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NEW ABERRANT SESSILE GRAPTOLITES FROM GLACIAL BOULDERS

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Two new aberrant sessile graptolites from glacial boulders are described. The Silurian form, *Urbanekicrusta reversa* gen. et sp.n., is interpreted as a crustoid (hormograptid?) graptolite, whereas the Ordovician (?), *Maenniligraptus ursulae* gen. et sp.n., represents presumably an unknown order of Graptolithina.

Key words: graptolites, taxonomy, glacial boulders, Ordovician, Silurian, Poland.

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INTRODUCTION

Ordovician and Silurian glacial boulders yield a rich fauna of non-dendroid sessile graptolites. These graptolites were studied mainly by Kozłowski (1962, 1963, 1971). Some forms were studied also by Andres (1961, 1977) and Mierzejewski (1977, 1978*a*). In 1984 Professor Adam Urbanek (Institute of Palaeobiology, Polish Academy of Sciences, Warszawa) put at the writer's disposal the collection of various non-dendroid sessile graptolites which were collected by the late Professor Roman Kozłowski from glacial boulders. The bulk of this unique collection, as well as forms from the author's own collection, will be described elsewhere. This paper presents descriptions of just two new monotypic genera: *Urbanekicrusta* (Silurian) and *Maenniligraptus* (Ordovician ?).

Acknowledgements. — The writer is deeply indebted to Professor Adam Urbanek for stimulating discussions and valuable remarks. Thanks are also due to Dr. Jerzy Dzik (Institute of Paleobiology, Polish Academy of Sciences, Warszawa) for estimating the age of boulder ZPAL 0.326. The writer is especially grateful to Dr. Peter R. Crowther (Leicestershire Museums, Art Galleries and Records Service) who kindly made a linguistic revision of text.

MATERIAL AND METHODS

Specimens of *Urbanekicrusta reversa* gen.n., sp.n. were derived from a glacial boulder (No. ZPAL 0.326) collected in 1959 by Professor Adam Urbanek and Mr. Wojciech Skarżyński from Mochty (near Warszawa). This boulder was a light grey limestone which also yielded remains of dendroid and tuboid graptolites, stolons and dormant bud cysts of *Kystodendron* sp. (Rhabdopleurida), isolated jaws of eunicid polychaetes *Vistulella kozlowskii* Kielan-Jaworowska, *Mochtyella* ex gr. *trapezoidea* Kielan-Jaworowska, *Paulinites* sp. and others, pieces of eurypterid cuticle, foraminifera. *Tasmanites* sp., chitinozoans, and melanosclerites *Melanoporella* sp. and *Semenola* sp. In addition, Dr. J. Dzik (pers. comm.) found the conodonts *Ozarkodina confluens* Branson *et* Mehl and *Panderodus* sp. and thereby determined the age of the boulder to be Wenlock-Přidoli.

Maenniligraptus ursulae gen.n., sp.n. was found in a glacial boulder (No. MZ/162) collected by the writer in 1978 from near Poddębie (near Słupsk). The age of this limestone is uncertain, although the residuum yielded jaws of the polychaete *Mochtyella fragilis* Szaniawski, a species described by Szaniawski (1970) from the Upper? Ordovician of the Mielnik borehole. Glacial boulders which yield *M. fragilis* are generally of Middle and Upper Ordovician age, although a Silurian age cannot be ruled out in some cases (Mierzejewski 1978*b*). Moreover, *M. fragilis* has been found in the Upper Ordovician beds of Anticosti Island, Canada (Mierzejewski, unpublished). The age of boulder No. MZ/162 therefore is more likely to be Ordovician than Silurian.

All specimens are housed in the Institute of Palaeobiology, Polish Academy of Sciences, Warszawa (ZPAL).

The techniques employed from both chemical isolation and study of the material are those described by Urbanek (1966). The SEM work was carried out by the writer at the Earth Sciences Department, University of Cambridge, with the use of a Philips SEM 501B at 15 kV.

NEW ORDER OF THE GRAPTOLITES?

The classification of sessile graptolites proposed by Bulman (1970) is now widely accepted. Bulman accepted only five orders: Dendroidea, Crustoidea, Tuboidea, Camaroidea and Stolonoidea. Excluding the first, all the orders were erected by Kozłowski (1938, 1949, 1962). Three other proposed orders, i.e. Archaeodendrida Obut, 1974, Dithecoidea Obut, 1964 and Inocaulida Bouček, 1957, are poorly defined and seem doubtful. Some of the alleged dithecoid and inocaulid graptolites are probably remnants of colonial scyphopolyps and algae (Mierzejewski 1986 and in prep.).

According to Kozłowski (1949, 1962), there are two main phylogenetic lines in the evolution of the Graptolithina: (1) Crustoidea — Dendroidea — Graptoloidea, and (2) Tuboidea — Camaroidea. The sessile members of these two lines differ distinctly in their mode of budding. The first line is characterized by the triad budding, the second by diad budding. The budding pattern is an important and diagnostic feature of sessile graptolite orders. According to whether budding occurs in diads or triads, there is a bifurcation or trifurcation of stolons respectively. At stolon nodes in both Crustoidea and Dendroidea the stolon divides into three secondary stolons (autothecal, bithecal, stolothecal stolons as a rule). The middle stolon in each node is always autothecal (see Kozłowski 1949, 1962). In contrast, at stolon nodes in Camaroidea and Tuboidea, the stolon divides into only two secondary stolons (identical or not). If the conclusion reached by Kozłowski (1949) is accepted, that both phylogenetic lines have an unknown common ancestor, what was its most likely mode of budding?

The present writer considers that the unknown common ancestor of crustoid and tuboid graptolites was similar, or even closely related to the form described below as *Maenniligraptus* gen.n. The following arguments are used to support this view. Contrary to all other known graptolites, the mode of the budding is not constant in *Maenniligraptus* gen.n. Some stolon nodes divide into two secondary stolons, as in the Camaroidea and the Tuboidea, while others trifurcate in the same way as in the Crustoidea and the Dendroidea. In addition, a previously unknown type of stolon trifurcation occurs, when the middle secondary stolon of the triad is not autothecal but stolothecal. This irregular budding pattern, involving three modes of budding, is evidently a very primitive feature. Moreover, it is likely that the common ancestors of both phylogenetic lines display a similar budding pattern. It is also likely that, among such ancestors, there developed a tendency towards a regularity in budding pattern. Evolution from these unknown forms to the Crustoidea line involved the loss of diad budding and one of the two types of triad budding. On the other hand, during evolution from *Maenniligraptus*-like forms to the Tuboidea line, both types of triad budding disappeared.

Numerous and spiral thickenings of the stolon occur in *Maenniligraptus* gen.n.: are they primitive or highly specialized features? Less numerous annular thickenings, termed diaphragms, are known from the stolons of some fossil and all recent rhabdopleurids (see Kozłowski 1956, Kulicki 1969, Mierzejewski 1986). The number and arrangement of these diaphragms is not constant; nor is it in the stolons of *Maenniligraptus* gen.n. Moreover, rare annular thickenings have also been found in the stolons of the most primitive camaroid graptolite *Bithecocamara gladiator* Kozłowski (Kozłowski 1949: fig. 54f). It follows, therefore, that these stolonal structures are a primitive feature and not a specialization. However, it must be remembered that the spiral thickenings appear to be a unique structure, completely unknown in both the Rhabdopleurida and the Graptolithina.

In the writer's opinion, *Maenniligraptus* gen.n. represents one of the lowest grades of the graptolite colony formation. This is suggested by the lack of any constant and regular budding pattern, and by changeable number of stolon thickenings. As present knowledge of this form is incomplete, the erection of new suprageneric taxa would be premature. None the less, it is likely that *Maenniligraptus* gen.n. represents a new order of the Graptolithina.

It is possible that Roman Kozłowski also succeeded in finding *Maenniligraptus*-like forms in Ordovician glacial boulders: in his collection mentioned above there was a plastic box labelled with his hand as follows: "?Crustoidea? A strange form. Stolons provided with diaphragms. Probably a new group!". Unfortunately, the present writer found the box to be completely empty.

SYSTEMATIC DESCRIPTION

Class **Graptolithina** Bronn, 1846
Order **Crustoidea** Kozłowski, 1962
Family **?Hormograptidae** Bulman, 1970

Type genus: *Hormograptus* Öpik, 1930 (= *Thallograptus* Öpik, 1928, *non* Ruedemann, 1925).

Remarks. — The family Hormograptidae was erected by Bulman (1970) to include an aberrant Upper Ordovician sessile graptolite *Hormograptus* Öpik. He defined this family as follows: "?Aberrant Crustoidea. Rhabdosome encrusting, irregularly branching; stolon system well developed, with triad budding commonly related to two stolothecae and an autotheca; autothecae adherent proximally, distally unknown; bithecae possibly absent or irregularly developed" (Bulman 1970:V52—V53). This diagnosis of the Hormograptidae was based only on observations made by Kozłowski on *Hormograptus sphaericola* (Öpik). It is worth noting that these observations were unillustrated and quite different from earlier observations published by Obut (1960), who reported only diad budding in this form. Because the morphology of *Hormograptus* Öpik is insufficiently known, the assignment of *Urbanekicrusta* gen.n. to the Hormograptidae is tentative.

Genus *Urbanekicrusta* gen.n.

Type species: *Urbanekicrusta reversa* sp.n.

Derivation of name: In honour of Professor Adam Urbanek, the eminent Polish palaeontologist.

Diagnosis. — As for the species.

The genus is monotypic, erected to include *Urbanekicrusta reversa* sp.n.

Remarks. — *Urbanekicrusta* gen.n. is an interesting form since it combines features of three non-dendroid orders of sessile graptolites: Crustoidea, Tuboidea, and Camaroidea. Each autotheca of *Urbanekicrusta* gen.n., like numerous genera of these three orders, is sharply differentiated into a distinct proximal creeping portion and a distal erect portion. Generally, autothecal shape is of camaroid or tuboid type rather than a crustoid type. The tubular erect part of each autotheca is provided with one linguiform process, and distinctly resembles the autothecae of some tuboids (*Epigraptus* Eisenack = *Idiotubus* Kozłowski) and camaroids (*Graptocamara* Kozłowski). In all other known encrusting graptolites, when the apertural apparatus consists of only one process, it is always ventral. But, in *Urbenekicrusta* gen.n. this situation is reversed, its apertural apparatus consisting entirely of a dorsal process. Nevertheless, this graptolite is assigned to the Crustoidea because of its triad budding, in contrast to the diad budding of Tuboidea and irregular budding of Camaroidea. The stolons of *Urbanekicrusta* gen.n. are completely smooth, while in the remaining crustoids they are marked with fine transverse annulations (cf. Kozłowski 1962, Urbanek and Mierzejewski 1984). In view of these facts, it seems beyond doubt that *Urbanekicrusta* gen.n. represents an unknown line of crustoid graptolite evolution.

Urbanekicrusta reversa sp.n.
(pl. 5)

Holotype: Specimen ZPAL G IX/2; figured in pl. 5.

Type horizon: Silurian (Wenlock — Přidoli); no precise age determination.

Type locality: Glacial boulder No. ZPAL 0.326 found at Mochty, near Warszawa.

Derivation of name: Lat. *reversus* — reversed, alludes to the "reverse" form of the apertural apparatus.

Diagnosis. — Encrusting rhabdosome composed of autothecae, stolothecae, and a well developed stolon system. Autothecae adherent proximally, distally tubular with a long dorsal process. Regular triad budding related to two stolothecae and an autotheca. Stolons smooth. Autothecal stolon long, distally widening with distinct diaphragms or constrictions.

Material. — Single fragment of a rhabdosome and an incomplete autotheca.

Description. — The holotype is a rhabdosome fragment composed of five autothecae (some incomplete), the remains of stolothecae, and well preserved stolons (pl. 5: 1).

The autothecae are encrusting; creeping and adnate proximally, tubular and erect distally. The erect portion is 1000—1340 μm long, with an apertural diameter of 230 μm. The apertural margin does not pass ventrally into an apertural apparatus, as in typical representatives of the Crustoidea, but continues on the dorsal side to form a long linguiform process (pl. 5: 1). Its length amounts to about 660—920 μm, but its uppermost part is always broken. The fusellar structure varies from one autotheca to another and does not show any trace of a regular zig-zag nature (pl. 5: 2).

There is no trace of bithecae.

Stolothecae are preserved badly, with well developed stolons (pl. 5: 1, 3, 4). Stolon diameter varies between 20 and 33 μm. The stolons trifurcate into a middle autothecal stolon and two lateral secondary stolothecal stolons (pl. 5: 3). The autothecal stolon is long and distally expanded with a rather distinct vesicular diaphragm (pl. 5: 4).

The second specimen is only a fragment of one autotheca.

Incertae ordinis et familiae
Maenniligraptus gen.n.

Type species: *Maenniligraptus ursulae* sp.n.

Derivation of name: In honour of Dr. Ralf Männil, the eminent Estonian geologist.

Diagnosis. — As for the type species.

The genus is monotypic, erected to include *Maenniligraptus ursulae* sp.n.

Maenniligraptus ursulae sp.n.
(pls. 6—8)

1982. Camaroid (?) graptolite; Mierzejewski: 148, fig. 1.

Holotype: An incomplete colony composed of several thecae, now in fragments, partly illustrated in pls. 6—8, ZPAL GIX/1.

Type horizon: Ordovician?

Type locality: Glacial boulder No. MZ/162 found near Poddębie, vicinity of Słupsk.

Derivation of name: In honour of the writer's wife, Ursula.

Diagnosis. — Encrusting graptolite. Thecae (autothecae?, bithecae?) tubular and creeping, devoid of erect parts and any apertural apparatus. Diameter of thecae 100—130 μm, diameter of thecal apertures 90—120 μm. Stolons bifurcate and trifurcate. In the middle of the stolonal triad there is a secondary stolothecal or thecal stolon. Numerous annular and helical thickenings are distributed irregularly along the stolons. Stolothecae occur in the deeper parts of the rhabdosome.

Material. — One incomplete colony, now in fragments.

Description. — A small fragment of the colony disintegrated during chemical bleaching. The fragment was of a rhabdosome composed of several irregularly distributed thecae (autothecae?, bithecae?), stolothecae and stolons. The upper surface of the colony was covered with a distinct cortical tissue.

Thecae are tubular and creeping, 100—130 μm in diameter, and similar to tuboid graptolite bithecae (pl. 6: 1—2). The thecal apertures have a diameter of 90—120 μm, open on the surface of the rhabdosome, and lack any apertural apparatus.

Stolothecae are situated in deeper parts of the rhabdosome. Strongly sclerotized stolons bifurcate and trifurcate irregularly (pl. 7: 1—4). In the middle of each stolonal triad there is a stolothecal (pl. 7: 1) or thecal (pl. 8: 1) secondary stolon. The stolons are provided with numerous irregularly distributed inner thickenings (pl. 7). The thickenings can be annular or helical in shape. The length of helical thickenings is variable (comp. pl. 7: 1*b* and 1*c*). Sporadically, there can be two different helical thickenings in the same section of one stolon (pl. 7: 1*b*). In one case, a regenerated stolon has been observed (pl. 7: 4*b*).

Remarks. — Unfortunately, the lack of well preserved material makes it impossible to clarify all morphological details of this species. In the present state of knowledge, it remains possible that the thecae described above are in fact bithecae and that genuine autothecae are not preserved. Because of the specific irregular budding pattern, and the lack of any regular rhythm in stolonal division, the arrangement of autothecae in a colony must also have been highly irregular.

The case of stolon regeneration mentioned in the description is worth of mentioning. Regeneration is quite common among graptolites and has been described by several authors (e.g. Kozłowski 1949, Urbanek 1953, 1958), but, in all cases so far recorded, regeneration affected only thecal periderm or the nema. The stolonal regeneration described above has not been observed previously in graptolites.

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NOWE ABERANTNE GRAPTOLITY OSIADŁE Z GŁAZÓW NARZUTOWYCH

Streszczenie

Z głazów narzutowych opisano dwa nowe aberantne graptolity osiadłe. Forma sylurska, *Urbenekicrusta reversa* gen. et sp.n., została rozpoznana jako graptolit krustoidowy i prowizorycznie zaliczona do rodziny Hormograptidae. Od znanych dotąd krustoidów różni się obecnością niezwykłego aparatu aperturalnego, tworzonego wyłącznie przez wyrostek dorsalny, oraz przypuszczalnym brakiem bitek. Forma ordowicka (?), *Maenniligraptus ursulae* gen. et sp.n., została opisana jako graptolit incertae ordinis et familiae. Graptolit ten charakteryzuje się pączkowaniem diadami i triadami oraz obecnością licznych pierścieniowatych i spiralnych zgrubień we wnętrzu stolonów. W triadach stolonalnych centralne położenie często zajmuje potomny stolon stolotekalny, a nie autotekalny jak u Crustoidea i Dendroidea. Istnienie w rabdozomie *Maenniligraptus ursulae* gen. et sp.n. stolonów zarówno bifurkujących jak i trifurkujących sugeruje, iż forma ta reprezentuje nieznany dotąd rząd graptolitów. Wydaje się prawdopodobnym, iż formy zbliżone do *Maenniligraptus* gen.n. mogły dać początek dwóm głównym liniom rozwojowym graptolitów, tj. Crustoidea — Dendroidea — Graptoloidea oraz Tuboidea-Camaroidea.

Praca została wykonana w ramach problemu MR II 6.

EXPLANATION OF PLATES 5—8

Abbreviations: *a* — aperture of theca, *p* apertural process, *sa* autothecal stolon, *s* stolothecal stolon, *st* thecal (autothecal?, bithecal?) stolon, *s*? thecal or stolothecal stolon, *x* regenerated section of stolon.

Plate 5

Urbanekicrusta reversa gen. et sp.n.

Silurian (Wenlock-Přidoli) glacial boulder No. ZPAL 0.326 (Mochty) Holotype, ZPAL G IX/2).

1. General view of holotype, × 60.
2. Fusellar structure of the autothecal ventral wall, × 140.
3. Trifurcation of the stolon system, infrared micrograph, × 100.
4. Details of the autothecal stolon × 300.

Plate 6

Maenniligraptus ursulae gen. et sp.n.

Ordovician? glacial boulder No. MZ/162 (Poddębie), fragment of the holotype ZPAL G IX/1. SEM micrographs.

1. General view of the fragment with one theca, $\times$ 200.
2. Apertural margin of theca revealing faint traces of an orthogonal superposition of two fibril systems, $\times$ 1000.

Plate 7

Maenniligraptus ursulae gen. et sp.n.

Ordovician? glacial boulder No. MZ/162 (Poddębie), fragments of the holotype, ZPAL G IX/1.

1. Fragment of stolonal system with two triads. 1*a* general view, stolothecal stolon *s'* in the centre of the triad, $\times$ 75. 1*b* distal part of the stolon *s?'*. 1*c* thecal? stolon *st'* with spiral thickening, $\times$ 560.
2. Stolonal diad; thecal? stolon *st* with spiral and annular thickenings, $\times$ 250.
3. Stolonal triad with the thecal stolon *st* in the centre, $\times$ 400.
4. Fragment of stolonal system with diad and triad. 4*a* general view, $\times$ 40. 4*b* stolonal triad with regenerated section of the stolon, $\times$ 200. 4*c* stolonal diad, thecal? stolon *st* spiral and thickenings, $\times$ 200.

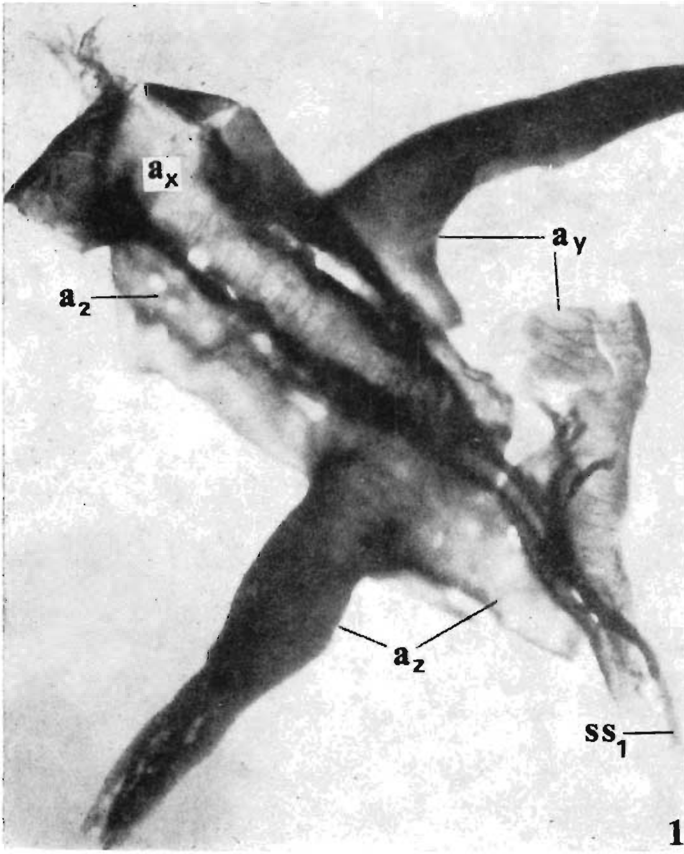
Plate 8

Maenniligraptus ursulae gen. et sp.n.

Ordovician? glacial boulder No. MZ/162 (Poddębie), fragments of the holotype, ZPAL G IX/1.

SEM micrographs

1. Stolonal triad with the thecal stolon *st* in the centre. 1*a* general view, $\times$ 260. 1*b* surface of the stolon *st* with impressions of inner thickenings, $\times$ 1800.
2. Cavity of stolon with annular thickening (arrow), $\times$ 900.
3. Stolonal triad, impressions of inner thickenings arrowed, $\times$ 150.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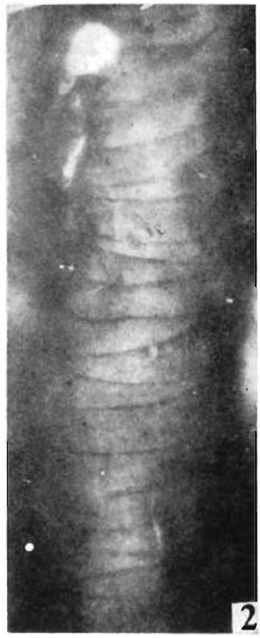
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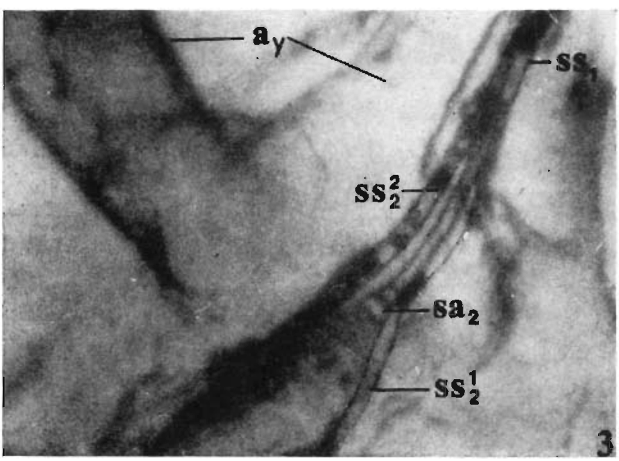
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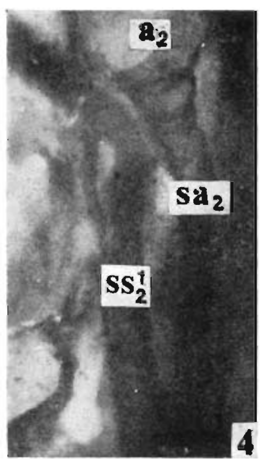
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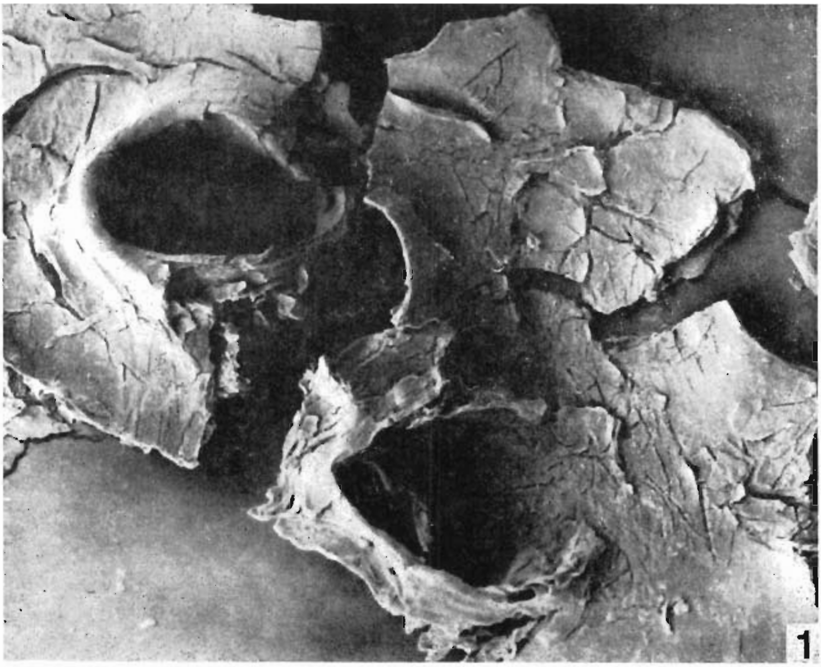
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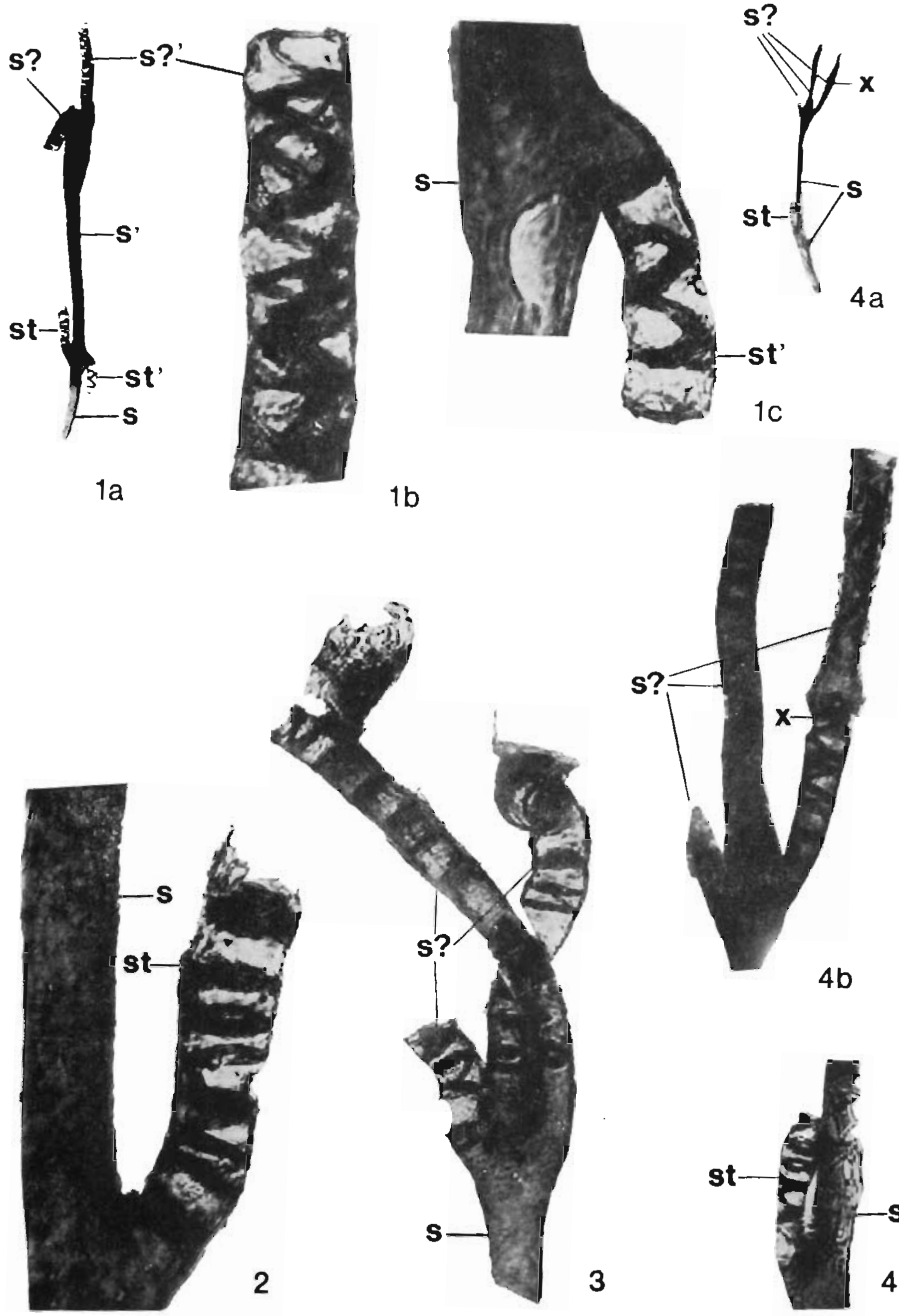
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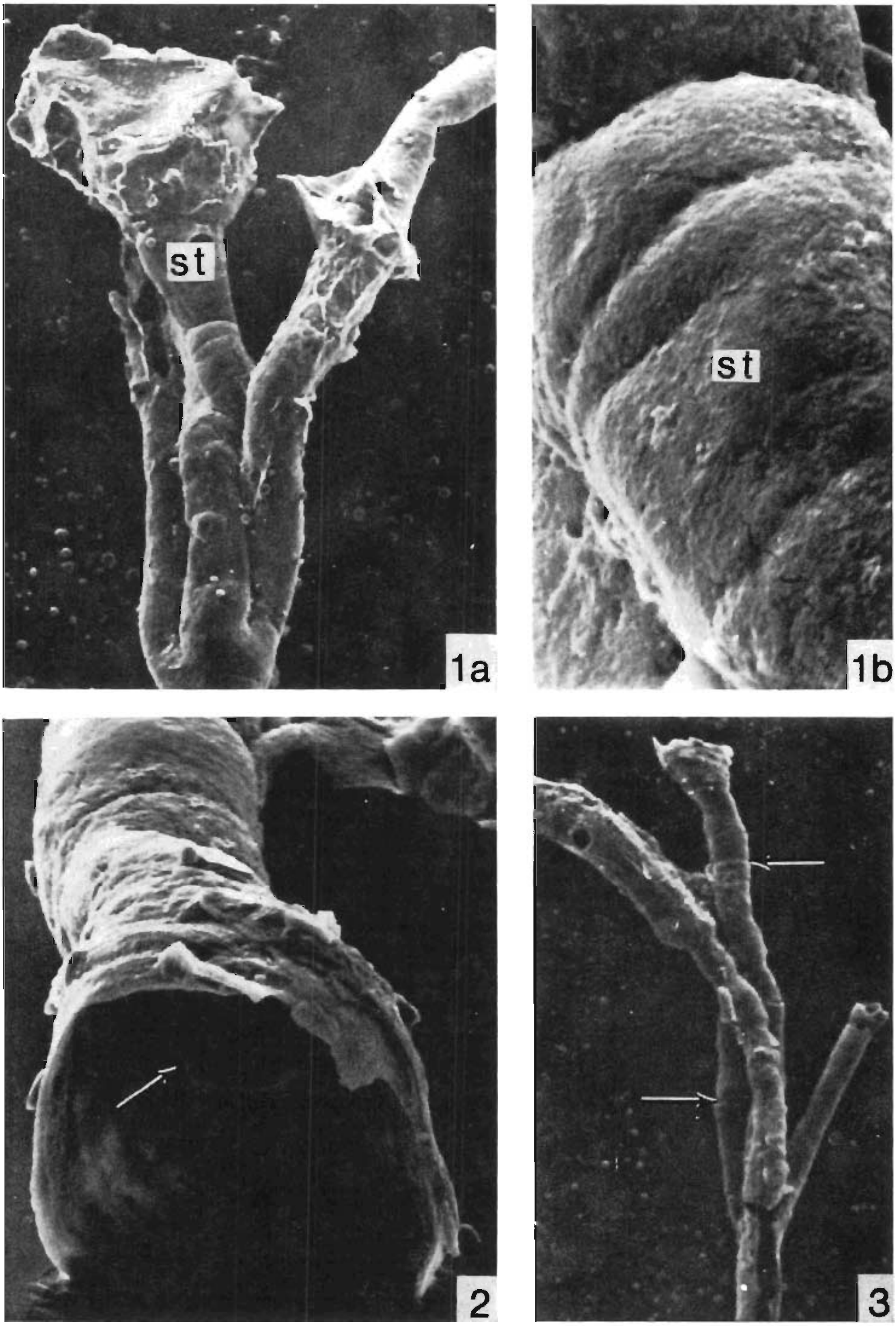
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