. 171

3) 5090, from loc. no. Gc-1096.50, early Turonian.
4) 6653, from loc. no. Asv-5-43, early Turonian.
5) 11242, from loc. no. Fl-4-21, early Turonian.

Figures 6-10 **Pogonias prodromus** nov. sp. x150 .... p. 172

6) 3201, from loc. no. Bo-685.20, late Albian.
7) 1708, from loc. no. Ap2-12, early Cenomanian.
8) 155, from loc. no. Ap2 (-7.78), middle Albian.
9) 2716, from loc. no. Bo-685.20, late Albian.
10) 3297 (holotype), from loc. no. Bo-685.20, late Albian.

Figures 11-19 **Pogonias harpago** nov. sp. x120 .... p. 173

11) 1896, from loc. no. Gc-1035.10, late Albian.
12) 1718, from loc. no. Ap2-12, early Cenomanian.
13) 1721, from loc. no. Ap2-12, early Cenomanian.
14) 1029, from loc. no. Gc-1027.10, middle Albian.
15) 1597, from loc. no. Ap2-12, early Cenomanian.
16) 1991, from loc. no. Gc-1035.10, late Albian.
17) 1918, from loc. no. Gc-1035.10, late Albian.
18) 3014 (holotype), from loc. no. Bo-685.20, late Albian.
19) 1919, from loc. no. Gc-1035.10, late Albian.

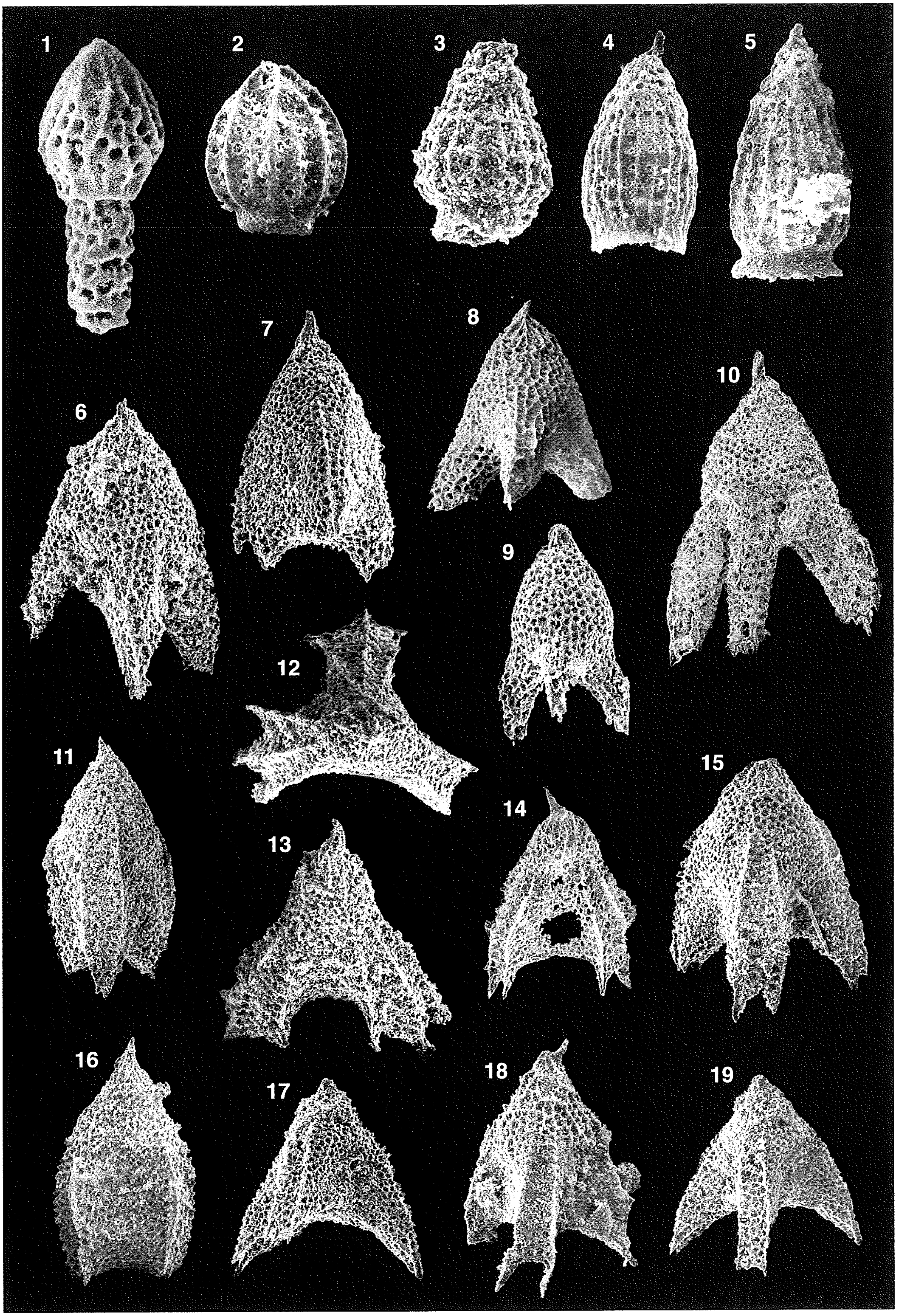
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PLATE 25

Figures 1-5 **Pogonias missilis** nov. sp. x150 .... p. 174

1) 3295 (holotype), from loc. no. Bo-685.20, late Albian.
2) 2962, from loc. no. Bo-685.20, late Albian.
3) 2749, from loc. no. Bo-685.20, late Albian.
4) 2750, from loc. no. Bo-685.20, late Albian.
5) 1404, from loc. no. Gc-1027.10, middle Albian.

Figures 6-8 **Pogonias incallidus** nov. sp. x100 .... p. 174

6) 5309, from loc. no. Gb-84.40, early Cenomanian.
7) 5246, from loc. no. Gb-84.40, early Cenomanian.
8) 5340 (holotype), from loc. no. Gb-84.40, early Cenomanian.

Figures 9-13 **Pogonias ? hirsutus** (SQUINABOL) x150 .... p. 175

9) 7448, from loc. no. Gb-108.60, late Cenomanian.
10) 3932, from loc. no. Gc-1073.94, middle Cenomanian.
11) 7435, from loc. no. Gb-108.60, late Cenomanian.
12) 3706, from loc. no. Gc-1073.94, middle Cenomanian.
13) 7449, from loc. no. Gb-108.60, late Cenomanian.

Figures 14-17 **Podobursa typica** (RÜST) x120 .... p. 177

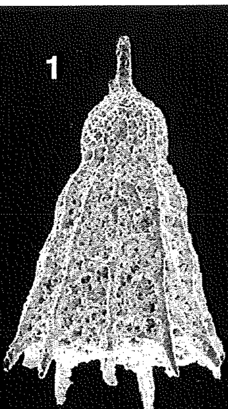
14) 9726, from loc. no. Ca1-9.70, late Barremian.
15) 9305, from loc. no. Ca1-22.30, early Aptian.
16) 9682, from loc. no. Ca1-9.70, late Barremian.
17) 9673, from loc. no. Ca1-9.70, late Barremian.

Figures 18-19 **Podobursa tytthopora** (FOREMAN) x150 .... p. 178

18) 9322, from loc. no. Ca1-22.30, early Aptian.
19) 9323, from loc. no. Ca1-22.30, early Aptian.

Figures 20-22 **Pseudoeucyrtis ? columbaria** (RENZ) x250 .... p. 180

20) 10097, from loc. no. Mc-268b, middle Aptian.
21) 8328, from loc. no. Ca1-22.30, early Aptian.
22) 10701, from loc. no. Pan-1, late Aptian.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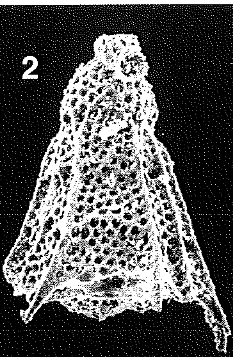
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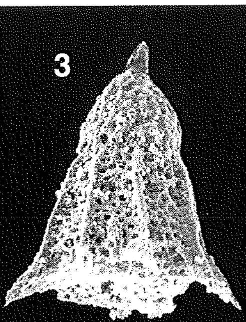
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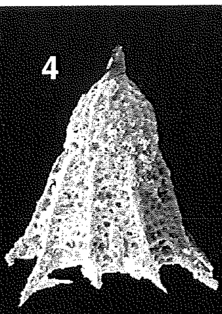
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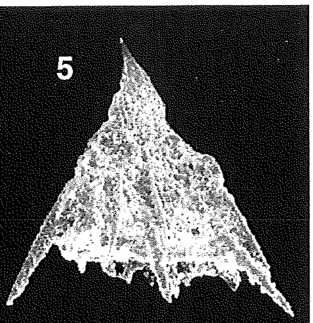
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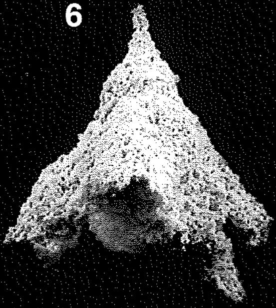
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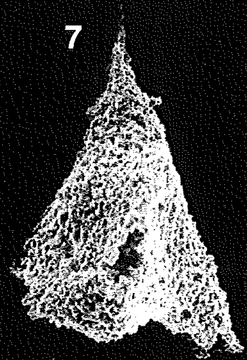
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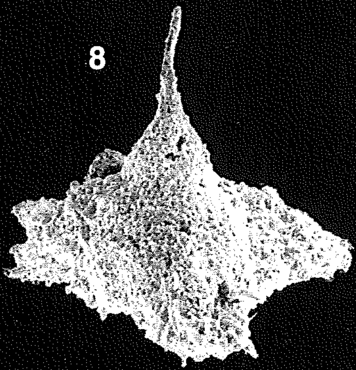
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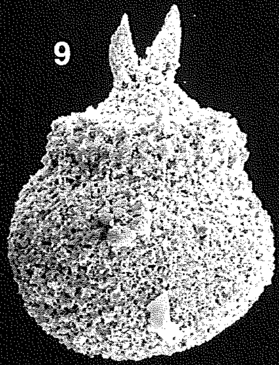
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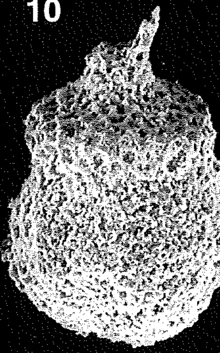
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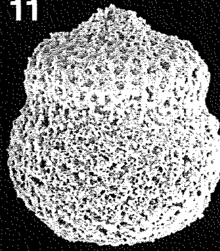
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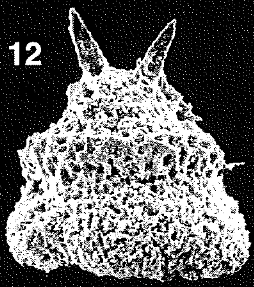
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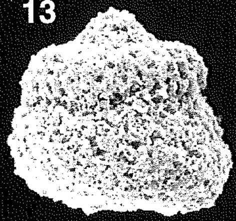
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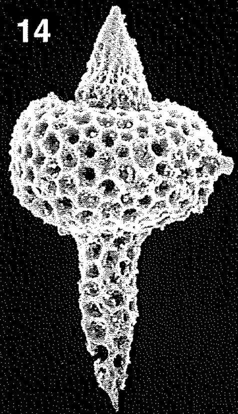
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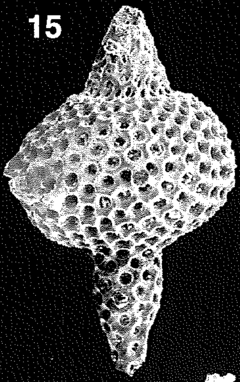
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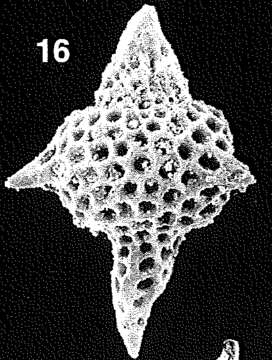
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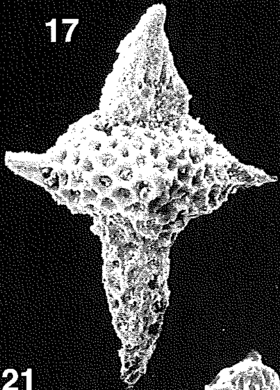
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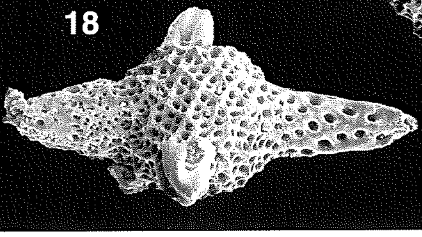
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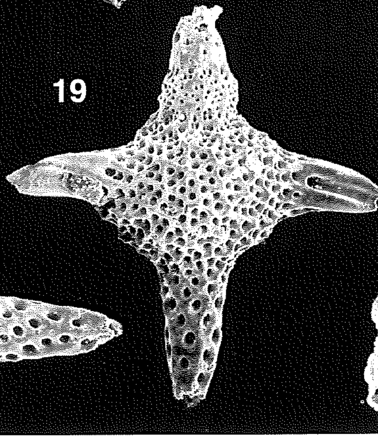
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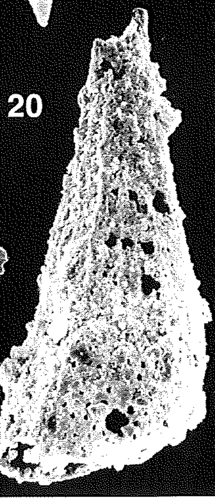
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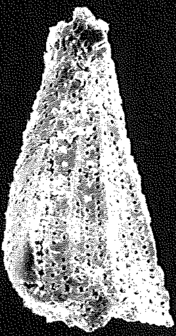
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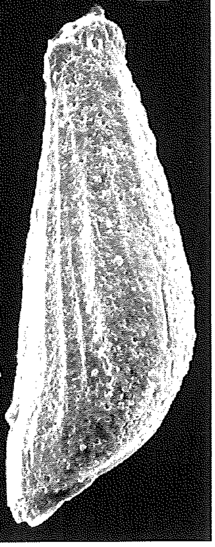
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PLATE 26

Figures 1-13 **Pseudoeucyrtis hanni** (TAN) x200 .... p. 180

1) 9896, from loc. no. Mc-268b, middle Aptian.
2) 9877, from loc. no. Mc-268b, middle Aptian.
3) 10808, from loc. no. Pan-1, late Aptian.
4) 10765, from loc. no. Pan-1, late Aptian.
5) 10784, from loc. no. Pan-1, late Aptian.
6) 10780, from loc. no. Pan-1, late Aptian.
7) 10194, from loc. no. Mc-268b, middle Aptian.
8) 9861, from loc. no. Mc-268b, middle Aptian.
9) 9973, from loc. no. Mc-268b, middle Aptian.
10) 9333, from loc. no. Cal-22.30, early Aptian.
11) 10185, from loc. no. Mc-268b, middle Aptian.
12) 9761, from loc. no. Cal-9.70, late Barremian.
13) 9343, from loc. no. Cal-22.30, early Aptian.

Figures 14-18 **Pseudoeucyrtis apochrypha** nov. sp. x200 .... p. 182

14) 7964, from loc. no. Cal-22.30, early Aptian.
15) 9318, from loc. no. Cal-22.30, early Aptian.
16) 9319 (holotype), from loc. no. Cal-22.30, early Aptian.
17) 8017, from loc. no. Cal-22.30, early Aptian.
18) R-533, from loc. no. Bo-566.50, early Barremian.

Plate 26

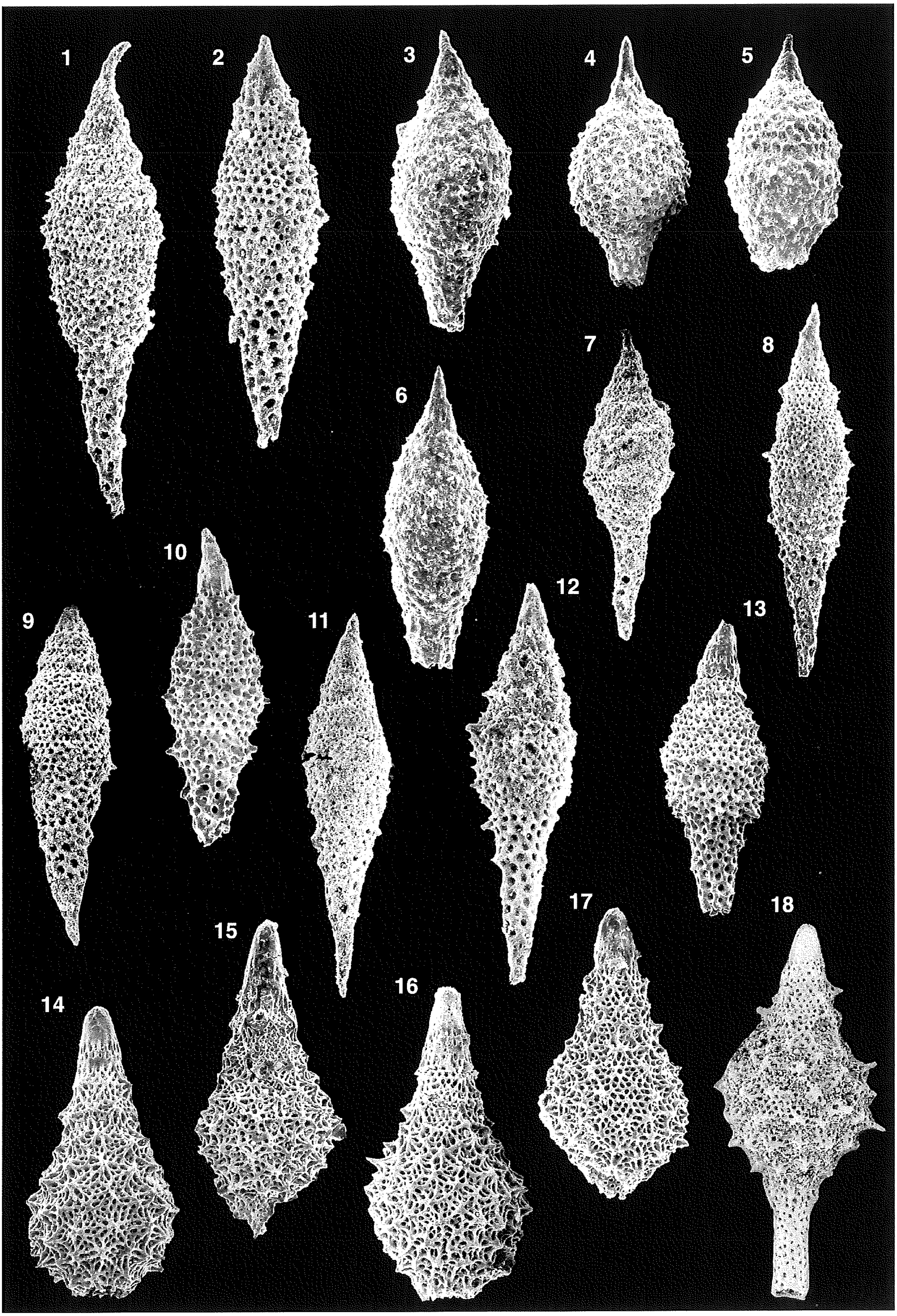


PLATE 27

Figures 1-8 **Pseudoeucyrtis spinosa** (SQUINABOL) x150 .... p. 183

1) 204, from loc. no. Ap2 (-7.78), middle Albian.
2) 120, from loc. no. Ap2 (-7.78), middle Albian.
3) 3410, from loc. no. Gc-1073.94, middle Cenomanian.
4) 7251, from loc. no. Gb-108.60, late Cenomanian.
5) 3240, from loc. no. Bo-685.20, late Albian.
6) 3407, from loc. no. Gc-1073.94, middle Cenomanian.
7) 3232, from loc. no. Bo-685.20, late Albian.
8) 3159, from loc. no. Bo-685.20, late Albian.

Figures 9-13 **Pseudoeucyrtis pulchra** (SQUINABOL) x130 .... p. 184

9) 7847, from loc. no. Gb-108.60, late Cenomanian.
10) 5079, from loc. no. Gc-1096.50, early Turonian.
11) 7783, from loc. no. Gb-108.60, late Cenomanian.
12) 7889, from loc. no. Gb-108.60, late Cenomanian.
13) 7182, from loc. no. Gb-108.60, late Cenomanian.

Figures 14-18 **Distylocapsa micropora** (SQUINABOL) x150 .... p. 185

14) 424, from loc. no. Ap2 (-7.78), middle Albian.
15) 579, from loc. no. Ap2 (-7.78), middle Albian.
16) 1775, from loc. no. Ap2-12, early Cenomanian.
17) 2034, from loc. no. Gc-1035.10, late Albian.
18) 2047, from loc. no. Gc-1035.10, late Albian.

Plate 27

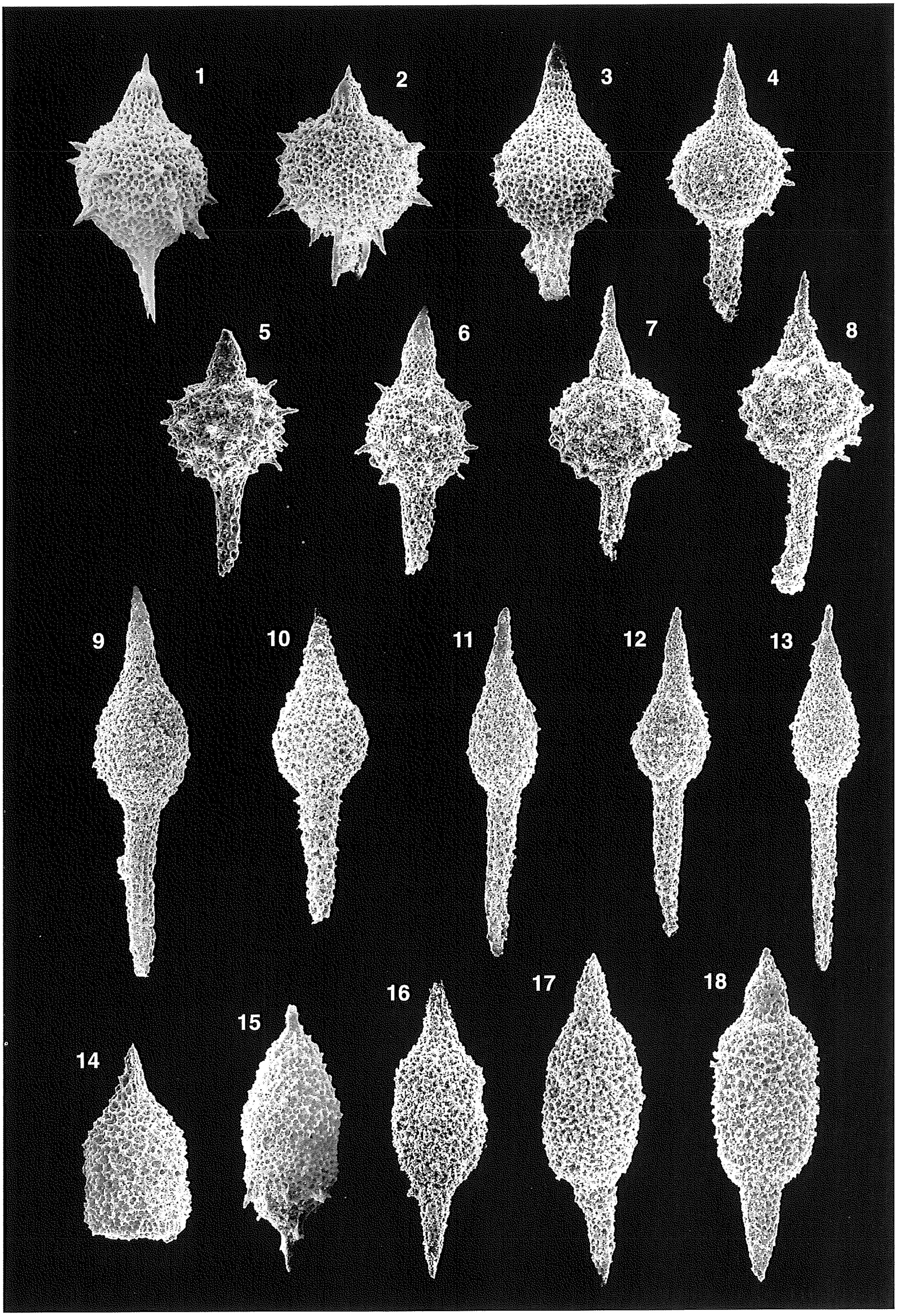


PLATE 28

Figures 1-7 **Distylocapsa micropora** (SQUINABOL) x150 .... p. 185

1) 5243, from loc. no. Gb-84.40, early Cenomanian.
2) 2834, from loc. no. Bo-685.20, late Albian.
3) 1628, from loc. no. Ap2-12, early Cenomanian.
4) 1245, from loc. no. Gc-1027.10, middle Albian.
5) 3249, from loc. no. Bo-685.20, late Albian.
6) 97, from loc. no. Ap2 (-7.78), middle Albian.
7) 3500, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 8-9 **Distylocapsa nova** SQUINABOL x150 .... p. 188

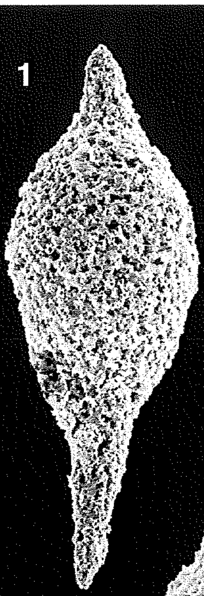
8) 5069, from loc. no. Gc-1096.50, early Turonian.
9) 7412, from loc. no. Gb-108.60, late Cenomanian.

Figures 10-15 **Distylocapsa veneta** (SQUINABOL) x200 .... p. 186

10) 2745, from loc. no. Bo-685.20, late Albian.
11) 3481, from loc. no. Gc-1073.94, middle Cenomanian.
12) 3445, from loc. no. Gc-1073.94, middle Cenomanian.
13) 3487, from loc. no. Gc-1073.94, middle Cenomanian.
14) 3456, from loc. no. Gc-1073.94, middle Cenomanian.
15) 3973, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 16-21 **Distylocapsa squama** nov. sp. x200 .... p. 189

16) 6960 (holotype), from loc. no. Asv-5-43, early Turonian.
17) 5804, from loc. no. Asv-5-43, early Turonian.
18) 5040, from loc. no. Gc-1096.50, early Turonian.
19) 5068, from loc. no. Gc-1096.50, early Turonian.
20) 5851, from loc. no. Asv-5-43, early Turonian.
21) 5884, from loc. no. Asv-5-43, early Turonian.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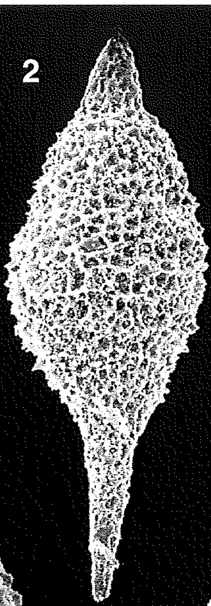
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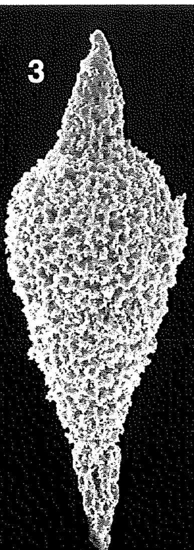
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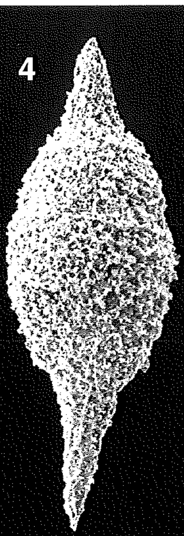
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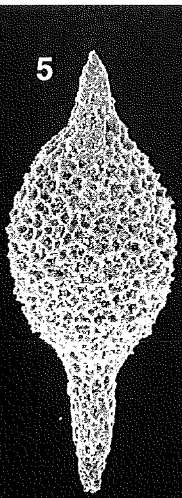
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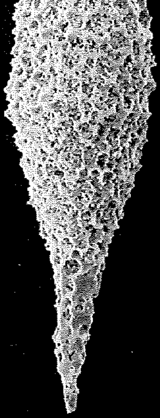
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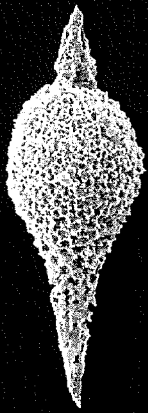
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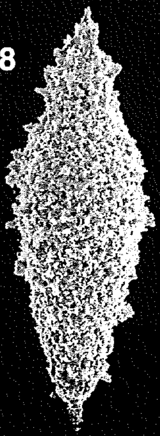
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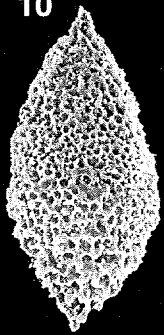
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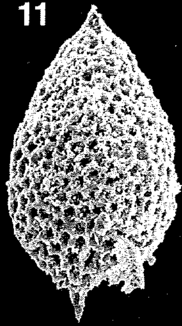
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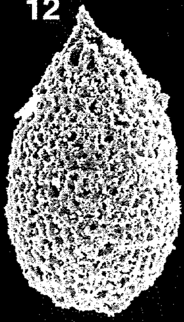
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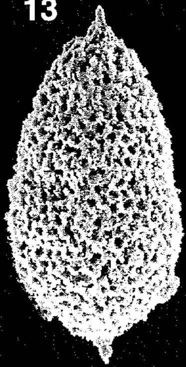
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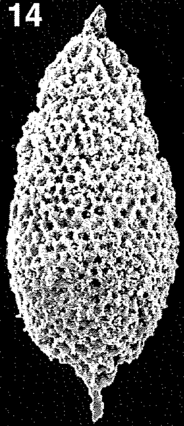
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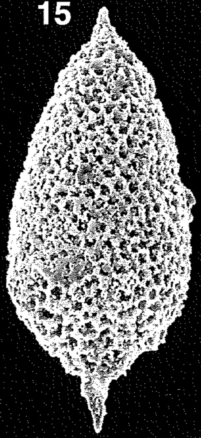
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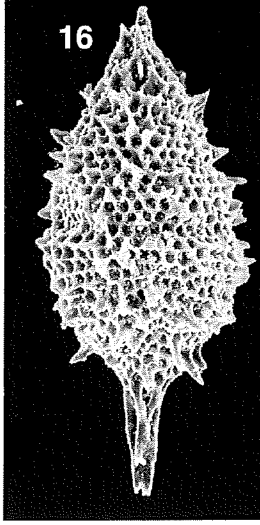
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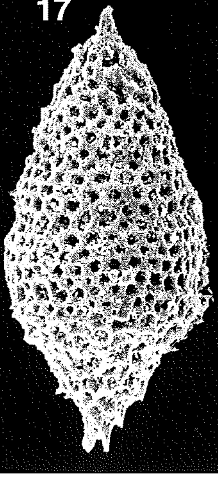
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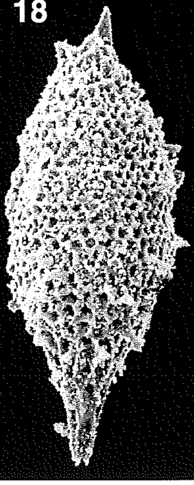
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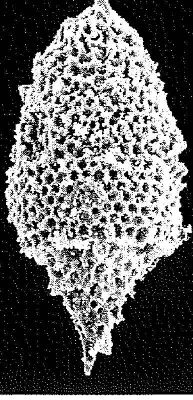
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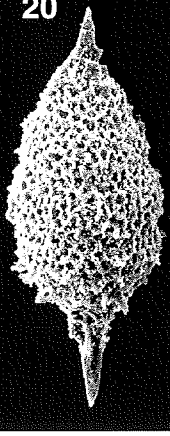
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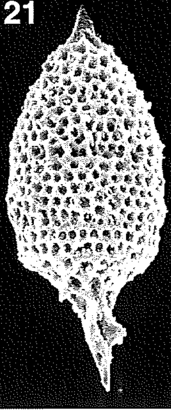
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PLATE 29

Figures 1-4 **Obeliscoites vinassai** (SQUINABOL) x100 .... p. 190
except figs. 3-4 x75

1) 941, from loc. no. Gc-1027.10, middle Albian.
2) 2636, from loc. no. Bo-685.20, late Albian.
3) 5334, from loc. no. Gb-84.40, early Cenomanian.
4) 5217, from loc. no. Gb-84.40, early Cenomanian.

Figures 5-18 **Obeliscoites perspicuus** (SQUINABOL) x75 .... p. 191
except figs. 12, 14 x100

5) 1920, from loc. no. Gc-1035.10, late Albian.
6) 2601, from loc. no. Bo-685.20, late Albian.
7) 2605, from loc. no. Bo-685.20, late Albian.
8) 2607, from loc. no. Bo-685.20, late Albian.
9) 3441, from loc. no. Gc-1073.94, middle Cenomanian.
10) 2444.1, from loc. no. Gc-1035.10, late Albian.
11) 802, from loc. no. Gc-1027.10, middle Albian.
12) 809, from loc. no. Gc-1027.10, middle Albian.
13) 389, from loc. no. Ap2 (-7.78), middle Albian.
14) 2614, from loc. no. Bo-685.20, late Albian.
15) 336.1, from loc. no. Ap2 (-7.78), middle Albian.
16) 336.2, from loc. no. Ap2 (-7.78), middle Albian.
17) 2444.2, from loc. no. Gc-1035.10, late Albian.
18) 82, from loc. no. Ap2 (-7.78), middle Albian.

Figures 19-24 **Obeliscoites giganteus** (ALIEV) x75 .... p. 192

19) 2620, from loc. no. Bo-685.20, late Albian.
20) 3205, from loc. no. Bo-685.20, late Albian.
21) 2594, from loc. no. Bo-685.20, late Albian.
22) 1656, from loc. no. Ap2-12, early Cenomanian.
23) 2592, from loc. no. Bo-685.20, late Albian.
24) 798, from loc. no. Gc-1027.10, middle Albian.

Plate 29

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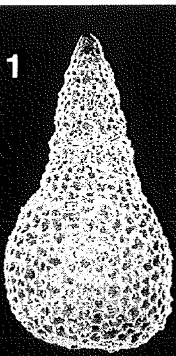

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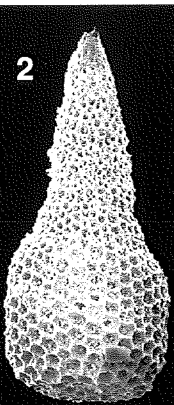

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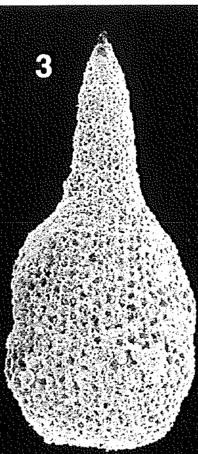

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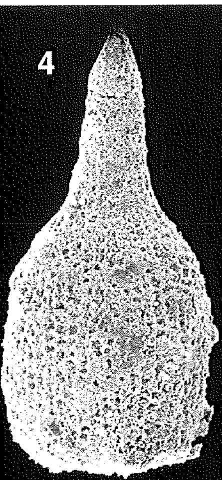

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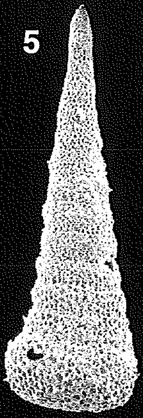

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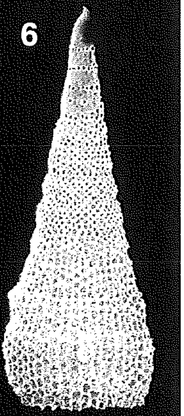

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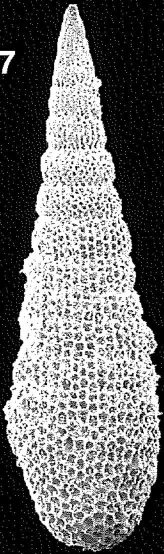

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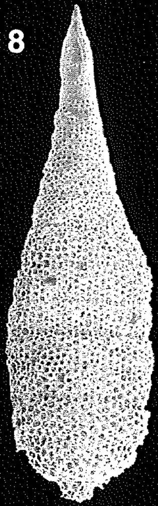

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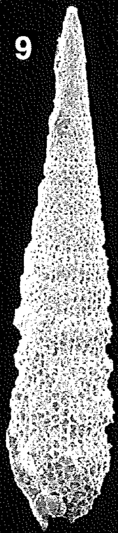

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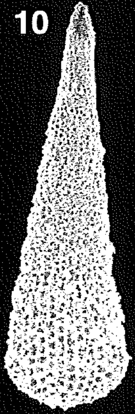

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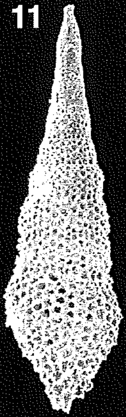

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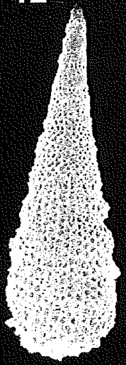

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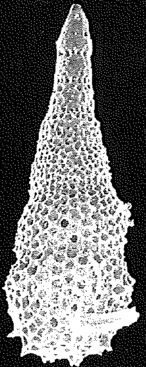

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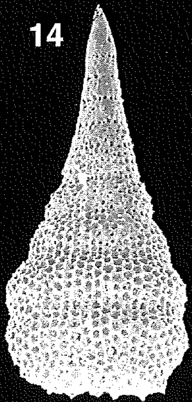

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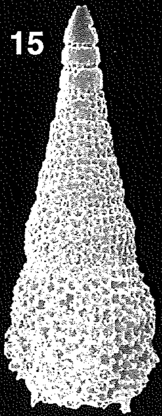

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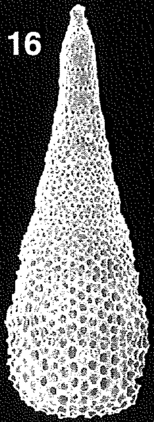

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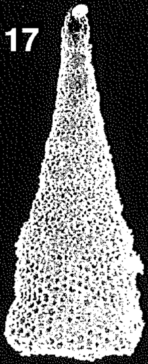

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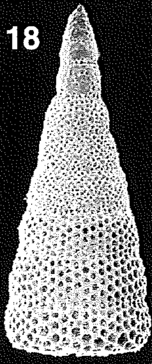

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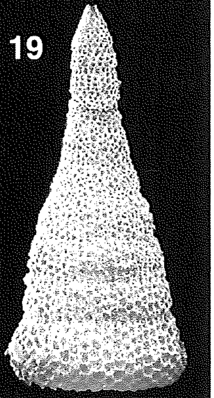

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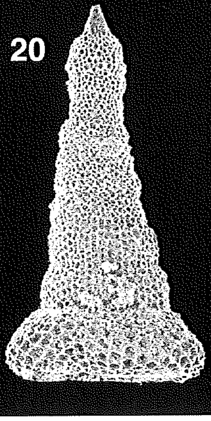

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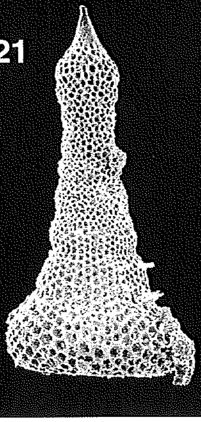

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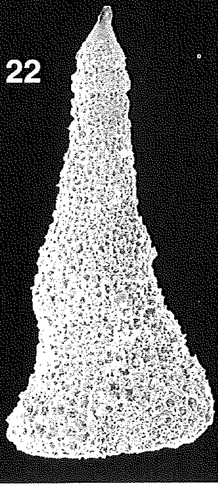

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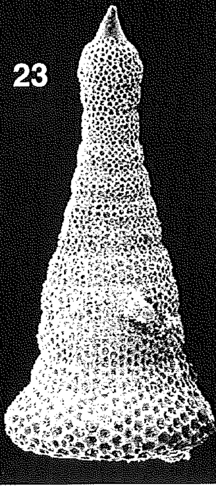

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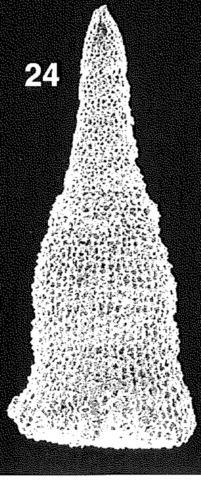

PLATE 30

Figures 1-6 **Obeliscoites turris** (SQUINABOL) x75 .... p. 194

1) 3067, from loc. no. Bo-685.20, late Albian.
2) 2783, from loc. no. Bo-685.20, late Albian.
3) 2637, from loc. no. Bo-685.20, late Albian.
4) 3218, from loc. no. Bo-685.20, late Albian.
5) 800, from loc. no. Gc-1027.10, middle Albian.
6) 7172, from loc. no. Gb-108.60, late Cenomanian.

Figures 7-11 **Obeliscoites maximus** (SQUINABOL) x75 .... p. 194

7) 7463, from loc. no. Gb-108.60, late Cenomanian.
8) 7350, from loc. no. Gb-108.60, late Cenomanian.
9) 3444, from loc. no. Gc-1073.94, middle Cenomanian.
10) 3337, from loc. no. Gc-1073.94, middle Cenomanian.
11) 3346, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 12-16 **Hiscocapsa uterculus** (PARONA) x250 .... p. 198

12) 9733, from loc. no. Ca1-9.70, late Barremian.
13) 8552, from loc. no. Ca1-22.30, early Aptian.
14) 9526, from loc. no. Ca1-26.05, early Aptian.
15) 8146, from loc. no. Ca1-22.30, early Aptian.
16) 8203, from loc. no. Ca1-22.30, early Aptian.

Plate 30

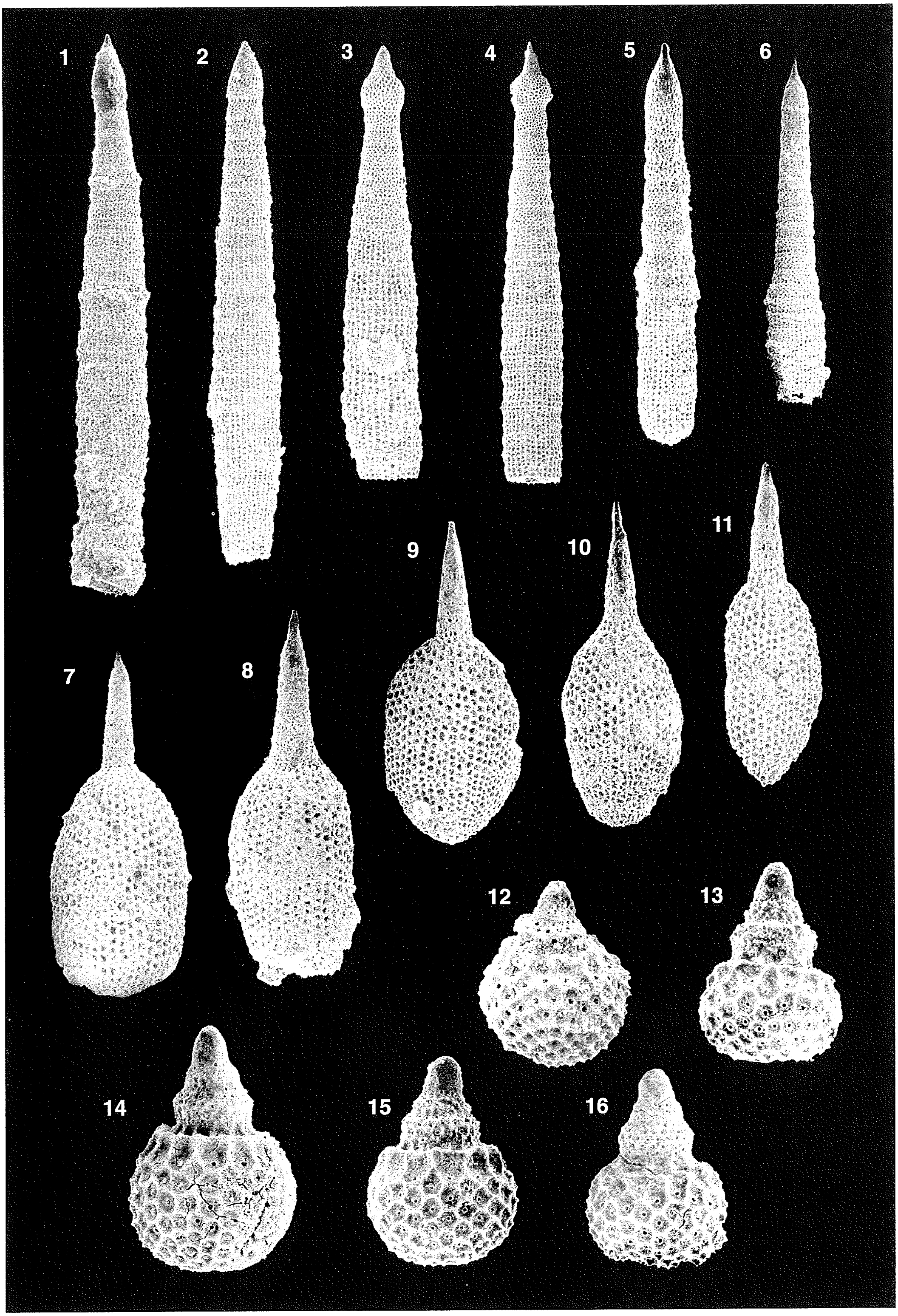

PLATE 31

Figures 1-6 **Hiscocapsa verbeeki** (TAN) x300 .... p. 199

1) 8601, from loc. no. Ca1-22.30, early Aptian.
2) 9149, from loc. no. Ca1-22.30, early Aptian.
3) 10126, from loc. no. Mc-268b, middle Aptian.
4) 10127, from loc. no. Mc-268b, middle Aptian.
5) 11008, from loc. no. Pan-1, late Aptian.
6) 8546, from loc. no. Ca1-22.30, early Aptian.

Figures 7-13 **Hiscocapsa asseni** (TAN) x250 .... p. 200

7) 8170, from loc. no. Ca1-22.30, early Aptian.
8) 8197, from loc. no. Ca1-22.30, early Aptian.
9) 8221, from loc. no. Ca1-22.30, early Aptian.
10) 9483, from loc. no. Ca1-26.05, early Aptian.
11) 10088, from loc. no. Mc-268b, middle Aptian.
12) 9955, from loc. no. Mc-268b, middle Aptian.
13) 11006, from loc. no. Pan-1, late Aptian.

Figures 14-16 **Hiscocapsa grutterinki** (TAN) x200 .... p. 201

14) 8507, from loc. no. Ca1-22.30, early Aptian.
15) 10212, from loc. no. Mc-268b, middle Aptian.
16) 9346, from loc. no. Ca1-22.30, early Aptian.

Plate 31

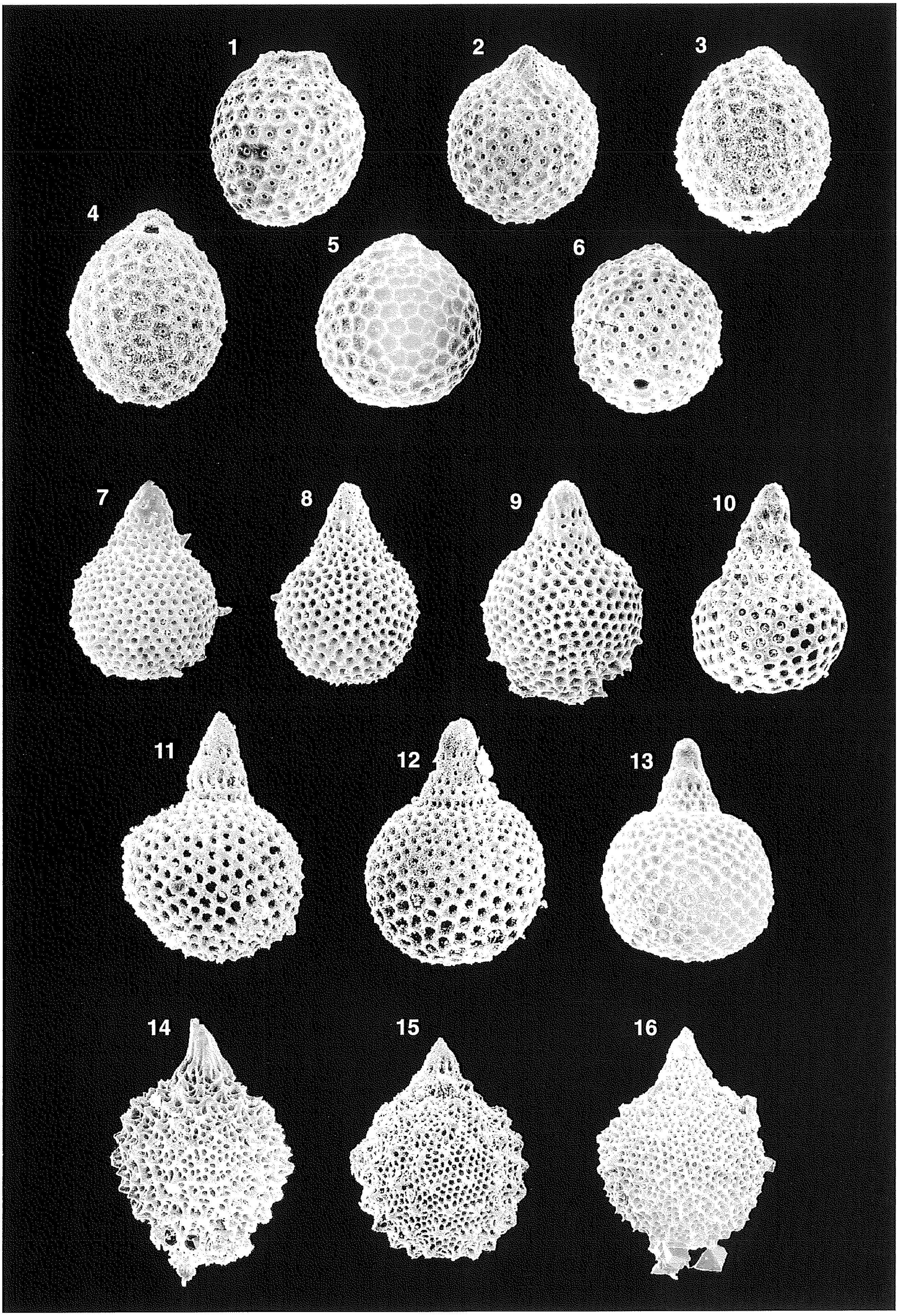

PLATE 32

Figures 1-3 **Hiscocapsa grutterinki** (TAN) x200 .... p. 201

1) 10171, from loc. no. Mc-268b, middle Aptian.
2) 10283, from loc. no. Mc-268b, middle Aptian.
3) 8144, from loc. no. Ca1-22.30, early Aptian.

Figures 4-10 **Squinabollum fossile** (SQUINABOL) x200 .... p. 203

4) 1188, from loc. no. Gc-1027.10, middle Albian.
5) 3121, from loc. no. Bo-685.20, late Albian.
6) 2204, from loc. no. Gc-1035.10, late Albian.
7) 7520, from loc. no. Gb-108.60, late Cenomanian.
8) 100, from loc. no. Ap2 (-7.78), middle Albian.
9) 7736, from loc. no. Gb-108.60, late Cenomanian.
10) 7804, from loc. no. Gb-108.60, late Cenomanian.

Figures 11-19 **Dorypyle communis** (SQUINABOL) x200 .... p. 204

11) 131, from loc. no. Ap2 (-7.78), middle Albian.
12) 2754, from loc. no. Bo-685.20, late Albian.
13) 764, from loc. no. Ap2 (-7.78), middle Albian.
14) 724, from loc. no. Ap2 (-7.78), middle Albian.
15) 1229, from loc. no. Gc-1027.10, middle Albian.
16) 146, from loc. no. Ap2 (-7.78), middle Albian.
17) 741, from loc. no. Ap2 (-7.78), middle Albian.
18) 168, from loc. no. Ap2 (-7.78), middle Albian.
19) 2171, from loc. no. Bo-685.20, late Albian.

Plate 32

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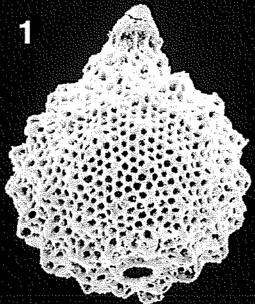
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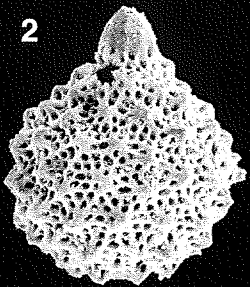
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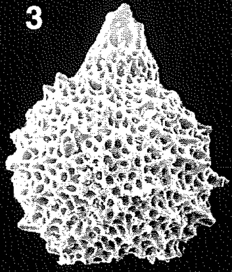
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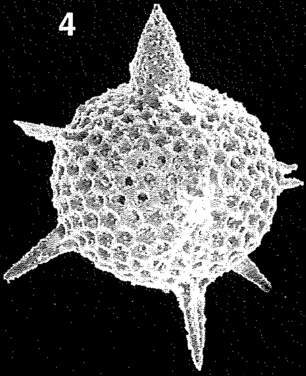
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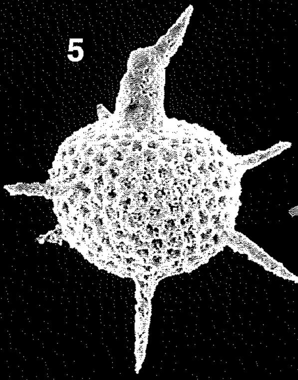
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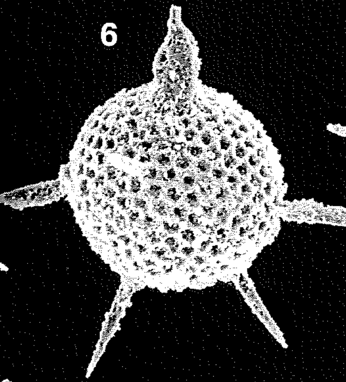
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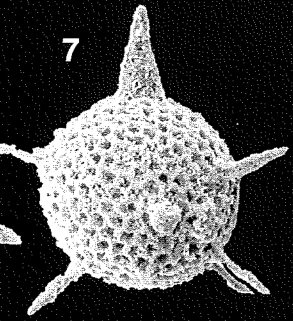
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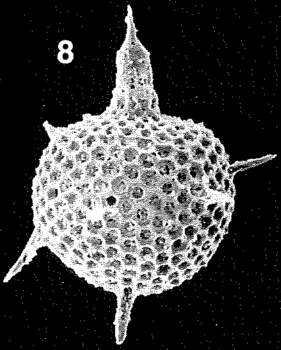
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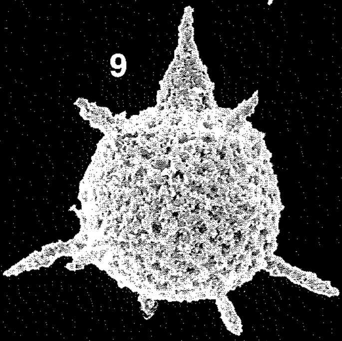
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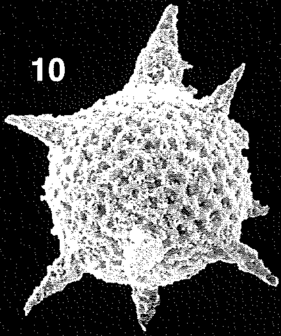
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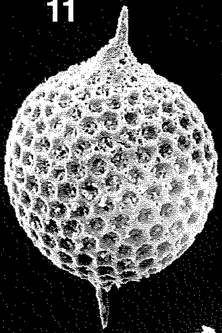
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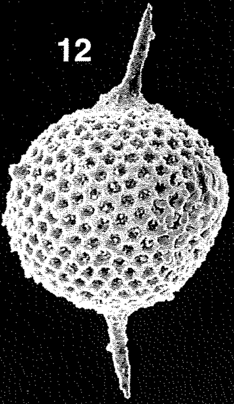
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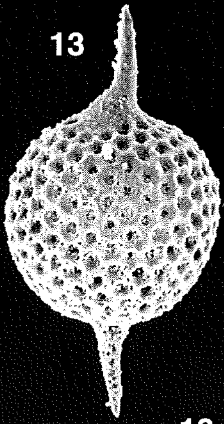
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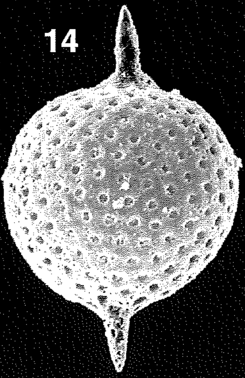
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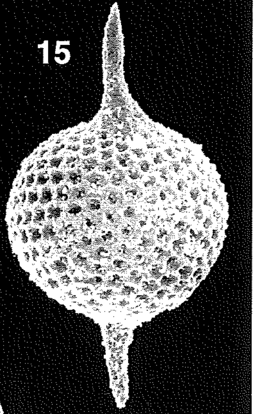
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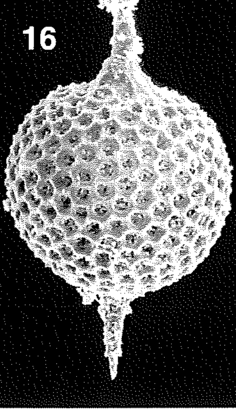
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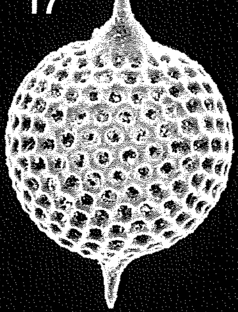
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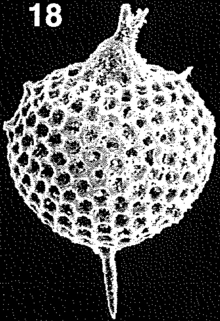
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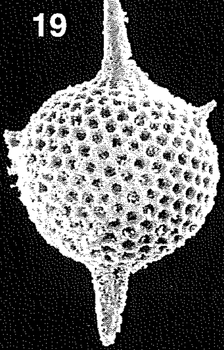

PLATE 33

Figures 1-7 **Dorypyle ovoidea** (SQUINABOL) x200 .... p. 205

1) 2109, from loc. no. Gc-1035.10, late Albian.
2) 2105, from loc. no. Gc-1035.10, late Albian.
3) 2167, from loc. no. Gc-1035.10, late Albian.
4) 2108, from loc. no. Gc-1035.10, late Albian.
5) 5718, from loc. no. Gb-84.40, early Cenomanian.
6) 7868, from loc. no. Gb-108.60, late Cenomanian.
7) 2100, from loc. no. Gc-1035.10, late Albian.

Figures 8-15 **Dorypyle elliptica** SQUINABOL x150 .... p. 206

8) 195, from loc. no. Ap2 (-7.78), middle Albian.
9) 128, from loc. no. Ap2 (-7.78), middle Albian.
10) 721, from loc. no. Ap2 (-7.78), middle Albian.
11) 96, from loc. no. Ap2 (-7.78), middle Albian.
12) 722, from loc. no. Ap2 (-7.78), middle Albian.
13) 226, from loc. no. Ap2 (-7.78), middle Albian.
14) 1200, from loc. no. Gc-1027.10, middle Albian.
15) 167, from loc. no. Ap2 (-7.78), middle Albian.

Figures 16-23 **Dorypyle ? anisa** (FOREMAN) x150 .... p. 206

16) 2084, from loc. no. Gc-1035.10, late Albian.
17) 2168, from loc. no. Gc-1035.10, late Albian.
18) 2107, from loc. no. Gc-1035.10, late Albian.
19) 1529, from loc. no. Ap2-12, early Cenomanian.
20) 2083, from loc. no. Gc-1035.10, late Albian.
21) 2163, from loc. no. Gc-1035.10, late Albian.
22) 5377, from loc. no. Gb-84.40, early Cenomanian.
23) 5588, from loc. no. Gb-84.40, early Cenomanian.

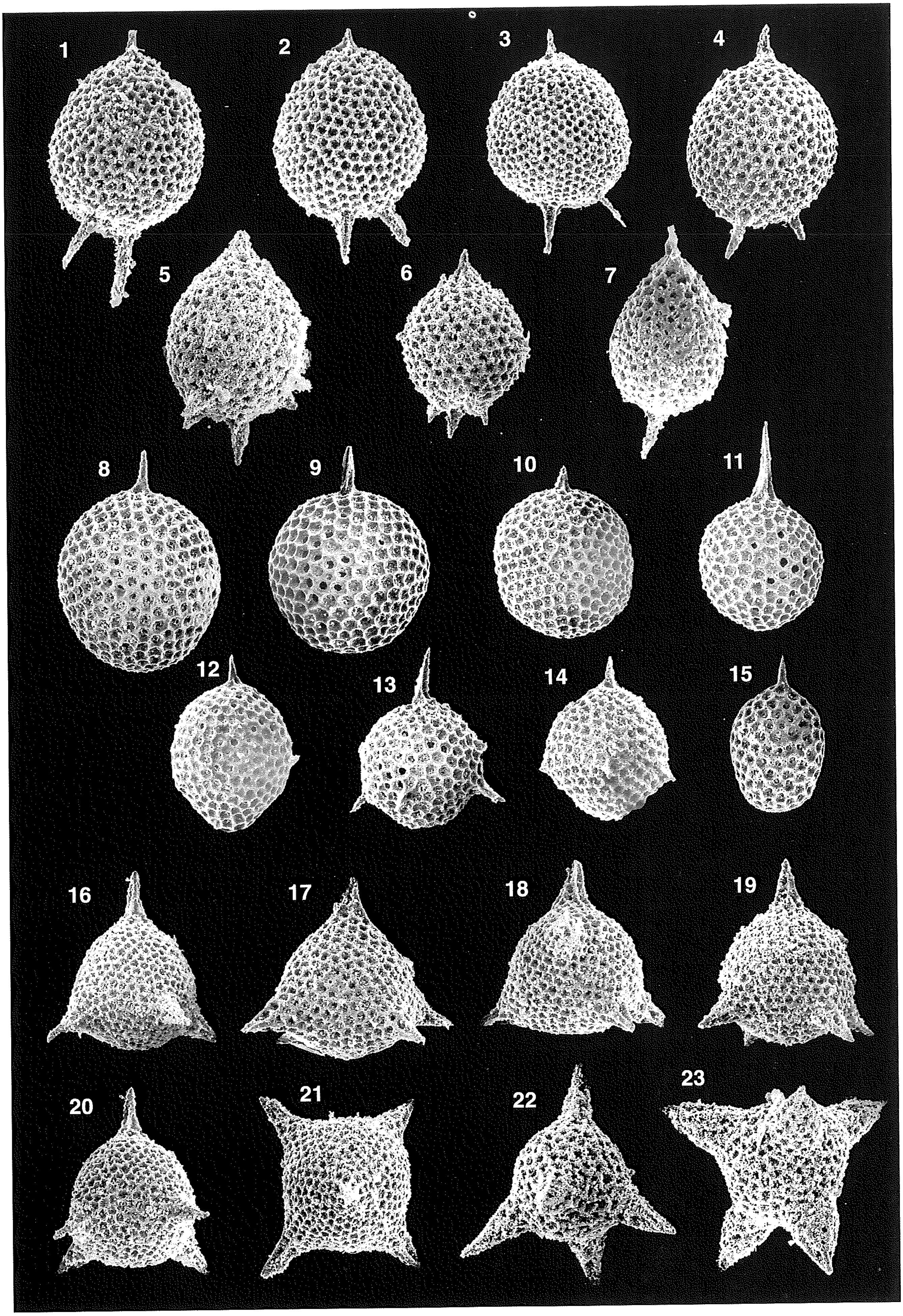
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PLATE 34

Figures 1-2 **Dorypyle ? anisa** (FOREMAN) x150 .... p. 206

1) 5583, from loc. no. Gb-84.40, early Cenomanian.
2) 5566, from loc. no. Gb-84.40, early Cenomanian.

Figures 3-4 **Trisyringium capellinii** VINASSA x200 .... p. 208

3) P-13, from loc. no. Pan-1, late Aptian.
4) R-40, from loc. no. Bo-617, late Barremian.

Figures 5-8 **Trisyringium echitonicum** (ALIEV) x150 .... p. 209

5) 774, from loc. no. Ap2 (-7.78), middle Albian.
6) 750, from loc. no. Ap2 (-7.78), middle Albian.
7) 2967, from loc. no. Bo-685.20, late Albian.
8) 772, from loc. no. Ap2 (-7.78), middle Albian.

Figures 9-14 **Cryptamphorella gilkeyi** (DUMITRICA) x200 .... p. 210

9) 9219, from loc. no. Ca1-22.30, early Aptian.
10) 9324, from loc. no. Ca1-22.30, early Aptian.
11) 8666, from loc. no. Ca1-22.30, early Aptian.
12) 9183, from loc. no. Ca1-22.30, early Aptian.
13) 9134, from loc. no. Ca1-22.30, early Aptian.
14) 9228, from loc. no. Ca1-22.30, early Aptian.

Figures 15-21 **Cryptamphorella crepida** nov. sp. x200 .... p. 210

15) 9242, from loc. no. Ca1-22.30, early Aptian.
16) 9020 (holotype), from loc. no. Ca1-22.30, early Aptian.
17) 9018, from loc. no. Ca1-22.30, early Aptian.
18) 9069, from loc. no. Ca1-22.30, early Aptian.
19) 9099, from loc. no. Ca1-22.30, early Aptian.
20) 9098, from loc. no. Ca1-22.30, early Aptian.
21) 9100, from loc. no. Ca1-22.30, early Aptian.

Plate 34

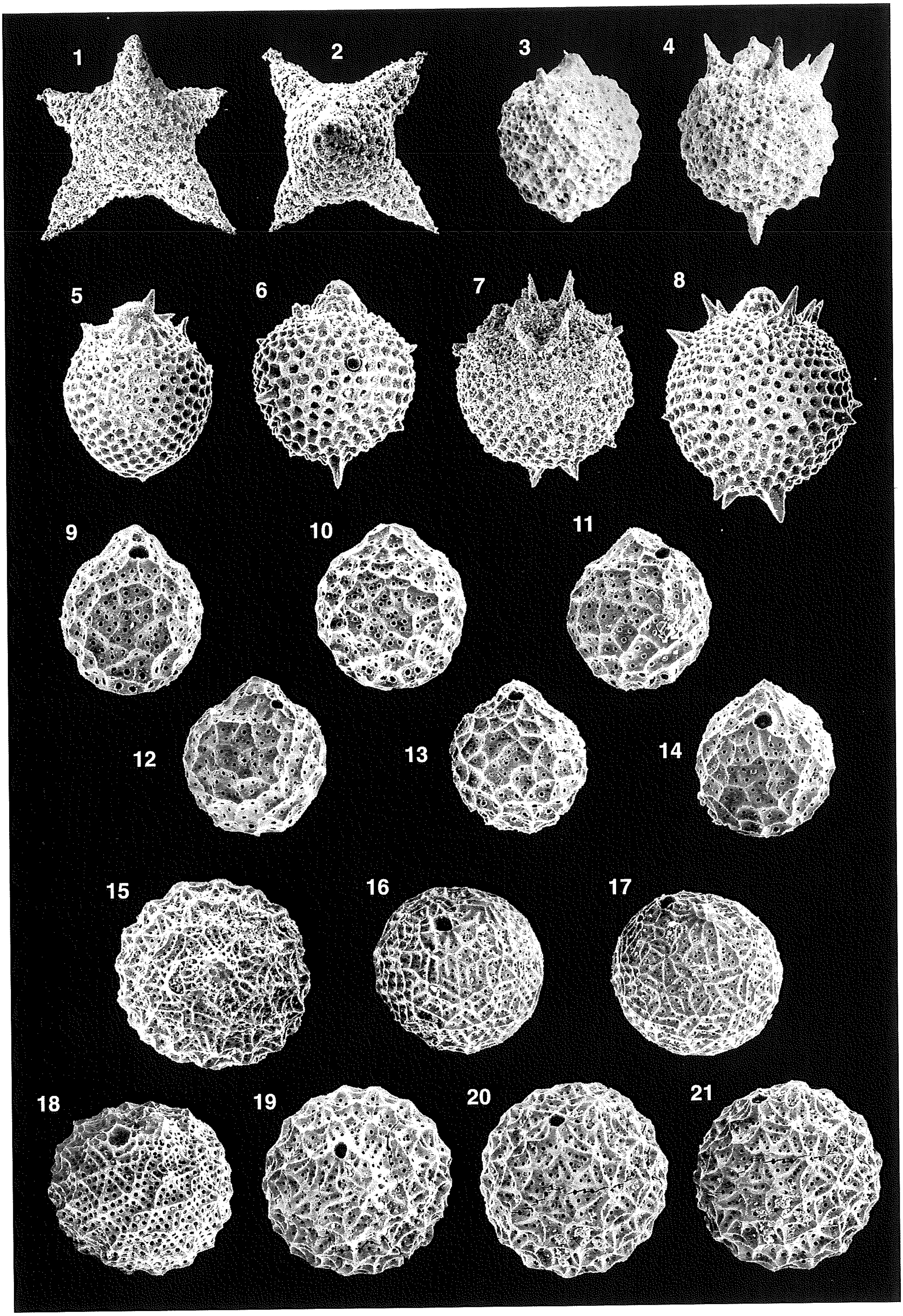

PLATE 35

Figures 1-8 **Cryptamphorella clivosa** (ALIEV) x200 .... p. 211

1) 9419, from loc. no. Ca1-26.05, early Aptian.
2) 9400, from loc. no. Ca1-26.05, early Aptian.
3) 8173, from loc. no. Ca1-22.30, early Aptian.
4) 8660, from loc. no. Ca1-22.30, early Aptian.
5) 8691, from loc. no. Ca1-22.30, early Aptian.
6) 9575, from loc. no. Ca1-26.05, early Aptian.
7) 8911, from loc. no. Ca1-22.30, early Aptian.
8) 9122, from loc. no. Ca1-22.30, early Aptian.

Figures 9-17 **Holocryptocapsa hindei** TAN x200 .... p. 212

9) 9061, from loc. no. Ca1-22.30, early Aptian.
10) 8815, from loc. no. Ca1-22.30, early Aptian.
11) 9252, from loc. no. Ca1-22.30, early Aptian.
12) 9167, from loc. no. Ca1-22.30, early Aptian.
13) 9037, from loc. no. Ca1-22.30, early Aptian.
14) 9251, from loc. no. Ca1-22.30, early Aptian.
15) 8928, from loc. no. Ca1-22.30, early Aptian.
16) 8161, from loc. no. Ca1-22.30, early Aptian.
17) 9255, from loc. no. Ca1-22.30, early Aptian.

Figures 18-21 **Holocryptocapsa fallax** (TAN) x200 .... p. 213

18) 9266, from loc. no. Ca1-22.30, early Aptian.
19) 9268, from loc. no. Ca1-22.30, early Aptian.
20) 8706, from loc. no. Ca1-22.30, early Aptian.
21) 8684, from loc. no. Ca1-22.30, early Aptian.

Figures 22-25 **Hemicryptocapsa prepolyhedra** DUMITRICA x200 .... p. 214

22) 4280, from loc. no. Gc-1094.48, late Cenomanian.
23) 4098, from loc. no. Gc-1094.48, late Cenomanian.
24) 6301, from loc. no. Asv-5-43, early Turonian.
25) 6915, from loc. no. Asv-5-43, early Turonian.

Figures 26-30 **Hemicryptocapsa polyhedra** DUMITRICA x120 .... p. 215

26) 6589, from loc. no. Asv-5-43, early Turonian.
27) 4701, from loc. no. Gc-1096.50, early Turonian.
28) 6227, from loc. no. Asv-5-43, early Turonian.
29) 6563, from loc. no. Asv-5-43, early Turonian.
30) 6208, from loc. no. Asv-5-43, early Turonian.

Plate 35

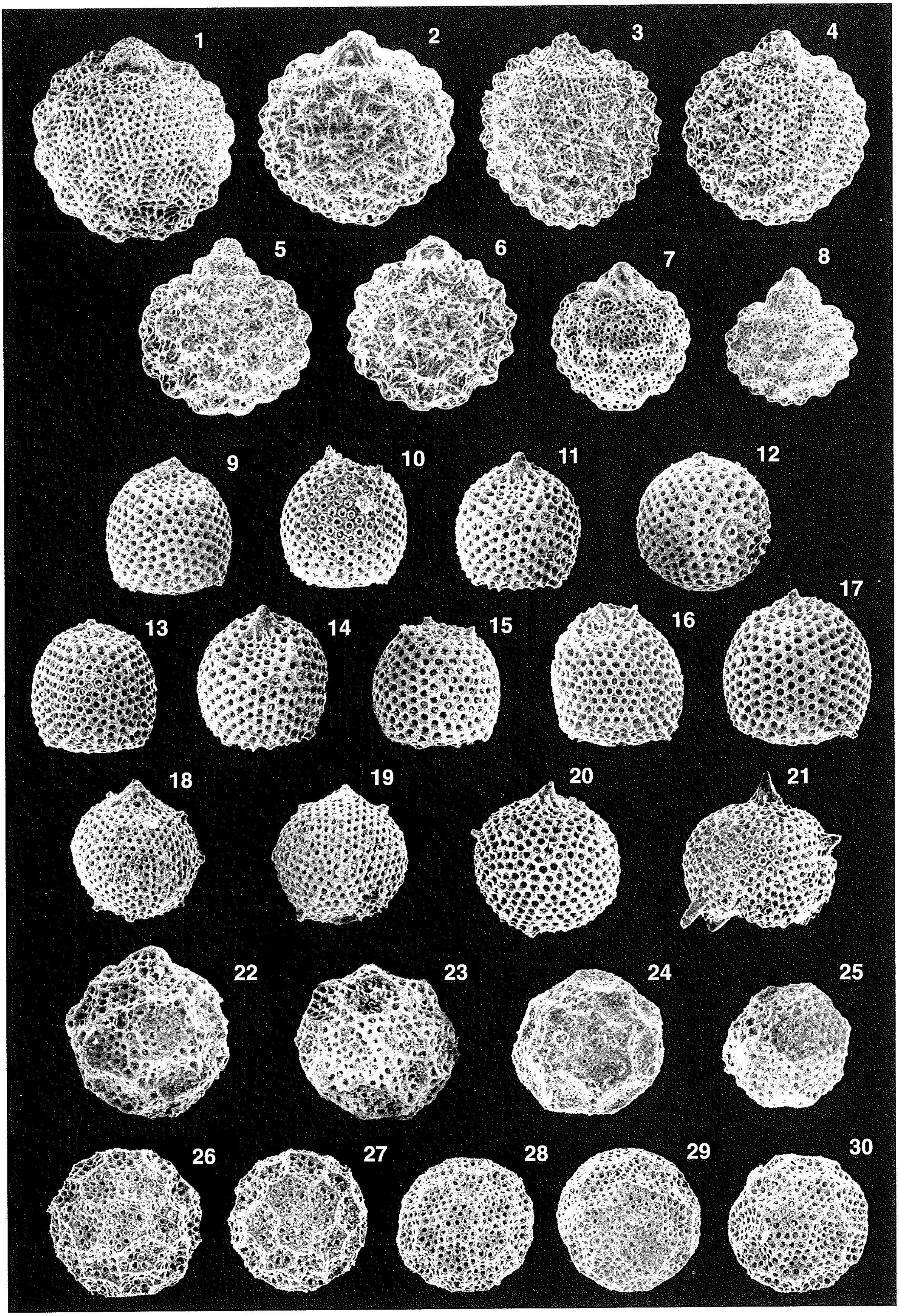
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PLATE 36

Figures 1-7 **Diacanthocapsa betica** nov. sp. x300 .... p. 216

1) 9967 (holotype), from loc. no. Mc-268b, middle Aptian.
2) 9960, from loc. no. Mc-268b, middle Aptian.
3) 9994, from loc. no. Mc-268b, middle Aptian.
4) 9902, from loc. no. Mc-268b, middle Aptian.
5) 10027, from loc. no. Mc-268b, middle Aptian.
6) 9472, from loc. no. Ca1-26.05, early Aptian.
7) 9653, from loc. no. Ca1-26.05, early Aptian.

Figures 8-11 **Diacanthocapsa fossilis** (SQUINABOL) x200 .... p. 217

8) 3498, from loc. no. Gc-1073.94, middle Cenomanian.
9) 3432, from loc. no. Gc-1073.94, middle Cenomanian.
10) 222, from loc. no. Ap2 (-7.78), middle Albian.
11) 906, from loc. no. Gc-1027.10, middle Albian.

Figures 12-18 **Diacanthocapsa rara** SQUINABOL x200 .... p. 218

12) 2988, from loc. no. Bo-685.20, late Albian.
13) 3388, from loc. no. Gc-1073.94, middle Cenomanian.
14) 3919, from loc. no. Gc-1073.94, middle Cenomanian.
15) 3404, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3501, from loc. no. Gc-1073.94, middle Cenomanian.
17) 4021, from loc. no. Gc-1073.94, middle Cenomanian.
18) 3414, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 19-21 **Diacanthocapsa euganea** SQUINABOL x250 .... p. 218

19) 4207, from loc. no. Gc-1094.48, late Cenomanian.
20) 3944, from loc. no. Gc-1073.94, middle Cenomanian.
21) 3946, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 22-24 **Diacanthocapsa matsumotoi** (TAKETANI) x200 .... p. 219

22) 4246, from loc. no. Gc-1094.48, late Cenomanian.
23) 4300, from loc. no. Gc-1094.48, late Cenomanian.
24) 7427, from loc. no. Gb-108.60, late Cenomanian.

Figures 25-28 **Diacanthocapsa antiqua** (SQUINABOL) x200 .... p. 220

25) 5061, from loc. no. Gc-1096.50, early Turonian.
26) 6835, from loc. no. Asv-5-43, early Turonian.
27) 5056, from loc. no. Gc-1096.50, early Turonian.
28) 4262, from loc. no. Gc-1094.48, late Cenomanian.

Plate 36

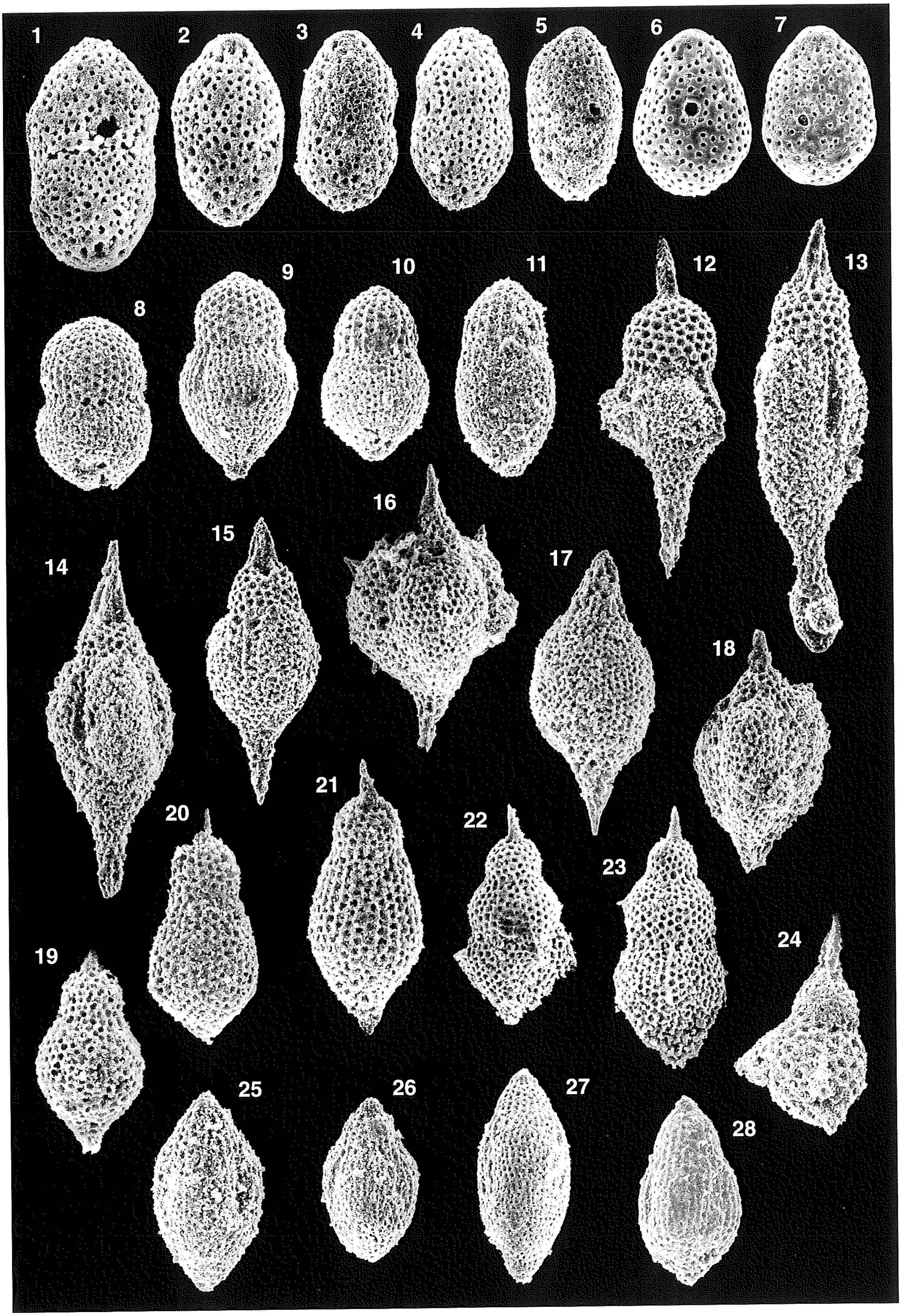

PLATE 37

Figures 1-6 **Diacanthocapsa ovoidea** DUMITRICA x200 .... p. 220

1) 4251, from loc. no. Gc-1094.48, late Cenomanian.
2) 5058, from loc. no. Gc-1096.50, early Turonian.
3) 3457, from loc. no. Gc-1073.94, middle Cenomanian.
4) 6333, from loc. no. Asv-5-43, early Turonian.
5) 5074, from loc. no. Gc-1096.50, early Turonian.
6) 6860, from loc. no. Asv-5-43, early Turonian.

Figures 7-11 **Diacanthocapsa brevithorax** DUMITRICA x250 .... p. 221

7) 5809, from loc. no. Asv-5-43, early Turonian.
8) 5986, from loc. no. Asv-5-43, early Turonian.
9) 6780, from loc. no. Asv-5-43, early Turonian.
10) 6342, from loc. no. Asv-5-43, early Turonian.
11) 4154, from loc. no. Gc-1094.48, late Cenomanian.

Figures 12-17 **Turbocapsula fugitiva** nov. sp. x200 .... p. 222

12) 9363, from loc. no. Ca1-22.30, early Aptian.
13) 9413, from loc. no. Ca1-26.05, early Aptian.
14) 9802 (holotype), from loc. no. Mc-268b, middle Aptian.
15) 9852, from loc. no. Mc-268b, middle Aptian.
16) 10133, from loc. no. Mc-268b, middle Aptian.
17) 10291, from loc. no. Mc-268b, middle Aptian.

Figures 18-23 **Turbocapsula giennensis** nov. sp. x300 .... p. 224

18) 8208, from loc. no. Ca1-22.30, early Aptian.
19) 8413, from loc. no. Ca1-22.30, early Aptian.
20) 8747, from loc. no. Ca1-22.30, early Aptian.
21) 8855, from loc. no. Ca1-22.30, early Aptian.
22) 9531, from loc. no. Ca1-26.05, early Aptian.
23) 9367 (holotype), from loc. no. Ca1-26.05, early Aptian.

Figures 24-30 **Turbocapsula costata** (WU) x200 .... p. 224

24) 9886, from loc. no. Mc-268b, middle Aptian.
25) 9855, from loc. no. Mc-268b, middle Aptian.
26) 10150, from loc. no. Mc-268b, middle Aptian.
27) 9998, from loc. no. Mc-268b, middle Aptian.
28) 9809, from loc. no. Mc-268b, middle Aptian.
29) 9950, from loc. no. Mc-268b, middle Aptian.
30) 9826, from loc. no. Mc-268b, middle Aptian.

Figures 31-35 **Guttacapsa biacuta** (SQUINABOL) x250 .... p. 226

31) 4152, from loc. no. Gc-1094.48, late Cenomanian.
32) 4151, from loc. no. Gc-1094.48, late Cenomanian.
33) 4227, from loc. no. Gc-1094.48, late Cenomanian.
34) 4122, from loc. no. Gc-1094.48, late Cenomanian.
35) 4071, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 37

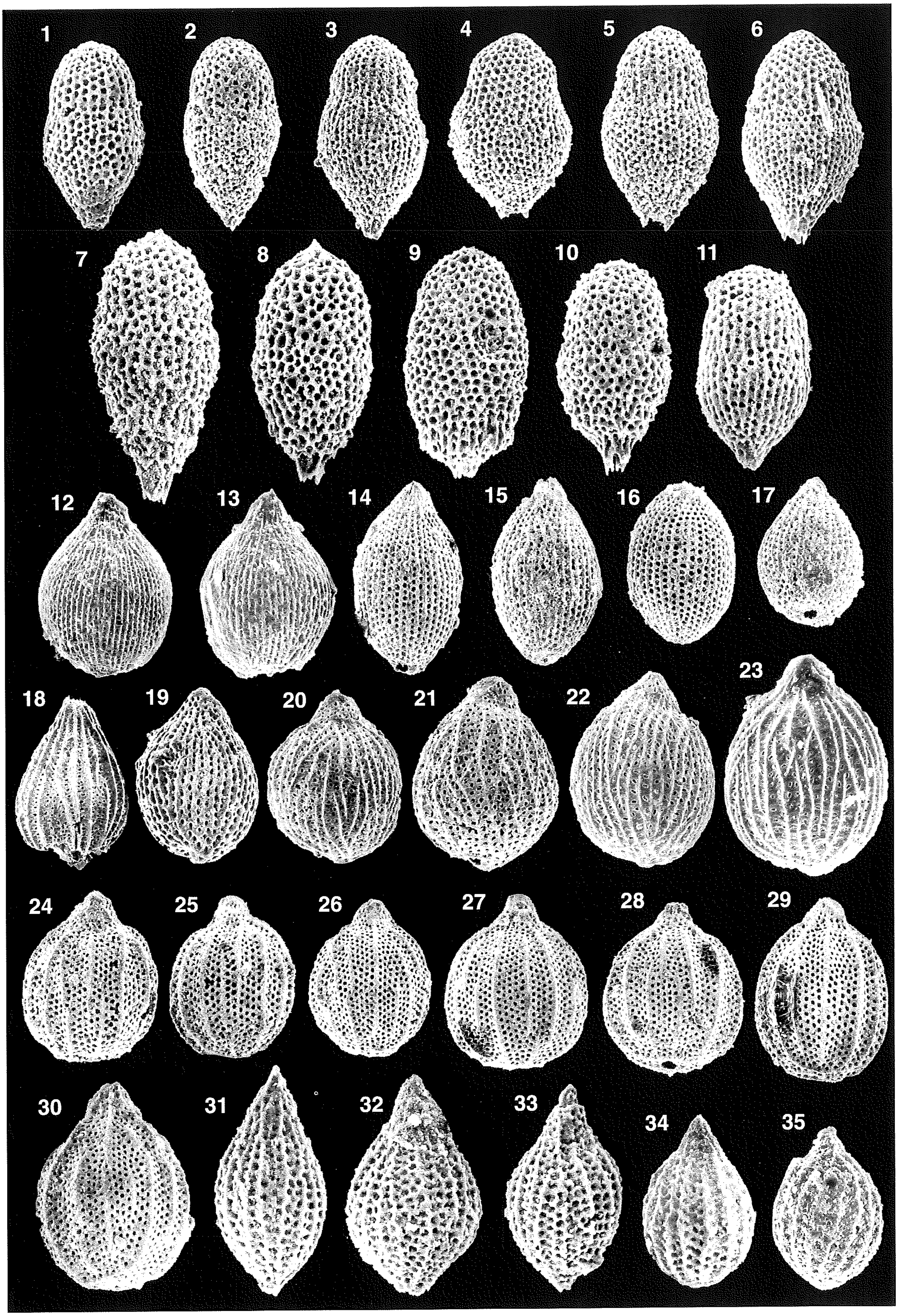
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PLATE 38

Figures 1-6 **Guttacapsa gutta** (SQUINABOL) x150 .... p. 227

1) 4112, from loc. no. Gc-1094.48, late Cenomanian.
2) 4116, from loc. no. Gc-1094.48, late Cenomanian.
3) 3514, from loc. no. Gc-1073.94, middle Cenomanian.
5) 4102, from loc. no. Gc-1094.48, late Cenomanian.
6) 4123, from loc. no. Gc-1094.48, late Cenomanian.

Figures 7-10 **Sciadiocapsa patera** nov. sp. x200 .... p. 228

7) R-450, from loc. no. Bo-566.50, early Barremian.
8) R-449 (holotype), from loc. no. Bo-566.50, early Barremian.
9) 10942, from loc. no. Pan-1, late Aptian.
10) 11024, from loc. no. Pan-1, late Aptian.

Figures 11-20 **Sciadiocapsa speciosa** (SQUINABOL) x130 .... p. 229

11) 3231, from loc. no. Bo-685.20, late Albian.
12) 2537, from loc. no. Gc-1035.10, late Albian.
13) 603, from loc. no. Ap2 (-7.78), middle Albian.
14) 950, from loc. no. Gc-1027.10, middle Albian.
15) 1449, from loc. no. Ap2-12, early Cenomanian.
16) 1433, from loc. no. Ap2-12, early Cenomanian.
17) 3485, from loc. no. Gc-1073.94, middle Cenomanian.
18) 3192, from loc. no. Bo-685.20, late Albian.
19) 3153, from loc. no. Bo-685.20, late Albian.
20) 3737, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 38

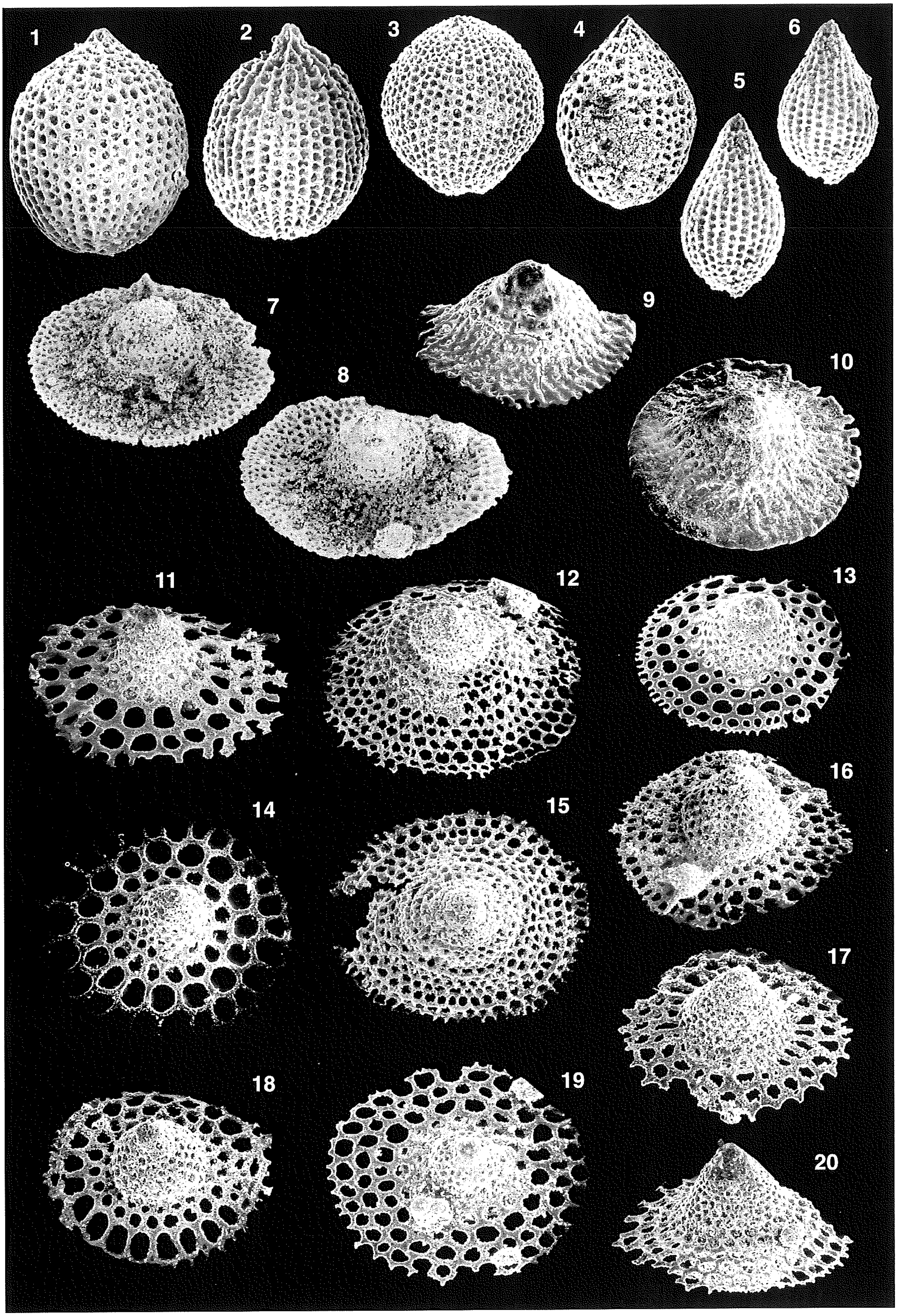

PLATE 39

Figures 1-8 **Sciadiocapsa pertica** nov. sp. x100 .... p. 230

1) 7299 (holotype), from loc. no. Gb-108.60, late Cenomanian.
2) 7507, from loc. no. Gb-108.60, late Cenomanian.
3) 7331, from loc. no. Gb-108.60, late Cenomanian.
4) 7508, from loc. no. Gb-108.60, late Cenomanian.
5) 7494, from loc. no. Gb-108.60, late Cenomanian.
6) 7527, from loc. no. Gb-108.60, late Cenomanian.
7) 7686, from loc. no. Gb-108.60, late Cenomanian.
8) 7356, from loc. no. Gb-108.60, late Cenomanian.

Figures 9-12 **Sciadiocapsa monticelloensis** (PESSAGNO) x130 .... p. 230

9) 7108, from loc. no. Asv-5-43, early Turonian.
10) 6143, from loc. no. Asv-5-43, early Turonian.
11) 6144, from loc. no. Asv-5-43, early Turonian.
12) 4958, from loc. no. Gc-1096.50, early Turonian.

Figures 13-15 **Sciadiocapsa elegans** (SQUINABOL) x150 .... p. 231

13) 210, from loc. no. Ap2 (-7.78), middle Albian.
14) 3150, from loc. no. Bo-685.20, late Albian.
15) 594, from loc. no. Ap2 (-7.78), middle Albian.

Figure 16 **Sciadiocapsa hibrida** nov. sp. x150 .... p. 232

16) 6761 (holotype), from loc. no. Asv-5-43, early Turonian.

Figures 17-21 **Sciadiocapsa euganea** SQUINABOL x200 .... p. 232

17) 5875, from loc. no. Asv-5-43, early Turonian.
18) 4991, from loc. no. Gc-1096.50, early Turonian.
19) 5803, from loc. no. Asv-5-43, early Turonian.
20) 6838, from loc. no. Asv-5-43, early Turonian.
21) 6649, from loc. no. Asv-5-43, early Turonian.

Plate 39

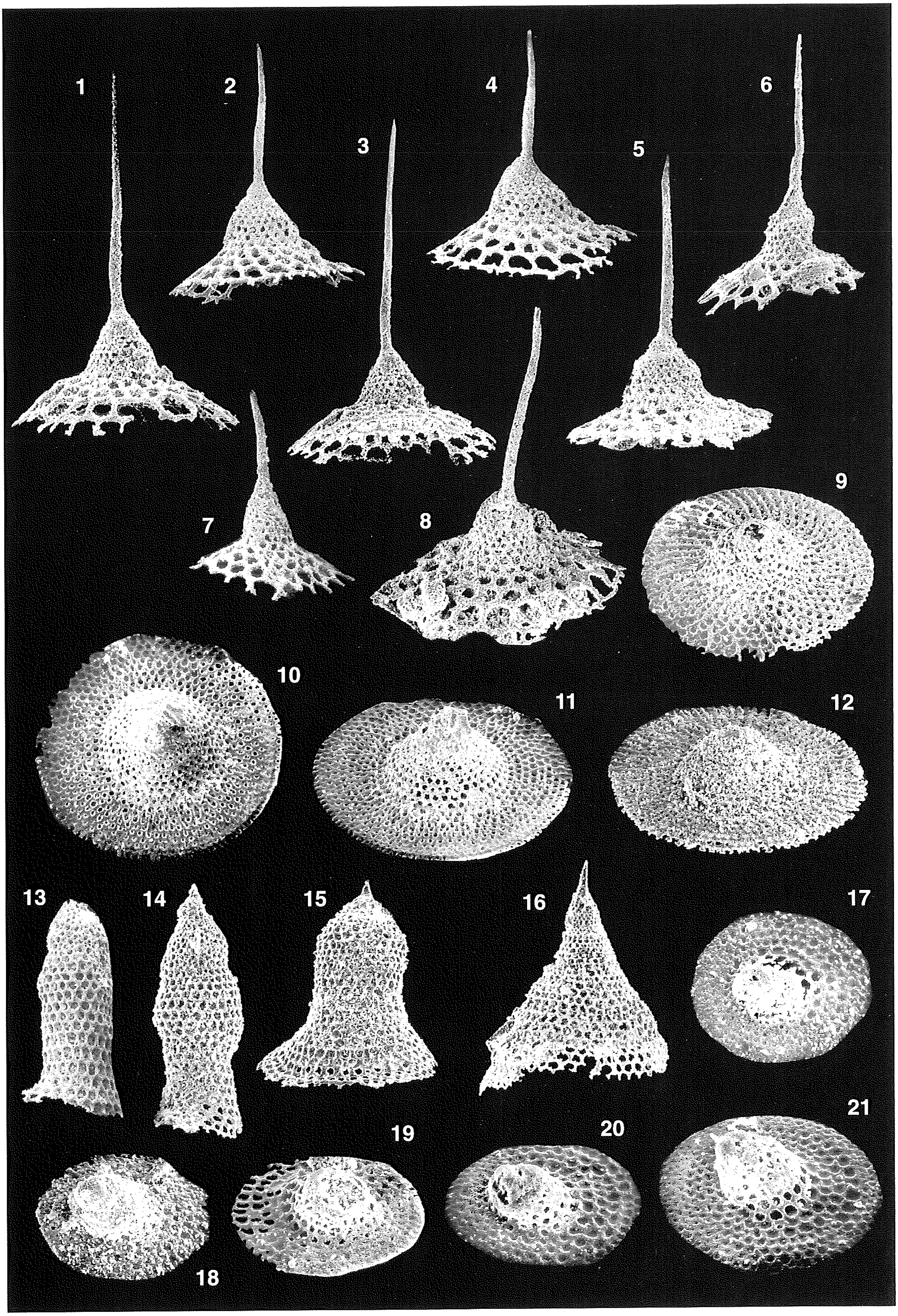

PLATE 40

Figures 1-5 **Sciadiocapsa radiata** (SQUINABOL) x130 .... p. 233

1) 4349, from loc. no. Gc-1096.50, early Turonian.
2) 3056, from loc. no. Bo-685.20, late Albian.
3) 4916, from loc. no. Gc-1096.50, early Turonian.
4) 1532, from loc. no. Ap2-12, early Cenomanian.
5) 3175, from loc. no. Bo-685.20, late Albian.

Figures 6-11 **Sciadiocapsa multiradiata** nom. nov. x200 .... p. 234

6) 6155, from loc. no. Asv-5-43, early Turonian.
7) 6154, from loc. no. Asv-5-43, early Turonian.
8) 6884, from loc. no. Asv-5-43, early Turonian.
9) 5210, from loc. no. Gc-1096.50, early Turonian.
10) 6729, from loc. no. Asv-5-43, early Turonian.
11) 6785, from loc. no. Asv-5-43, early Turonian.

Figures 12-14 **Rotaforma volatilis** nov. sp. x120 .... p. 238

12) 939, from loc. no. Gc-1027.10, middle Albian.
13) 2858, from loc. no. Bo-685.20, late Albian.
14) 3140 (holotype), from loc. no. Bo-685.20, late Albian.

Figures 15-19 **Rotaforma haeckeli** (SQUINABOL) x120 .... p. 239

15) 1236, from loc. no. Gc-1027.10, middle Albian.
16) 1461, from loc. no. Ap2-12, early Cenomanian.
17) 1747, from loc. no. Ap2-12, early Cenomanian.
18) 989, from loc. no. Gc-1027.10, middle Albian.
19) 1447, from loc. no. Ap2-12, early Cenomanian.

Figures 20-23 **Rotaforma mirabilis** PESSAGNO x150 .... p. 239

20) 7167, from loc. no. Gb-108.60, late Cenomanian.
21) 7503, from loc. no. Gb-108.60, late Cenomanian.
22) 2786, from loc. no. Bo-685.20, late Albian.
23) 3170, from loc. no. Bo-685.20, late Albian.

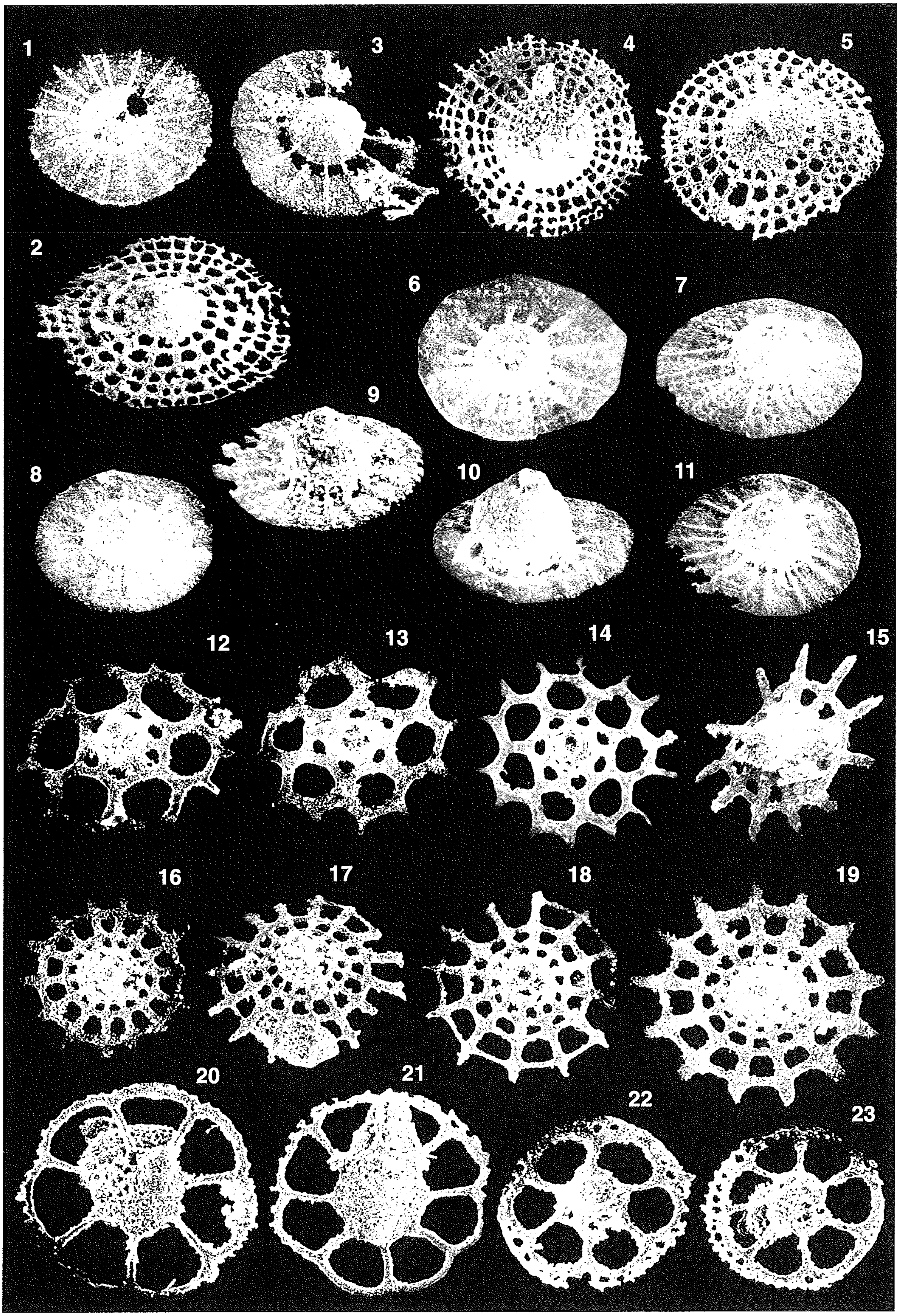
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PLATE 41

Figures 1-6 **Dictyodedalus acuticephalus** (SQUINABOL) x150 .... p. 236

1) 5365, from loc. no. Gb-84.40, early Cenomanian.
2) 3063, from loc. no. Bo-685.20, late Albian.
3) 930, from loc. no. Gc-1027.10, middle Albian.
4) 7486, from loc. no. Gb-108.60, late Cenomanian.
5) 525, from loc. no. Ap2 (-7.78), middle Albian.
6) 931, from loc. no. Gc-1027.10, middle Albian.

Figures 7-12 **Dictyodedalus hesperis** nov. sp. x150 .... p. 236

7) 11255, from loc. no. Fl-3-3, early Turonian.
8) 6220, from loc. no. Asv-5-43, early Turonian.
9) 6958, from loc. no. Asv-5-43, early Turonian.
10) 5024, from loc. no. Gc-1096.50, early Turonian.
11) 6379 (holotype), from loc. no. Asv-5-43, early Turonian.
12) 11303, from loc. no. Fl-4-21, early Turonian.

Figures 13-14 **Dictyodedalus cretaceus** (TAKETANI) x200 .... p. 237

13) 6418, from loc. no. Asv-5-43, early Turonian.
14) 6253, from loc. no. Asv-5-43, early Turonian.

Figures 15-23 **Ultranapora praespinifera** PESSAGNO x150 .... p. 241

15) 553, from loc. no. Ap2 (-7.78), middle Albian.
16) 98, from loc. no. Ap2 (-7.78), middle Albian.
17) 214, from loc. no. Ap2 (-7.78), middle Albian.
18) 535, from loc. no. Ap2 (-7.78), middle Albian.
19) 2807, from loc. no. Bo-685.20, late Albian.
20) 165, from loc. no. Ap2 (-7.78), middle Albian.
21) 562, from loc. no. Ap2 (-7.78), middle Albian.
22) 2711, from loc. no. Bo-685.20, late Albian.
23) 518, from loc. no. Ap2 (-7.78), middle Albian.

Plate 41

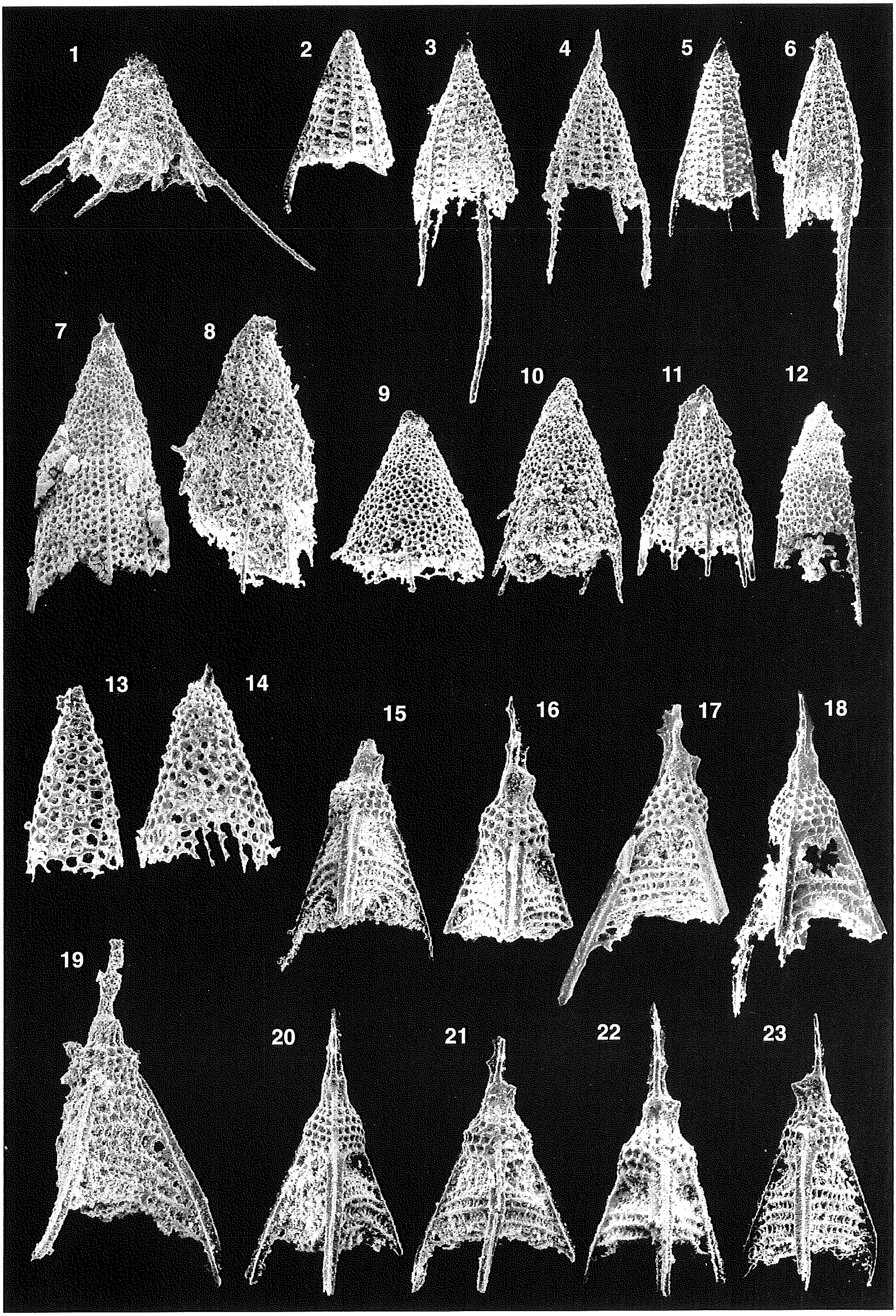

PLATE 42

Figures 1-5 **Ultranapora crassispina** (SQUINABOL) x150 .... p. 242

1) 2125, from loc. no. Gc-1035.10, late Albian.
2) 2217, from loc. no. Ap2 (-7.78), middle Albian.
3) 530, from loc. no. Ap2 (-7.78), middle Albian.
4) 970, from loc. no. Gc-1027.10, middle Albian.
5) 2973, from loc. no. Bo-685.20, late Albian.

Figures 6-9 **Ultranapora durhami** PESSAGNO x150 .... p. 242

6) 533, from loc. no. Ap2 (-7.78), middle Albian.
7) 3013, from loc. no. Bo-685.20, late Albian.
8) 538, from loc. no. Ap2 (-7.78), middle Albian.
9) 56, from loc. no. Ap2 (-7.78), middle Albian.

Figures 10-12 **Ultranapora dendroacanthos** (SQUINABOL) x200 .... p. 243

10) 5924, from loc. no. Asv-5-43, early Turonian.
11) 6555, from loc. no. Asv-5-43, early Turonian.
12) 6458, from loc. no. Asv-5-43, early Turonian.

Figures 13-18 **Ultranapora cretacea** (SQUINABOL) x150 .... p. 244

13) 5039, from loc. no. Gc-1096.50, early Turonian.
14) 6280, from loc. no. Asv-5-43, early Turonian.
15) 7161, from loc. no. Asv-5-43, early Turonian.
16) 6611, from loc. no. Asv-5-43, early Turonian.
17) 7112, from loc. no. Asv-5-43, early Turonian.
18) 5057, from loc. no. Gc-1096.50, early Turonian.

Figures 19-22 **Saitoum ? mercuriale** nov. sp. x200 .... p. 245

19) 642, from loc. no. Ap2 (-7.78), middle Albian.
20) 63, from loc. no. Ap2 (-7.78), middle Albian.
21) 557 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
22) 556, from loc. no. Ap2 (-7.78), middle Albian.

Figures 23-26 **Afens liriodes** RIEDEL & SANFILIPPO x150 .... p. 246

23) 6556, from loc. no. Asv-5-43, early Turonian.
24) 6533, from loc. no. Asv-5-43, early Turonian.
25) 5824, from loc. no. Asv-5-43, early Turonian.
26) 6140, from loc. no. Asv-5-43, early Turonian.

Figures 27-28 **Eribotrys ? sp. 1** x150 .... p. 247

27) 2257, from loc. no. Gc-1035.10, late Albian.
28) 343, from loc. no. Ap2 (-7.78), middle Albian.

Figures 29-30 **Eribotrys ? sp. 2** x150 .... p. 247

29) 1438, from loc. no. Ap2-12, early Cenomanian.
30) 3061, from loc. no. Bo-685.20, late Albian.

Plate 42

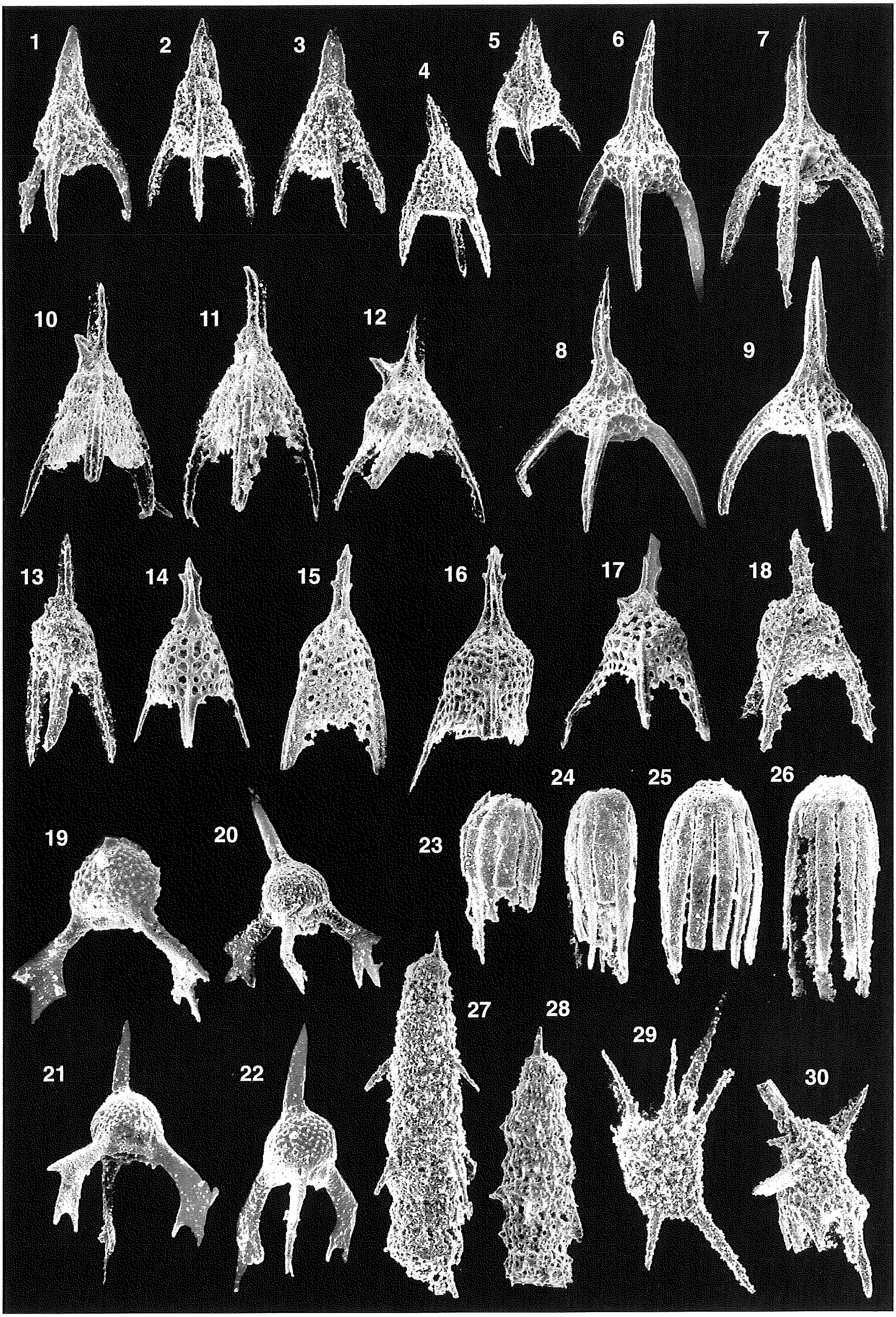
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PLATE 43

Figures 1-3 **Dicerosaturnalis amissus** (SQUINABOL) x100 .... p. 248

1) 11742, from loc. no. Gc-911.35, late Aptian.
2) 11719, from loc. no. Gc-911.35, late Aptian.
3) 11722, from loc. no. Gc-911.35, late Aptian.

Figure 4 **Aurisaturnalis carinatus** (FOREMAN) x100 .... p. 250

4) R-3956, from loc. no. Bo-581.65, early Barremian.

Figures 5-7 **Acanthocircus levis** (DONOFRIO & MOSTLER) x120 .... p. 251

5) 1273, from loc. no. Gc-1027.10, middle Albian.
6) 624, from loc. no. Ap2 (-7.78), middle Albian.
7) 1, from loc. no. Ap2 (-7.78), middle Albian.

Figures 8-13 **Acanthocircus dendroacanthos** SQUINABOL x120 .... p. 252

8) 3283, from loc. no. Bo-685.20, late Albian.
9) 3156, from loc. no. Bo-685.20, late Albian.
10) 3163, from loc. no. Bo-685.20, late Albian.
11) 1409, from loc. no. Gc-1027.10, middle Albian.
12) 1268, from loc. no. Gc-1027.10, middle Albian.
13) 1292, from loc. no. Gc-1027.10, middle Albian.

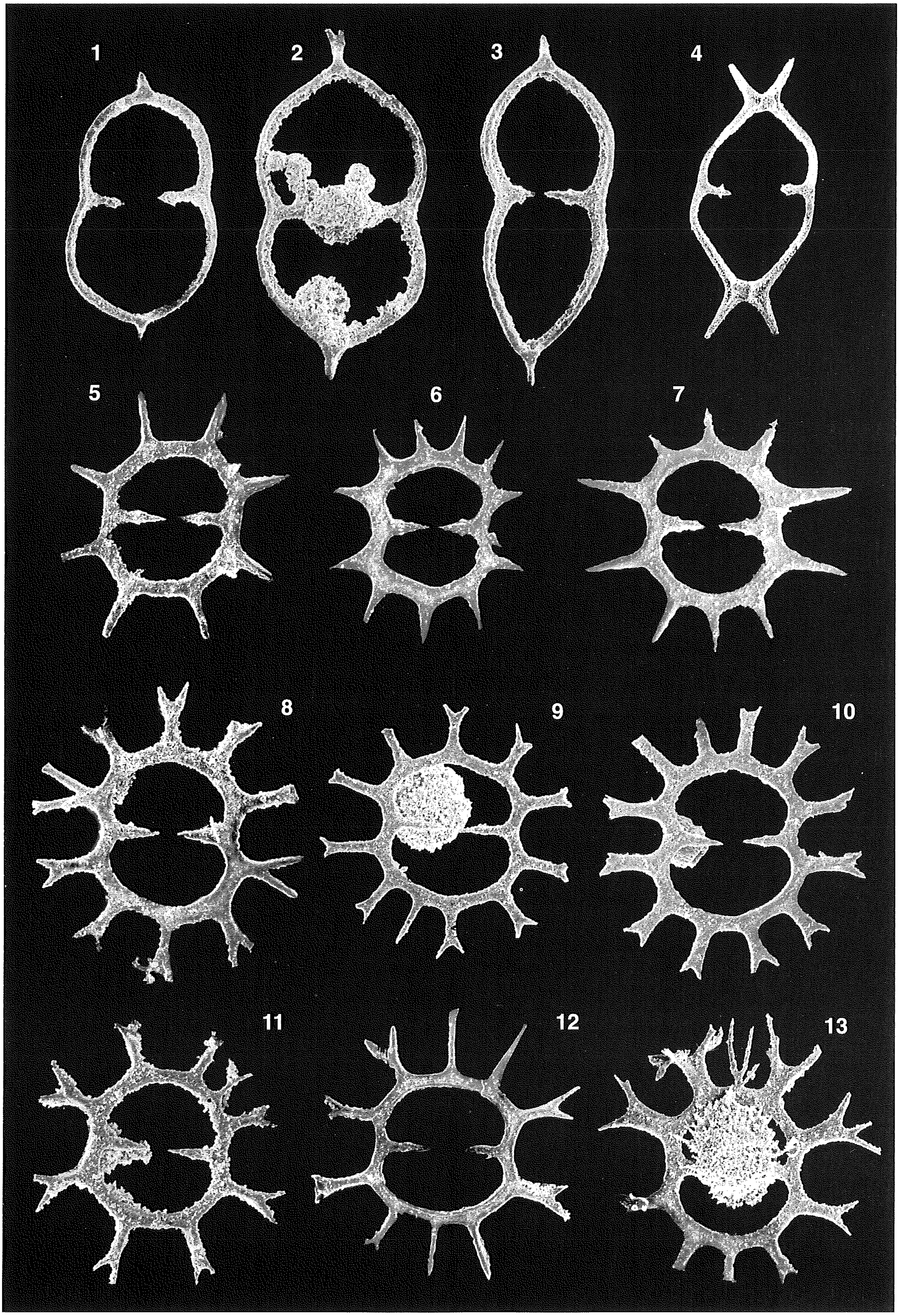
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PLATE 44

Figures 1-6 **Acanthocircus horridus** SQUINABOL x100 .... p. 253

1) 2281, from loc. no. Gc-1035.10, late Albian.
2) 2240, from loc. no. Gc-1035.10, late Albian.
3) 2214, from loc. no. Gc-1035.10, late Albian.
4) 2233, from loc. no. Gc-1035.10, late Albian.
5) 2248, from loc. no. Gc-1035.10, late Albian.
6) 2196, from loc. no. Gc-1035.10, late Albian.

Figures 7-10 **Acanthocircus multidentatus** (SQUINABOL) x75 .... p. 255

7) 2289, from loc. no. Gc-1035.10, late Albian.
8) 3282, from loc. no. Bo-685.20, late Albian.
9) 1269, from loc. no. Gc-1027.10, middle Albian.
10) 6037, from loc. no. Asv-5-43, early Turonian.

Figures 11-15 **Acanthocircus angustus** DONOFRIO & MOSTLER x75 .... p. 254

11) 2292, from loc. no. Gc-1035.10, late Albian.
12) 3171, from loc. no. Bo-685.20, late Albian.
13) 1263, from loc. no. Gc-1027.10, middle Albian.
14) 3194, from loc. no. Bo-685.20, late Albian.
15) 3036, from loc. no. Bo-685.20, late Albian.

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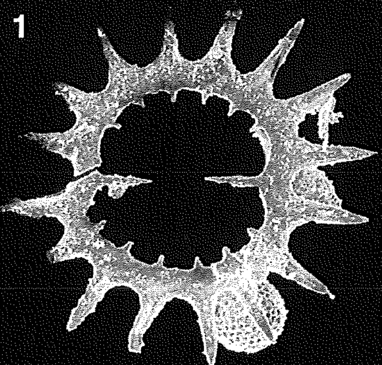

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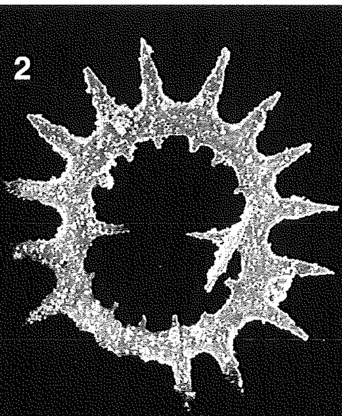

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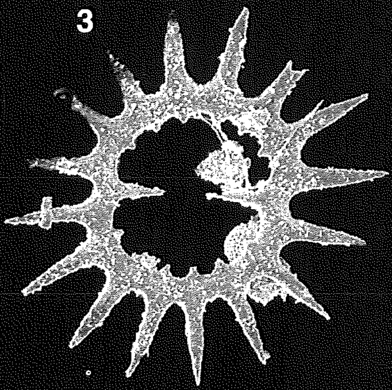

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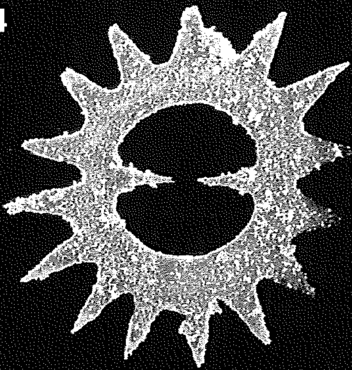

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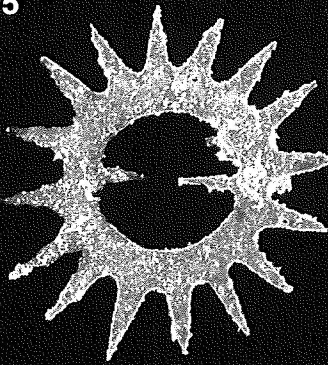

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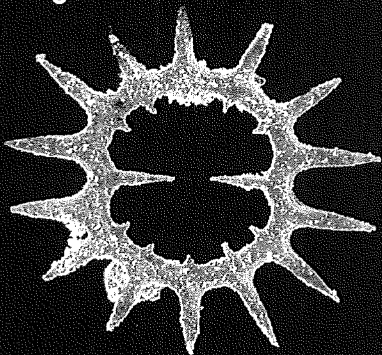

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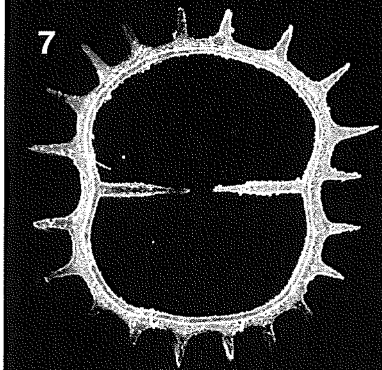

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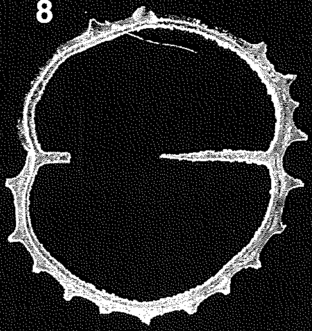

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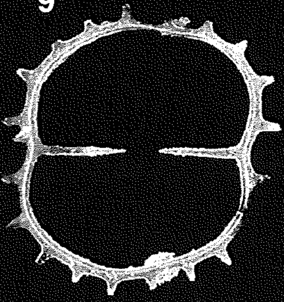

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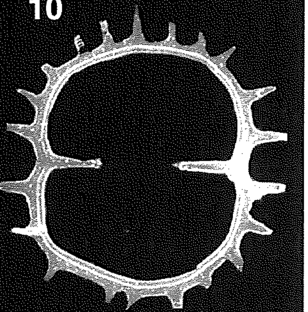

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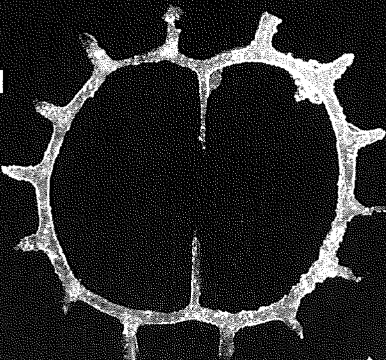

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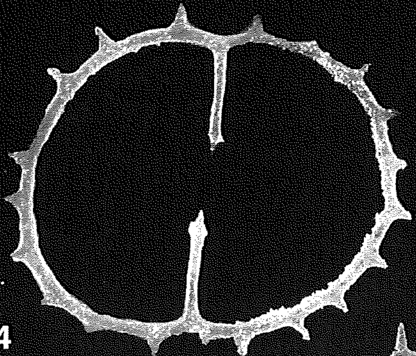

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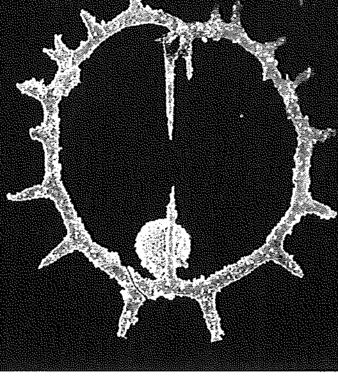

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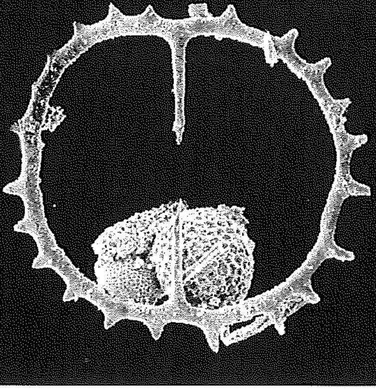

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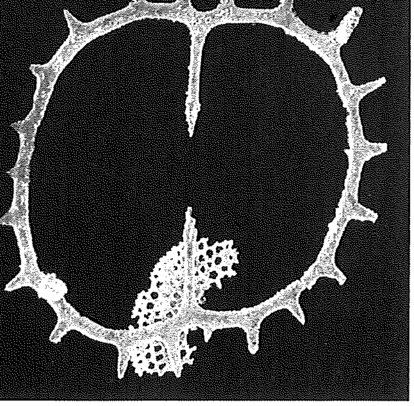

PLATE 45

Figures 1-8 **Acanthocircus venetus** (SQUINABOL) x130 .... p. 256

1) 11331, from loc. no. Fl-4-21, early Turonian.
2) 5169, from loc. no. Gc-1096.50, early Turonian.
3) 5172, from loc. no. Gc-1096.50, early Turonian.
4) 5174, from loc. no. Gc-1096.50, early Turonian.
5) 7026, from loc. no. Asv-5-43, early Turonian.
6) 7654, from loc. no. Gb-108.60, late Cenomanian.
7) 1780, from loc. no. Ap2-12, early Cenomanian.
8) 5156, from loc. no. Gc-1096.50, early Turonian.

Figures 9-13 **Acanthocircus bestiarius** nov. sp. x100 .... p. 257

9) 7016 (holotype), from loc. no. Asv-5-43, early Turonian.
10) 11279, from loc. no. Fl-3-3, early Turonian.
11) 5126, from loc. no. Gc-1096.50, early Turonian.
12) 5138, from loc. no. Gc-1096.50, early Turonian.
13) 6063, from loc. no. Asv-5-43, early Turonian.

Figures 14-16 **Acanthocircus euganeus** (SQUINABOL) x100 .... p. 257

14) 5142, from loc. no. Gc-1096.50, early Turonian.
15) 5159, from loc. no. Gc-1096.50, early Turonian.
16) 5175, from loc. no. Gc-1096.50, early Turonian.

Figures 17-24 **Acanthocircus tympanum** nov. sp. x100 .... p. 259

17) 6769 (holotype), from loc. no. Asv-5-43, early Turonian.
18) 6278, from loc. no. Asv-5-43, early Turonian.
19) 5185, from loc. no. Gc-1096.50, early Turonian.
20) 6524, from loc. no. Asv-5-43, early Turonian.
21) 6408, from loc. no. Asv-5-43, early Turonian.
22) 6407, from loc. no. Asv-5-43, early Turonian.
23) 6771, from loc. no. Asv-5-43, early Turonian.
24) 5170, from loc. no. Gc-1096.50, early Turonian.

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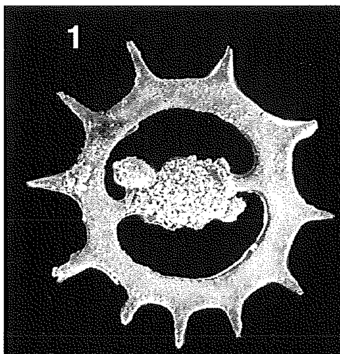

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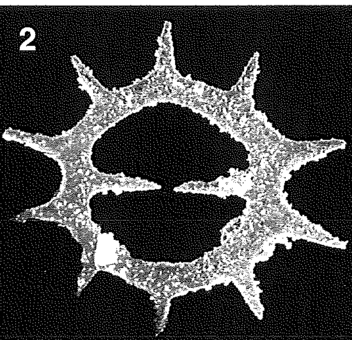

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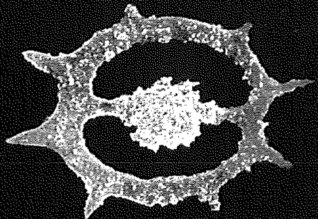

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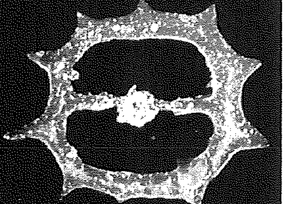

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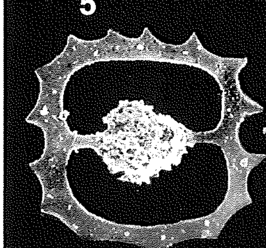

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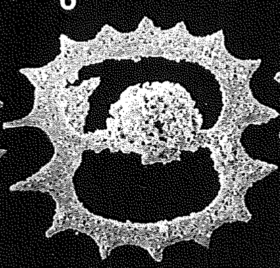

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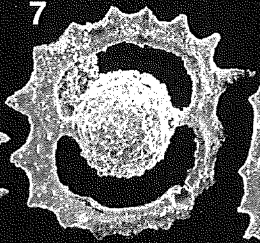

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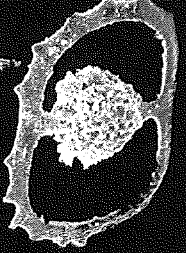

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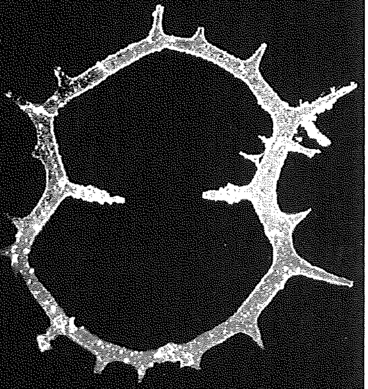

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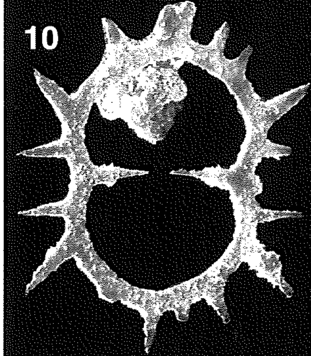

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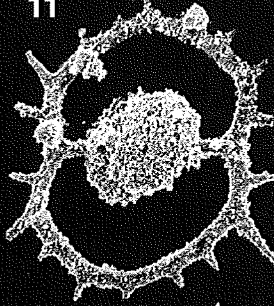

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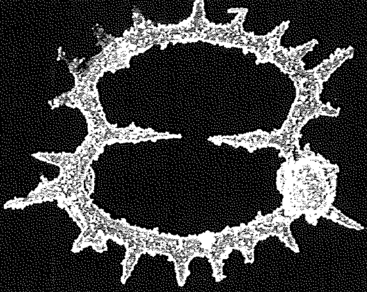

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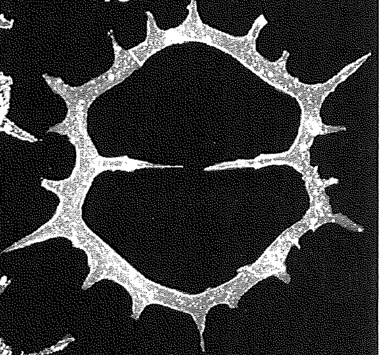

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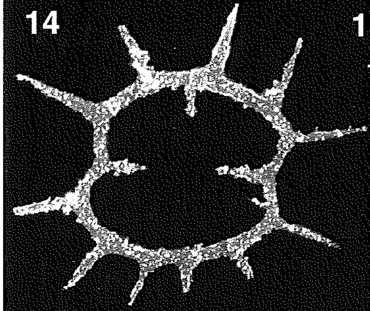

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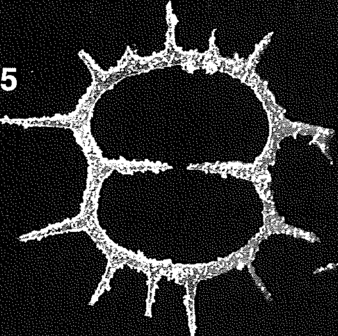

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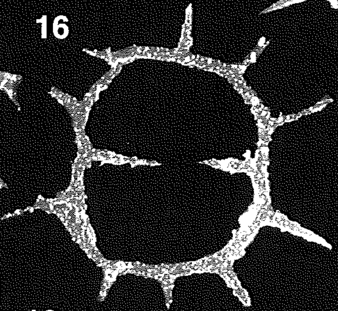

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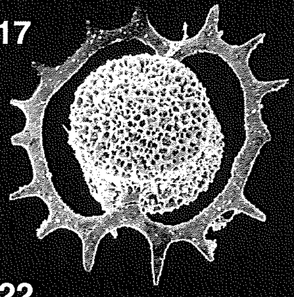

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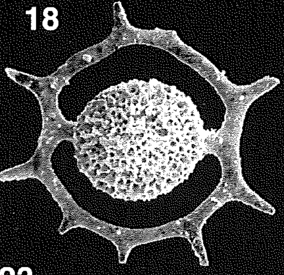

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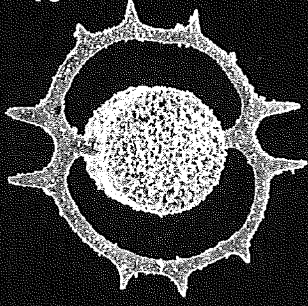

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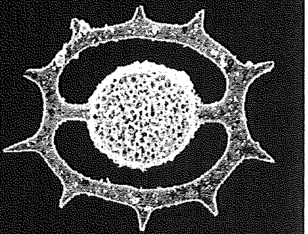

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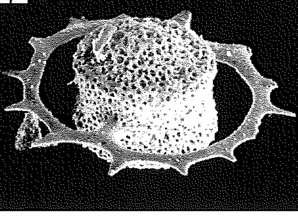

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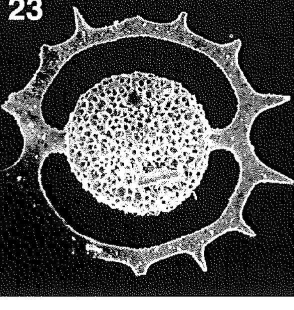

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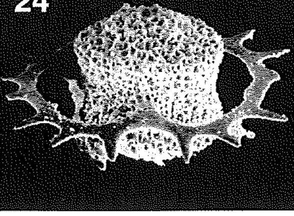

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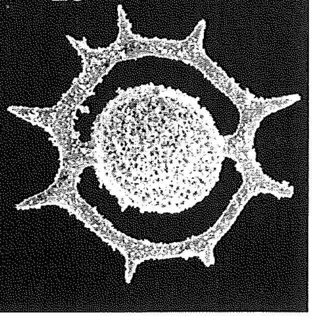

PLATE 46

Figures 1-5 **Acanthocircus hueyi** (PESSAGNO) x100 .... p. 260

1) 6062, from loc. no. Asv-5-43, early Turonian.
2) 11413, from loc. no. E-12, early Turonian.
3) 7148, from loc. no. Asv-5-43, early Turonian.
4) 6766, from loc. no. Asv-5-43, early Turonian.
5) 5976, from loc. no. Asv-5-43, early Turonian.

Figures 6-9 **Acanthocircus impolitus** nov. sp. x120 .... p. 261

6) 5176, from loc. no. Gc-1096.50, early Turonian.
7) 583 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
8) 2806, from loc. no. Bo-685.20, late Albian.
9) 11284, from loc. no. Fl-3-3, early Turonian.

Figures 10-12 **Acanthocircus ellipticus** (SQUINABOL) x130 .... p. 261

10) 2822, from loc. no. Bo-685.20, late Albian.
11) 3007, from loc. no. Bo-685.20, late Albian.
12) 3213, from loc. no. Bo-685.20, late Albian.

Figures 13-14 **Acanthocircus floridus** nov. sp. x150 .... p. 262

13) 7772, from loc. no. Gb-108.60, late Cenomanian.
14) 1351 (holotype), from loc. no. Gc-1027.10, middle Albian.

Figures 15-16 **Acanthocircus nanus** nov. sp. x150 .... p. 263

15) 5152 (holotype), from loc. no. Gc-1096.50, early Turonian.
16) 6715, from loc. no. Asv-5-43, early Turonian.

Figures 17-25 **Acanthocircus irregularis** SQUINABOL x100 .... p. 264

17) 3978, from loc. no. Gc-1073.94, middle Cenomanian.
18) 2286, from loc. no. Gc-1035.10, late Albian.
19) 7574, from loc. no. Gb-108.60, late Cenomanian.
20) 2273, from loc. no. Gc-1035.10, late Albian.
21) 7870, from loc. no. Gb-108.60, late Cenomanian.
22) 4000, from loc. no. Gc-1073.94, middle Cenomanian.
23) 3980, from loc. no. Gc-1073.94, middle Cenomanian.
24) 3989, from loc. no. Gc-1073.94, middle Cenomanian.
25) 3985, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 46

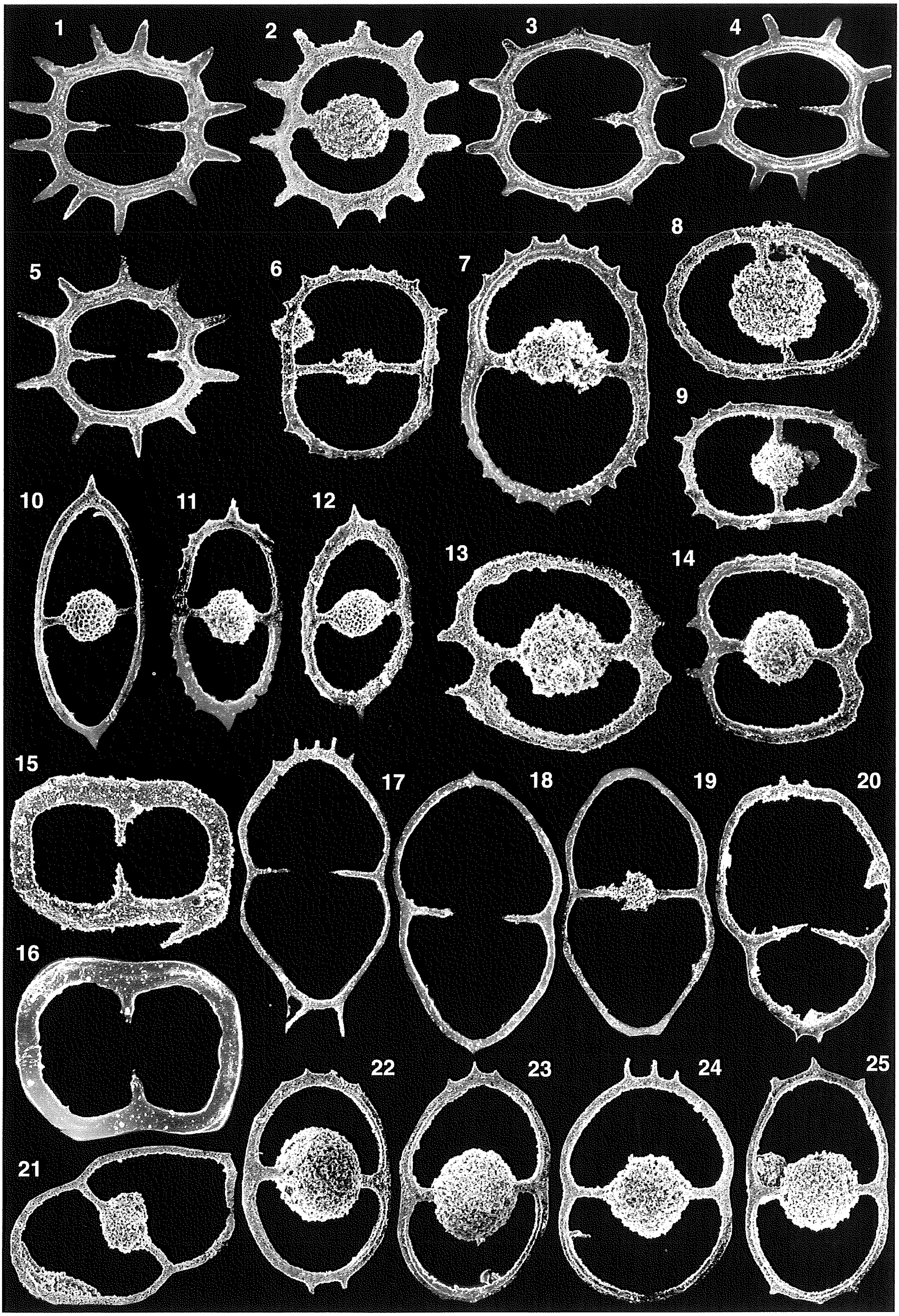

PLATE 47

Figures 1-3 **Acanthocircus subquadratus** (DONOFRIO & MOSTLER) x200 .... p. 263

1) 7152, from loc. no. Asv-5-43, early Turonian.
2) 7150, from loc. no. Asv-5-43, early Turonian.
3) 7151, from loc. no. Asv-5-43, early Turonian.

Figures 4-7 **Vitorfus minimus** (SQUINABOL) x150 .... p. 266

4) 11330, from loc. no. Fl-4-21, early Turonian.
5) 6221, from loc. no. Asv-5-43, early Turonian.
6) 6098, from loc. no. Asv-5-43, early Turonian.
7) 5186, from loc. no. Gc-1096.50, early Turonian.

Figures 8-11 **Vitorfus brustolensis** (SQUINABOL) x150 .... p. 266

8) 3158, from loc. no. Bo-685.20, late Albian.
9) 3991, from loc. no. Gc-1073.94, middle Cenomanian.
10) 7488, from loc. no. Gb-108.60, late Cenomanian.
11) 7489, from loc. no. Gb-108.60, late Cenomanian.

Figures 12-15 **Vitorfus morini** EMPSON-MORIN x150 .... p. 267

12) 11419, from loc. no. E-12, early Turonian.
13) 11430, from loc. no. E-12, early Turonian.
14) 11401, from loc. no. E-12, early Turonian.
15) 5921, from loc. no. Asv-5-43, early Turonian.

Figures 16-20 **Vitorfus campbelli** PESSAGNO x150 .... p. 265

16) 11258, from loc. no. Fl-3-3, early Turonian.
17) 5782, from loc. no. Asv-5-43, early Turonian.
18) 1746, from loc. no. Ap2-12, early Cenomanian.
19) 5191, from loc. no. Gc-1096.50, early Turonian.
20) 1788, from loc. no. Ap2-12, early Cenomanian.

Figures 21-24 **Quinquecapsularia ombonii** (SQUINABOL) x150 .... p. 268

21) 3735, from loc. no. Gc-1073.94, middle Cenomanian.
22) 1497, from loc. no. Ap2-12, early Cenomanian.
23) 762, from loc. no. Ap2 (-7.78), middle Albian.
24) 419, from loc. no. Ap2 (-7.78), middle Albian.

Figures 25-28 **Quinquecapsularia parvipora** (SQUINABOL) x100 .... p. 269

25) 5451, from loc. no. Gb-84.40, early Cenomanian.
26) 2190, from loc. no. Gc-1035.10, late Albian.
27) 3478, from loc. no. Gc-1073.94, middle Cenomanian.
28) 4390, from loc. no. Gc-1096.50, early Turonian.

Plate 47

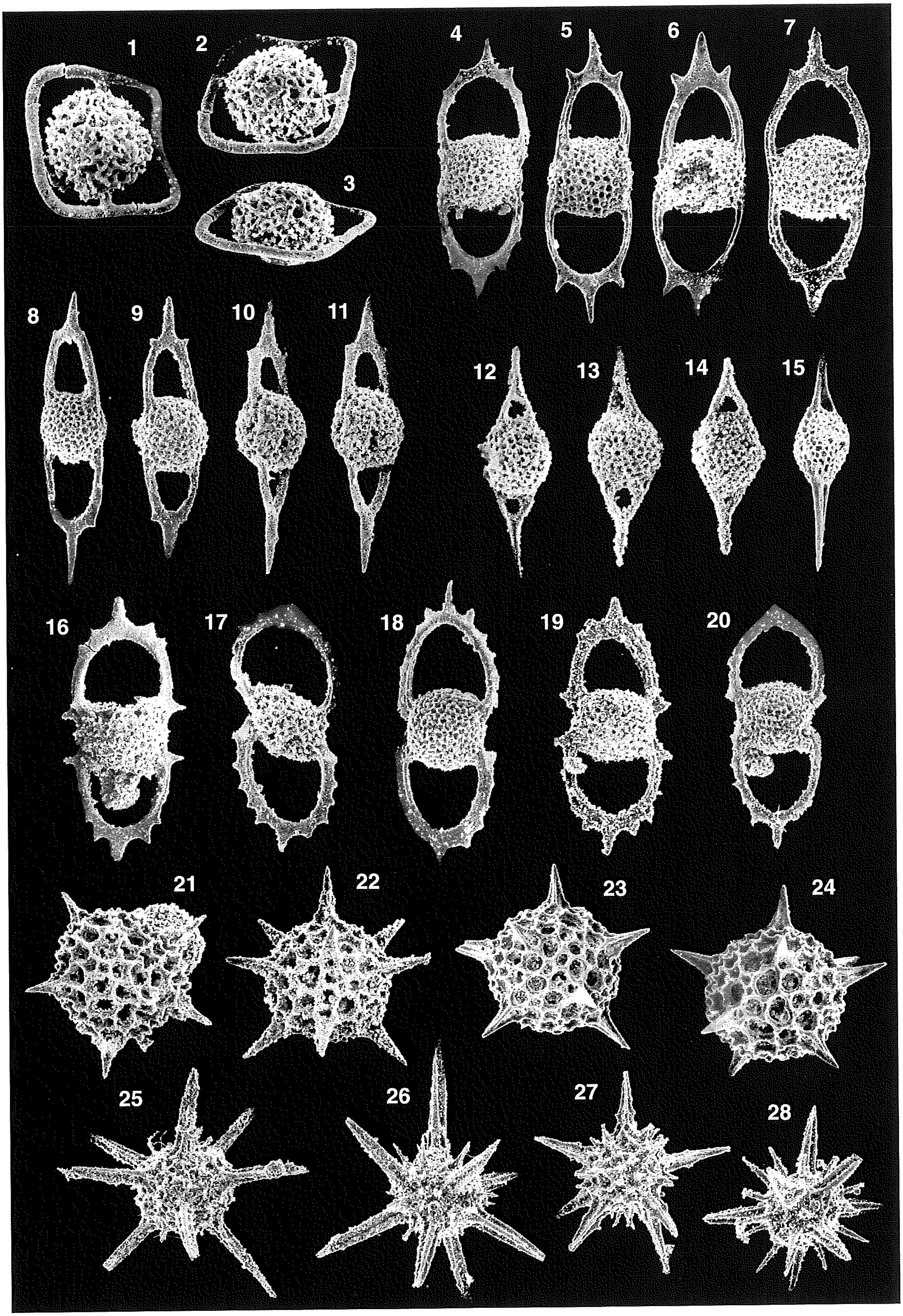

PLATE 48

Figures 1-5 **Quinquecapsularia grandiloqua** nov. sp. x200 .... p. 270

1) 5831 (holotype), from loc. no. Asv-5-43, early Turonian.
2) 6070, from loc. no. Asv-5-43, early Turonian.
3) 5821, from loc. no. Asv-5-43, early Turonian.
4) 6541, from loc. no. Asv-5-43, early Turonian.
5) 7123, from loc. no. Asv-5-43, early Turonian.

Figures 6-10 **Quinquecapsularia panacea** nov. sp. x150 .... p. 270

6) 5904, from loc. no. Asv-5-43, early Turonian.
7) 6226, from loc. no. Asv-5-43, early Turonian.
8) 6901, from loc. no. Asv-5-43, early Turonian.
9) 6288 (holotype), from loc. no. Asv-5-43, early Turonian.
10) 5822, from loc. no. Asv-5-43, early Turonian.

Figures 11-15 **Falsocromyodrymus mirabilis** (SQUINABOL) x100 .... p. 272

11) 1232, from loc. no. Gc-1027.10, middle Albian.
12) 2092, from loc. no. Gc-1035.10, late Albian.
13) 1865, from loc. no. Gc-1035.10, late Albian.
14) 2221, from loc. no. Gc-1035.10, late Albian.
15) 1851, from loc. no. Gc-1035.10, late Albian.

Figures 16-19 **Falsocromyodrymus ? fragosus** nov. sp. x120 .... p. 272

16) 2197 (holotype), from loc. no. Gc-1035.10, late Albian.
17) 1862, from loc. no. Gc-1035.10, late Albian.
18) 1061, from loc. no. Gc-1027.10, middle Albian.
19) 1060, from loc. no. Gc-1027.10, middle Albian.

Figures 20-23 **Falsocromyodrymus ? nebulosus** nov. sp. x200 .... p. 275

20) 6857 (holotype), from loc. no. Asv-5-43, early Turonian.
21) 6850, from loc. no. Asv-5-43, early Turonian.
22) 6855, from loc. no. Asv-5-43, early Turonian.
23) 7034, from loc. no. Asv-5-43, early Turonian.

Plate 48

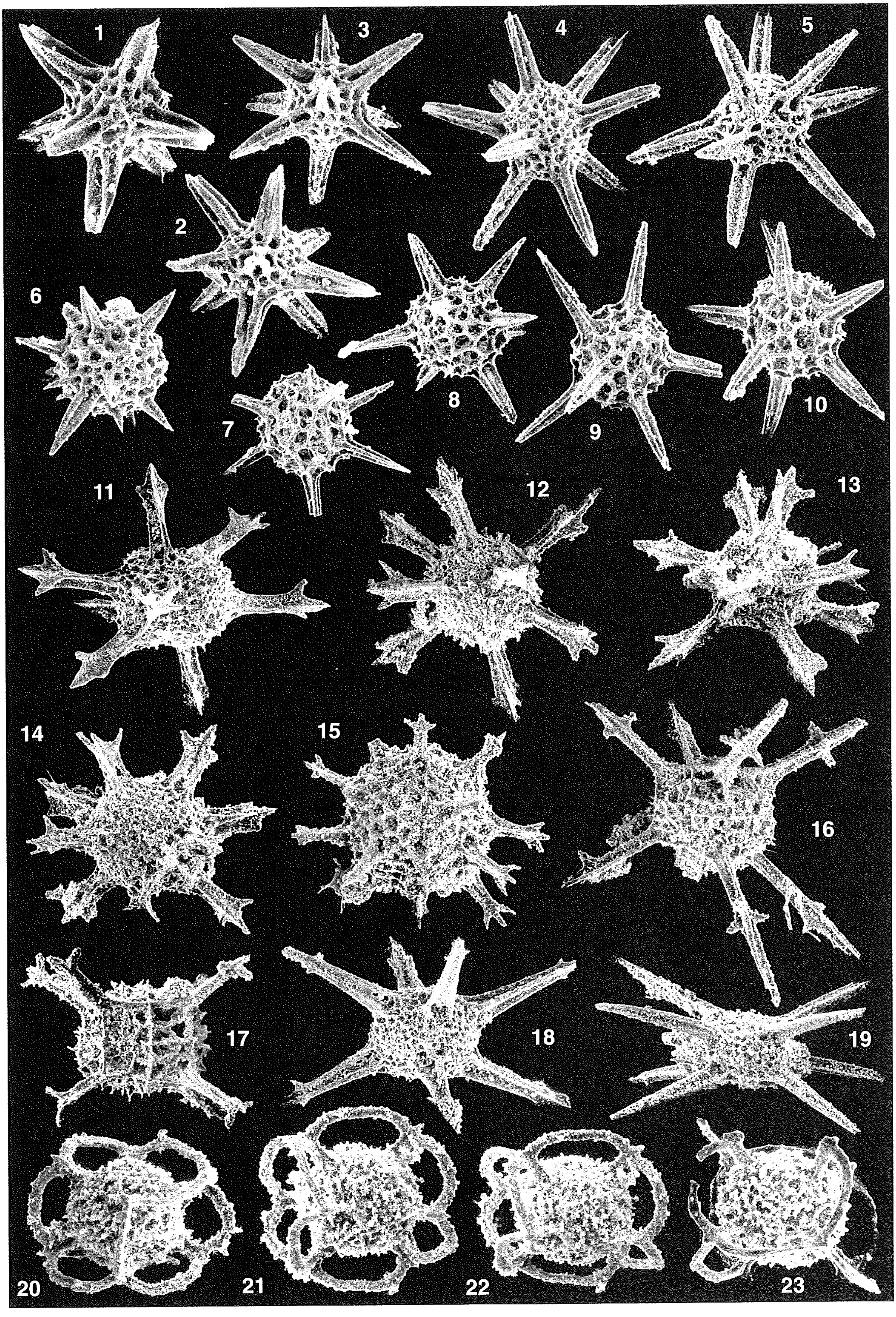

PLATE 49

Figures 1-8 **Falsocromyodrymus cardulus** nov. sp. x100 .... p. 274

1) 7267, from loc. no. Gb-108.60, late Cenomanian.
2) 7475, from loc. no. Gb-108.60, late Cenomanian.
3) 7687, from loc. no. Gb-108.60, late Cenomanian.
4) 7750, from loc. no. Gb-108.60, late Cenomanian.
5) 7302 (holotype), from loc. no. Gb-108.60, late Cenomanian.
6) 7506, from loc. no. Gb-108.60, late Cenomanian.
7) 7473, from loc. no. Gb-108.60, late Cenomanian.
8) 7269, from loc. no. Gb-108.60, late Cenomanian.

Figures 9-12 **Falsocromyodrymus noxiosus** nov. sp. x200 .... p. 274

9) 7588, from loc. no. Gb-108.60, late Cenomanian.
10) 7655, from loc. no. Gb-108.60, late Cenomanian.
11) 6078 (holotype), from loc. no. Asv-5-43, early Turonian.
12) 7056, from loc. no. Asv-5-43, early Turonian.

Figures 13-16 **Protoxiphotractus machinosus** nov. sp. x250 .... p. 276
except fig. 13 x200

13) 6550 (holotype), from loc. no. Asv-5-43, early Turonian.
14) 6919, from loc. no. Asv-5-43, early Turonian.
15) 7089, from loc. no. Asv-5-43, early Turonian.
16) 5909, from loc. no. Asv-5-43, early Turonian.

Figures 17-20 **Protoxiphotractus ventosus** nov. sp. x250 .... p. 277

17) 6478, from loc. no. Asv-5-43, early Turonian.
18) 5880 (holotype), from loc. no. Asv-5-43, early Turonian.
19) 6390, from loc. no. Asv-5-43, early Turonian.
20) 5985, from loc. no. Asv-5-43, early Turonian.

Figures 21-24 **Pantanellium lanceola** (PARONA) x200 .... p. 278

21) 9671, from loc. no. Ca1-9.70, late Barremian.
22) 9937, from loc. no. Mc-268b, middle Aptian.
23) 9661, from loc. no. Ca1-9.70, late Barremian.
24) 9680, from loc. no. Ca1-9.70, late Barremian.

Figure 25 **Dicroa periosa** FOREMAN x130 .... p. 280

25) R-615, from loc. no. Bo-566.50, early Barremian.

Figures 26-30 **Dicroa rara** (SQUINABOL) x120 .... p. 281

26) 68, from loc. no. Ap2 (-7.78), middle Albian.
27) 3406, from loc. no. Gc-1073.94, middle Cenomanian.
28) 4205, from loc. no. Gc-1094.48, late Cenomanian.
29) 1467, from loc. no. Ap2-12, early Cenomanian.
30) 944, from loc. no. Gc-1027.10, middle Albian.

Plate 49

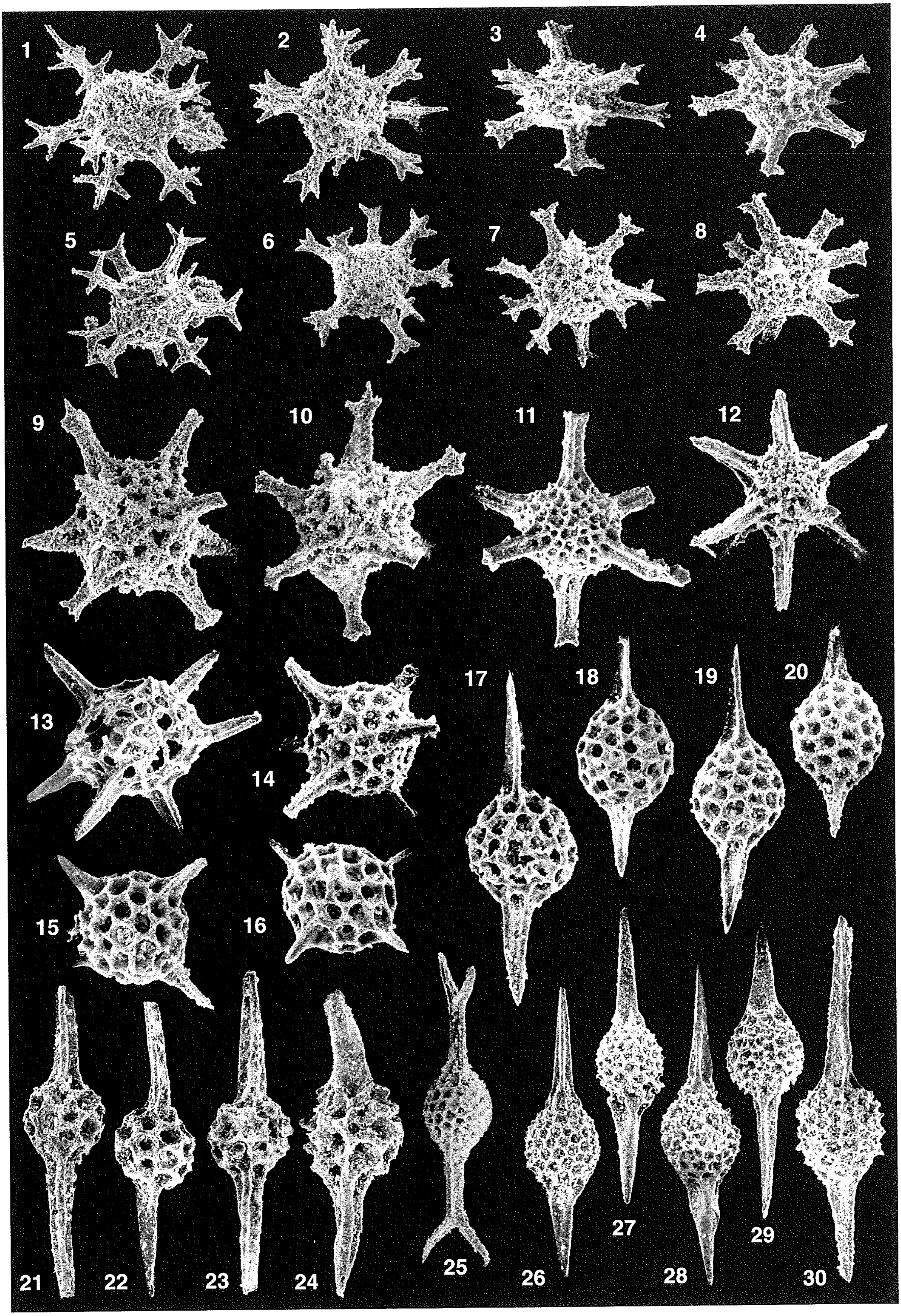
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PLATE 50

Figures 1-2 **Hexapyramis precedis** JUD x130 .... p. 282

1) 51, from loc. no. Ap2 (-7.78), middle Albian.
2) R-1109, from loc. no. Bo-561.50, early Barremian.

Figures 3-7 **Hexapyramis pantanellii** SQUINABOL x100 .... p. 283

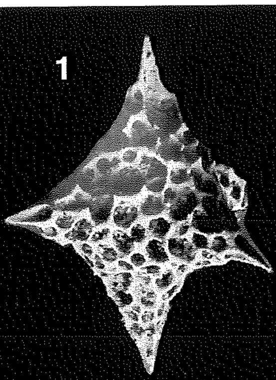
3) 2148, from loc. no. Gc-1035.10, late Albian.
4) 7218, from loc. no. Gb-108.60, late Cenomanian.
5) 3030, from loc. no. Bo-685.20, late Albian.
6) 5363, from loc. no. Gb-84.40, early Cenomanian.
7) 7375, from loc. no. Gb-108.60, late Cenomanian.

Figures 8-11 **Acaeniotyle diaphorogona** FOREMAN x130 .... p. 284

8) 3835, from loc. no. Gc-1073.94, middle Cenomanian.
9) 3837, from loc. no. Gc-1073.94, middle Cenomanian.
10) 160, from loc. no. Ap2 (-7.78), middle Albian.
11) 685, from loc. no. Ap2 (-7.78), middle Albian.

Figures 12-19 **Acaeniotyle tribulosa** FOREMAN x100 .... p. 286

12) 2158, from loc. no. Gc-1035.10, late Albian.
13) 2943, from loc. no. Bo-685.20, late Albian.
14) 66, from loc. no. Ap2 (-7.78), middle Albian.
15) 1577, from loc. no. Ap2-12, early Cenomanian.
16) 2149, from loc. no. Gc-1035.10, late Albian.
17) 2961, from loc. no. Bo-685.20, late Albian.
18) 2176, from loc. no. Gc-1035.10, late Albian.
19) 677, from loc. no. Ap2 (-7.78), middle Albian.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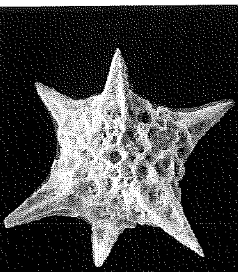
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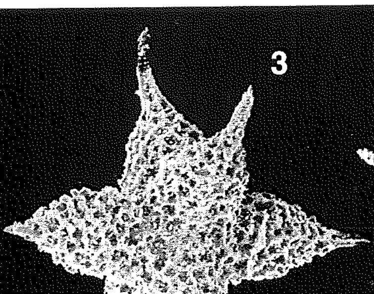
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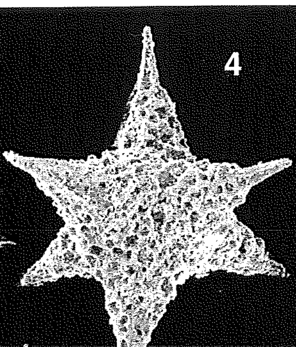
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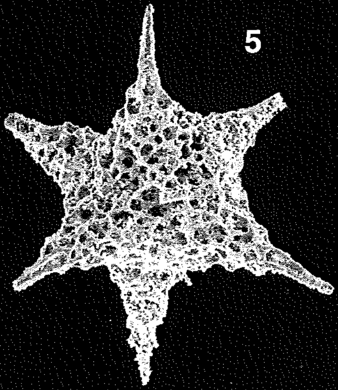
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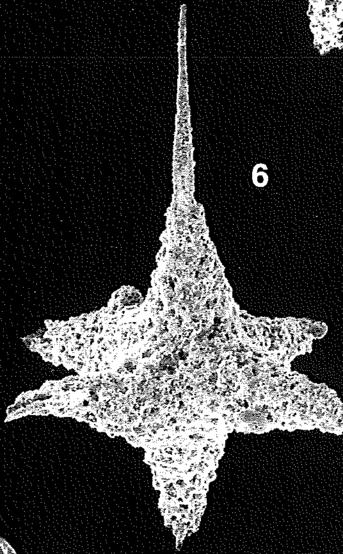
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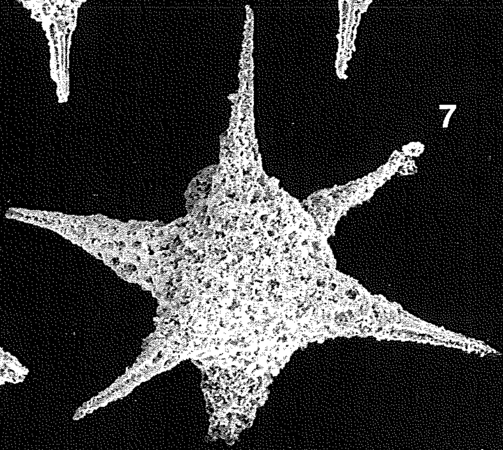
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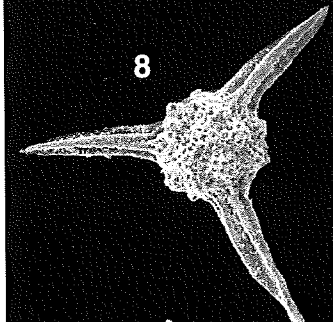
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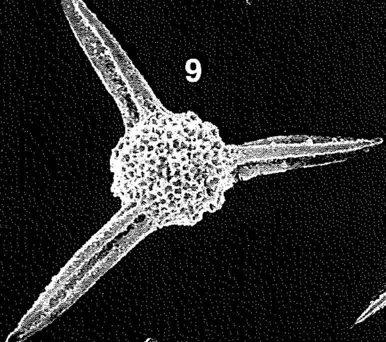
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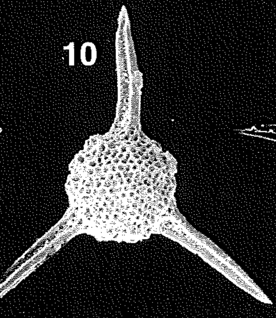
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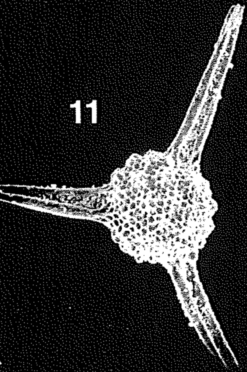
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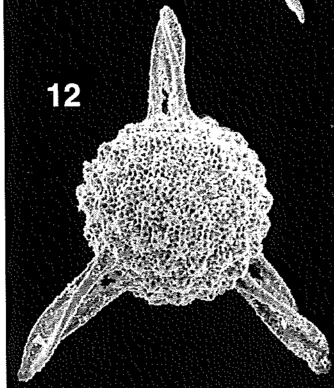
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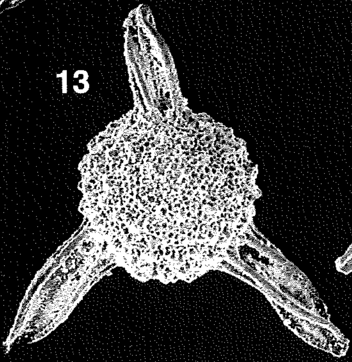
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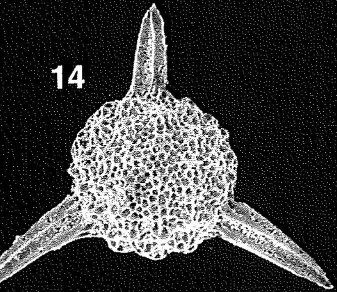
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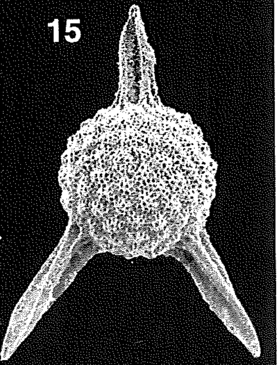
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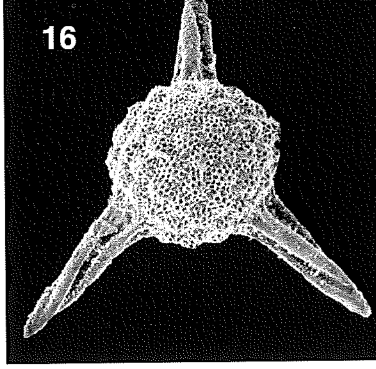
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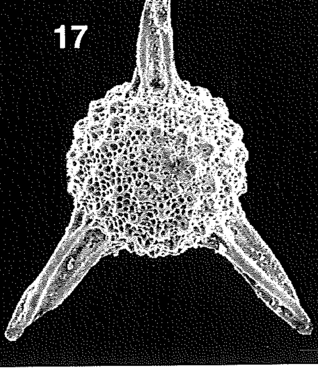
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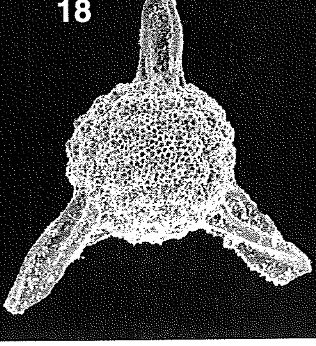
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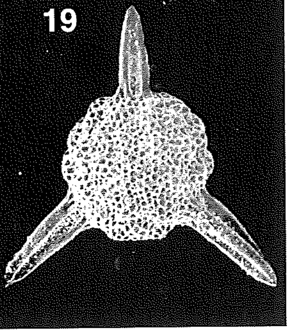
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PLATE 51

Figures 1-4 **Acaeniotyle vitalis** nov. sp. x150 .... p. 287
except fig. 1 x100

1) 713, from loc. no. Ap2 (-7.78), middle Albian.
2) 3921, from loc. no. Gc-1073.94, middle Cenomanian.
3) 6988, from loc. no. Asv-5-43, early Turonian.
4) 5946 (holotype), from loc. no. Asv-5-43, early Turonian.

Figures 5-10 **Acaeniotyle rebellis** nov. sp. x130 .... p. 287

5) 7125, from loc. no. Asv-5-43, early Turonian.
6) 6203 (holotype), from loc. no. Asv-5-43, early Turonian.
7) 6205, from loc. no. Asv-5-43, early Turonian.
8) 4873, from loc. no. Gc-1096.50, early Turonian.
9) 7110, from loc. no. Asv-5-43, early Turonian.
10) 5960, from loc. no. Asv-5-43, early Turonian.

Figures 11-14 **Acaeniotyle amplissima** (FOREMAN) x120 .... p. 288

11) 2152, from loc. no. Gc-1035.10, late Albian.
12) 696, from loc. no. Ap2 (-7.78), middle Albian.
13) 689, from loc. no. Ap2 (-7.78), middle Albian.
14) 2702, from loc. no. Bo-685.20, late Albian.

Figures 15-18 **Acaeniotyle macrospina** (SQUINABOL) x120 .... p. 289

15) 2185, from loc. no. Gc-1035.10, late Albian.
16) 2182, from loc. no. Gc-1035.10, late Albian.
17) 3034, from loc. no. Bo-685.20, late Albian.
18) 1569, from loc. no. Ap2-12, early Cenomanian.

Figures 19-20 **Acaeniotyle umbilicata** (RÜST) x120 .... p. 289

19) R-249, from loc. no. Bo-566.50, early Barremian.
20) 9321, from loc. no. Ca1-22.30, early Aptian.

Figures 21-25 **Acaeniotyle longispina** (SQUINABOL) x100 .... p. 290

21) 654, from loc. no. Ap2 (-7.78), middle Albian.
22) 670, from loc. no. Ap2 (-7.78), middle Albian.
23) 647, from loc. no. Ap2 (-7.78), middle Albian.
24) 2697, from loc. no. Bo-685.20, late Albian.
25) 3165, from loc. no. Bo-685.20, late Albian.

Plate 51

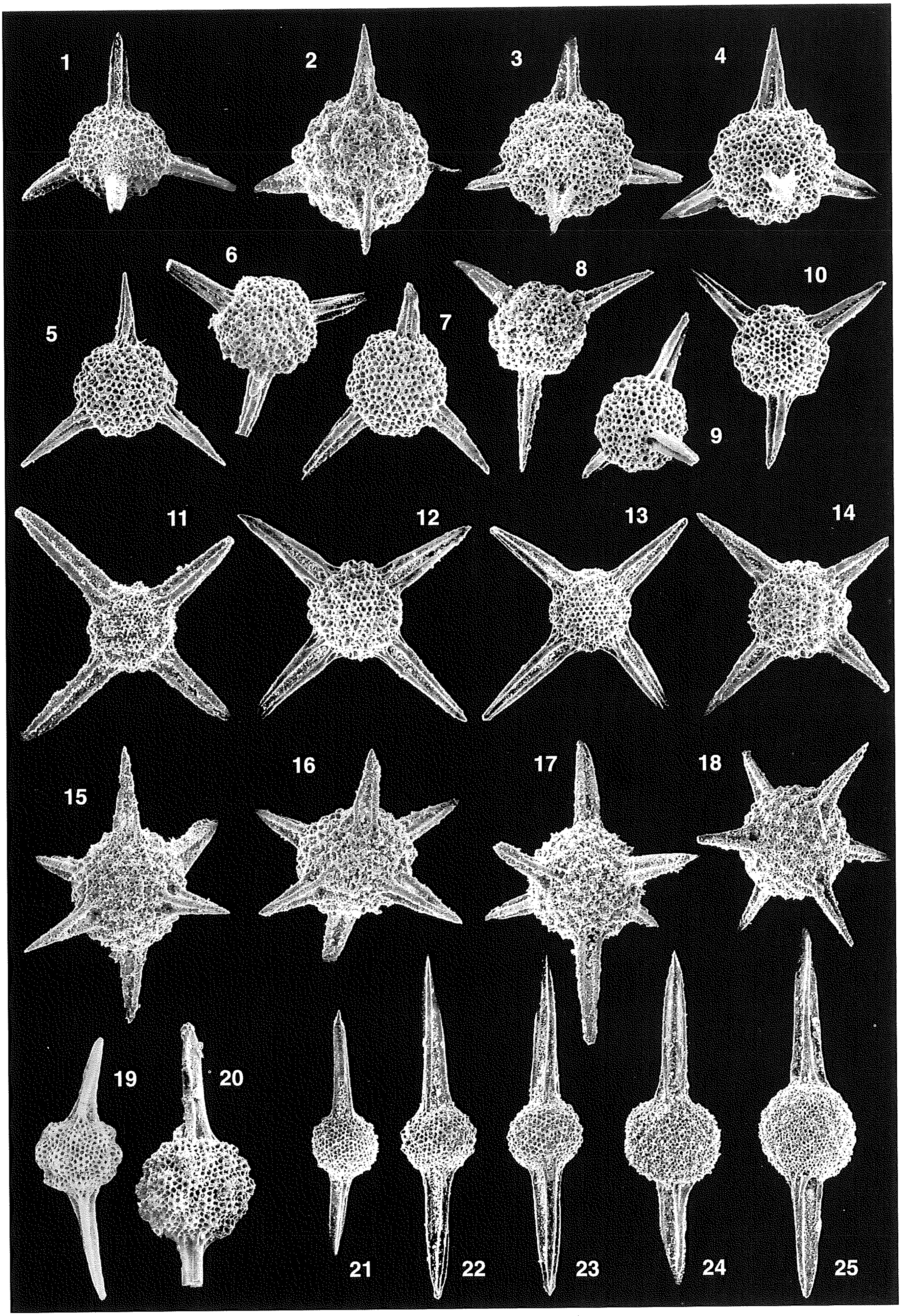

PLATE 52

Figures 1-5 **Staurosphaeretta euganea** (SQUINABOL) x100 .... p. 292

1) 698, from loc. no. Ap2 (-7.78), middle Albian.
2) 1066, from loc. no. Gc-1027.10, middle Albian.
3) 83, from loc. no. Ap2 (-7.78), middle Albian.
4) 59, from loc. no. Ap2 (-7.78), middle Albian.
5) 693, from loc. no. Ap2 (-7.78), middle Albian.

Figures 6-10 **Staurosphaeretta longispina** (SQUINABOL) x120 .... p. 292

6) 2459, from loc. no. Gc-1035.10, late Albian.
7) 3260, from loc. no. Bo-685.20, late Albian.
8) 1751, from loc. no. Ap2-12, early Cenomanian.
9) 1715, from loc. no. Ap2-12, early Cenomanian.
10) 1596, from loc. no. Ap2-12, early Cenomanian.

Figures 11-18 **Staurosphaeretta grandipora** (SQUINABOL) x100 .... p. 293

11) 1929, from loc. no. Gc-1035.10, late Albian.
12) 1892, from loc. no. Gc-1035.10, late Albian.
13) 1854, from loc. no. Gc-1035.10, late Albian.
14) 5473, from loc. no. Gb-84.40, early Cenomanian.
15) 1880, from loc. no. Gc-1035.10, late Albian.
16) 5446, from loc. no. Gb-84.40, early Cenomanian.
17) 1891, from loc. no. Gc-1035.10, late Albian.
18) 2111, from loc. no. Gc-1035.10, late Albian.

Plate 52

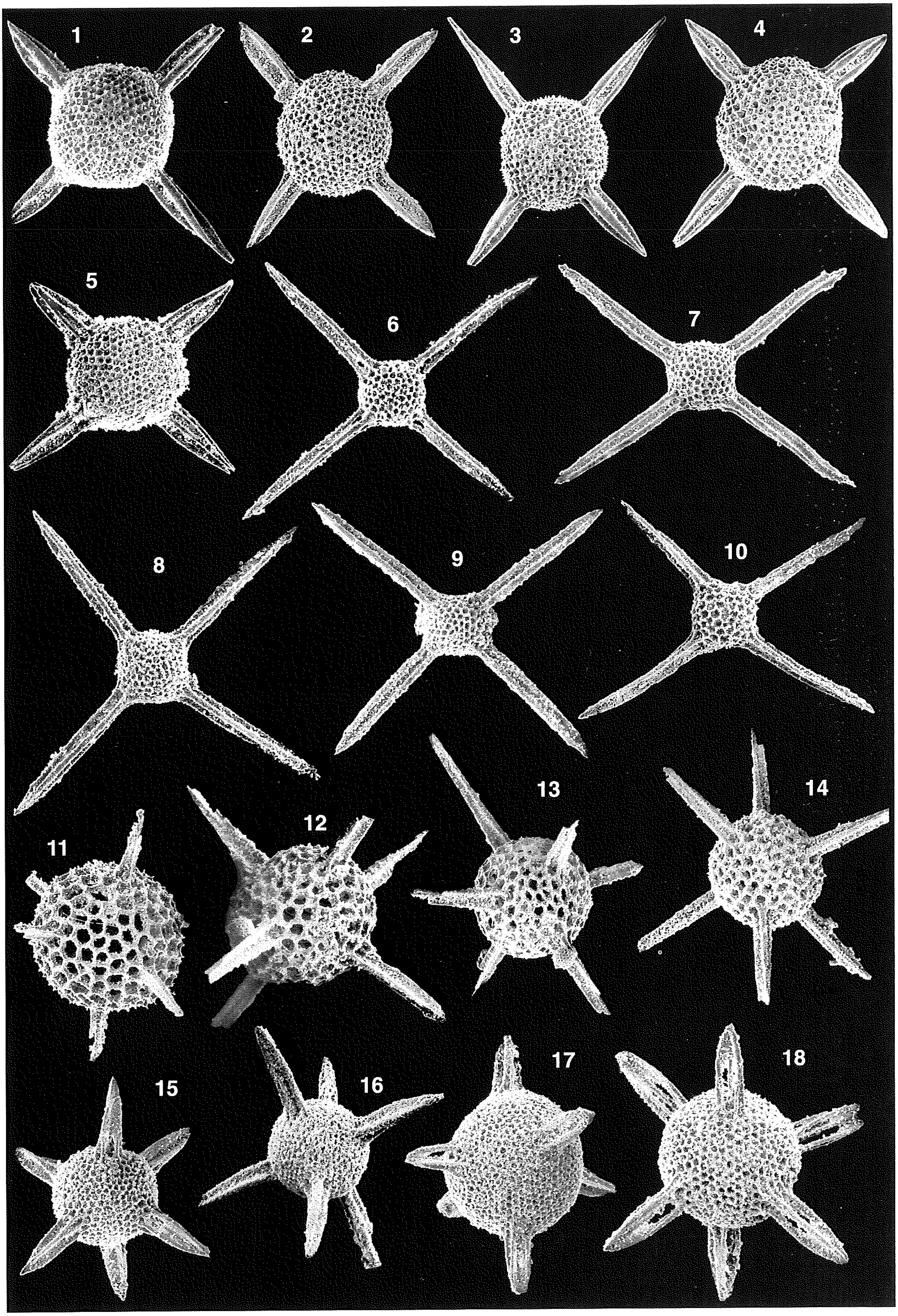

PLATE 53

Figures 1-7 **Staurosphaeretta wisniowskii** (SQUINABOL) x100 .... p. 294

1) 64, from loc. no. Ap2 (-7.78), middle Albian.
2) 5453, from loc. no. Gb-84.40, early Cenomanian.
3) 5432, from loc. no. Gb-84.40, early Cenomanian.
4) 1836, from loc. no. Gc-1035.10, late Albian.
5) 3, from loc. no. Ap2 (-7.78), middle Albian.
6) 91, from loc. no. Ap2 (-7.78), middle Albian.
7) 1848, from loc. no. Gc-1035.10, late Albian.

Figures 8-10 **Tetracanthellipsis euganeus** SQUINABOL x150 .... p. 295

8) 3834, from loc. no. Gc-1073.94, middle Cenomanian.
9) 5712, from loc. no. Gb-84.40, early Cenomanian.
10) 1813, from loc. no. Ap2-12, early Cenomanian.

Figures 11-15 **Tetracanthellipsis gregalis** nov. sp. x150 .... p. 296

11) 6566, from loc. no. Asv-5-43, early Turonian.
12) 6942, from loc. no. Asv-5-43, early Turonian.
13) 6272 (holotype), from loc. no. Asv-5-43, early Turonian.
14) 7068, from loc. no. Asv-5-43, early Turonian.
15) 7007, from loc. no. Asv-5-43, early Turonian.

Figures 16-19 **Pseudoacanthosphaera galeata** nov. sp. x75 .... p. 297

16) 5470, from loc. no. Gb-84.40, early Cenomanian.
17) 1856, from loc. no. Gc-1035.10, late Albian.
18) 3302 (holotype), from loc. no. Bo-685.20, late Albian.
19) 45, from loc. no. Ap2 (-7.78), middle Albian.

Plate 53

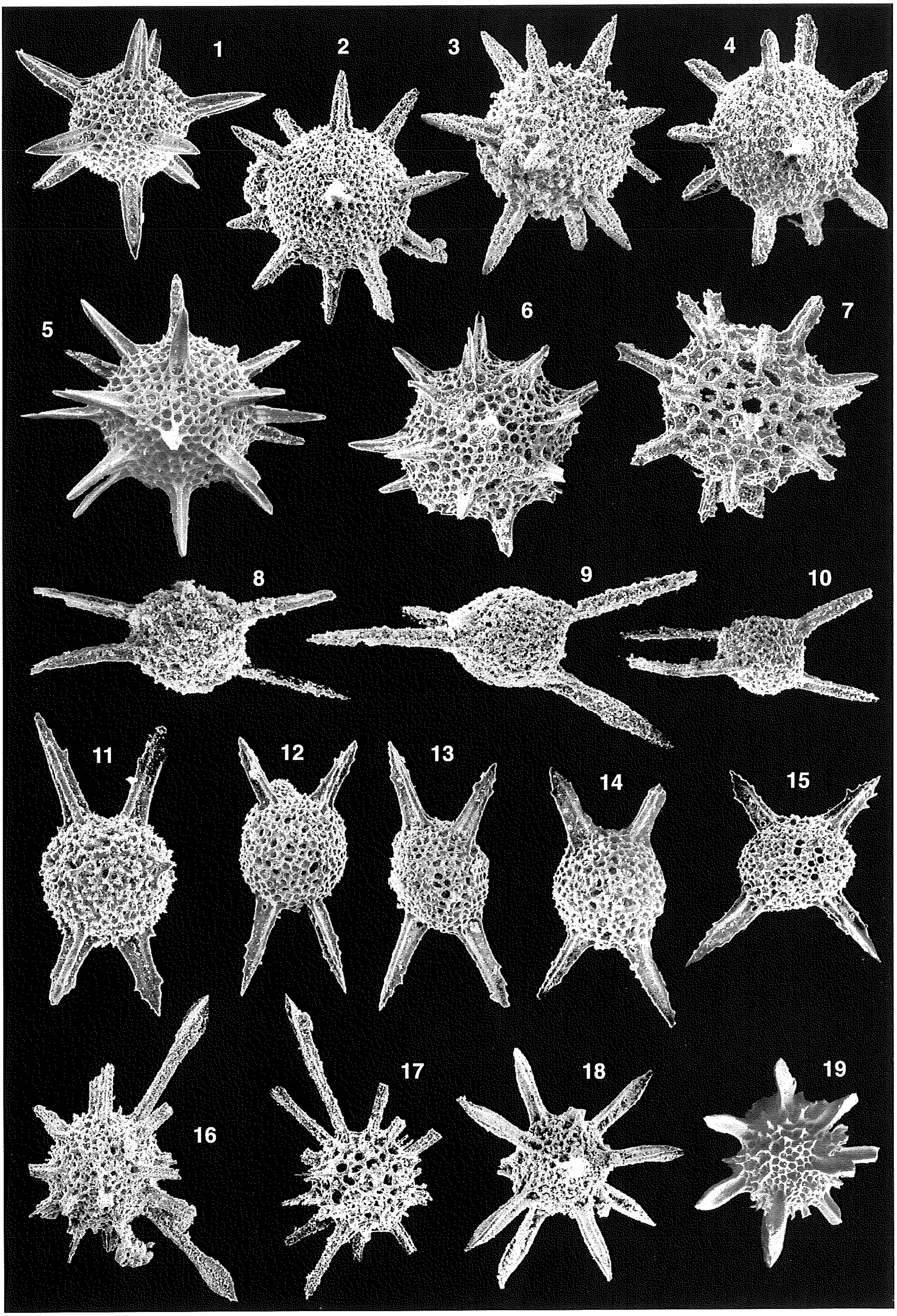

PLATE 54

Figures 1-4 **Pseudoacanthosphaera magnifica** (SQUINABOL) x75 .... p. 297

1) 2248, from loc. no. Gc-1035.10, late Albian.
2) 692, from loc. no. Ap2 (-7.78), middle Albian.
3) 1568, from loc. no. Ap2-12, early Cenomanian.
4) 2156, from loc. no. Gc-1035.10, late Albian.

Figures 5-10 **Pseudoacanthosphaera superba** (SQUINABOL) x75 .... p. 298

5) 5477, from loc. no. Gb-84.40, early Cenomanian.
6) 6701, from loc. no. Asv-5-43, early Turonian.
7) 6109, from loc. no. Asv-5-43, early Turonian.
8) 6966, from loc. no. Asv-5-43, early Turonian.
9) 6832, from loc. no. Asv-5-43, early Turonian.
10) 7092, from loc. no. Asv-5-43, early Turonian.

Figures 11-15 **Pseudoacanthosphaera spinosissima** (SQUINABOL) x120 .... p. 299

11) 6565, from loc. no. Asv-5-43, early Turonian.
12) 6513, from loc. no. Asv-5-43, early Turonian.
13) 4947, from loc. no. Gc-1096.50, early Turonian.
14) 6773, from loc. no. Asv-5-43, early Turonian.
15) 5094, from loc. no. Gc-1096.50, early Turonian.

Figures 16-18 **Triactoma hybum** FOREMAN x150 .... p. 300

16) 9306, from loc. no. Ca1-22.30, early Aptian.
17) 9844, from loc. no. Ca1-22.30, early Aptian.
18) 9845, from loc. no. Ca1-22.30, early Aptian.

Figures 19-23 **Triactoma cellulosa** FOREMAN x130 .... p. 300

19) 6735, from loc. no. Asv-5-43, early Turonian.
20) 2150, from loc. no. Gc-1035.10, late Albian.
21) 566, from loc. no. Ap2 (-7.78), middle Albian.
22) 610, from loc. no. Ap2 (-7.78), middle Albian.
23) 569, from loc. no. Ap2 (-7.78), middle Albian.

Figures 24-27 **Triactoma parva** (SQUINABOL) x120 .... p. 303

24) 4834, from loc. no. Gc-1096.50, early Turonian.
25) 4820, from loc. no. Gc-1096.50, early Turonian.
26) 4789, from loc. no. Gc-1096.50, early Turonian.
27) 4896, from loc. no. Gc-1096.50, early Turonian.

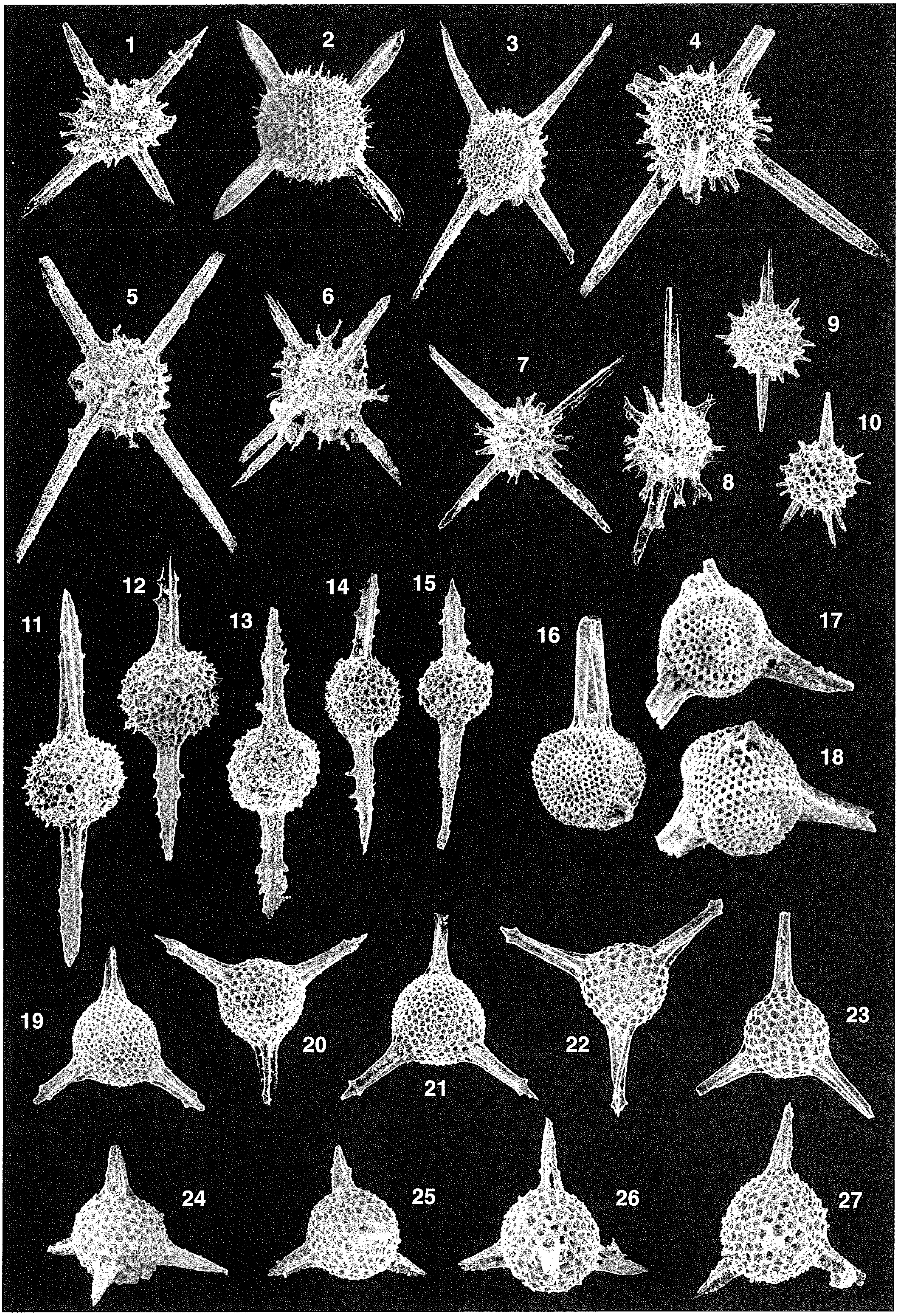
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PLATE 55

Figures 1-8 **Triactoma paronai** (SQUINABOL) x100 .... p. 301

1) 77, from loc. no. Ap2 (-7.78), middle Albian.
2) 1444, from loc. no. Ap2-12, early Cenomanian.
3) 3235, from loc. no. Bo-685.20, late Albian.
4) 1344, from loc. no. Gc-1027.10, middle Albian.
5) 613, from loc. no. Ap2 (-7.78), middle Albian.
6) 2528, from loc. no. Gc-1035.10, late Albian.
7) 3116, from loc. no. Bo-685.20, late Albian.
8) 3126, from loc. no. Bo-685.20, late Albian.

Figures 9-13 **Triactoma compressa** (SQUINABOL) x120 .... p. 302

9) 1728, from loc. no. Ap2-12, early Cenomanian.
10) 3793, from loc. no. Gc-1073.94, middle Cenomanian.
11) 1501, from loc. no. Ap2-12, early Cenomanian.
12) 5681, from loc. no. Gb-84.40, early Cenomanian.
13) 1500, from loc. no. Ap2-12, early Cenomanian.

Figures 14-21 **Triactoma hexeris** nov. sp. x120 .... p. 303

14) 6622, from loc. no. Asv-5-43, early Turonian.
15) 6628, from loc. no. Asv-5-43, early Turonian.
16) 6436 (holotype), from loc. no. Asv-5-43, early Turonian.
17) 4798, from loc. no. Gc-1096.50, early Turonian.
18) 6720, from loc. no. Asv-5-43, early Turonian.
19) 6673, from loc. no. Asv-5-43, early Turonian.
20) 5963, from loc. no. Asv-5-43, early Turonian.
21) 7030, from loc. no. Asv-5-43, early Turonian.

Figures 22-25 **Pyramispongia costarricensis** (SCHMIDT-EFFING) x120 .... p. 304

22) 5498, from loc. no. Gb-84.40, early Cenomanian.
23) 5485, from loc. no. Gb-84.40, early Cenomanian.
24) 2177, from loc. no. Gc-1035.10, late Albian.
25) 5528, from loc. no. Gb-84.40, early Cenomanian.

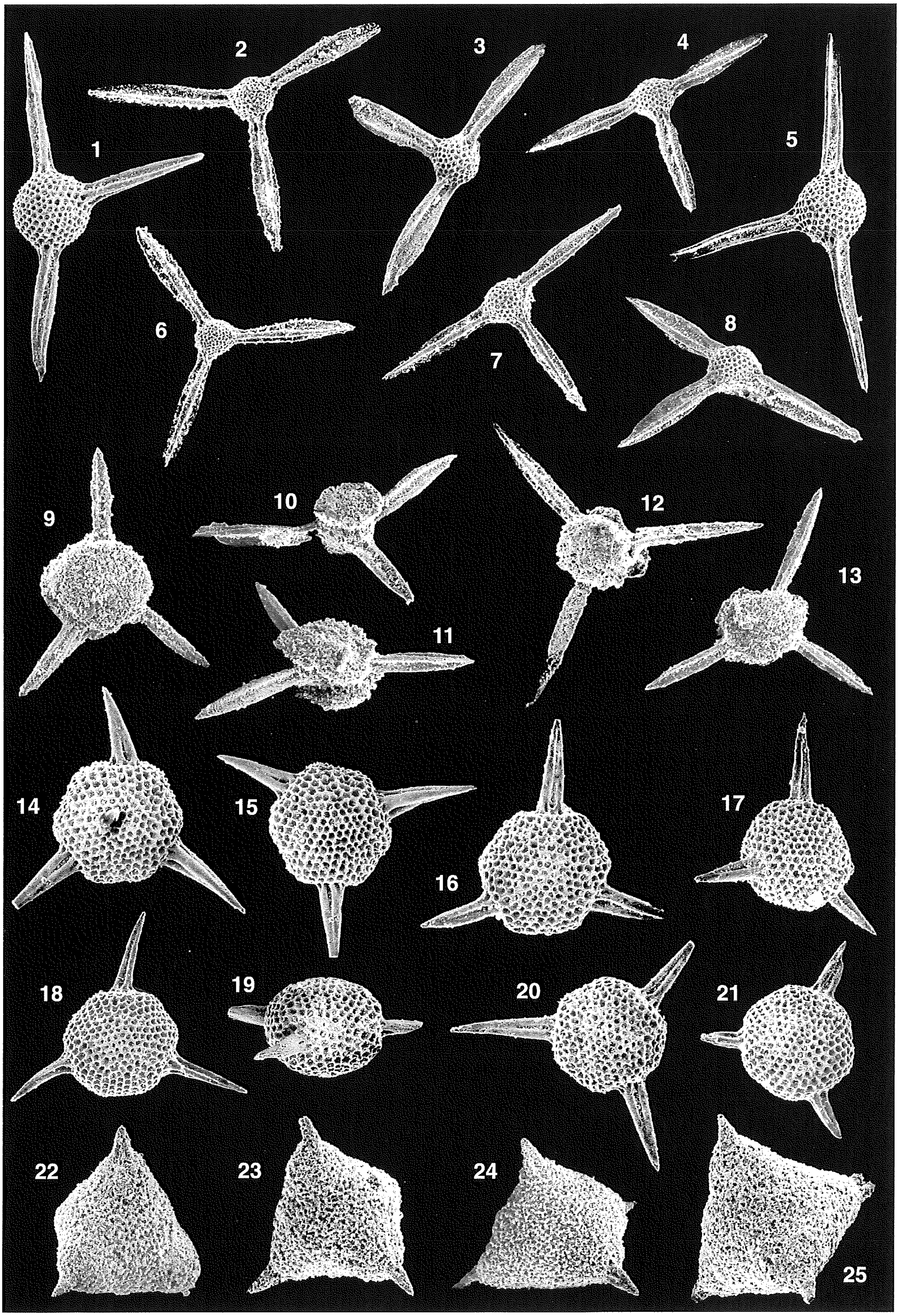
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PLATE 56

Figures 1-5 **Pyramispongia glascockensis** PESSAGNO x120 .... p. 305

1) 6180, from loc. no. Asv-5-43, early Turonian.
2) 5463, from loc. no. Gb-84.40, early Cenomanian.
3) 4361, from loc. no. Gc-1096.50, early Turonian.
4) 7480, from loc. no. Gb-108.60, late Cenomanian.
5) 3504, from loc. no. Gc-1073.94, middle Cenomanian.

Figure 6 **Cyclastrum infudibuliforme** RÜST x100 .... p. 307

6) 9767, from loc. no. Ca1-22.30, early Aptian.

Figure 7 **Cyclastrum satoi** (TUMANDA) x100 .... p. 307

7) R-113, from loc. no. Pr-225.3, early Barremian.

Figures 8-14 **Cavaspongia euganea** (SQUINABOL) x120 .... p. 309

8) 5399, from loc. no. Gb-84.40, early Cenomanian.
9) 4855, from loc. no. Gc-1096.50, early Turonian.
10) 3653, from loc. no. Gc-1073.94, middle Cenomanian.
11) 5698, from loc. no. Gb-84.40, early Cenomanian.
12) 3663, from loc. no. Gc-1073.94, middle Cenomanian.
13) 2764, from loc. no. Bo-685.20, late Albian.
14) 1508, from loc. no. Ap2-12, early Cenomanian.

Figures 15-17 **Cavaspongia helice** nov. sp. x100 .... p. 310

15) 3771 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
16) 3674, from loc. no. Gc-1073.94, middle Cenomanian.
17) 7215, from loc. no. Gb-108.60, late Cenomanian.

Figures 18-24 **Cavaspongia cilindrica** nov. sp. x120 .... p. 309

18) 2833, from loc. no. Bo-685.20, late Albian.
19) 1752, from loc. no. Ap2-12, early Cenomanian.
20) 1054, from loc. no. Gc-1027.10, middle Albian.
21) 1463, from loc. no. Ap2-12, early Cenomanian.
22) 2715 (holotype), from loc. no. Bo-685.20, late Albian.
23) 2857, from loc. no. Bo-685.20, late Albian.
24) 2714, from loc. no. Bo-685.20, late Albian.

Plate 56

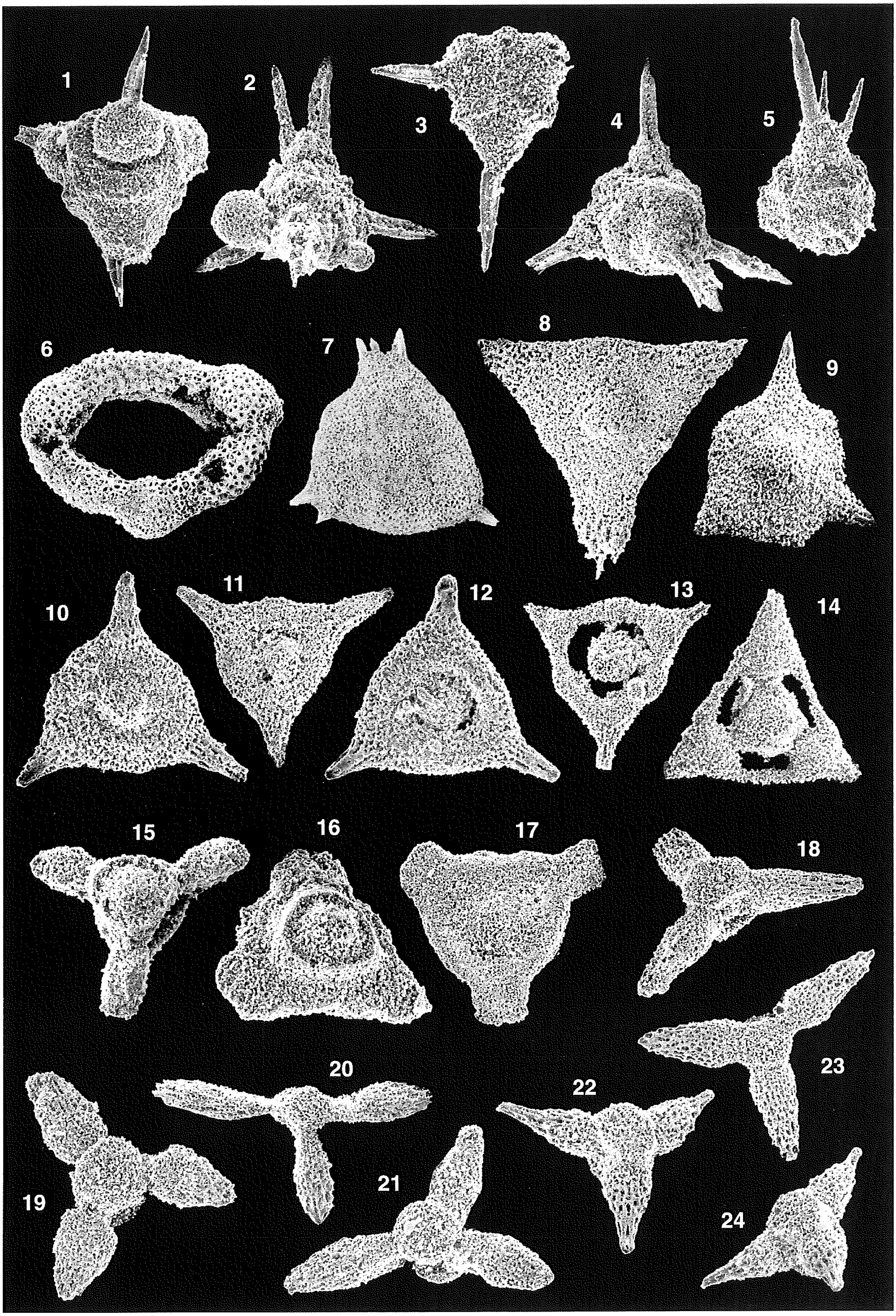

PLATE 57

Figures 1-7 **Cavaspongia sphaerica** nov. sp. x120 .... p. 311

1) 3712 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
2) 2845, from loc. no. Bo-685.20, late Albian.
3) 1439, from loc. no. Ap2-12, early Cenomanian.
4) 5108, from loc. no. Gc-1096.50, early Turonian.
5) 3568, from loc. no. Gc-1073.94, middle Cenomanian.
6) 4018, from loc. no. Gc-1073.94, middle Cenomanian.
7) 2844, from loc. no. Bo-685.20, late Albian.

Figures 8-11 **Cavaspongia contracta** nov. sp. x120 .... p. 311

8) 6585, from loc. no. Asv-5-43, early Turonian.
9) 7593, from loc. no. Gb-108.60, late Cenomanian.
10) 5710 (holotype), from loc. no. Gb-84.40, early Cenomanian.
11) 4389, from loc. no. Gc-1096.50, early Turonian.

Figures 12-16 **Cavaspongia californiaensis** PESSAGNO x100 .... p. 312

12) 3942, from loc. no. Gc-1073.94, middle Cenomanian.
13) 3874, from loc. no. Gc-1073.94, middle Cenomanian.
14) 3876, from loc. no. Gc-1073.94, middle Cenomanian.
15) 3875, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3941, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 17-23 **Cavaspongia antelopensis** PESSAGNO x120 .... p. 313

17) 4388, from loc. no. Gc-1096.50, early Turonian.
18) 6166, from loc. no. Asv-5-43, early Turonian.
19) 4589, from loc. no. Gc-1096.50, early Turonian.
20) 6167, from loc. no. Asv-5-43, early Turonian.
21) 5893, from loc. no. Asv-5-43, early Turonian.
22) 4617, from loc. no. Gc-1096.50, early Turonian.
23) 5894, from loc. no. Asv-5-43, early Turonian.

Figures 24-28 **Cavaspongia tricornis** nov. sp. x130 .... p. 313

24) 7116 (holotype), from loc. no. Asv-5-43, early Turonian.
25) 7118, from loc. no. Asv-5-43, early Turonian.
26) 7081, from loc. no. Asv-5-43, early Turonian.
27) 6338, from loc. no. Asv-5-43, early Turonian.
28) 7008, from loc. no. Asv-5-43, early Turonian.

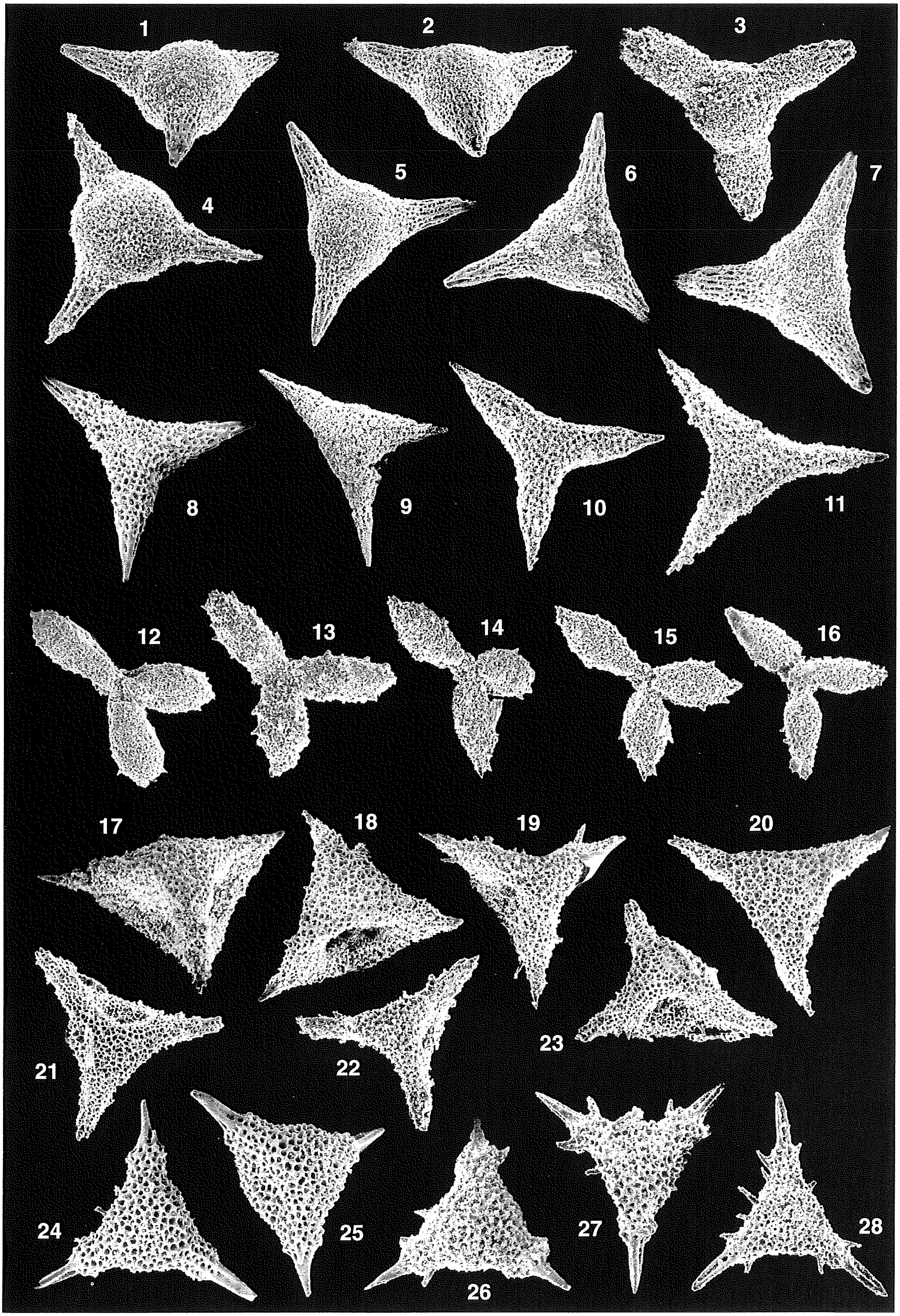
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PLATE 58

Figures 1-3 **Becus helenae** (SCHAAF) x200 .... p. 316

1) 8506, from loc. no. Ca1-22.30, early Aptian.
2) R-569, from loc. no. Bo-566.50, early Barremian.
3) 9253, from loc. no. Ca1-22.30, early Aptian.

Figures 4-8 **Becus gemmatus** WU x150 .... p. 317

4) R-563, from loc. no. Bo-566.50, early Barremian.
5) R-583, from loc. no. Bo-566.50, early Barremian.
6) 8475, from loc. no. Ca1-22.30, early Aptian.
7) 8499, from loc. no. Ca1-22.30, early Aptian.
8) 8492, from loc. no. Ca1-22.30, early Aptian.

Figures 9-17 **Becus horridus** (SQUINABOL) x100 .... p. 318
except figs. 9-10 x150

9) 625, from loc. no. Ap2 (-7.78), middle Albian.
10) 10905, from loc. no. Pan-1, late Aptian.
11) 3065, from loc. no. Bo-685.20, late Albian.
12) 1252, from loc. no. Gc-1027.10, middle Albian.
13) 126, from loc. no. Ap2 (-7.78), middle Albian.
14) 1795, from loc. no. Ap2-12, early Cenomanian.
15) 715, from loc. no. Ap2 (-7.78), middle Albian.
16) 645, from loc. no. Ap2 (-7.78), middle Albian.
17) 1523, from loc. no. Ap2-12, early Cenomanian.

Figures 18-26 **Becus regius** nov. sp. x100 .... p. 318

18) 3567, from loc. no. Gc-1073.94, middle Cenomanian.
19) 7729, from loc. no. Gb-108.60, late Cenomanian.
20) 3676 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
21) 3679, from loc. no. Gc-1073.94, middle Cenomanian.
22) 3553, from loc. no. Gc-1073.94, middle Cenomanian.
23) 3535, from loc. no. Gc-1073.94, middle Cenomanian.
24) 7887, from loc. no. Gb-108.60, late Cenomanian.
25) 1547, from loc. no. Ap2-12, early Cenomanian.
26) 3544, from loc. no. Gc-1073.94, middle Cenomanian.

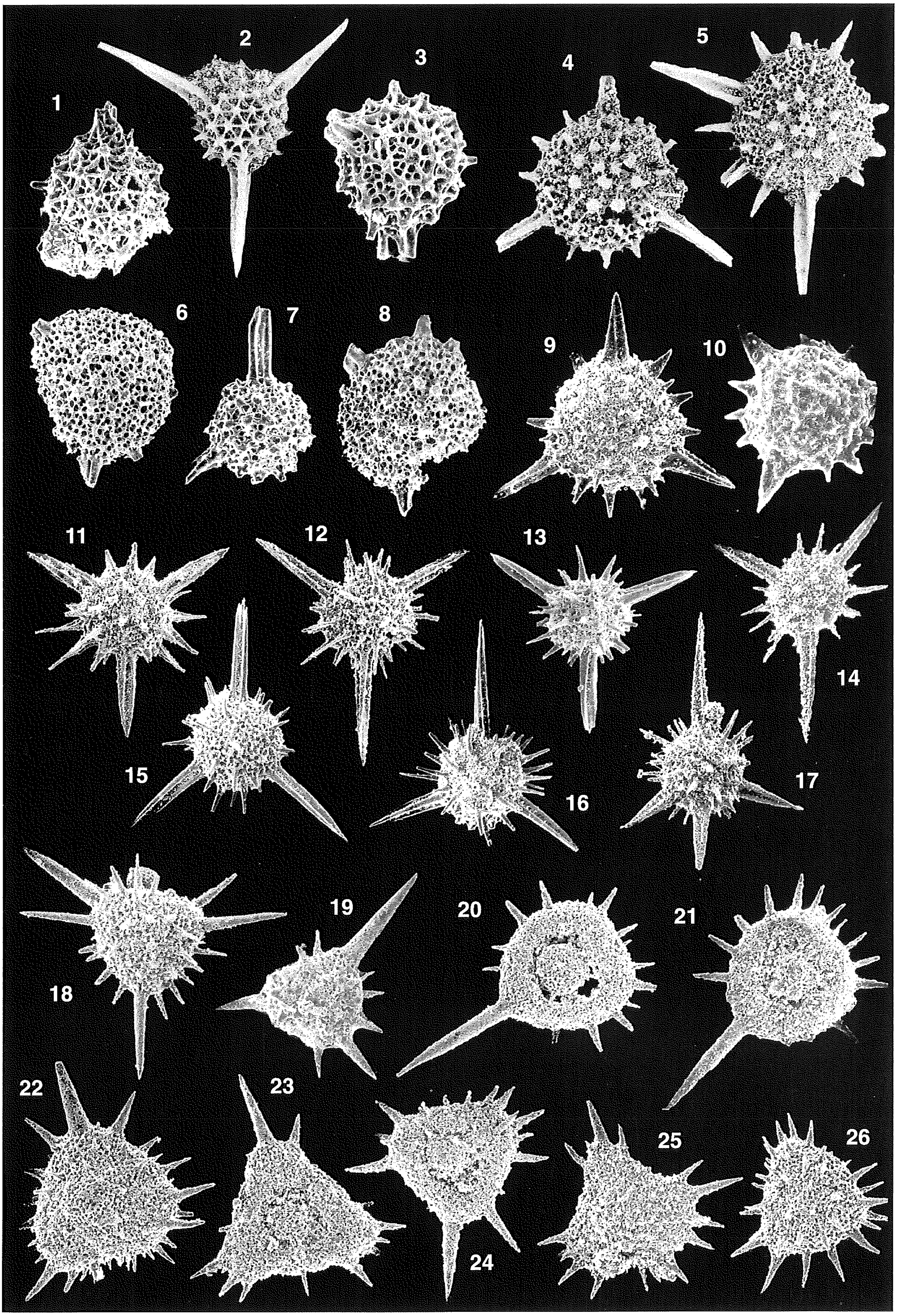
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PLATE 59

Figures 1-4 **Pseudoaulophacus sculptus** (SQUINABOL) x120 .... p. 319

1) 2122, from loc. no. Gc-1035.10, late Albian.
2) 745, from loc. no. Ap2 (-7.78), middle Albian.
3) 1096, from loc. no. Gc-1027.10, middle Albian.
4) 3221, from loc. no. Bo-685.20, late Albian.

Figures 5-13 **Pseudoaulophacus putahensis** PESSAGNO x120 .... p. 320

5) 4795, from loc. no. Gc-1096.50, early Turonian.
6) 6920, from loc. no. Asv-5-43, early Turonian.
7) 4724, from loc. no. Gc-1096.50, early Turonian.
8) 5780, from loc. no. Asv-5-43, early Turonian.
9) 3525, from loc. no. Gc-1073.94, middle Cenomanian.
10) 4886, from loc. no. Gc-1096.50, early Turonian.
11) 4717, from loc. no. Gc-1096.50, early Turonian.
12) 1477, from loc. no. Ap2-12, early Cenomanian.
13) 6385, from loc. no. Asv-5-43, early Turonian.

Figures 14-18 **Alievium superbum** (SQUINABOL) x150 .... p. 322

14) 6863, from loc. no. Asv-5-43, early Turonian.
15) 6005, from loc. no. Asv-5-43, early Turonian.
16) 7087, from loc. no. Asv-5-43, early Turonian.
17) 6497, from loc. no. Asv-5-43, early Turonian.
18) 6079, from loc. no. Asv-5-43, early Turonian.

Figures 19-24 **Dispongotripus triangularis** (SQUINABOL) x120 .... p. 324

19) 5347, from loc. no. Gb-84.40, early Cenomanian.
20) 1610, from loc. no. Gb-84.40, early Cenomanian.
21) 3661, from loc. no. Gc-1073.94, middle Cenomanian.
22) 3552, from loc. no. Gc-1073.94, middle Cenomanian.
23) 2262, from loc. no. Ap2-12, early Cenomanian.
24) 3637, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 25-27 **Dispongotripus acutispinus** SQUINABOL x75 .... p. 323

25) 2199, from loc. no. Gc-1035.10, late Albian.
26) 2198, from loc. no. Gc-1035.10, late Albian.
27) 2169, from loc. no. Gc-1035.10, late Albian.

Plate 59

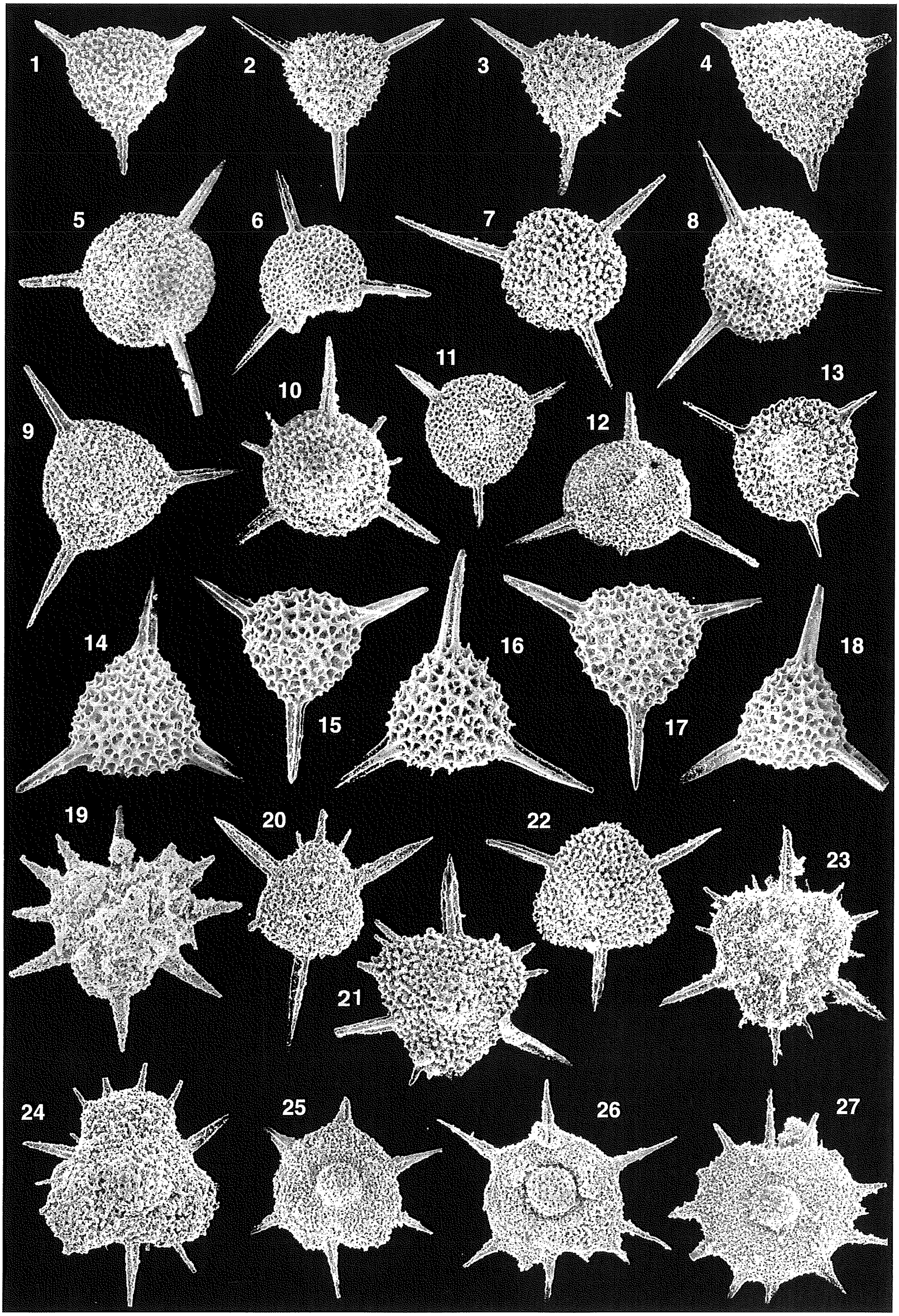

PLATE 60

Figures 1-5 **Patellula minuscula** nov. sp. x150 .... p. 325

1) 3884, from loc. no. Gc-1073.94, middle Cenomanian.
2) 3520 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
3) 6254, from loc. no. Asv-5-43, early Turonian.
4) 4824, from loc. no. Gc-1096.50, early Turonian.
5) 5097, from loc. no. Gc-1096.50, early Turonian.

Figures 6-12 **Patellula cognata** nov. sp. x120 .... p. 326

6) 5482 (holotype), from loc. no. Gb-84.40, early Cenomanian.
7) 7766, from loc. no. Gb-108.60, late Cenomanian.
8) 4011, from loc. no. Gc-1073.94, middle Cenomanian.
9) 5404, from loc. no. Gb-84.40, early Cenomanian.
10) 7849, from loc. no. Gb-108.60, late Cenomanian.
11) 7381, from loc. no. Gb-108.60, late Cenomanian.
12) 3739, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 13-18 **Patellula spica** nov. sp. x120 .... p. 327

13) 3719 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
14) 3720, from loc. no. Gc-1073.94, middle Cenomanian.
15) 4009, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3725, from loc. no. Gc-1073.94, middle Cenomanian.
17) 5443, from loc. no. Gb-84.40, early Cenomanian.
18) 3747, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 19-24 **Patellula helios** (SQUINABOL) x120 .... p. 327

19) 3908, from loc. no. Gc-1073.94, middle Cenomanian.
20) 3536, from loc. no. Gc-1073.94, middle Cenomanian.
21) 3590, from loc. no. Gc-1073.94, middle Cenomanian.
22) 6311, from loc. no. Asv-5-43, early Turonian.
23) 6159, from loc. no. Asv-5-43, early Turonian.
24) 6327, from loc. no. Asv-5-43, early Turonian.

Figures 25-26 **Patellula verteroensis** (PESSAGNO) x120 .... p. 328

25) 6395, from loc. no. Asv-5-43, early Turonian.
26) 6394, from loc. no. Asv-5-43, early Turonian.

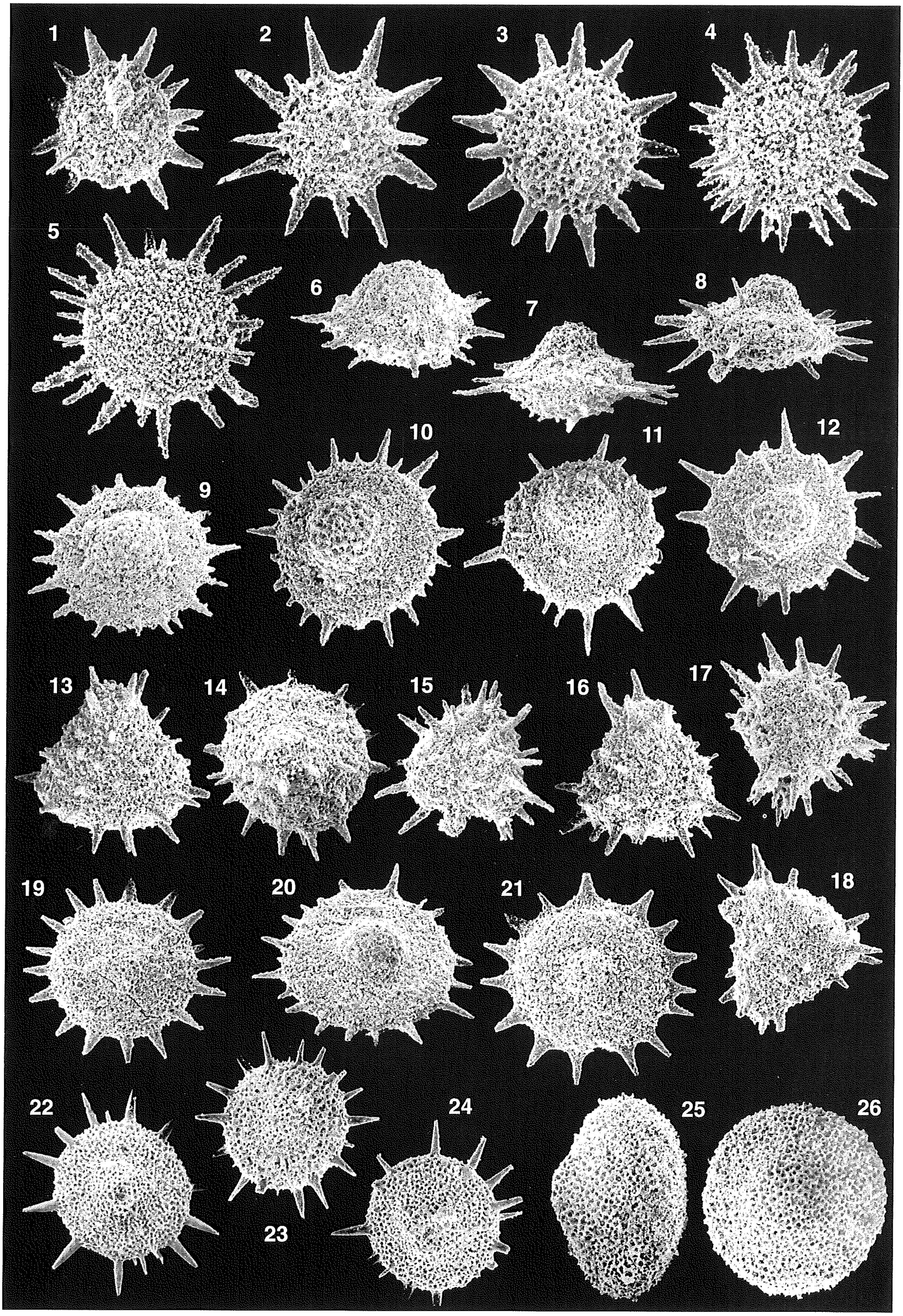
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PLATE 61

Figures 1-5 **Patellula ecliptica** nov. sp. x130 .... p. 329

1) 6427, from loc. no. Asv-5-43, early Turonian.
2) 5899, from loc. no. Asv-5-43, early Turonian.
3) 6537, from loc. no. Asv-5-43, early Turonian.
4) 5902, from loc. no. Asv-5-43, early Turonian.
5) 6538 (holotype), from loc. no. Asv-5-43, early Turonian.

Figures 6-11 **Patellula heroica** nov. sp. x100 .... p. 330

6) 4953, from loc. no. Gc-1096.50, early Turonian.
7) 6545, from loc. no. Asv-5-43, early Turonian.
8) 6324 (holotype), from loc. no. Asv-5-43, early Turonian.
9) 6777, from loc. no. Asv-5-43, early Turonian.
10) 6323, from loc. no. Asv-5-43, early Turonian.
11) 6322, from loc. no. Asv-5-43, early Turonian.

Figures 12-15 **Dactyliodiscus lenticulatus** (JUD) x75 .... p. 331

12) 3612, from loc. no. Gc-1073.94, middle Cenomanian.
13) 5373, from loc. no. Gb-84.40, early Cenomanian.
14) 703, from loc. no. Ap2 (-7.78), middle Albian.
15) 596, from loc. no. Ap2 (-7.78), middle Albian.

Figures 16-23 **Dactyliodiscus cayeuxi** SQUINABOL x75 .... p. 332

16) 76, from loc. no. Ap2 (-7.78), middle Albian.
17) 719, from loc. no. Ap2 (-7.78), middle Albian.
18) 702, from loc. no. Ap2 (-7.78), middle Albian.
19) 600, from loc. no. Ap2 (-7.78), middle Albian.
20) 1459, from loc. no. Ap2-12, early Cenomanian.
21) 717, from loc. no. Ap2 (-7.78), middle Albian.
22) 584, from loc. no. Ap2 (-7.78), middle Albian.
23) 2146, from loc. no. Gc-1035.10, late Albian.

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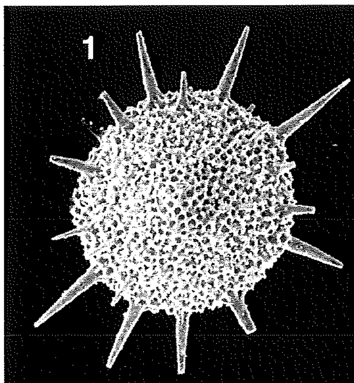
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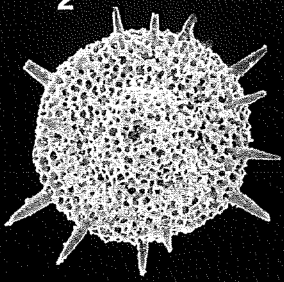
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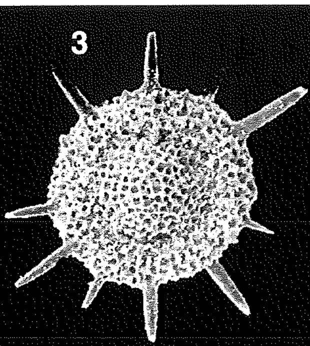
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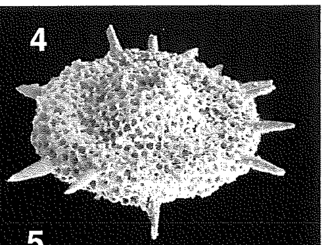
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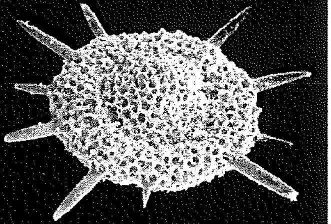
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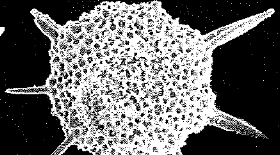
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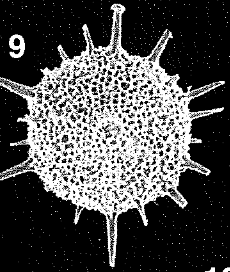
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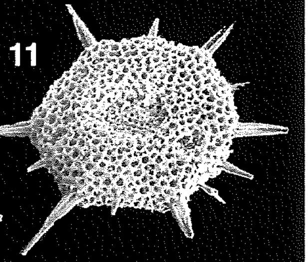
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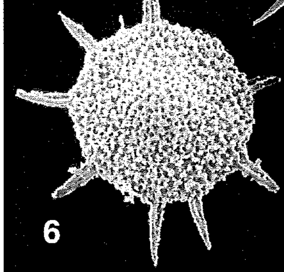
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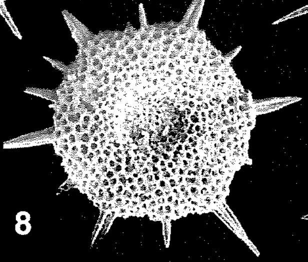
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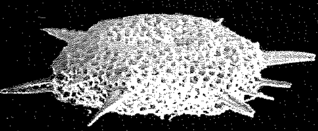
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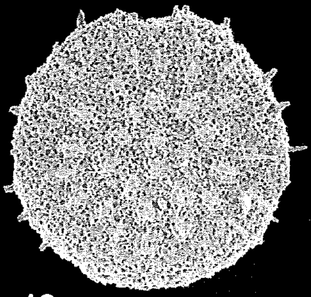
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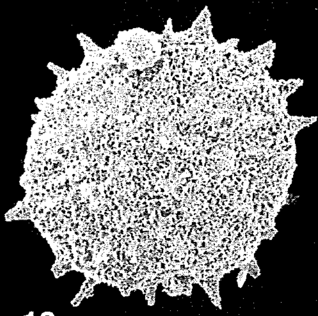
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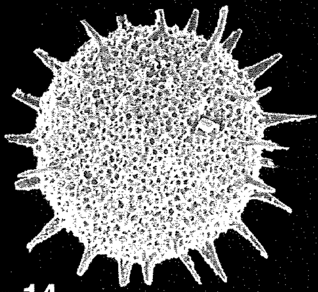
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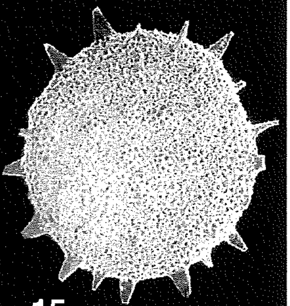
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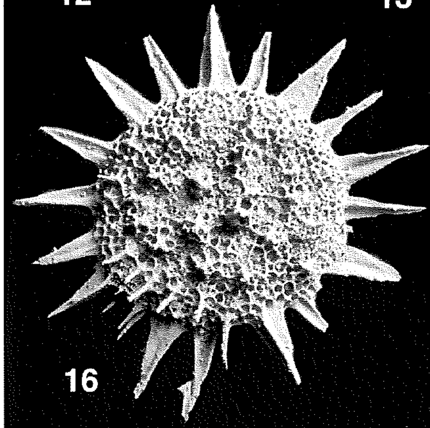
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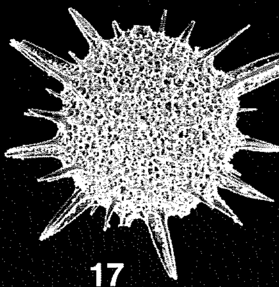
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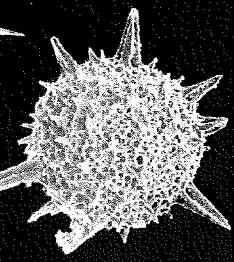
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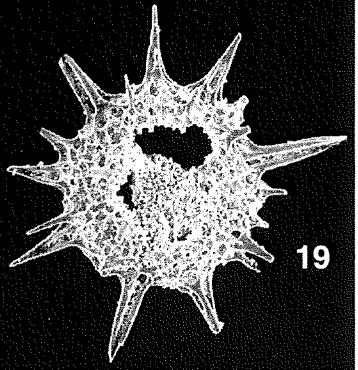
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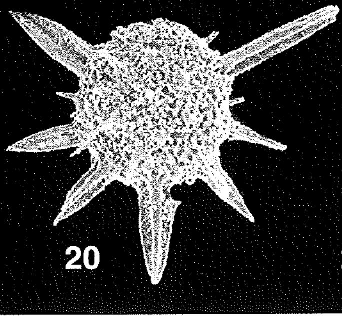
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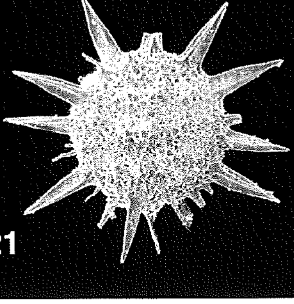
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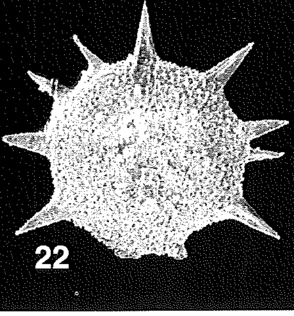
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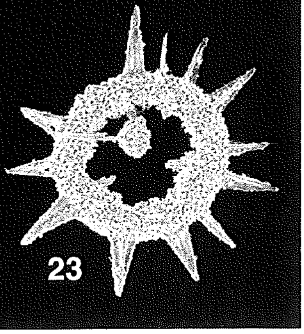

PLATE 62

Figures 1-5 **Dactyliodiscus rubus** nov. sp. x120 .... p. 332

1) 2095, from loc. no. Gc-1035.10, late Albian.
2) 1480 (holotype), from loc. no. Ap2-12, early Cenomanian.
3) 2191, from loc. no. Gc-1035.10, late Albian.
4) 3033, from loc. no. Bo-685.20, late Albian.
5) 2117, from loc. no. Gc-1035.10, late Albian.

Figures 6-11 **Dactyliodiscus longispinus** (SQUINABOL) x100 .... p. 333

6) 5535, from loc. no. Gc-1073.94, middle Cenomanian.
7) 3660, from loc. no. Gc-1073.94, middle Cenomanian.
8) 3546, from loc. no. Gc-1073.94, middle Cenomanian.
9) 3710, from loc. no. Gc-1073.94, middle Cenomanian.
10) 3539, from loc. no. Gc-1073.94, middle Cenomanian.
11) 4029, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 12-15 **Godia concava** (LI & WU) x75 .... p. 334
except fig. 15 x100

12) 9273, from loc. no. Ca1-22.30, early Aptian.
13) 9272, from loc. no. Ca1-22.30, early Aptian.
14) 5387, from loc. no. Gb-84.40, early Cenomanian.
15) 5380, from loc. no. Gb-84.40, early Cenomanian.

Figures 16-18 **Godia coronata** (TUMANDA) x75 .... p. 335

16) 978, from loc. no. Gc-1027.10, middle Albian.
17) 7203, from loc. no. Gb-108.60, late Cenomanian.
18) 5484, from loc. no. Gb-84.40, early Cenomanian.

Figures 19-21 **Godia pelta** nov. sp. x100 .... p. 337

19) 42, from loc. no. Ap2 (-7.78), middle Albian.
20) 224 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
21) 223, from loc. no. Ap2 (-7.78), middle Albian.

Plate 62

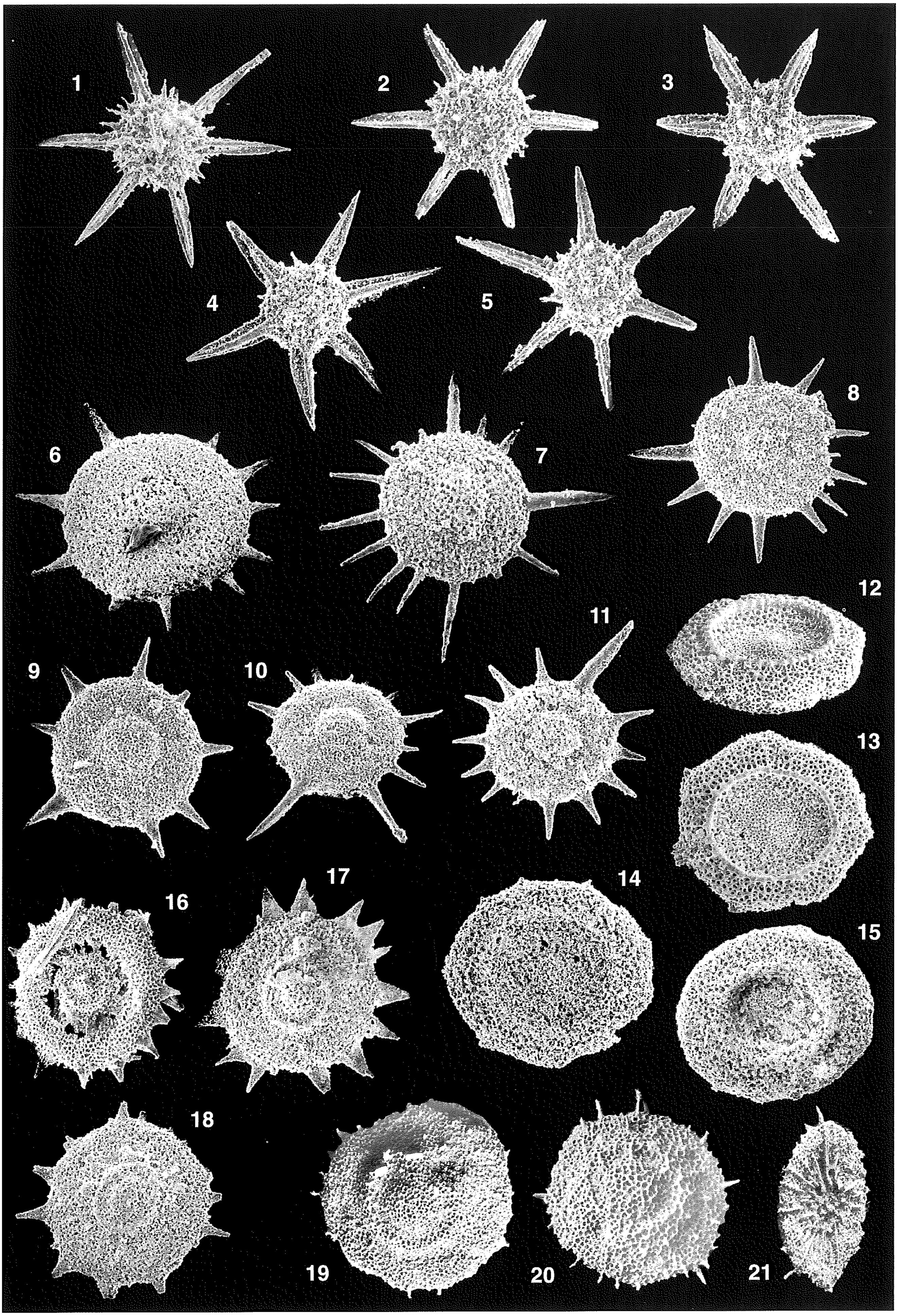

PLATE 63

Figures 1-4 **Godia decora** (LI & WU) x150 .... p. 336

1) 10889, from loc. no. Pan-1, late Aptian.
2) 10902, from loc. no. Pan-1, late Aptian.
3) 10906, from loc. no. Pan-1, late Aptian.
4) 11018, from loc. no. Pan-1, late Aptian.

Figures 5-8 **Dactyliosphaera maxima** (PESSAGNO) x100 .... p. 338

5) 183, from loc. no. Ap2 (-7.78), middle Albian.
6) 199, from loc. no. Ap2 (-7.78), middle Albian.
7) 3204, from loc. no. Bo-685.20, late Albian.
8) 1051, from loc. no. Gc-1027.10, middle Albian.

Figures 9-12 **Dactyliosphaera acutispina** (SQUINABOL) x100 .... p. 339

9) 1074, from loc. no. Gc-1027.10, middle Albian.
10) 219, from loc. no. Ap2 (-7.78), middle Albian.
11) 3154, from loc. no. Bo-685.20, late Albian.
12) 1011, from loc. no. Gc-1027.10, middle Albian.

Figures 13-21 **Dactyliosphaera lepta** (FOREMAN) x100 .... p. 340

13) 3752, from loc. no. Gc-1073.94, middle Cenomanian.
14) 5407, from loc. no. Gb-84.40, early Cenomanian.
15) 4040, from loc. no. Gc-1073.94, middle Cenomanian.
16) 4014, from loc. no. Gc-1073.94, middle Cenomanian.
17) 3300, from loc. no. Bo-685.20, late Albian.
18) 7326, from loc. no. Gb-108.60, late Cenomanian.
19) 3726, from loc. no. Gc-1073.94, middle Cenomanian.
20) 5401, from loc. no. Gb-84.40, early Cenomanian.
21) 4050, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 22-26 **Dactyliosphaera silviae** SQUINABOL x120 .... p. 341

22) 5398, from loc. no. Gb-84.40, early Cenomanian.
23) 3604, from loc. no. Gc-1073.94, middle Cenomanian.
24) 5414, from loc. no. Gb-84.40, early Cenomanian.
25) 3917, from loc. no. Gc-1073.94, middle Cenomanian.
26) 3558, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 63

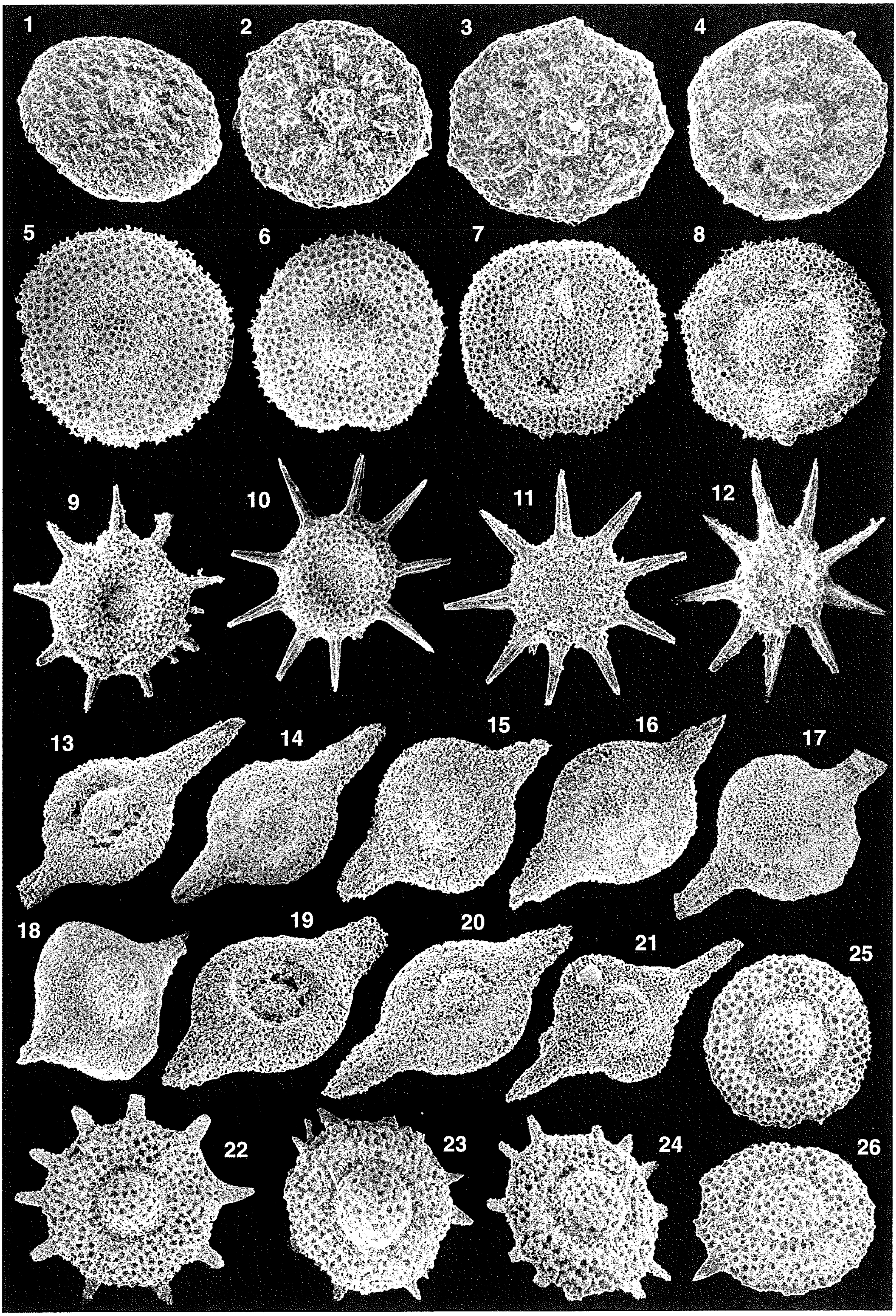

PLATE 64

Figures 1-4 **Quadrigastrum lapideum** nov. sp. x120 .... p. 342

1) 3561 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
2) 5417, from loc. no. Gb-84.40, early Cenomanian.
3) 3538, from loc. no. Gc-1073.94, middle Cenomanian.
4) 1180, from loc. no. Gc-1027.10, middle Albian.

Figures 5-10 **Quadrigastrum oculus** nov. sp. x100 .... p. 342

5) 3530, from loc. no. Gc-1073.94, middle Cenomanian.
6) 3643, from loc. no. Gc-1073.94, middle Cenomanian.
7) 3649, from loc. no. Gc-1073.94, middle Cenomanian.
8) 3785, from loc. no. Gc-1073.94, middle Cenomanian.
9) 3532 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
10) 3854, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 11-13 **Quadrigastrum insulsum** nov. sp. x100 .... p. 343

11) 3960, from loc. no. Gc-1073.94, middle Cenomanian.
12) 6798, from loc. no. Asv-5-43, early Turonian.
13) 3692 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.

Figure 14 **Deviatus diamphidius** (FOREMAN) x100 .... p. 345

14) 10923, from loc. no. Pan-1, late Aptian.

Figures 15-16 **Angulobracchia portmanni** BAUMGARTNER x120 .... p. 346

15) 9011, from loc. no. Ca1-22.30, early Aptian.
16) 8731, from loc. no. Ca1-22.30, early Aptian.

Figures 17-18 **Halesium crassum** (OZVOLDOVA) x120 .... p. 348

17) 9297, from loc. no. Ca1-22.30, early Aptian.
18) 9300, from loc. no. Ca1-22.30, early Aptian.

Figures 19-24 **Halesium nevianii** (SQUINABOL) x80 .... p. 348

19) 1465, from loc. no. Ap2-12, early Cenomanian.
20) 2719, from loc. no. Bo-685.20, late Albian.
21) 1084, from loc. no. Gc-1027.10, middle Albian.
22) 117, from loc. no. Ap2 (-7.78), middle Albian.
23) 1526, from loc. no. Ap2-12, early Cenomanian.
24) 2814, from loc. no. Bo-685.20, late Albian.

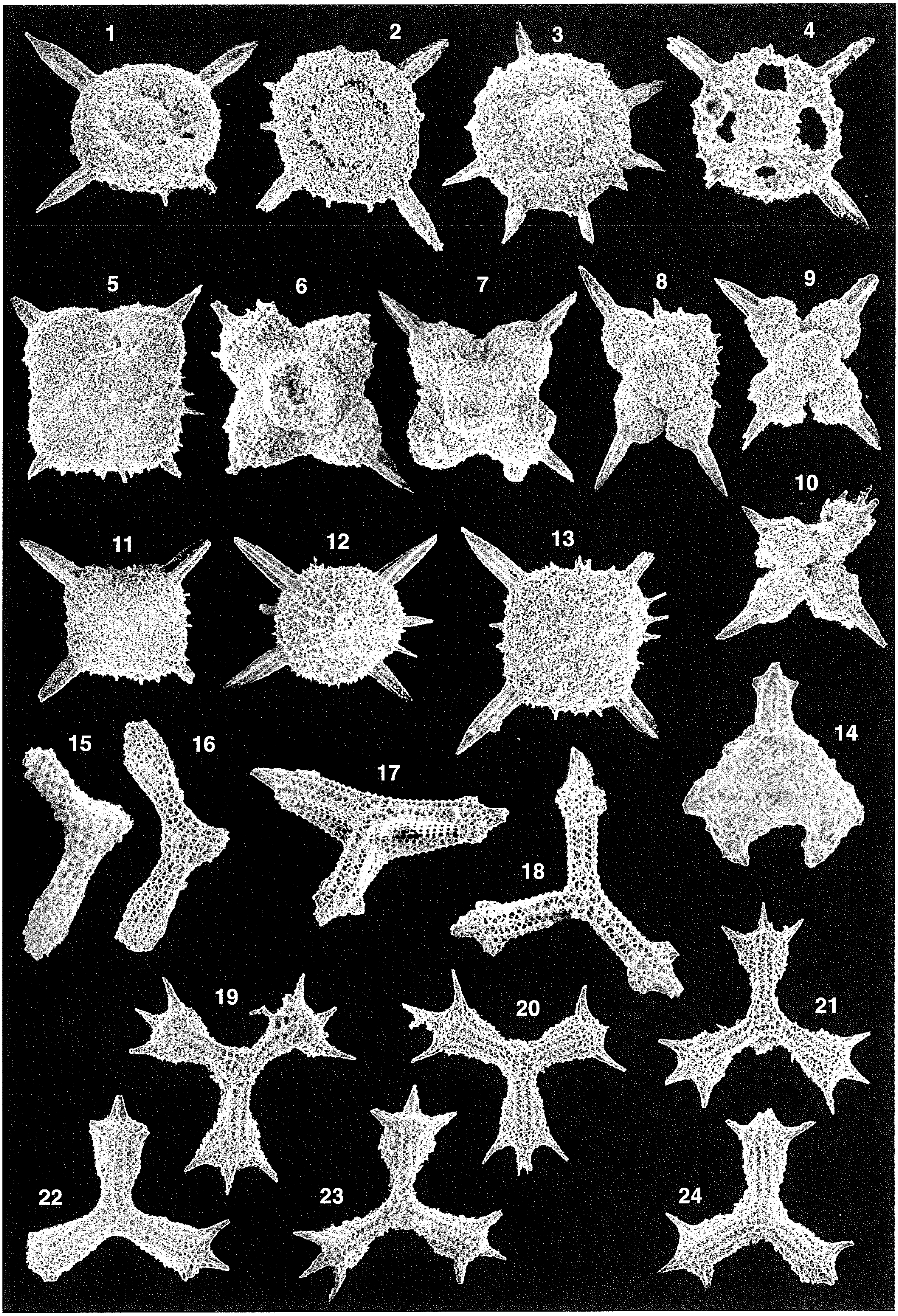
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PLATE 65

Figures 1-8 **Halesium diacanthum** (SQUINABOL) x80 .... p. 349

1) 4064, from loc. no. Gc-1073.94, middle Cenomanian.
2) 2471, from loc. no. Bo-685.20, late Albian.
3) 3043, from loc. no. Bo-685.20, late Albian.
4) 1513, from loc. no. Ap2-12, early Cenomanian.
5) 2559, from loc. no. Gc-1035.10, late Albian.
6) 2548, from loc. no. Gc-1035.10, late Albian.
7) 2494, from loc. no. Bo-685.20, late Albian.
8) 2481, from loc. no. Bo-685.20, late Albian.

Figures 9-14 **Halesium triacanthum** (SQUINABOL) x80 .... p. 350

9) 4460, from loc. no. Gc-1096.50, early Turonian.
10) 7813, from loc. no. Gb-108.60, late Cenomanian.
11) 4643, from loc. no. Gc-1096.50, early Turonian.
12) 4465, from loc. no. Gc-1096.50, early Turonian.
13) 11321, from loc. no. Fl-4-21, early Turonian.
14) 3841, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 15-23 **Halesium amissum** (SQUINABOL) x100 .... p. 351

15) 6267, from loc. no. Asv-5-43, early Turonian.
16) 4585, from loc. no. Gc-1096.50, early Turonian.
17) 6266, from loc. no. Asv-5-43, early Turonian.
18) 4414, from loc. no. Gc-1096.50, early Turonian.
19) 7602, from loc. no. Gb-108.60, late Cenomanian.
20) 4480, from loc. no. Gc-1096.50, early Turonian.
21) 6065, from loc. no. Asv-5-43, early Turonian.
22) 4482, from loc. no. Gc-1096.50, early Turonian.
23) 6975, from loc. no. Asv-5-43, early Turonian.

Plate 65

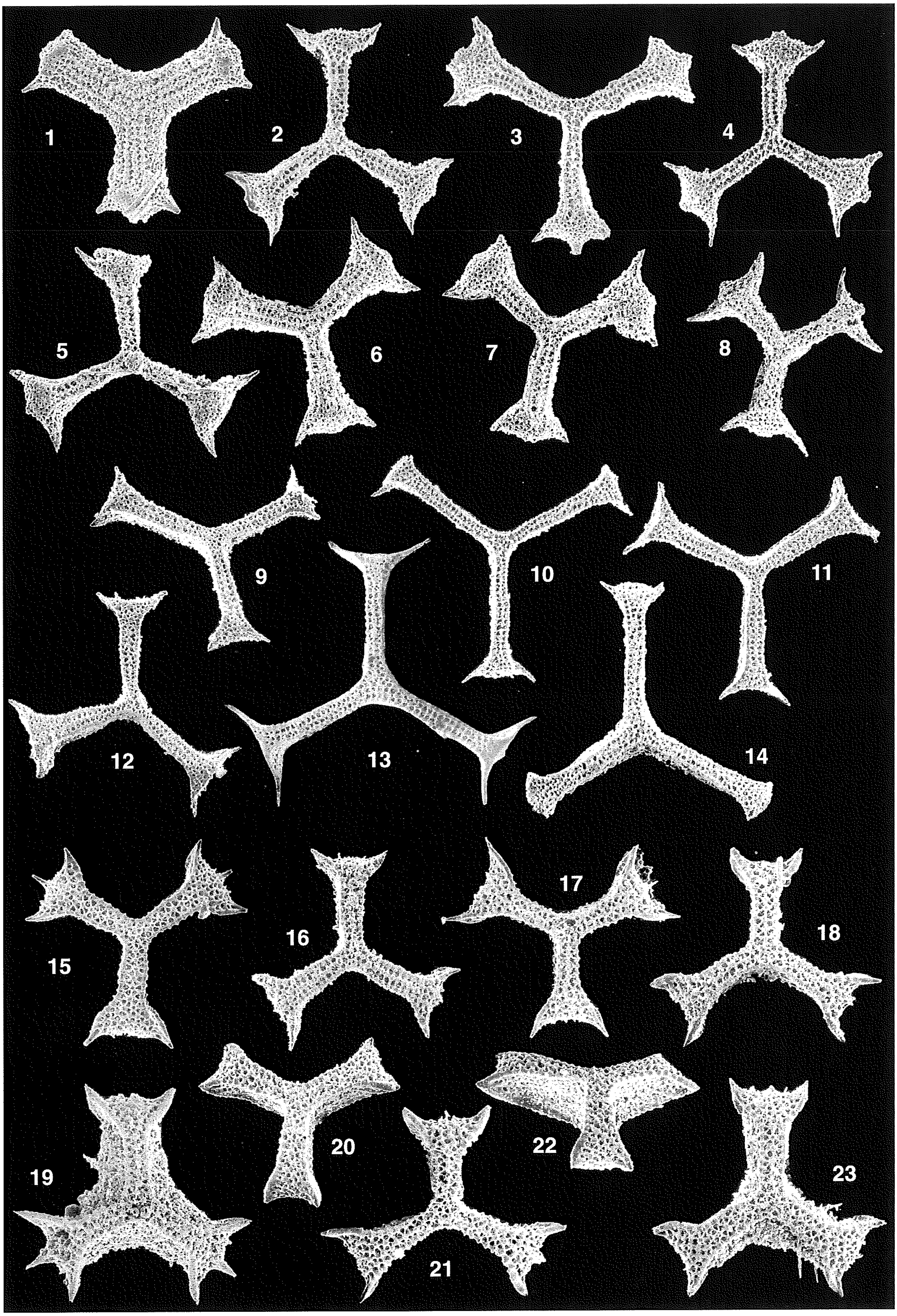

PLATE 66

Figures 1-8 **Paronaella grapevinensis** (PESSAGNO) x100 .... p. 352

1) 1566, from loc. no. Ap2-12, early Cenomanian.
2) 85, from loc. no. Ap2 (-7.78), middle Albian.
3) 6260, from loc. no. Asv-5-43, early Turonian.
4) 1108, from loc. no. Gc-1027.10, middle Albian.
5) 2291, from loc. no. Gc-1035.10, late Albian.
6) 2781, from loc. no. Bo-685.20, late Albian.
7) 1546, from loc. no. Ap2-12, early Cenomanian.
8) 1042, from loc. no. Gc-1027.10, middle Albian.

Figures 9-16 **Paronaella communis** (SQUINABOL) x120 .... p. 353

9) 7424, from loc. no. Gb-108.60, late Cenomanian.
10) 5800, from loc. no. Asv-5-43, early Turonian.
11) 4580, from loc. no. Gc-1096.50, early Turonian.
12) 7315, from loc. no. Gb-108.60, late Cenomanian.
13) 7163, from loc. no. Gb-108.60, late Cenomanian.
14) 4479, from loc. no. Gc-1096.50, early Turonian.
15) 6757, from loc. no. Asv-5-43, early Turonian.
16) 6535, from loc. no. Asv-5-43, early Turonian.

Figures 17-18 **Paronaella acuta** nov. sp. x120 .... p. 354

17) 6511 (holotype), from loc. no. Asv-5-43, early Turonian.
18) 6510, from loc. no. Asv-5-43, early Turonian.

Figures 19-24 **Paronaella solanoensis** PESSAGNO x120 .... p. 354

19) 5936, from loc. no. Asv-5-43, early Turonian.
20) 6316, from loc. no. Asv-5-43, early Turonian.
21) 4706, from loc. no. Gc-1096.50, early Turonian.
22) 6459, from loc. no. Asv-5-43, early Turonian.
23) 6994, from loc. no. Asv-5-43, early Turonian.
24) 6904, from loc. no. Asv-5-43, early Turonian.

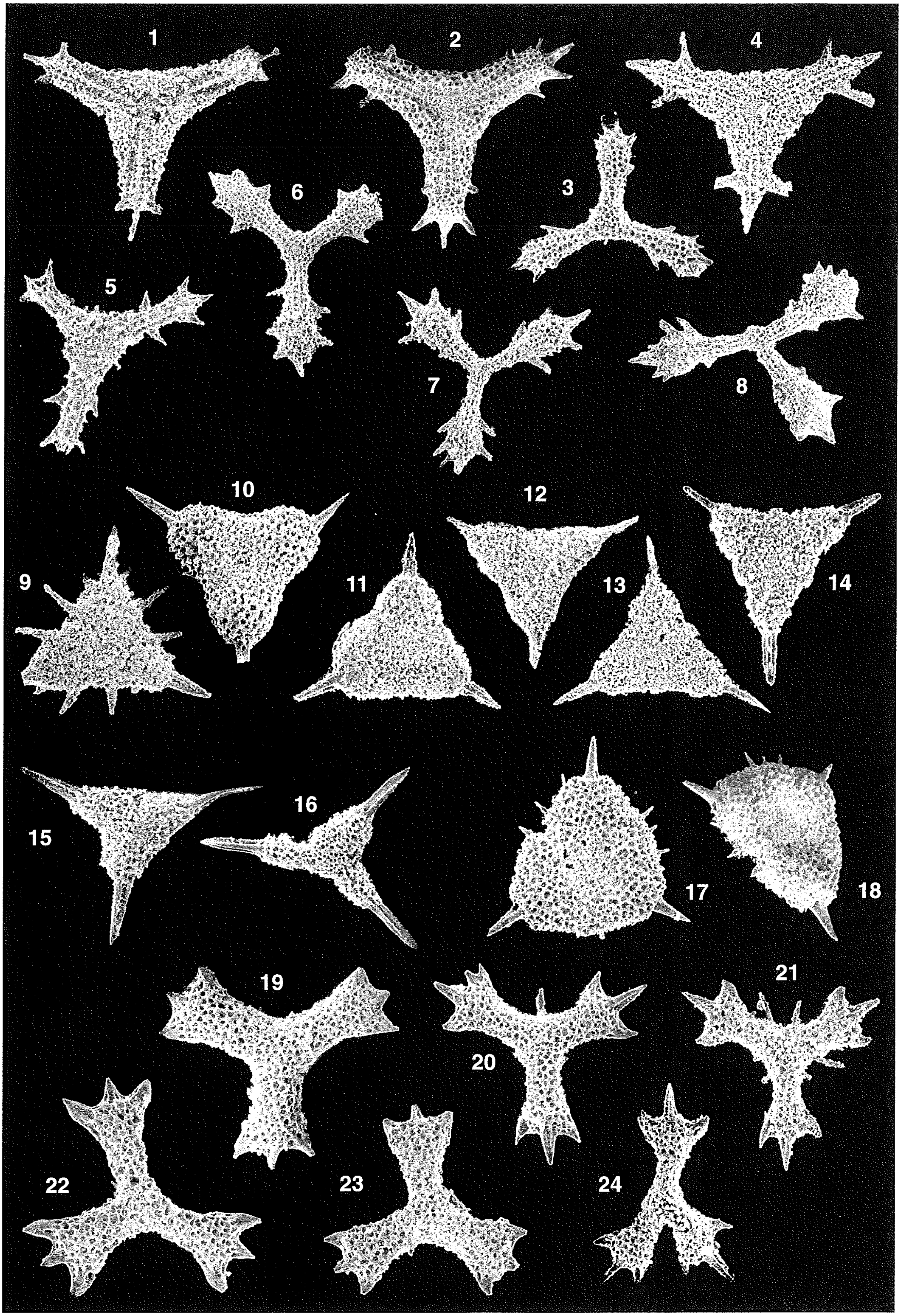
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PLATE 67

Figures 1-7 **Paronaella californiaensis** PESSAGNO x120 .... p. 355

1) 5801, from loc. no. Asv-5-43, early Turonian.
2) 4597, from loc. no. Gc-1096.50, early Turonian.
3) 5761, from loc. no. Asv-5-43, early Turonian.
4) 4705, from loc. no. Gc-1096.50, early Turonian.
5) 7037, from loc. no. Asv-5-43, early Turonian.
6) 4651, from loc. no. Gc-1096.50, early Turonian.
7) 4593, from loc. no. Gc-1096.50, early Turonian.

Figures 8-9 **Paronaella pseudoaulophacoides** nov. sp. x120 .... p. 356

8) 6627 (holotype), from loc. no. Asv-5-43, early Turonian.
9) 6610, from loc. no. Asv-5-43, early Turonian.

Figures 10-16 **Pessagnobrachia dalpiazii** (SQUINABOL) x100 .... p. 358

10) 2790, from loc. no. Bo-685.20, late Albian.
11) 2792, from loc. no. Bo-685.20, late Albian.
12) 1390, from loc. no. Gc-1027.10, middle Albian.
13) 2809, from loc. no. Bo-685.20, late Albian.
14) 3784, from loc. no. Gc-1073.94, middle Cenomanian.
15) 3798, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3142, from loc. no. Bo-685.20, late Albian.

Figures 17-25 **Pessagnobrachia fabianii** (SQUINABOL) x80 .... p. 359

17) 3763, from loc. no. Gc-1073.94, middle Cenomanian.
18) 7262, from loc. no. Gb-108.60, late Cenomanian.
19) 7788, from loc. no. Gb-108.60, late Cenomanian.
20) 6503, from loc. no. Asv-5-43, early Turonian.
21) 6713, from loc. no. Asv-5-43, early Turonian.
22) 6931, from loc. no. Asv-5-43, early Turonian.
23) 4437, from loc. no. Gc-1096.50, early Turonian.
24) 2495, from loc. no. Gc-1035.10, late Albian.
25) 2445, from loc. no. Gc-1035.10, late Albian.

Plate 67

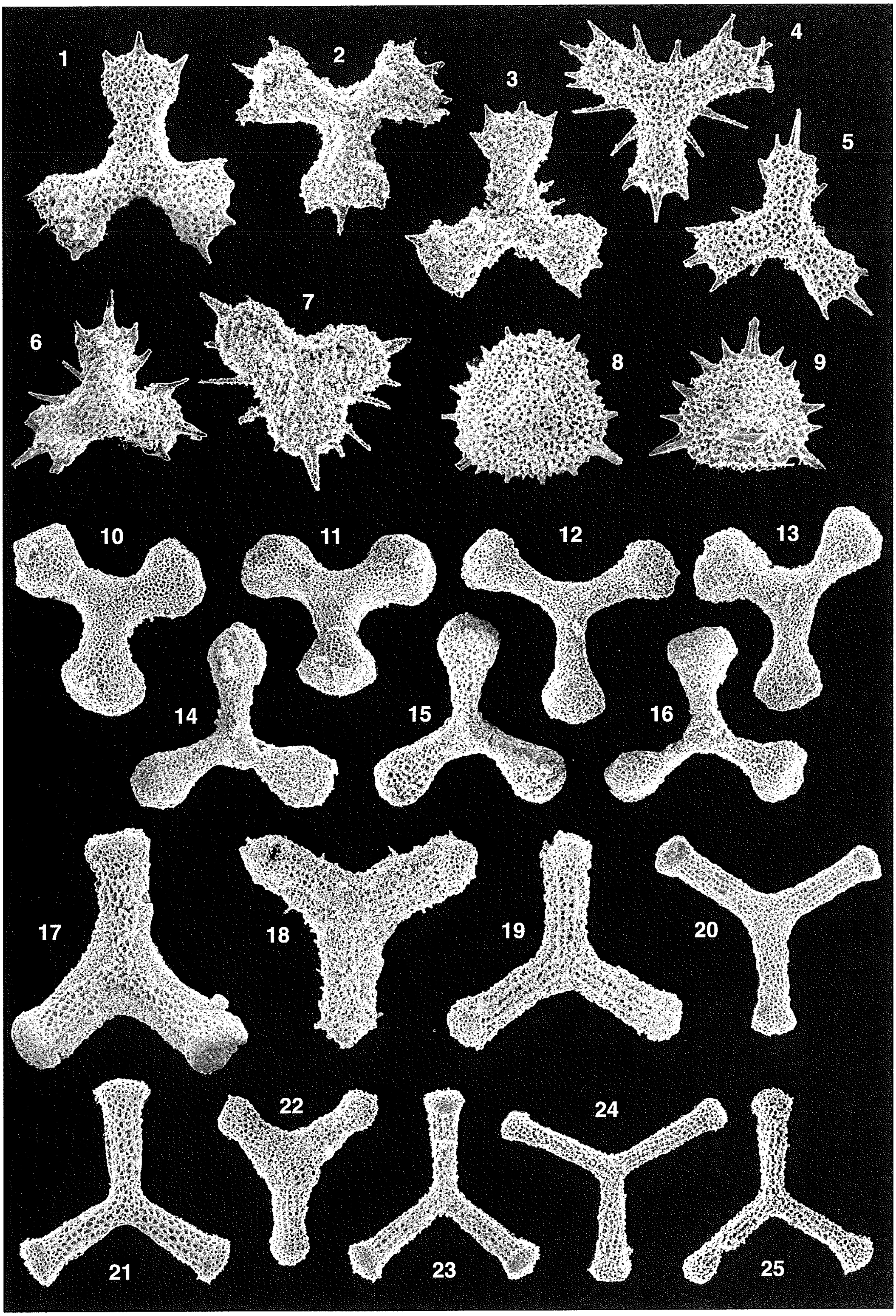

PLATE 68

Figures 1-8 **Pessagnobrachia irregularis** (SQUINABOL) x80 .... p. 360

1) 1018, from loc. no. Gc-1027.10, middle Albian.
2) 3226, from loc. no. Bo-685.20, late Albian.
3) 1574, from loc. no. Gc-1035.10, late Albian.
4) 1005, from loc. no. Gc-1027.10, middle Albian.
5) 1017, from loc. no. Gc-1027.10, middle Albian.
6) 3851, from loc. no. Gc-1073.94, middle Cenomanian.
7) 2516, from loc. no. Gc-1035.10, late Albian.
8) 3931, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 9-13 **Pessagnobrachia rara** (SQUINABOL) x80 .... p. 361

9) 3222, from loc. no. Bo-685.20, late Albian.
10) 1056, from loc. no. Gc-1027.10, middle Albian.
11) 1022, from loc. no. Gc-1027.10, middle Albian.
12) 2531, from loc. no. Gc-1035.10, late Albian.
13) 3229, from loc. no. Bo-685.20, late Albian.

Figures 14-20 **Pessagnobrachia macphersoni** nov. sp. x100 .... p. 361

14) 3768, from loc. no. Gc-1073.94, middle Cenomanian.
15) 3772, from loc. no. Gc-1073.94, middle Cenomanian.
16) 3782, from loc. no. Gc-1073.94, middle Cenomanian.
17) 5544, from loc. no. Gb-84.40, early Cenomanian.
18) 3767 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
19) 3781, from loc. no. Gc-1073.94, middle Cenomanian.
20) 3820, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 21-26 **Pessagnobrachia clavata** (SQUINABOL) x80 .... p. 362

21) 4466, from loc. no. Gc-1096.50, early Turonian.
22) 6813, from loc. no. Asv-5-43, early Turonian.
23) 5767, from loc. no. Asv-5-43, early Turonian.
24) 4431, from loc. no. Gc-1096.50, early Turonian.
25) 4435, from loc. no. Gc-1096.50, early Turonian.
26) 4457, from loc. no. Gc-1096.50, early Turonian.

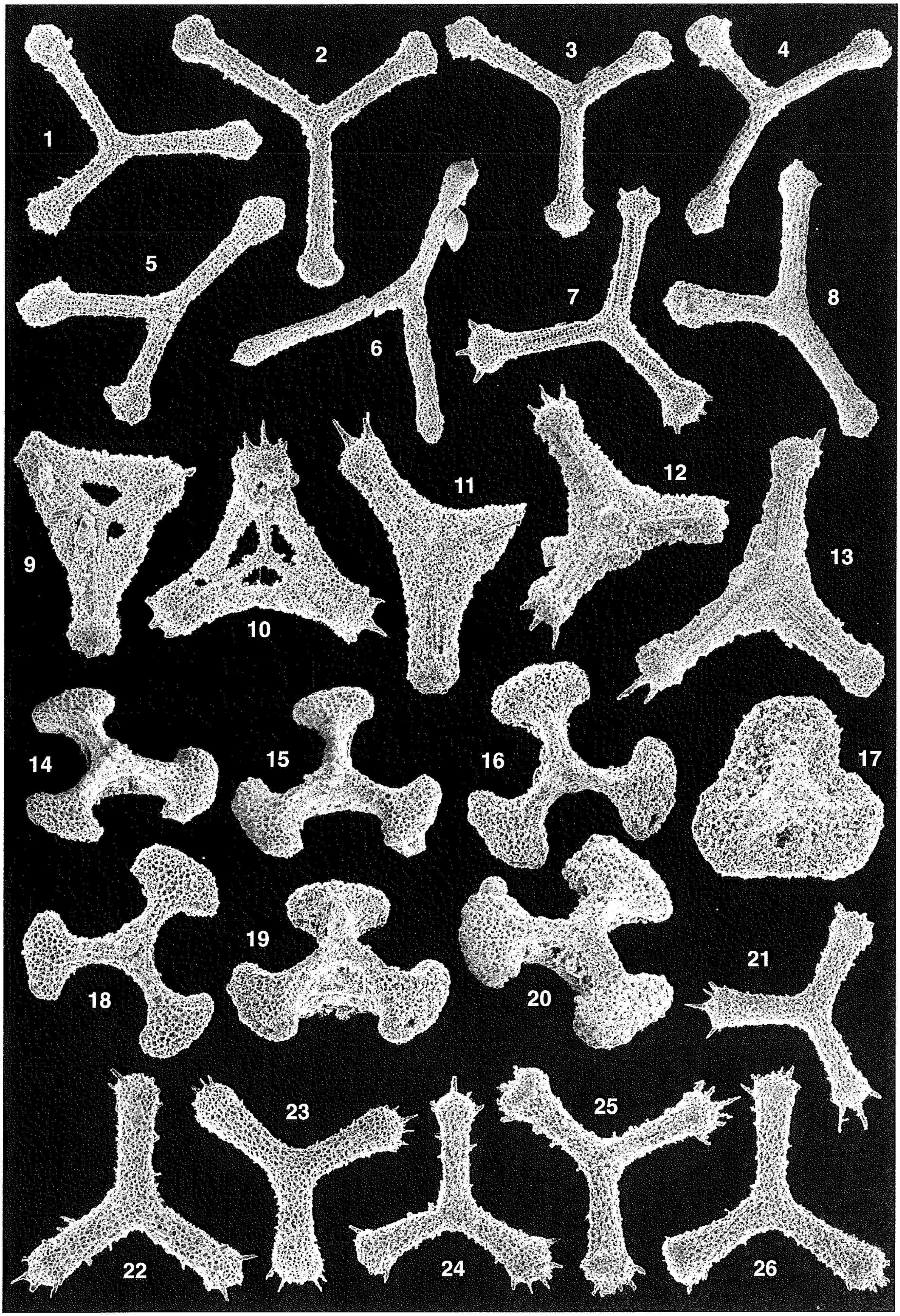
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PLATE 69

Figures 1-6 **Crucella bossoensis** JUD x150 .... p. 363
except fig. 4 x100

1) R-458 (Holotype), from loc. no. Bo-566.50, early Barremian.
2) R-457, from loc. no. Bo-566.50, early Barremian.
3) 8459, from loc. no. Ca1-22.30, early Aptian.
4) R-361, from loc. no. Bo-566.50, early Barremian.
5) R-472, from loc. no. Bo-566.50, early Barremian.
6) 8464, from loc. no. Ca1-22.30, early Aptian.

Figures 7-10 **Crucella remanei** JUD x150 .... p. 364

7) 9052, from loc. no. Ca1-22.30, early Aptian.
8) 9276, from loc. no. Ca1-22.30, early Aptian.
9) 9051, from loc. no. Ca1-22.30, early Aptian.
10) 10995, from loc. no. Pan-1, late Aptian.

Figures 11-21 **Crucella gavalai** nov. sp. x200 .... p. 365

11) 9833, from loc. no. Mc-268b, middle Aptian.
12) 10050, from loc. no. Mc-268b, middle Aptian.
13) 9792, from loc. no. Mc-268b, middle Aptian.
14) 9793, from loc. no. Mc-268b, middle Aptian.
15) 9834, from loc. no. Mc-268b, middle Aptian.
16) 9829, from loc. no. Mc-268b, middle Aptian.
17) 9935, from loc. no. Mc-268b, middle Aptian.
18) 10225, from loc. no. Mc-268b, middle Aptian.
19) 9791, from loc. no. Mc-268b, middle Aptian.
20) 10234, from loc. no. Mc-268b, middle Aptian.
21) 9835 (holotype), from loc. no. Mc-268b, middle Aptian.

Plate 69

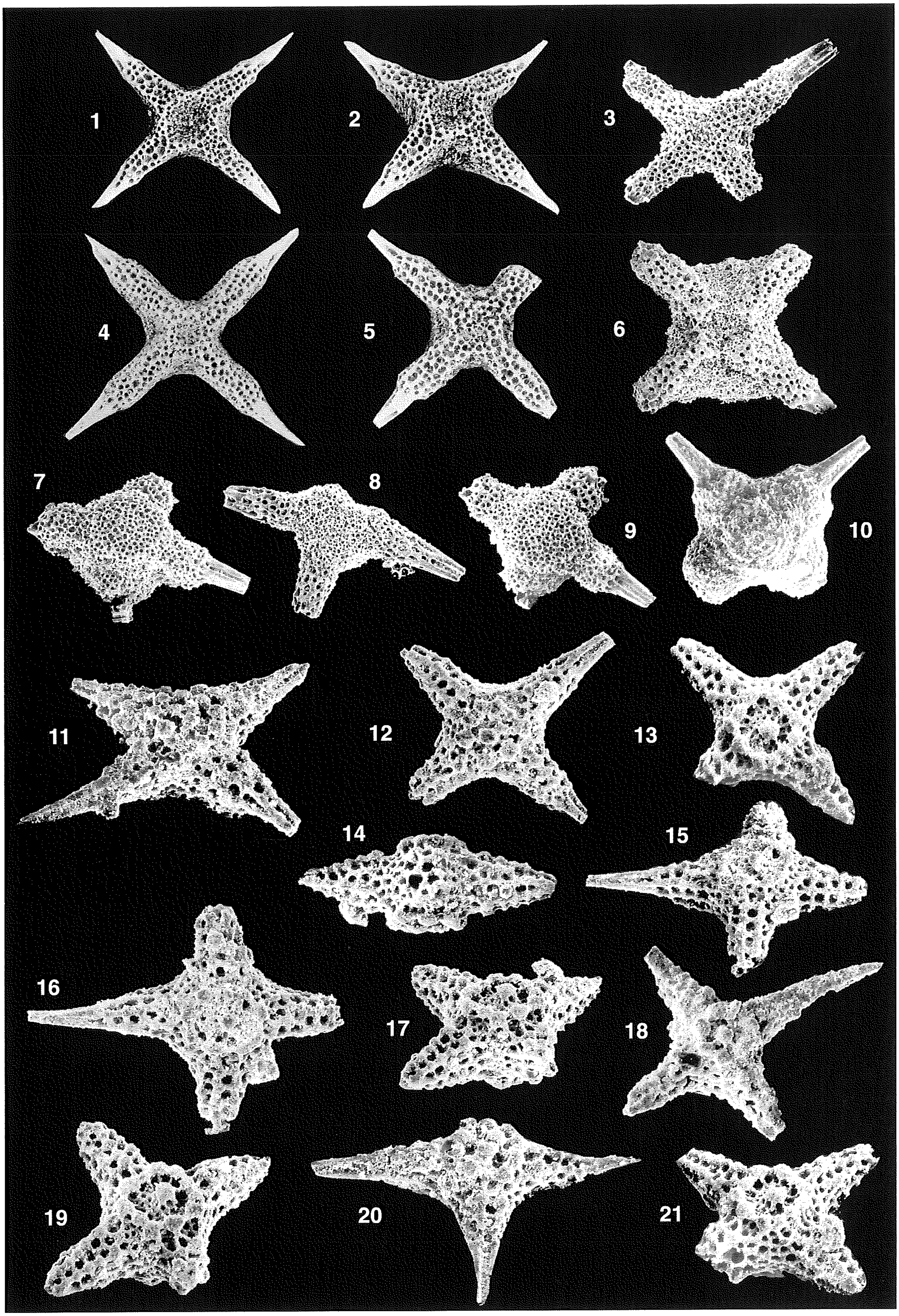


PLATE 70

Figures 1-5 **Crucella hispana** nov. sp. x150 .... p. 365

1) 10958 (holotype), from loc. no. Pan-1, late Aptian.
2) 10957, from loc. no. Pan-1, late Aptian.
3) 10938, from loc. no. Pan-1, late Aptian.
4) 10919, from loc. no. Pan-1, late Aptian.
5) 11022, from loc. no. Pan-1, late Aptian.

Figures 6-9 **Crucella baliarica** nov. sp. x120 .... p. 366

6) 10898 (holotype), from loc. no. Pan-1, late Aptian.
7) 10944, from loc. no. Pan-1, late Aptian.
8) 10909, from loc. no. Pan-1, late Aptian.
9) 10977, from loc. no. Pan-1, late Aptian.

Figures 10-20 **Crucella euganea** (SQUINABOL) x130 .... p. 367

10) 5762, from loc. no. Asv-5-43, early Turonian.
11) 6271, from loc. no. Asv-5-43, early Turonian.
12) 4529, from loc. no. Gc-1096.50, early Turonian.
13) 1548, from loc. no. Ap2-12, early Cenomanian.
14) 7134, from loc. no. Asv-5-43, early Turonian.
15) 6432, from loc. no. Asv-5-43, early Turonian.
16) 7091, from loc. no. Asv-5-43, early Turonian.
17) 6136, from loc. no. Asv-5-43, early Turonian.
18) 7028, from loc. no. Asv-5-43, early Turonian.
19) 6156, from loc. no. Asv-5-43, early Turonian.
20) 6151, from loc. no. Asv-5-43, early Turonian.

Figures 21-24 **Crucella messinae** PESSAGNO x120 .... p. 368

21) 2815, from loc. no. Bo-685.20, late Albian.
22) 3761, from loc. no. Gc-1073.94, middle Cenomanian.
23) 3041, from loc. no. Bo-685.20, late Albian.
24) 3963, from loc. no. Gc-1073.94, middle Cenomanian.

Plate 70

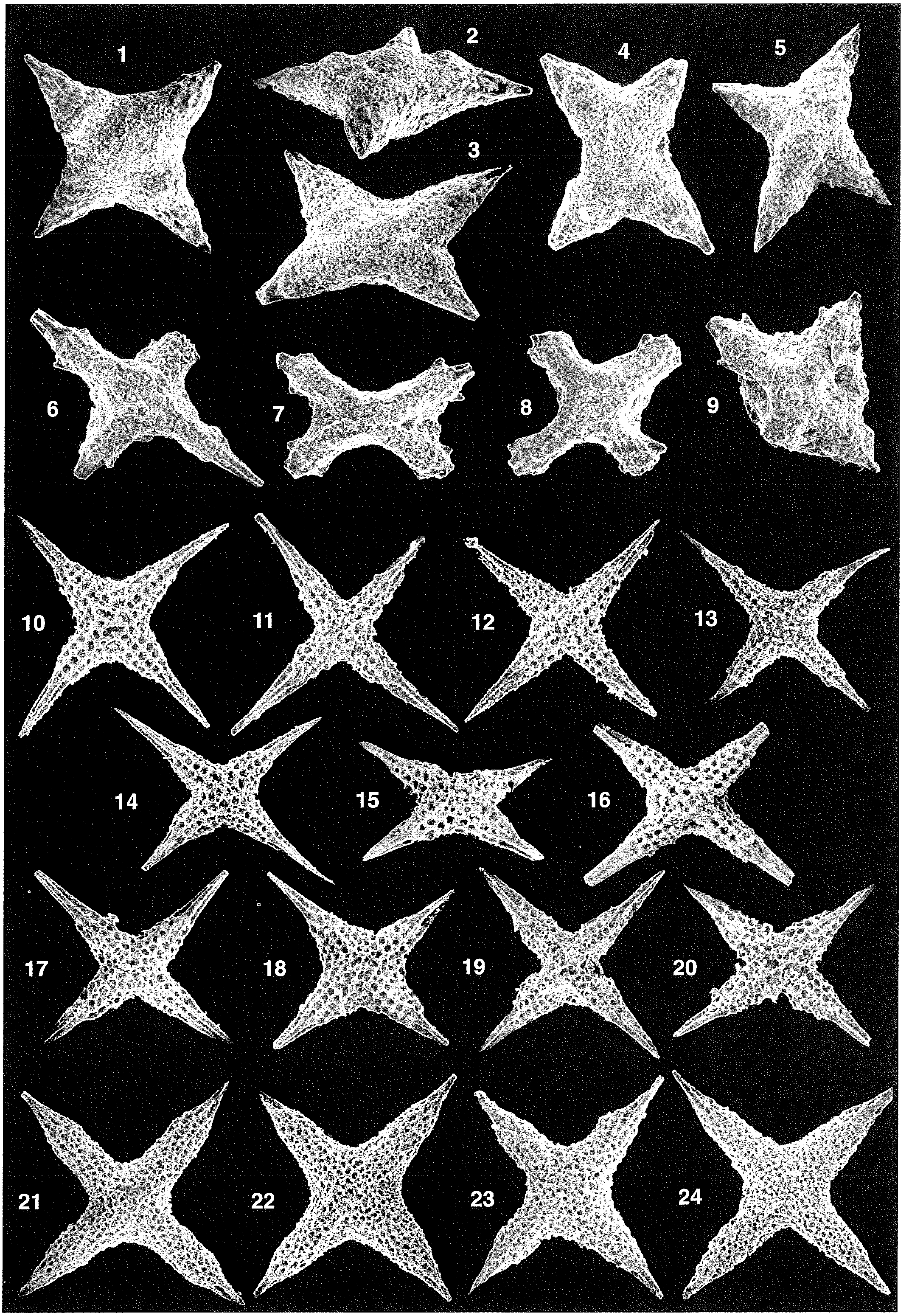


PLATE 71

Figures 1-6 **Crucella messinae** PESSAGNO x120 .... p. 368

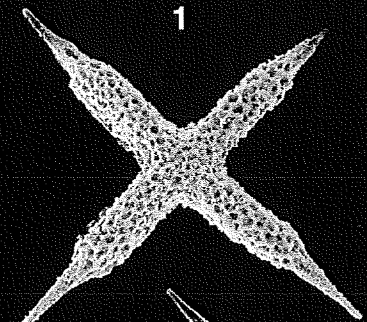
1) 7529, from loc. no. Gb-108.60, late Cenomanian.
2) 7510, from loc. no. Gb-108.60, late Cenomanian.
3) 7422, from loc. no. Gb-108.60, late Cenomanian.
4) 1009, from loc. no. Gc-1027.10, middle Albian.
5) 4081, from loc. no. Gc-1073.94, middle Cenomanian.
6) 7239, from loc. no. Gb-108.60, late Cenomanian.

Figures 7-14 **Crucella irwini** PESSAGNO x120 .... p. 369

7) 3804, from loc. no. Gc-1073.94, middle Cenomanian.
8) 5603, from loc. no. Gb-84.40, early Cenomanian.
9) 3766, from loc. no. Gc-1073.94, middle Cenomanian.
10) 7040, from loc. no. Asv-5-43, early Turonian.
11) 3906, from loc. no. Gc-1073.94, middle Cenomanian.
12) 4417, from loc. no. Gc-1096.50, early Turonian.
13) 6655, from loc. no. Asv-5-43, early Turonian.
14) 6462, from loc. no. Asv-5-43, early Turonian.

Figures 15-22 **Crucella cachensis** PESSAGNO x120 .... p. 370

15) 4571, from loc. no. Gc-1096.50, early Turonian.
16) 6045, from loc. no. Asv-5-43, early Turonian.
17) 5995, from loc. no. Asv-5-43, early Turonian.
18) 6682, from loc. no. Asv-5-43, early Turonian.
19) 6818, from loc. no. Asv-5-43, early Turonian.
20) 6977, from loc. no. Asv-5-43, early Turonian.
21) 6320, from loc. no. Asv-5-43, early Turonian.
22) 4442, from loc. no. Gc-1096.50, early Turonian.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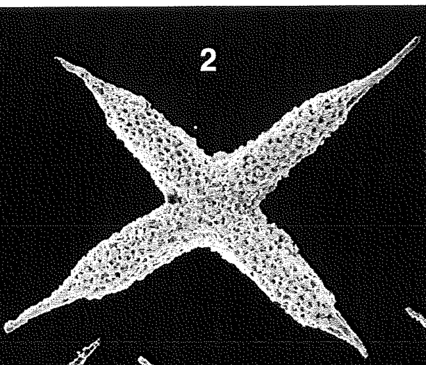
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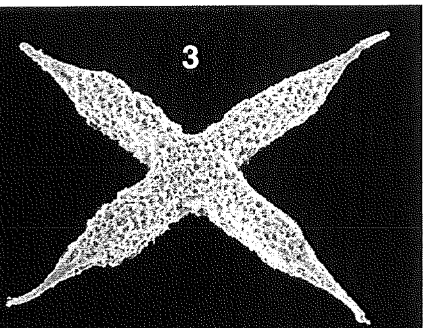
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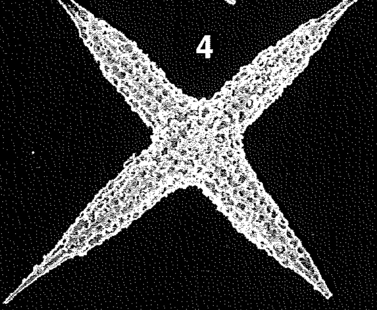
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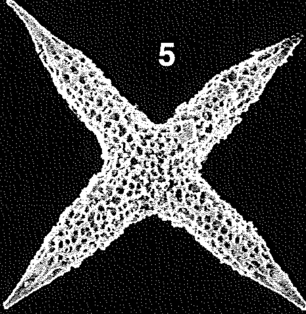
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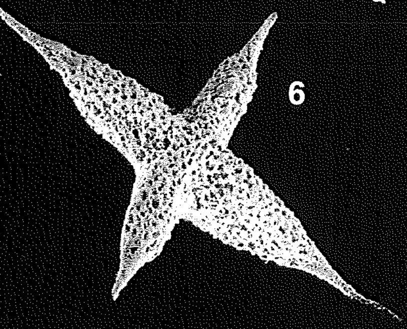
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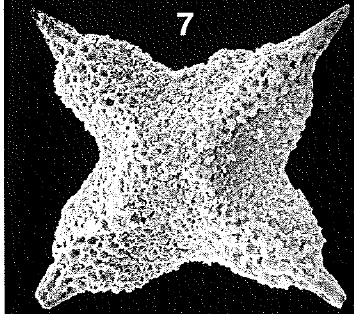
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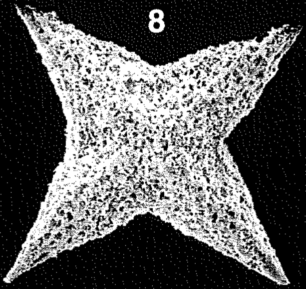
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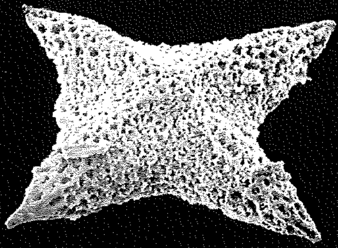
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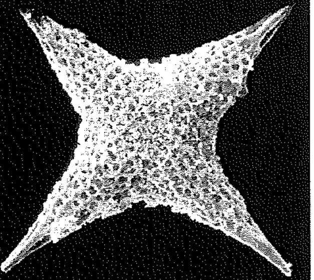
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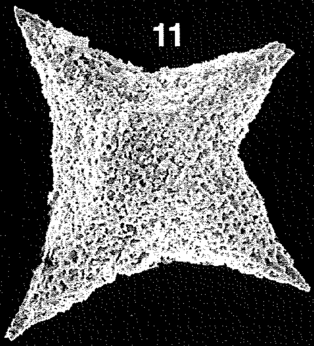
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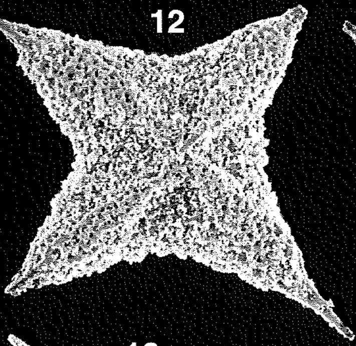
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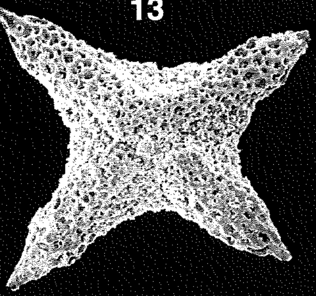
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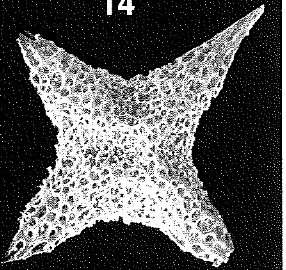
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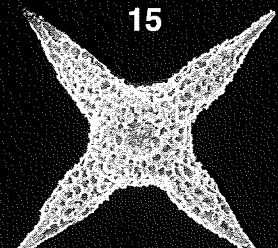
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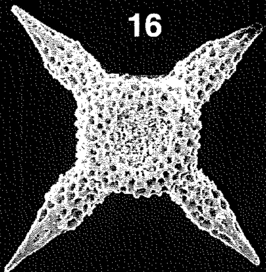
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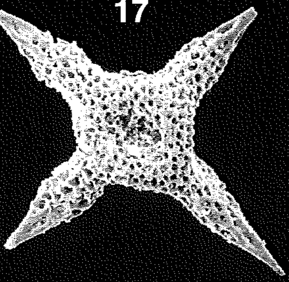
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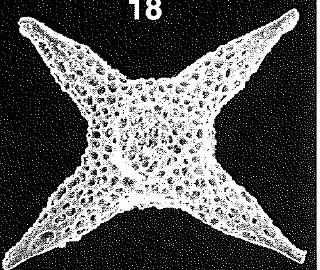
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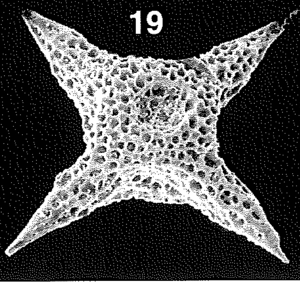
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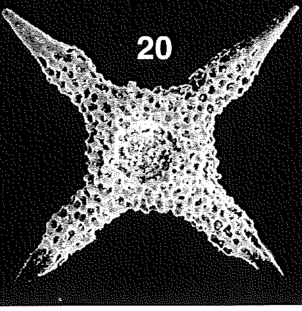
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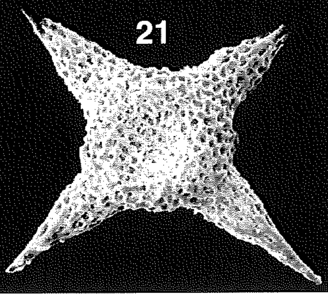
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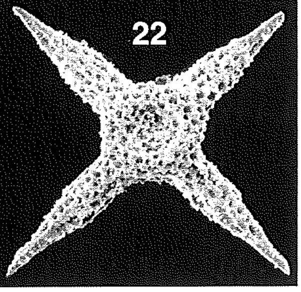
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PLATE 72

Figures 1-11 **Savaryella quadra** (FOREMAN) x120 .... p. 372
except fig. 2 x100

1) 2825, from loc. no. Bo-685.20, late Albian.
2) 3161, from loc. no. Bo-685.20, late Albian.
3) 3069, from loc. no. Bo-685.20, late Albian.
4) 1063, from loc. no. Gc-1027.10, middle Albian.
5) 2840, from loc. no. Bo-685.20, late Albian.
6) 1458, from loc. no. Ap2-12, early Cenomanian.
7) 2734, from loc. no. Bo-685.20, late Albian.
8) 3893, from loc. no. Gc-1073.94, middle Cenomanian.
9) 2770, from loc. no. Bo-685.20, late Albian.
10) 2780, from loc. no. Bo-685.20, late Albian.
11) 3032, from loc. no. Bo-685.20, late Albian.

Figures 12-19 **Savaryella novalensis** (SQUINABOL) x100 .... p. 372

12) 2818, from loc. no. Bo-685.20, late Albian.
13) 608, from loc. no. Ap2 (-7.78), middle Albian.
14) 5668, from loc. no. Gb-84.40, early Cenomanian.
15) 3131, from loc. no. Bo-685.20, late Albian.
16) 2800, from loc. no. Bo-685.20, late Albian.
17) 3812, from loc. no. Gc-1073.94, middle Cenomanian.
18) 1443, from loc. no. Ap2-12, early Cenomanian.
19) 1665, from loc. no. Ap2-12, early Cenomanian.

Plate 72

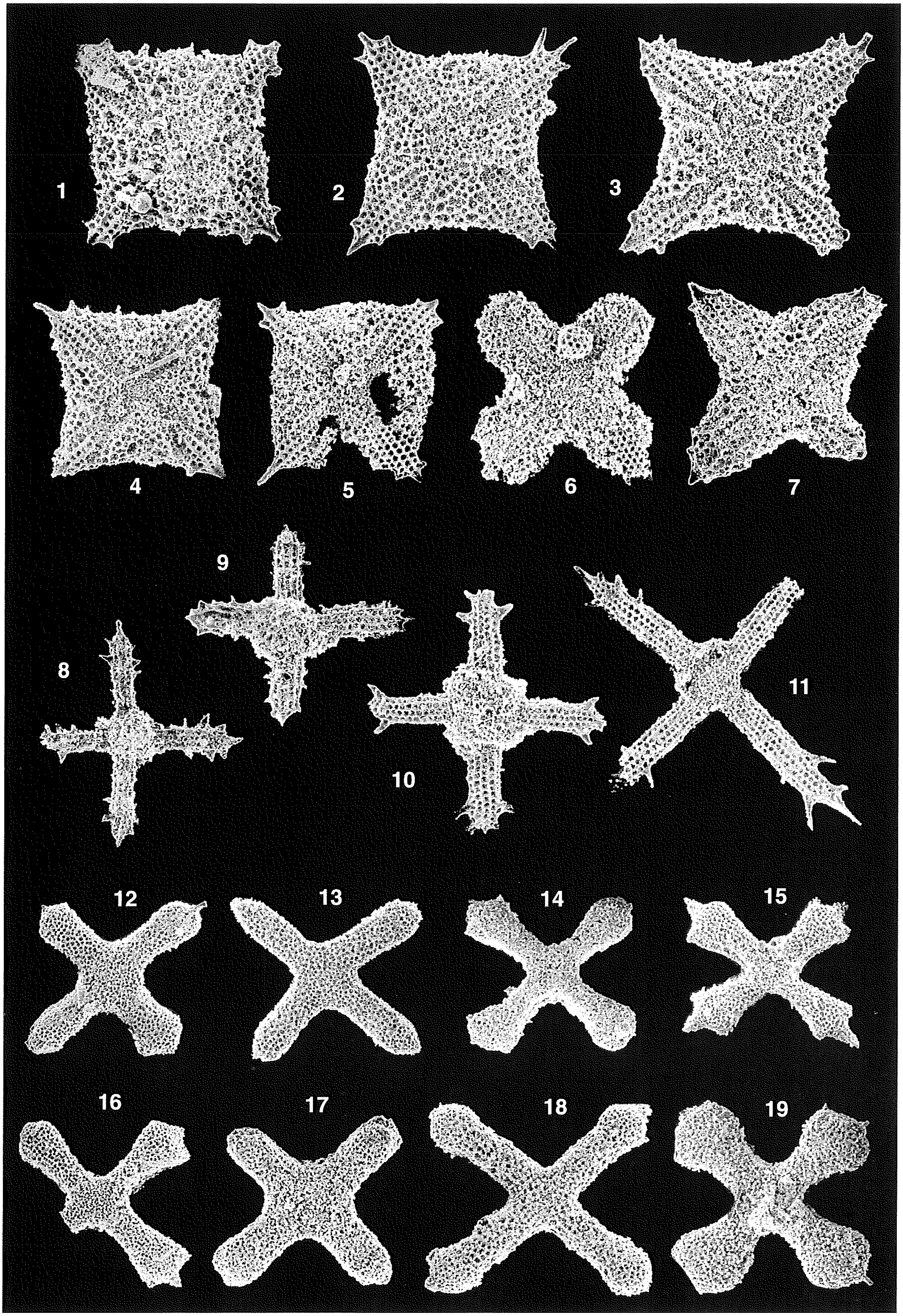


PLATE 73

Figures 1-8 **Savaryella spinosa** nov. sp. x120 .... p. 373

1) 3826, from loc. no. Gc-1073.94, middle Cenomanian.
2) 3533, from loc. no. Gc-1073.94, middle Cenomanian.
3) 2466, from loc. no. Gc-1035.10, late Albian.
4) 3780, from loc. no. Gc-1073.94, middle Cenomanian.
5) 3796 (holotype), from loc. no. Gc-1073.94, middle Cenomanian.
6) 3801, from loc. no. Gc-1073.94, middle Cenomanian.
7) 3899, from loc. no. Gc-1073.94, middle Cenomanian.
8) 3957, from loc. no. Gc-1073.94, middle Cenomanian.

Figures 9-12 **Savaryella sinistra** nov. sp. x100 .... p. 371

9) 2742 (holotype), from loc. no. Bo-685.20, late Albian.
10) 2830, from loc. no. Bo-685.20, late Albian.
11) 988, from loc. no. Gc-1027.10, middle Albian.
12) 7891, from loc. no. Gb-108.60, late Cenomanian.

Figures 13-17 **Savaryella stella** nov. sp. x150 .... p. 374

13) 7436 (holotype), from loc. no. Gb-108.60, late Cenomanian.
14) 3856, from loc. no. Gc-1073.94, middle Cenomanian.
15) 7814, from loc. no. Gb-108.60, late Cenomanian.
16) 3857, from loc. no. Gc-1073.94, middle Cenomanian.
17) 7401, from loc. no. Gb-108.60, late Cenomanian.

Plate 73

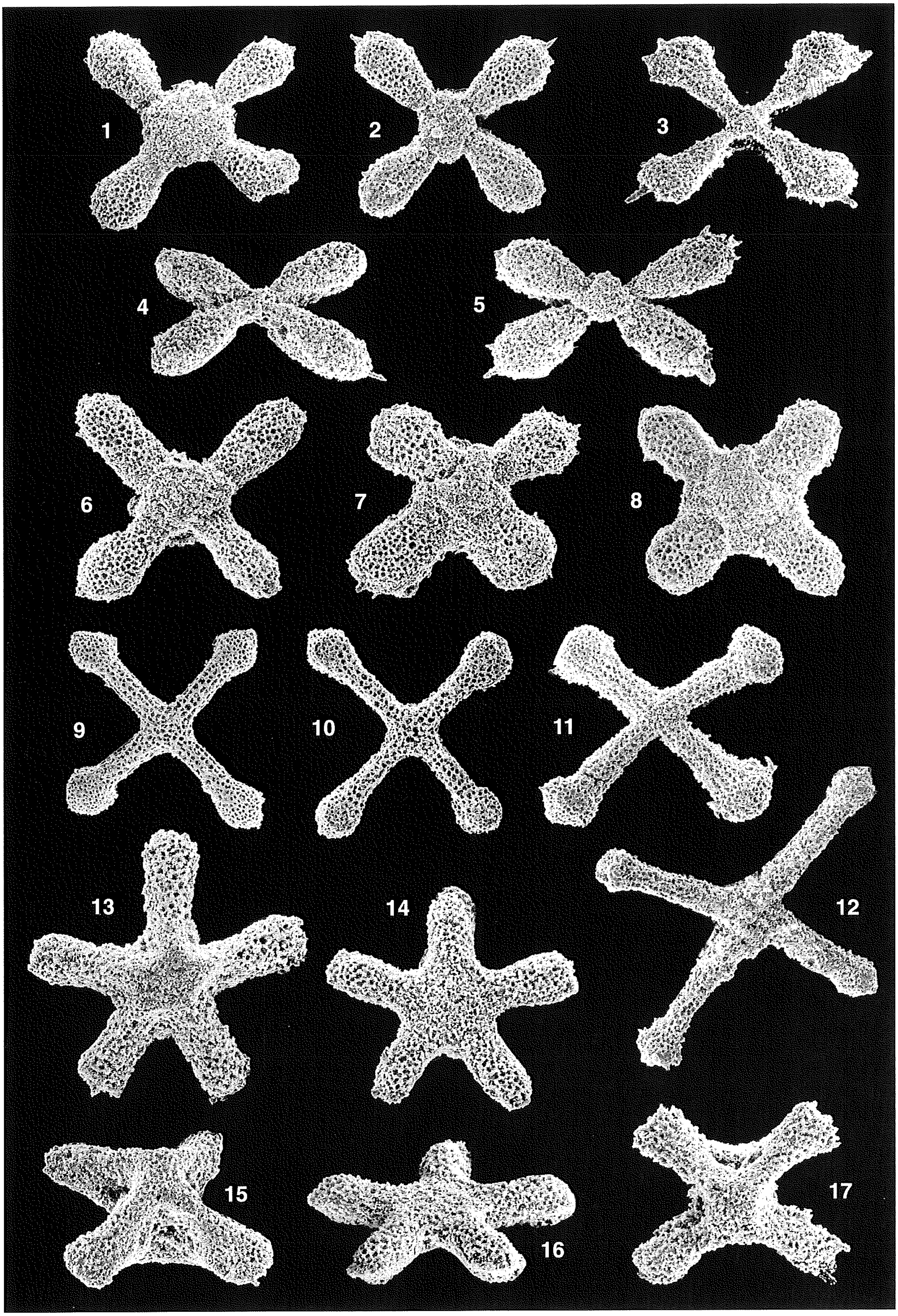


PLATE 74

Figures 1-5 **Archaeocenosphaera ? mellifera** nov. sp. x100 .... p. 375

1) 136, from loc. no. Ap2 (-7.78), middle Albian.
2) 6583, from loc. no. Asv-5-43, early Turonian.
3) 156, from loc. no. Ap2 (-7.78), middle Albian.
4) 138 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
5) 6620, from loc. no. Asv-5-43, early Turonian.

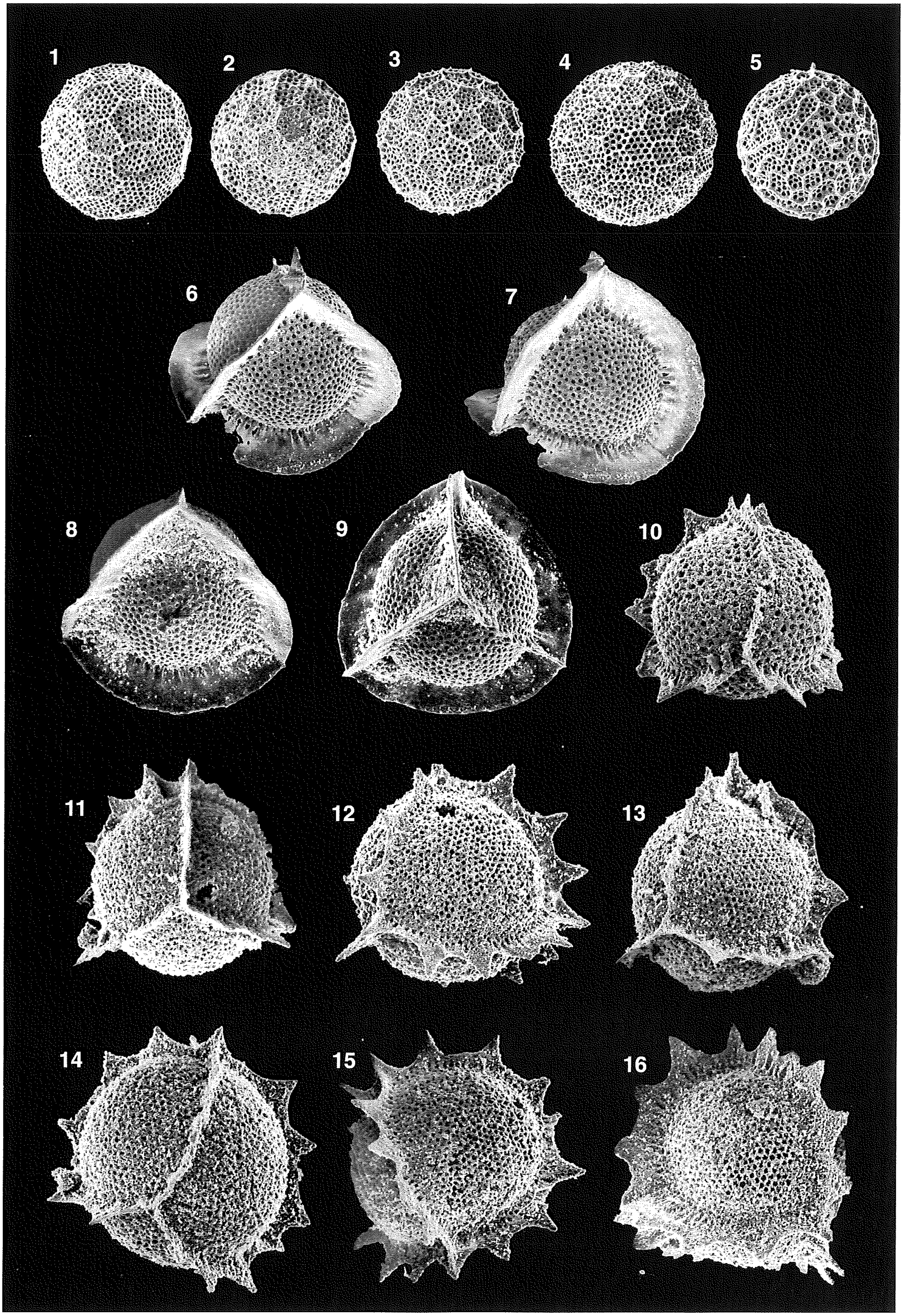
Figures 6-9 **Mallanites romanus** nov. sp. x120 .... p. 376

6) 24 (holotype), from loc. no. Ap2 (-7.78), middle Albian.
7) 22, from loc. no. Ap2 (-7.78), middle Albian.
8) 629, from loc. no. Ap2 (-7.78), middle Albian.
9) 628, from loc. no. Ap2 (-7.78), middle Albian.

Figures 10-16 **Mallanites triquetrus** (SQUINABOL) x120 .... p. 377

10) 1484, from loc. no. Ap2-12, early Cenomanian.
11) 1816, from loc. no. Ap2-12, early Cenomanian.
12) 1605, from loc. no. Ap2-12, early Cenomanian.
13) 1843, from loc. no. Gc-1035.10, late Albian.
14) 1417, from loc. no. Ap2-12, early Cenomanian.
15) 1606, from loc. no. Ap2-12, early Cenomanian.
16) 1607, from loc. no. Ap2-12, early Cenomanian.

Plate 74



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