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Radiolaria and Porifera (Spicula) from the Upper Triassic of Aghdarband (NE-Iran)

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With 1 Text-Figure and 5 Plates

NE-Iran
Aghdarband
Upper Triassic
Biostratigraphy
Radiolaria
Porifera

Contents

Zusammenfassung

Eine monospezifische neue Radiolariengattung (*Spicularina ericae* n. gen., n.sp.) und eine neue Art (*Vinassospongus ruttneri* n.sp.) werden beschrieben. Die mögliche Verwendung der Radiolarien und Poriferen(-Spicula) als verläßliche Zeitmarke wird diskutiert.

Für basale Obertrias spricht in erster Linie die Radiolarienassoziation. Zudem unterstreichen die Morphologie spezifischer Pinulhexactine, die von jenen der Mitteltrias deutlich abweichen, und das erstmalige Auftreten der Mikroskleren Scopul und Clavul den obertriadischen Charakter der gesamten Spicula-Assoziation.

Abstract

A new monotypic Radiolarian genus (*Spicularina ericae* n.g., n.sp.) and a new species (*Vinassospongus ruttneri* n.sp.) are described, and the possibility is discussed whether radiolarians and poriferans (-spicules) are suitable for reliable time markers.

In the first place, the particular association of Radiolarians suggests an early Late Triassic (Late Cordevolian) age. Moreover, the morphology of specific Pinulhexactines (which clearly differ from those of Middle Triassic age) as well as the first appearance of the Microscleres Scopule and Clavule emphasize the Upper Triassic character of the entire spicule assemblage.

1. Introduction

The microfauna in question is part of the undissoluble residue of sample No. Agh. 76/61, which was collected in the year 1976 by Dr. A. W. RUTTNER in the area of Aghdarband, about 100m kilometers to the East of the town Mashhad in NE- Iran, close to the Russian border (see RUTTNER, 1984: 258 and this vol.).

Among the Radiolarians and Poriferans (spicules) are forms which are stratigraphically useful; some of them are described for the first time.

RUTTNER's composite section (Fig. 1) serves as basis for the stratigraphical classification of the sample. Particulars concerning the geological situation as well as associated problems can be gathered from RUTTNER's papers (1980, 1984, this vol.).

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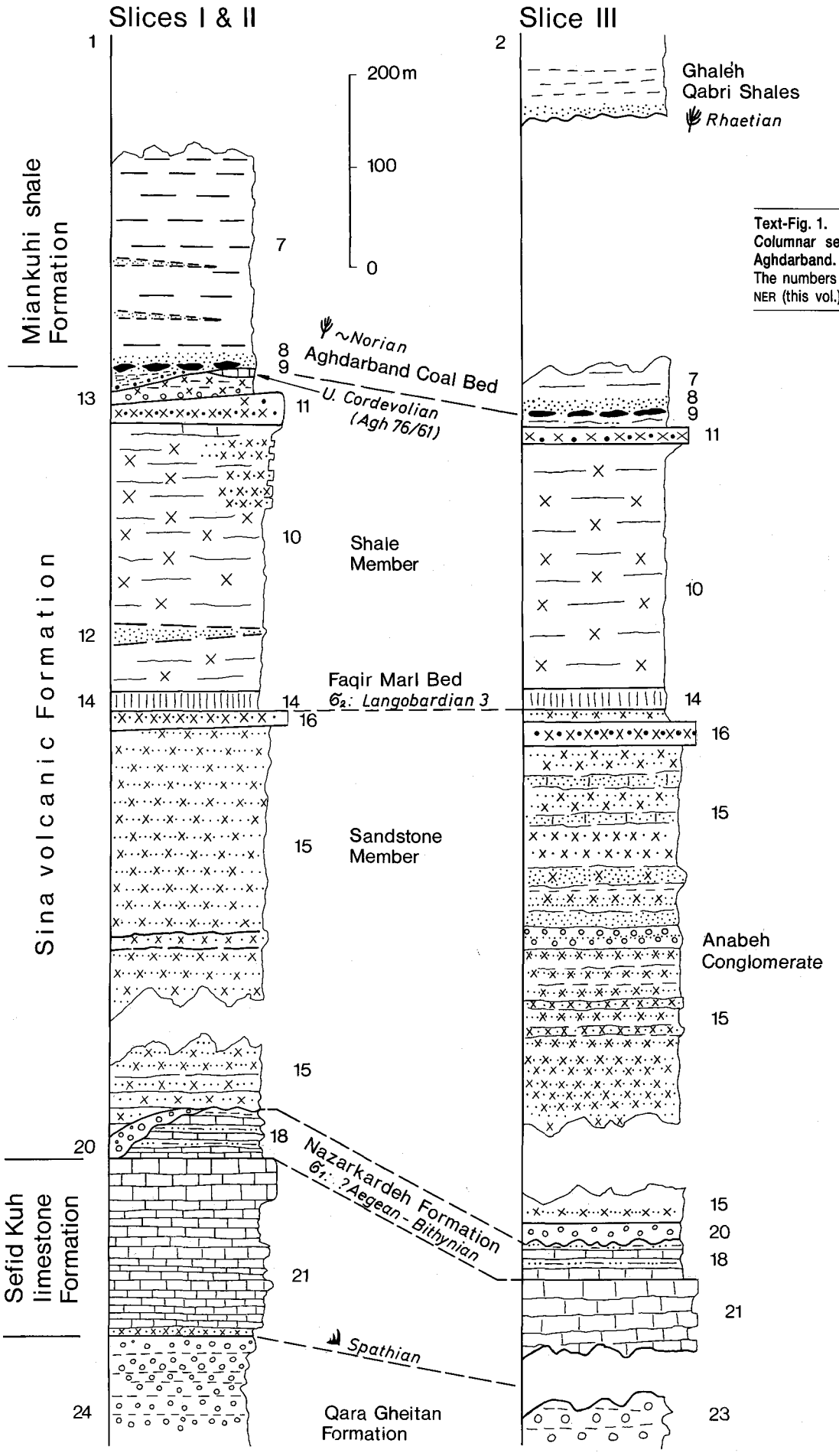


Text-Fig. 1.
Columnar sections of the Triassic of Aghdarband.
The numbers refer to Pl. 3 in A.W. RUTTNER (this vol.).

2. Faunal Spectrum (Diversity)

The faunal assemblage is characterized by Radiolarians, which are – together with the Poriferans (spicules) – the predominant faunal element of the assemblage.

Foraminifera – both calcareous and agglutinated tests – are of secondary importance.

Gastropods (casts and glauconitized on the whole) are rarely to be found; so are also fish teeth and fish scales.

Remains of Echinoderms are extremely rare: i. e. two lateralia of ophiuroids and a single spine of an echinide (type Cidaris).

The state of preservation of the fossil remains is not the best. Especially as far as the radiolarians are concerned, certain morphological details are recrystallised to an extent, that frequently only higher systematic categories are determinable.

Nevertheless, by using a careful treatment with acetic acid, it was possible to obtain forms which permitted their specific classification.

3. Radiolaria

Two newly established species, one of them belonging to a newly established monotype genus, represent nearly 80 % of the entire radiolarian assemblage, i.e.:

Spicularina ericae n. g., n. sp., totalling up to 122 individuals, makes a well represented population which, in fact, displaces all the other groups.

Vinassospongus ruttneri n. sp. was obviously the only group (95 individuals counted) which could compete with the population mentioned above.

In comparison with these two new species, the remaining already known ones are rather subordinate in the assemblage. They are:

- *Sarla vetusta* PESSAGNO, 1979, 14 individuals.
- *Plafkerium contortum* DUMITRICA, KOZUR & MOSTLER, 1980, 3 individuals.
- *Poulpus* aff. *phasmatodes* DE WEVER, 1979, 2 individuals.
- *Spongopallium contortum* DUMITRICA, KOZUR & MOSTLER, 1980, 1 individual.

At the genus level, *Poulpus* sp. DE WEVER, 1979, *Mosotylus* sp. CAYEUX, 1897 and *Capuchnosphaera* sp. DE WEVER, 1982 could be ascertained. Only one specimen, or two at most, of each genus mentioned above was found in the material in question.

This association of radiolarians points clearly to a Late Triassic age. All the known genera mentioned above – except for one – are recorded from the Upper Triassic.

The genus *Spongopallium* is the only one known up till now from the Middle Triassic. The single specimen (*S. contortum*) found in the assemblage proves that this species became extinct not before the Upper Triassic; it was still rather well represented in the Middle Triassic.

Plafkterium contortum ranges from the Middle Triassic to the Norian (PESSAGNO et al., 1979: 179).

The genus *Poulpus*, known in the Upper Triassic by numerous species, is represented in the Middle Triassic by the species *P. curvispinus* only (DUMITRICA, KOZUR & MOSTLER, 1980: 22).

The genus *Monostilus* is recorded also from the Upper Cordevolian of Großreifling (Austria) (LAHM, 1984: 68).

Considering the higher taxonomical categories, it is evident that the diversification of the Entactinaria, being significant of the time-span Anisian–Ladinian, is strikingly diminished in the Aghdarband occurrence; there, only a single genus (*Spicularina*) could be identified.

The Spumellaria are relatively well represented and well differentiated; the Nasselaria, however, are represented only by the primitive Poulpines: a picture which is known already with respect to the Carnian (KOZUR, 1988: 23).

A Carnian age of the assemblage is also suggested by the occurrence of the genus *Vinassospongus*, represented by numerous individuals of a single species (*V. ruttneri*). *Vinassospongus* is known as yet from the Carnian (Upper Cordevolian) of Göstling and Großreifling (Austria) (KOZUR & MOSTLER, 1979:75; LAHM, 1984:74). Only a single species (*V. transitus*) is recorded from the Lower Norian of the Western Carpathian Mountains (KOZUR & MOCK in KOZUR & MOSTLER, 1981:69).

Radiolarians on genus level were used already as stratigraphical time markers, for instance by BLOME (1987: 373) with respect of the Triassic of North America: a stratigraphic picture which comes near to

3.1. Systematic Paleontology

Subclass	Radiolaria MÜLLER, 1858
Order	Polycystida EHRENBERG, 1838
Suborder	Entactinaria KOZUR & MOSTLER, 1982
Superfamily	Hexastylacea HAECKEL, 1982 emend. PETRUSEVSKAJA, 1979
Family	Eptingiidae DUMITRICA, 1978

Genus *Spicularina* DONOFRIO, n. gen.

Derivatio nominis: After the significant spicular system.

Type species: *Spicularina ericae* DONOFRIO, n.gen. n.sp.

Diagnosis: A pseudo-spongy, sub-spheric test with three arms, all of them lying in a single plane. Two of the arms are equivalent to each other; the third arm, however, is considerably divergent in its whole bearing. The spicular system is free in the test cavity; it is attached to the side-walls of the shell by short beams.

Occurrence: Upper Triassic of Aghdarband, Iran; top of the Sina Formation (see RUTTNER, this vol.).

Spicularina ericae DONOFRIO, n. gen. n. sp.

(Pl. 1, Figs. 1–5)

Derivatio nominis: The species is dedicated to my wife Erika.

Holotype: The specimen shown at Pl. 1, Fig. 1.

Locus typicus: Aghdarband, 100 kilometers to the east of Mashhad, Province Khorassan, Iran.

Stratum typicum: Top of the Sina Formation, Aghdarband Group (see RUTTNER, this. vol.).

Diagnosis: Applies to the characteristics of the genus. The loosely spongy single wall of the test is rather thick; it should be interpreted very probably as having been primarily a coarse latticed shell. The same structure is shown at the surface of the arms. The length of the three arms, being rather equal, does not excel the diameter of the shell.
The cross sections of the arms are round. One of the arms is characterized by a distinct tubular appearance. This arm shows – maintaining a constant sectional area – an extension of its distal rim which is divided into four lobes. The other two arms are equipollent with each other; they become slimmer distalward and carry two to three rings at their respective distal ends.
The spicular system shows a median bar from which extend four spicular spines which lie in a single plane and are attached to the ring of the spicular system. Vertically to these spicular spines a fifth ray is observed which is connected with the above mentioned ring by an arch.
The spicular system shows, as far as preserved, elements which are homologeous with those of the nasselarian spicular apparatus; however, their individual partial systems are not identificable. Thus, an exact designation of the three apical appendices is not possible, with regard to the apical and lateral positioned spicular spines; the appendices are simply named arms therefore.

Material: 122 specimens.

Measurements:
Diameter of the shell: 70–115 μm.
Length of the arms: 57–64 μm.
Diameter of the tubular arm: 32 μm.

Remarks and relations: The specimen obtained from the Upper Triassic (Upper Carnian – Tuvalian 3) and described by DE WEVER et al., 1979, as *Capuchnosphaera* ? sp. A (p. 85; Pl. 4, fig. 12) shows a certain resemblance to *Spicularina ericae* n. gen., n. sp. An equal habit show, for example, the heterogeneous arms and the globose shell. Divergent from *Sp. ericae* are the perforation of the arms and the lack of rings at the arms. The internal structure is not known. It should be noted, that only a single specimen was at DE WEVER's disposal, and this was not in the best state of preservation as well (see also DE WEVER, 1982: 163, Vol. I; Pl. 6, Figs. 11,12, Vol. II).
The diversity of the arm-morphology which can endure even strong diagenetic changes, in combination with the presence of a spicular system, are easily ascertainable criteria of discrimination and determination.
The disadvantage caused by a rather strong diagenetic alteration of the material is compensated by the amount of specimens available.
By this means it was possilbe to check whether the characteristics described above are discernible in fact at each specimen: the rings at the arms, e. g., are always perceptible, even if only in the form of spur-like projections.
The degree of variation manifests itself on the sculpture (rings) of the two equivalent arms mainly. Based on the material at hand, it is not possible to affirm whether this variability conceals a subspecies or even a species. For this reason the genus *Spicularina* has to remain monotypic at present.

Suborder Spumellaria EHRENBERG, 1875
Superfamily Actinomacea HAECKEL, 1862
Family Actinomidae HAECKEL, 1862 emend. KOZUR & MOSTLER, 1979
Subfamily Stylosphaerinae HAECKEL, 1862 emend. KOZUR & MOSTLER, 1979
Genus *Vinassospongus* KOZUR & MOSTLER, 1979
Type-species: *Vinassospongus subsphaericus* KOZUR & MOSTLER; 1979

Vinassospongus ruttneri DONOFRIO, n. sp.
(Pl. 2, Figs. 1–6)

Derivatio nominis: In honour of Dr. A. W. RUTTNER.

Holotype: The specimen shown on Pl. 2, Fig. 1.

Locus typicus: Aghdarband, 100 kilometers to the East of Mashhad, Province Khorassan, Iran.

Stratum typicum: Top of the Sina Formation, Upper Triassic (see RUTTNER, this vol.).

Diagnosis: Cortical shell subspheric, spongy; medullary shell coarsely latticed. Three equal spicules lying in a single plane and being triradiate in cross section; they are twisted, having a torsion-free proximal region.

Description: The relatively small cortical shell carries three rather long spicules which lie in a single plane. The triangular spicules show a slight torsion which is limited rather to their distal region, ending with a point.
The proximal non-torsive parts of the spicules extend into the interior of the shell till the medullary shell; the latter has a spheric contour and shows a coarse-meshed lattice-structure. Numerous radially arranged short beams connect the medullary shell with the cortical shell.

Material: 95 specimens.

Measurements:
Diameter of the cortical shell: 64–83 μm.
Diameter of the medullary shell: 25–32 μm.
Length of the spicules:
Measured from the cortical shell: 64–102 μm.
Measured from the medullary shell: 83–115μm.

Occurrence: Upper Triassic of Aghdarband, Iran.

Remarks and relations: The typical state of preservation of this new species shows the three main spicules and the medullary shell with the always clearly visible sockets of the cortical shell. This fact may be explained by the instability of the exterior shell which can be attributed primarily to its spongy nature. On the other hand, the main spicules are grounded solidly in the medullary shell by their root structures, so forming a stable skeleton.
Thus, *Vinassospongus ruttneri* differs from *Vinassospongus subsphaericus, Vinassospongus discoidales* KOZUR & MOSTLER, 1979 and *Vinassospongus transitus* KOZUR & MOCK, 1981 (in KOZUR & MOSTLER, 1981) by the existence of

both, the cortical shell and the medullary shell, and by the distinct morphology of the spicules.

Family Capuchnospheridae De Wever, 1982
Subfamily Sarlinae De Wever, 1982
Genus *Plafkerium* Pessagno, 1979

Plafkerium ? contortum Dumitrica, Kozur & Mostler, 1980

(Pl. 3, Figs. 1, 2)

*1980 *Plafkerium contortum* n. sp. – Dumitrica; Kozur & Mostler, p. 13–14, Pl. 1, Fig. 4.
1984 *Plafkerium contortum* – Lahm, S. 86, Pl. 15, Figs. 9–10.

Remarks: The specimen represented on Pl. 3, Figs. 1 and 2, with three of the four spicules lying in a single plane, shows clearly the essential characteristics: the torsion-free region of the three-edged spicules; the subquadrate morphology of the test, with small tubercules at its surface.

Occurrences: Very rare in the Upper Triassic of Aghdarband: three specimens. 10 specimens are recorded from the Middle Triassic of Recoaro (Southern Alps) by Lahm (1984). No particulars about the material, collected also at Recoaro, are recorded by Dumitrica, Kozur & Mostler, 1980.

Genus *Sarla* Pessagno, 1979

Sarla vetusta Pessagno, 1979

(Pl. 3, Fig. 3)

*1979 *Sarla vetusta* n. sp. – Pessagno, Finch & Abbot, p. 174, Pl. 7, Figs. 4,6–7,13–14.

Remarks: The external shell is subsphaeric, with polygonal perforations which are distributed irregularly over the whole surface. The main spicules are short and rather broad in relation to the shell; they are triradiate in cross section. The torsion, which becomes stronger distalward, ends with a spike-like point.

Occurrences: Upper Triassic of Aghdarband, top of the Sina Formation (14 specimens); San Hipolite Formation, Baja California; *Pantanellum silberlingi* zone – Pessagno, Finch & Abbot, 1979: 163 (6 specimens).

Genus *Spongopallium* Dumitrica, Kozur & Mostler, 1980

Spongopallium contortum Dumitrica, Kozur & Mostler, 1980

(Pl. 3, Fig. 4)

*1980 *Spongopallium contortum* n. gen. n. sp. – Dumitrica, Kozur & Mostler, p. 16; Pl. 2, Fig. 5; Pl. 11, Fig. 1.
1984 *Spongopallium contortum* – Lahm, p. 109; Pl. 19, Figs. 8,9.

Remarks: Only remains of the primarily thick and spongy external shell are preserved on the two polar spines. Well visible is only the second ellipsoidal shell which is spongy as well. A third finely porous medullary shell is characteristic of this genus.

Occurrences: Represented in the Upper Triassic of Aghdarband solely by a single specimen. The species is abundant in the Middle Triassic of Recoaro (Lahm, 1984, 24 specimens).

Suborder Nasselaria Ehrenberg, 1875
Family Pylentomenidae Deflandre, 1963
Subfamily Poulpinae De Wever, 1981
Genus *Poulpus* De Wever, 1979

Poulpus sp. aff. *P. phasmatodes* De Wever, 1979

(Pl. 3, Fig. 5; Pl. 4, Fig. 1)

Remarks: The strong affinity to *P. phasmatodes* is given in the first place by the kind of the bend of the foot and by the cross cut through the foot: strong bend proximally downward, and distally inward; distinct trilobate cross cut. Further, the spicular system with its round actines is well discernible; it is not possible to ascertain the existence of 8 spicules.
Some differences exist with regard to the kind of peristomal projections; there are obviously only four at the very specimen represented, one between two feet, each.

Occurrences: Upper Triassic of Aghdarband (2 specimens), Iran. *Poulous phasmatodes* is recorded from: Greece (Karpenission) and Turkey (d'Isparta Cay), Upper Triassic – De Wever et al., 1979: 76 (4 specimens); Austria (Göstling), Upper Triassic – Kozur & Mostler, 1979: 106).

4. Porifera (Spicula)

The siliceous spicules which could be obtained are megascleres for the most part. From these, nearly all main types are present: Monaxons, Triaxons and Tetraxons; only the Desmas are missing. Of the extremely rarely occurring Microscleres – which are so important for the taxonomy – only two polyactine spicules were found.

The paper of Mostler (1976), which deals with the Poriferan spicules of the Alpine Triassic, served as base for the identification and naming of the different types of spicules as well as for their possible taxonomic assignment.

4.1. Megascleres

Diverse fragments of Monaxons which may have been either Monactines or Diactines. Since there are always only single poles preserved, solely the monaxonal nature of these fragments is confirmed.

Triactines: Oxytriods and Anadiaenes (Pl. 5, Figs. 4,5). The latter – being rather frequent (12 specimens) and characterized by its typical anchor-shaped morphology – are to be classified as basalia of the order Lyssakida (Class Hexactinellida).

Tetractines: Orthodichotriaenes and Oxycaltropes. The Orthodichotraenes are represented by spicules showing long rhabdomes and dichotomously branched cladi. Taxonomically, the class Demospongea comes into question.

Pentactines: Anatetraenes (Pl. 4, Fig. 2) and Pentactines which have spikes and spicules (Pl. 5, Figs. 7,10,11). Pentactines which have spicules and spikes are recorded from the Fassanian only (MOSTLER, 1976: 35); they are frequently to be found in the material in question (20 specimens).
Classification: Order Lyssakida, superfamily Brachiospongioidea.

Hexactines: This type of spicules is the prevailing element in the material. Out of the 76 specimens which could be isolated, 70 belong to the Oxyhexactines, 5 to the Pinulhexactines, and one specimen to the Hexactines having spines.
Apart from the subordinate Pinulhexactines with a long rhabdome (Pl. 5, Figs. 2,3), those forms predominate in the material in question which are characterized by a short rhabdome and – in comparison to it – by a long pinul (Pl. 5, Figs. 1,8). SCHRAMMEN (1924: 22, Pl. X; Fig. 30) recorded a very similar form from the Senonian of Oberg (North-West Germany); a second Pinulhexactine is described and represented in the same monography (22, Pl. X; Fig. 31) showing a characteristic ovoidal pinul and a very reduced rhabdome.
REIF (1967: 94. Pl. 15; Fig. 12) describes the same spicule form from the white Jurassic of Nattheim, i.e. characterized by an ovoidal pinul and by a reduced rhabdome.
MOSTLER (1976: 22, Fig. 6, Figs. 4–8; 1980: 343, Pl. 1, Figs. 16,18,21) describes Pinulhexactines showing constantly long rhabdomes and – in relation to the Rhabdome – small pinuls from the Middle Triassic of Recoaro and Tretto (Vicentinic Alps, Italy). The data known so far suggest that the spicule-types of the Upper Triassic originated from the Middle Triassic Pinulhexactine types by reduction of the rhabdomes and by elongation of the pinul. In the Jurassic and Cretaceous, a modification in the shape of the pinul took place so far as the latter is to be found now as an ovoidal pinul. Pinulpentactines occur – as is well known – not before Cretaceous (Senonian). As classification of the Pinulhexactines comes in question the Family Docodermatidae of the Order Lyssakida.

4.2. Microscleres

Clavule and Scopule are the only microscleres which could be obtained from the Upper Triassic (Cordevolian) of Aghdarband. They represent the oldest Triassic microscleres of this type known so far.

Relevant with respect to the taxonomy are especially the Clavules which are regarded to be specific also neo-zoologically for the Sub-class Hexasterophora (class Hexactinellida).

The Scopules, too, are assigned to the Order Dictiyda of the Sub-class Hexasterophora.

○ **Scopule**
(Pl. 5, Fig. 6)

SCHRAMMEN (1924: 22) records this microsclere from the Cretaceous (Senonian) of North-West Germany and MOSTLER (1976: 22) from the boundary Triassic/Jurassic of the Alpine Triassic.

Neither the drawings nor the figures given in the papers quoted above show a clearly discernible sculpture of the prongs which has proved to be so characteristic for the material in question. The number of prongs amounts there to 10 at the most; it is noteworthy, however, that the prongs are very fragile and that sockets of missing prongs are not clearly visible enough for a reconstruction.

○ **Clavule**
(Pl. 5, Fig. 9)

The Clavule represented here is characterized by a screen showing a foliaceous structure. 6 or 8 "lamellae" are present. The apex of this spicule is formed either flattened (8 rays) or more pointed (6 rays). The "lamellae" are equally fringed by a conspicuous band.

The specimens described and represented by MOSTLER (1986: 330) from the Upper Triassic (Upper Norian part of the Zlambach Beds, pers. comm.) show a completely different morphology of the umbrella; this morphology appears again in the case of the Clavules obtained from the Upper Jurassic of Nattheim (BRD) and from the Tithonian of the Oberalm Beds (MOSTLER, 1986a: 330).

The Clavules of the Upper Cretaceous of North-West Germany (SCHRAMMEN, 1924: 22), only, show a total morphology which is comparable with that of the Clavules obtained from the basal Upper Triassic of Aghdarband.

Based on morphological comparisons of the microscleres Clavule and Scopule as well as of the megasclere Pinulhexactine with scleres of the same morphologic categories from older and/or younger occurrences, the association of poriferans in question can be timed and assigned – like the Radiolarians – to the early Late Triassic (late Cordevolian).

Acknowledgements

I thank most cordially Professor Dr. H. MOSTLER (Innsbruck) for the critical revision of the manuscript, and Dr. A. W. RUTTNER (Vienna) for his permanent stimulating interest for the progress of this paper as well as for its translation into English which was, certainly, not a simple task.

Plate 1

Spicularina ericae n. gen. n. sp. DONOFRIO

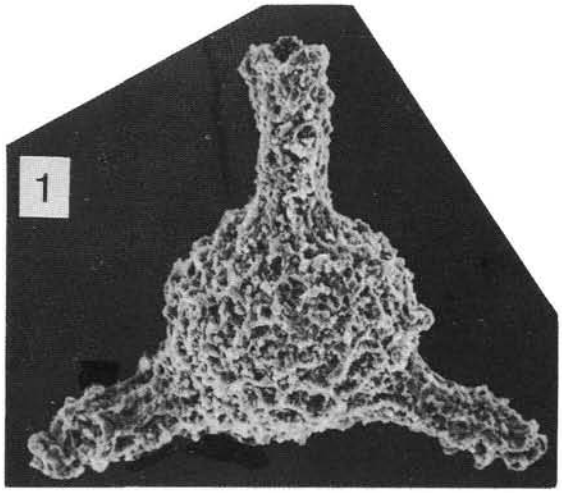
Fig. 1: Holotype.
× 300.

Fig. 2: Broken test, showing the partly preserved spicular system.
× 300.

Fig. 3: a) Spicular system, from above.
× 500.
b) Askance, showing the horizontal and vertical elements.
× 800.
c) Detail.
× 2000.

Fig. 4: Extreme development of the ring-sculpture.
× 300.

Fig. 5: Total, showing the cross section of the tubular arm.
× 300.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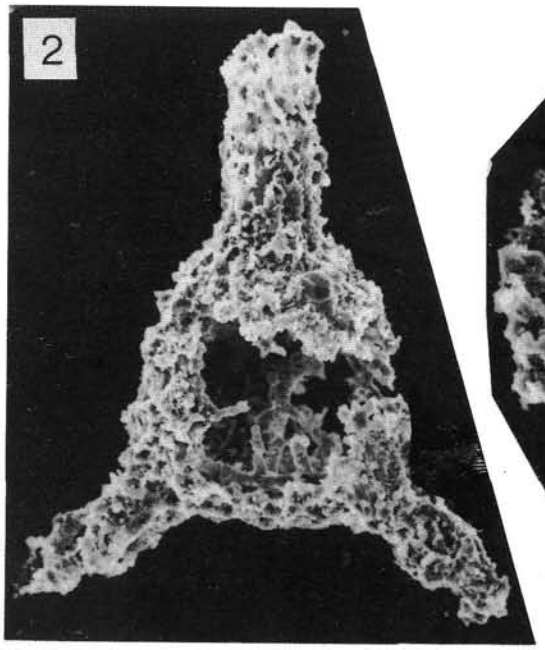
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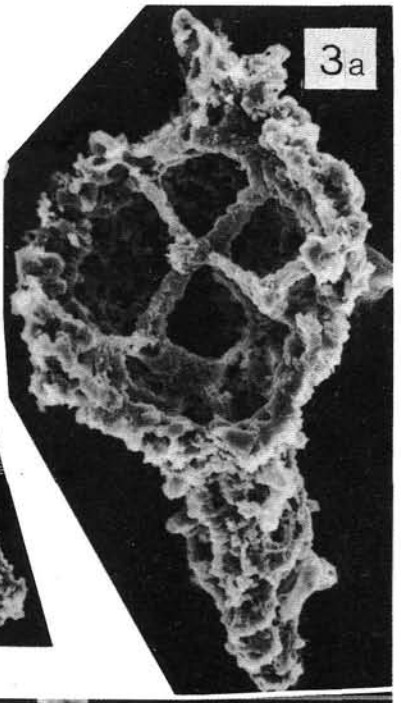
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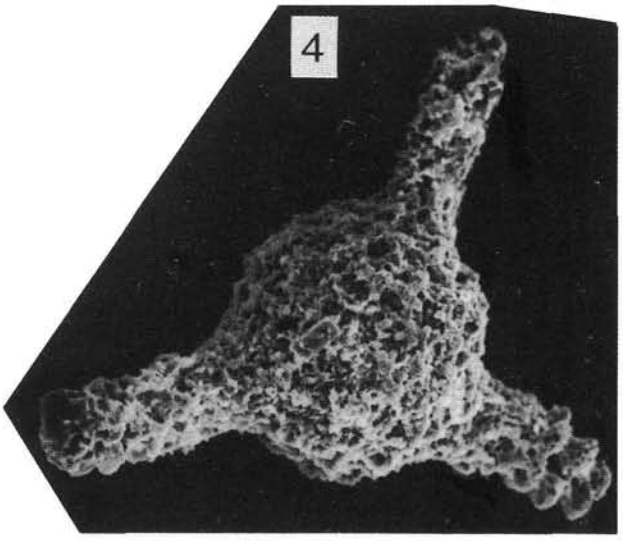
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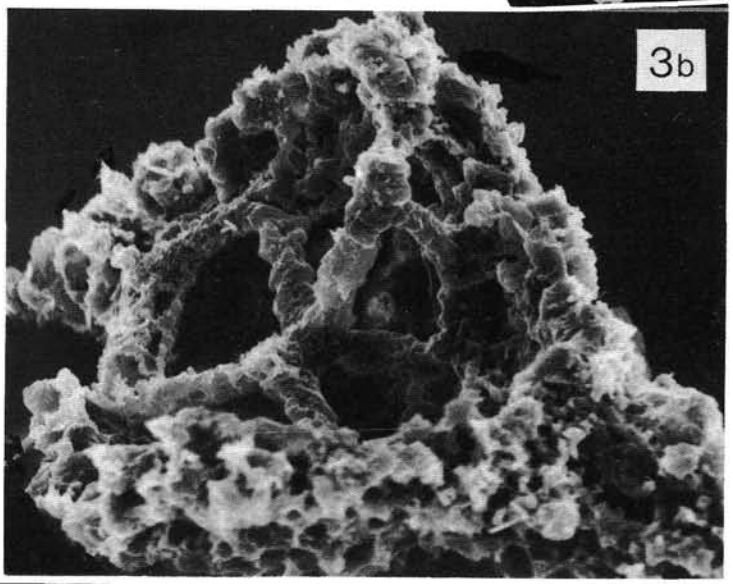
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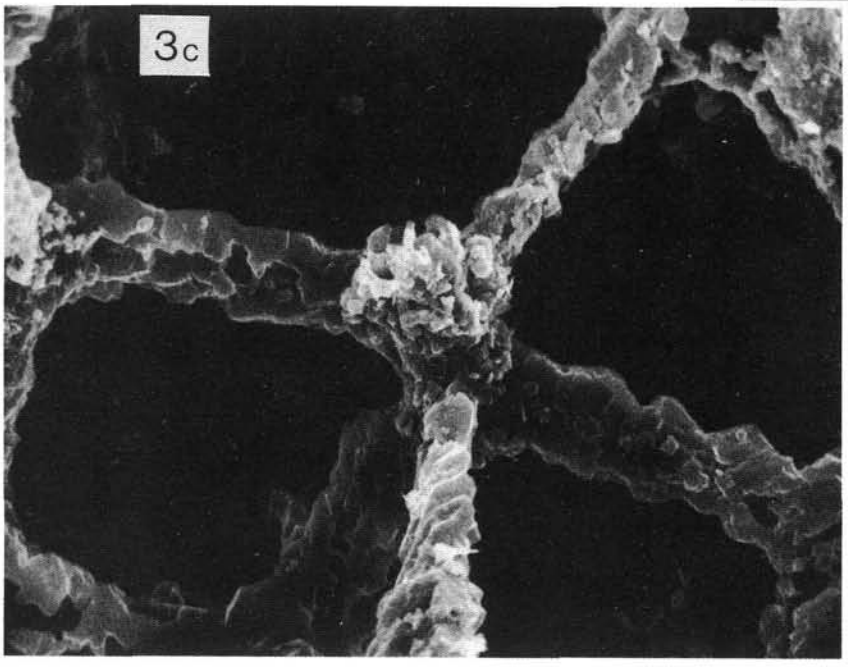
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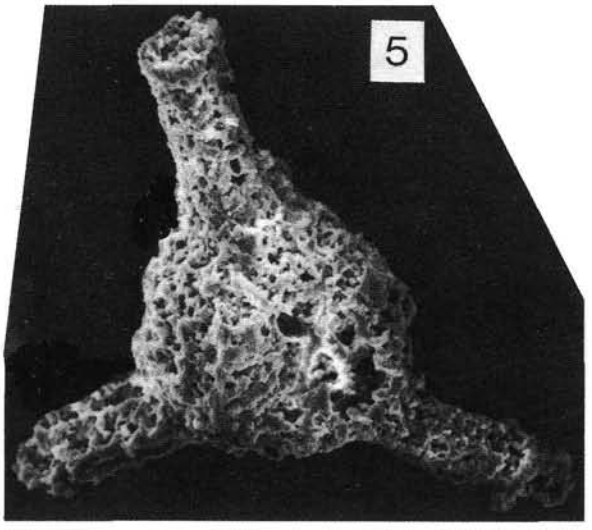
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Plate 2

Vinassospongus ruttneri n. sp. DONOFRIO

Fig. 1: Holotype.
× 300.

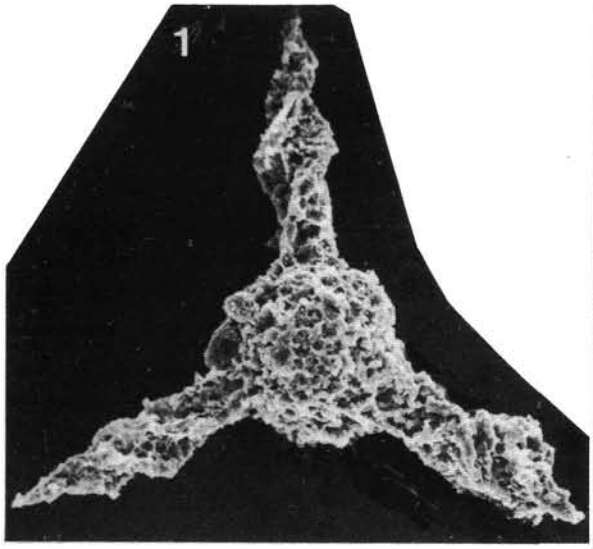
Fig. 2: Main spicules, with both the remains of the medullary shell and the sockets of the cortical shell.
× 300.

Fig. 3: Medullary shell, with attached remains of the cortical shell.
× 300.

Fig. 4: a) Medullary shell, completely preserved, with connecting beams to the cortical shell.
× 500.
b) Detail.
× 1000.

Fig. 5: Main spicules with the pith-shell.
× 500.

Fig. 6: Cortical shell.
× 750.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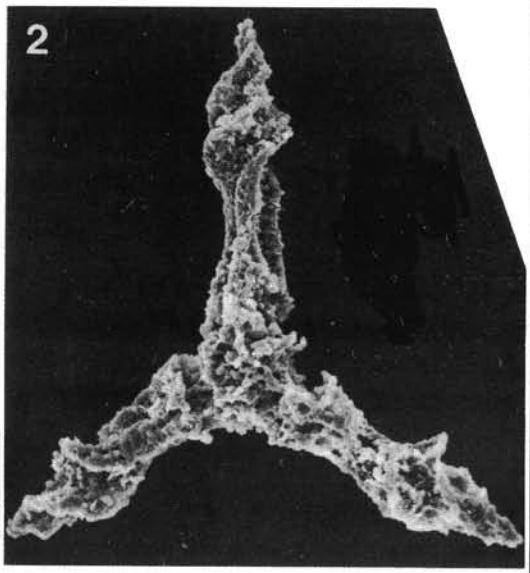
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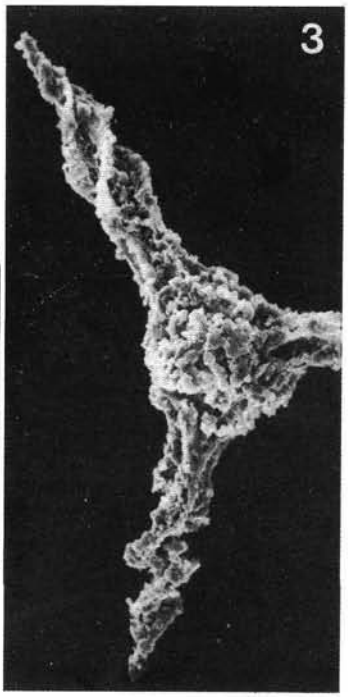
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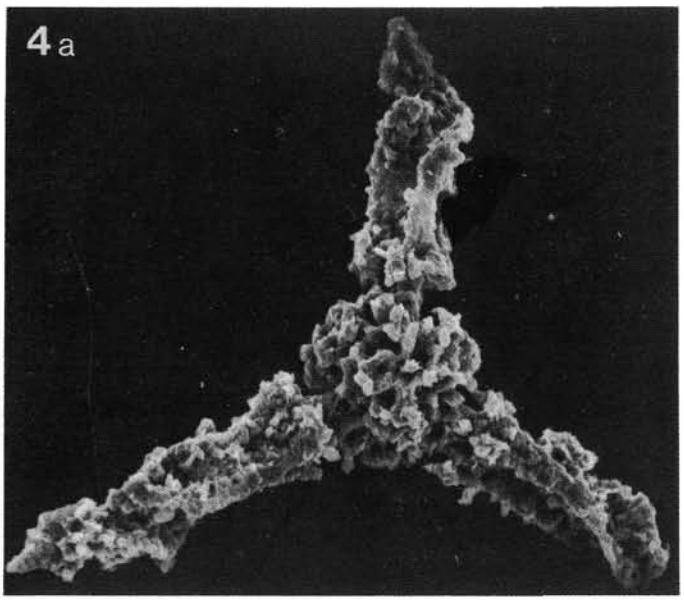
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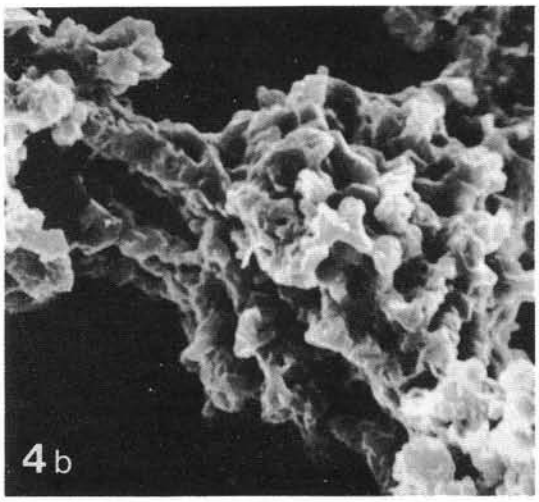
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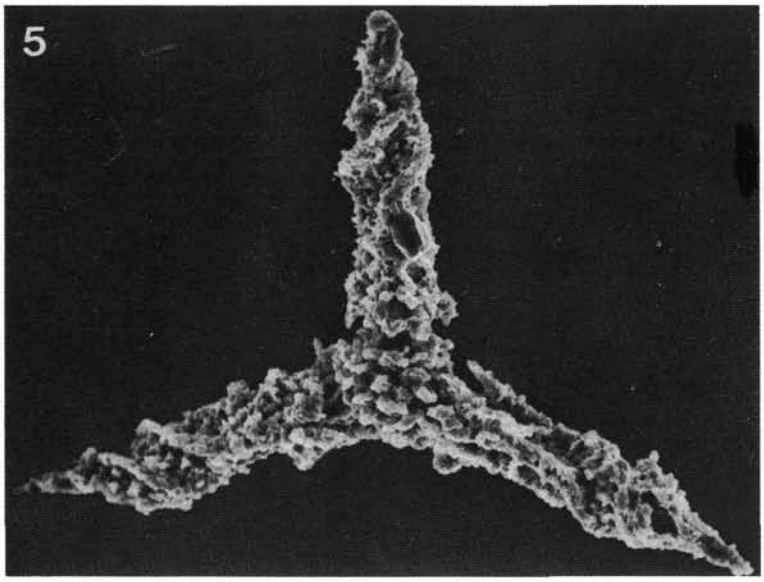
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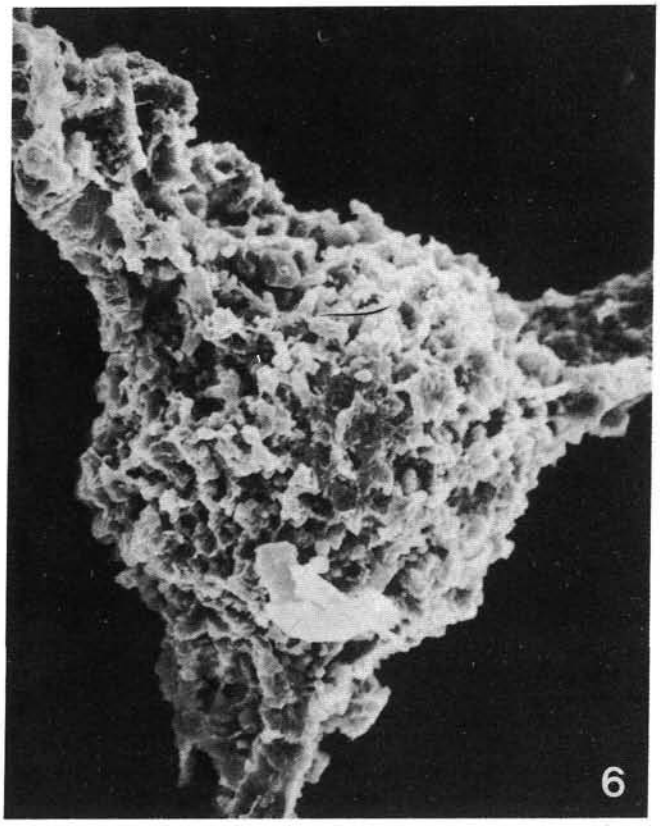
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Plate 3

***Plafkerium contortum* DUMITRICA, KOZUR & MOSTLER, 1980.**

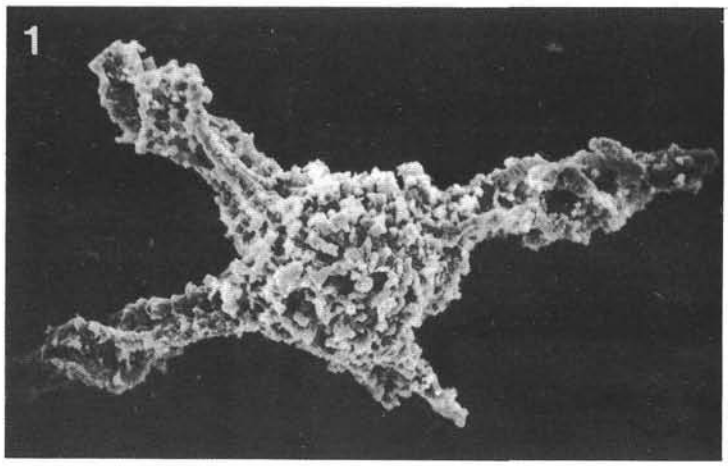
Fig. 1: External shell showing a tuberculate surface; spicules showing regions both with and without torsion. × 350.

Fig. 2: External shell, preserved only as remains; the mode of connection of the spicules one with another is visible. × 350.

Fig. 3: ***Sarla vetusta* PESAGNO, 1979.**
a) Total.
× 300.
b) Detail of an arm.
× 1000.

Fig. 4: ***Spongopallium contortum* DUMITRICA, KOZUR & MOSTLER, 1980.**

Fig. 5: ***Poulpus* sp. aff. *P. phasmatodes* DE WEVER, 1979.**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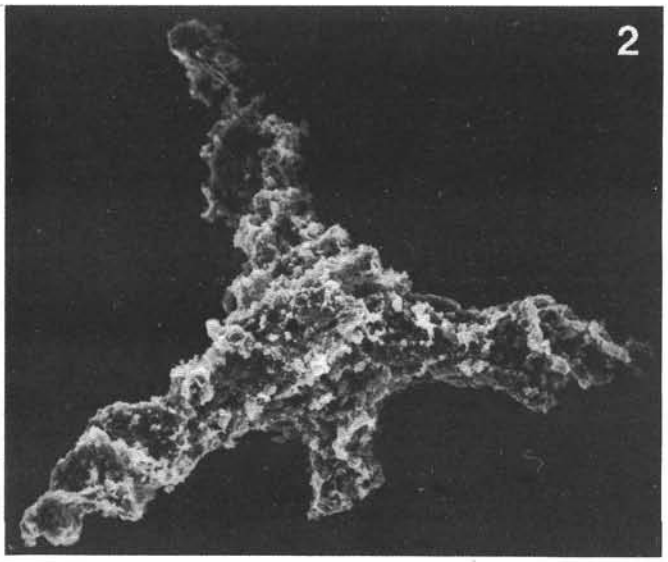
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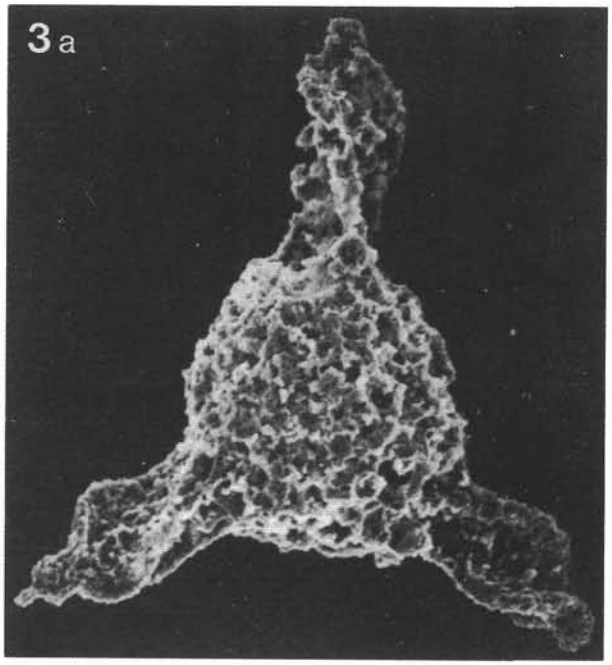
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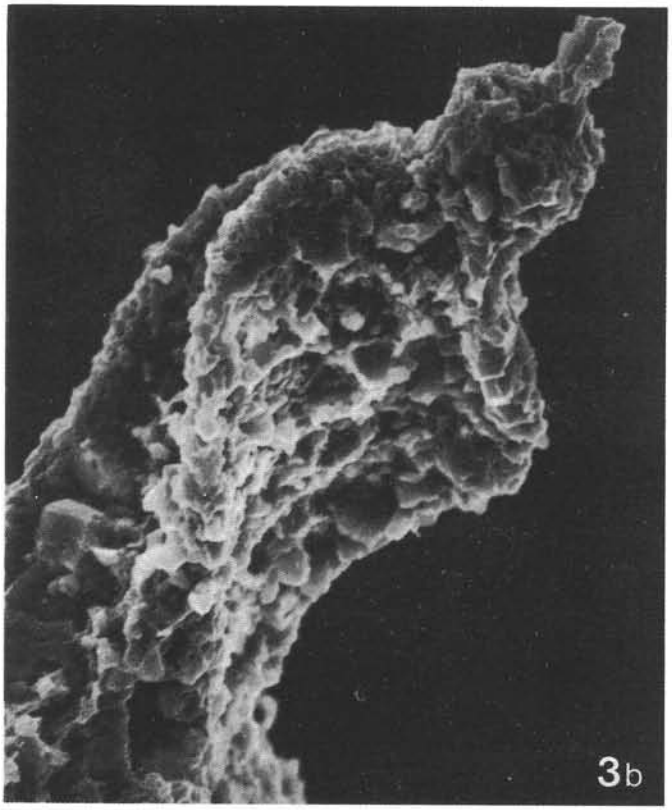
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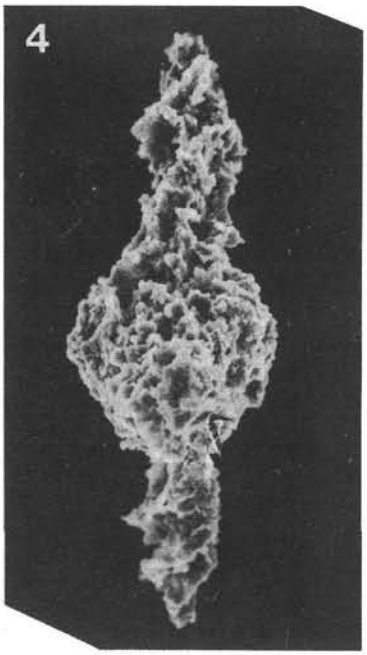
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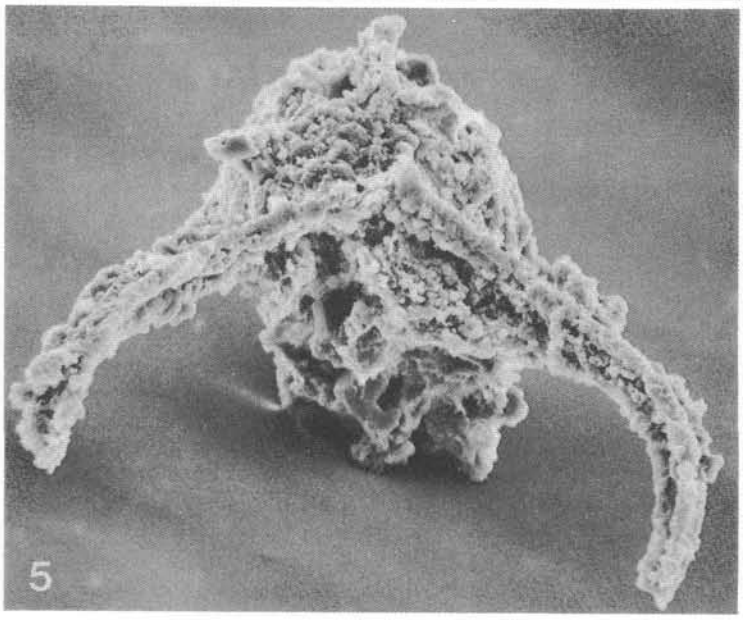
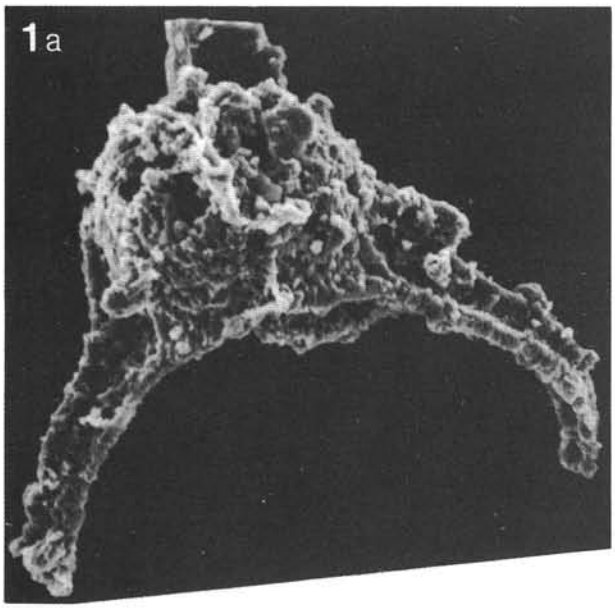

5

Plate 4

Fig. 1: ***Poulpus* sp. aff. *phasmatodes* De Wever, 1979.**
a) Total, oblique from below.
× 400.
b) Cephalis, lower side.
× 400.
c) Spicular system, view from above.
× 950.
d) Detail of the trilobate foot.
× 1000.

Fig. 2: **Pentactines-Anatetraens.**
a) Dorsal view of the four bended equivalent rays.
× 350.
b) Ventral view showing the socket of the disjointed Rhabdome and the Central Channel.
× 400.
c) Detail to Fig. 2b: Central Channel with internal and external wall.
× 5000.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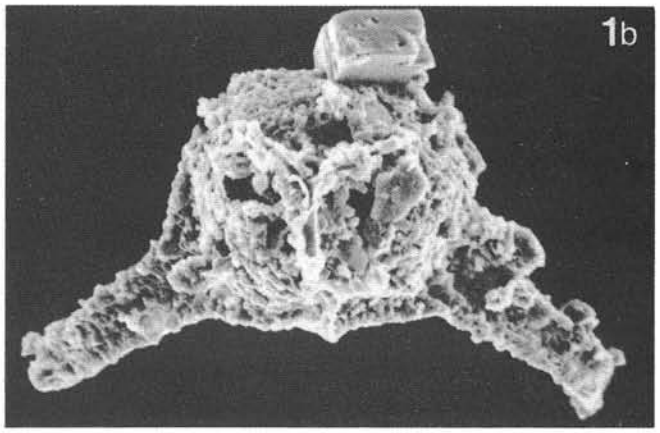
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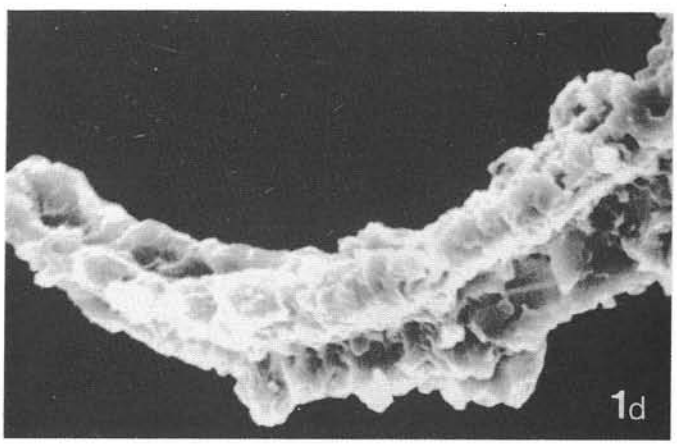
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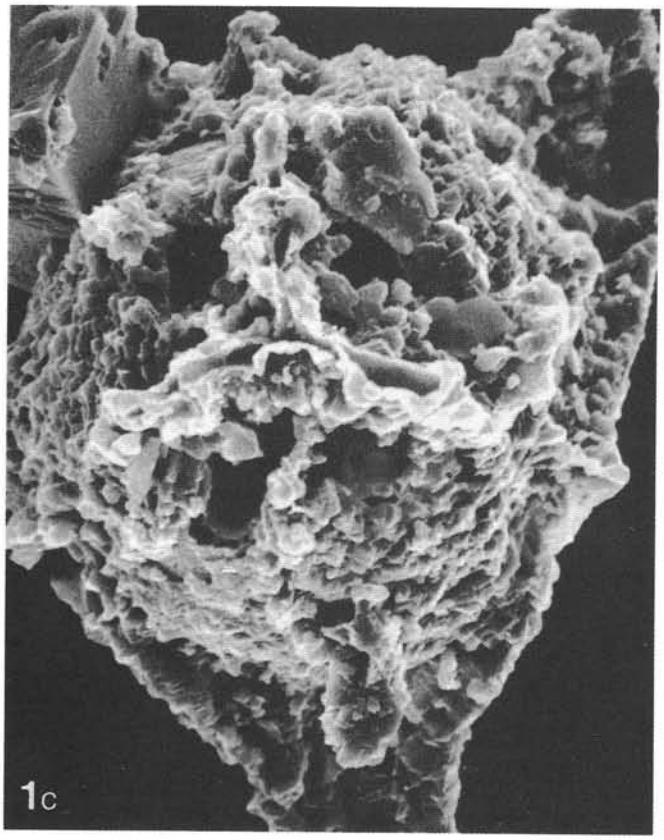
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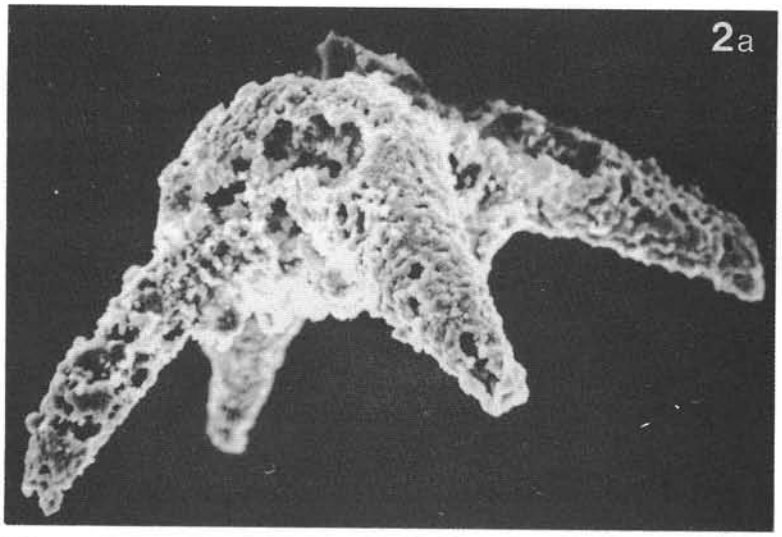
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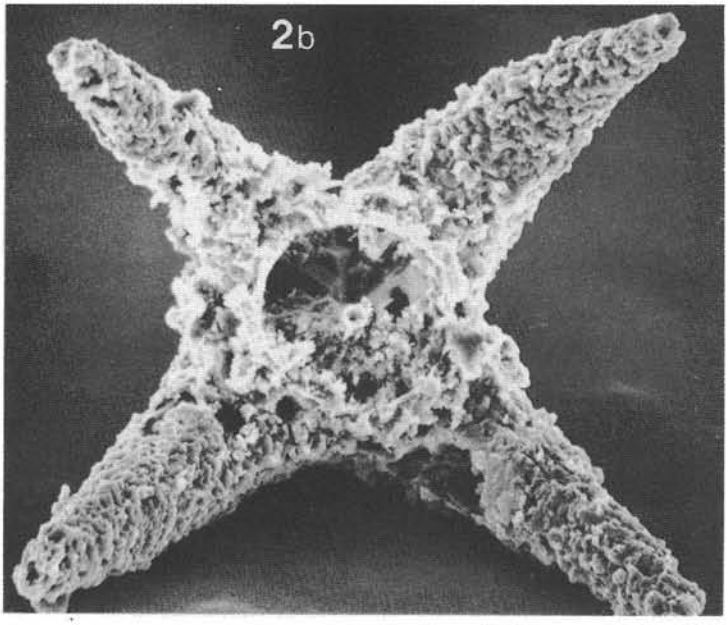
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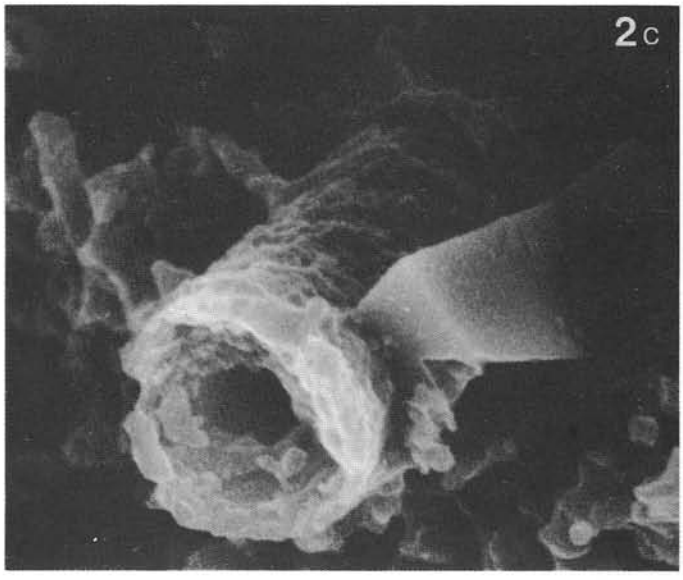

2c

Plate 5

Hexactines.

Fig. 1: Pinulhexactine with extremely long pinul.
× 400.

Fig. 2: Pinulhexactine with a long Rhabdome, four equivalent rays which lie in a single plane, and a small pinul.
× 200.

Fig. 3: As Fig. 2.

Fig. 8: Pinulhexactine with extremely long pinul.
× 240.

Triactine: Anadiaene.

Fig. 4: × 300.

Fig. 5: × 120.

Pentactine, with spines and spikes.

Fig. 7: × 200.

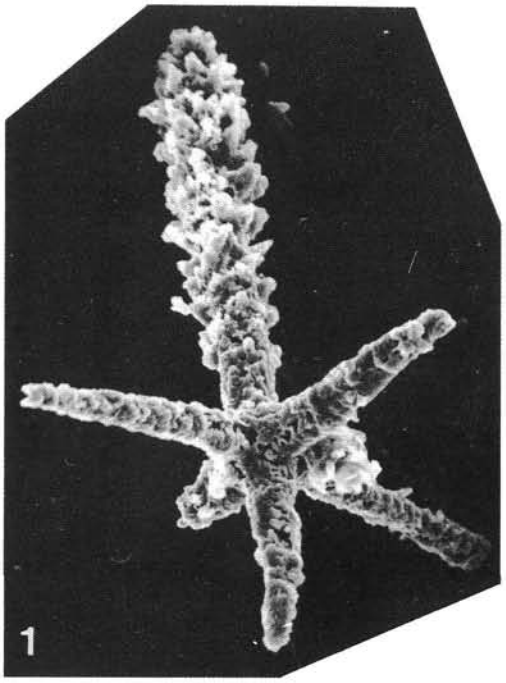
Fig. 10: × 100.

Fig. 11: × 120.

Microscleres.

Fig. 6: Scopule with sculptered prong.
× 300.

Fig. 9: Clavule with laminated umbrella.
× 300.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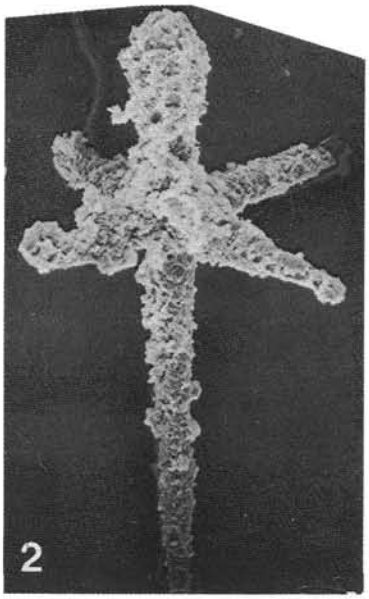
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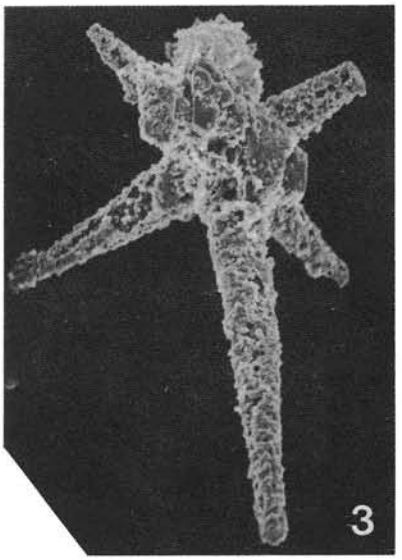
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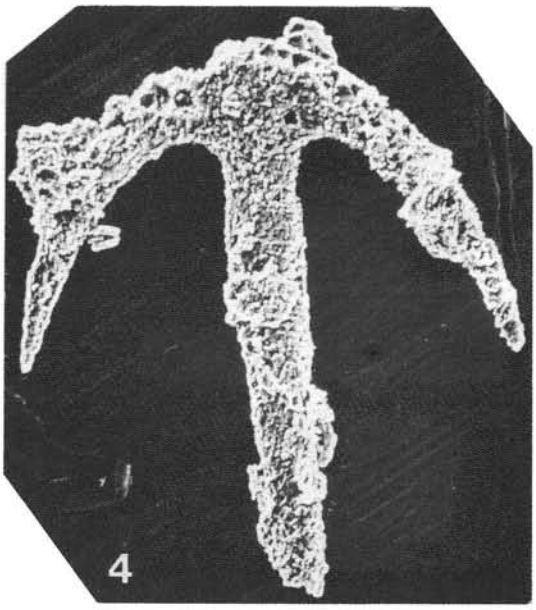
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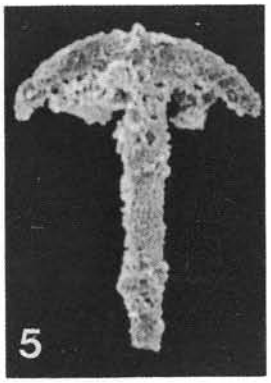
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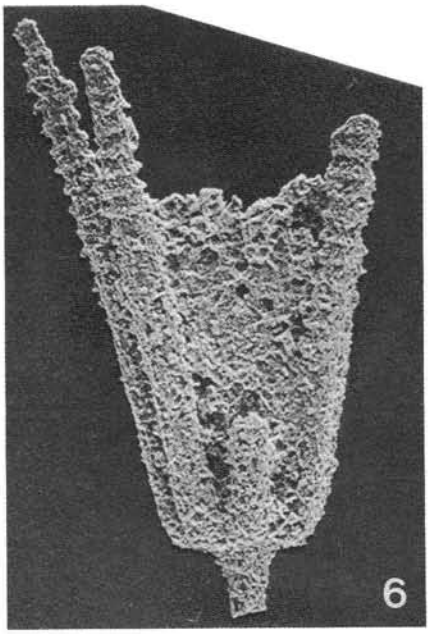
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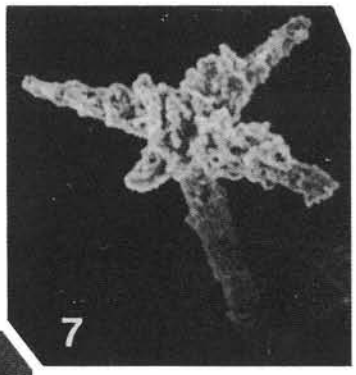
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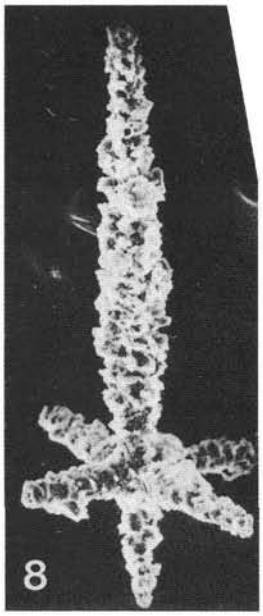
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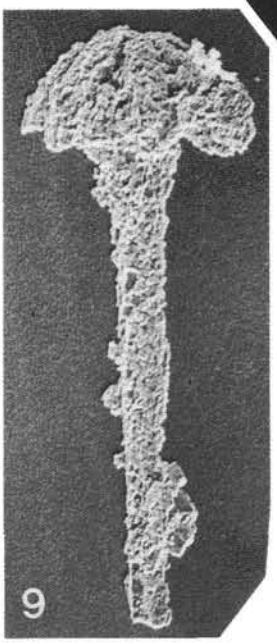
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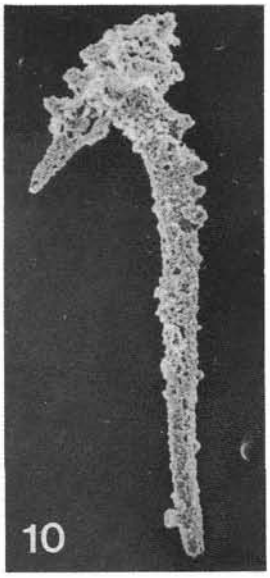
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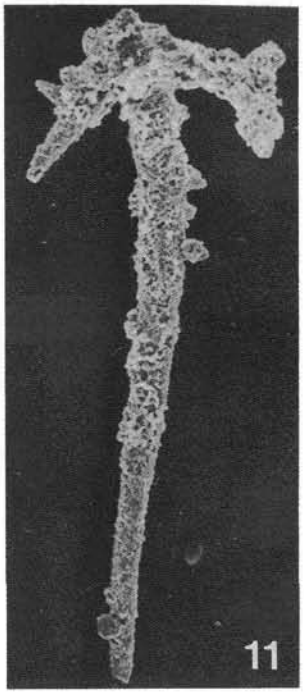
11

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