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MISSISSIPPIAN MEGASPORES FROM MICHIGAN AND ADJACENT STATES

BY

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BY

WILLIAM G. CHALONER*

CONTENTS

INTRODUCTION

CONSIDERABLE work on Carboniferous megaspores has been done in the last twenty-five years, both in the United States and in Europe, principally so that they could be used as stratigraphic indices in coal mining geology. This aim has tended to concentrate attention on the horizons or formations in which economically workable coal seams occur. These are mainly the Pennsylvanian in America and Upper Carboniferous in Europe, rather than the Mississippian and Lower Carboniferous.

Although Mississippian megaspores have no immediate application in coal geology, they are of much biological interest. The distinction between Mississippian and Pennsylvanian megaspores is of both paleontologic and stratigraphic significance. Since there has been an increase in knowledge concerning the identity of the parent plants of many megaspore types (Schopf, 1941*a*, 1941*b*; Chaloner, 1953*a*, 1953*b*), these megaspores furnish information on the composition of the contemporary lycopod flora.

* Commonwealth Fund Fellow at the University of Michigan, 1953–54.

LOCALITIES

The megaspores described in this paper were obtained from the following localities:

1. Exposure on Willow Creek, one mile south of Grindstone City, Huron County, Michigan. Spores occur in a gray, medium-grained, flaggy, micaceous sandstone, the stratigraphic position of which is in strata designated by Monnett (1948, p. 677) as "Coldwater—lower Marshall." The formation corresponds (Fig. 1) to the upper part of the Kinderhookian or possibly the lowermost Osagean (Weller, 1948).

2. Quimbey-Stevens Quarry, Bloomington Quadrangle, Monroe County, Indiana, lat. 39° 4′ N., long. 86° 40′ W. Spores are present in the basal 6 inches of the Beaver Bend limestone, which is correlated with the lower part of the Chester Series (Weller, p. 17).

3. Cape Horn railway cut of the Pennsylvania Railroad, Pottsville Gap, near Pottsville, Schuylkill County, Pennsylvania. Spores occur in a black carbonaceous shale in the upper part of the Pocono Group which is of Osage or possibly Kinderhook age. This is the area in which localities 2, 3 and 4 of Jongmans, Gothan, and Darrah (1937, p. 425) are located.

TECHNIQUE

In material from localities No. 1 and No. 3 megaspores were isolated from the matrix by treatment with hydrofluoric acid. The acid broke down the rock to the consistency of an unconsolidated mud and the flattened megaspores, which appeared to be unaffected, were separated by sieves of suitable grade. The limestone from locality No. 2 was partly dissolved by hydrochloric acid and the megaspores picked out from the residue with a fine paint brush.

The megaspores from the relatively coarse-grained Coldwater—Marshall sandstone (locality No. 1) are least well preserved. In some instances marks of sand grains are imprinted on the spore coat, which results in thin patches that give a mottled appearance to the spores when seen by transmitted light. Spores of the same species from fine-grained shale (locality No. 3) have not been marked in this way, but are rather more flattened, probably because of the greater compaction of the argillaceous sediment as compared with the arenaceous. The megaspores freed by solution of limestone (locality No. 2) are on the whole in the best state of preservation (Pl. II, Fig. 4). They have been less affected by compaction of the matrix than those from the other two localities and all the fine

surface detail is plainly visible. Spores with relatively thin walls, which could be cleared satisfactorily in Schulze's solution to make transparent preparations (Arnold, 1950, p. 63), were photographed by transmitted light (Pl. I, Figs. 2–8). The thicker-walled spores or those most susceptible

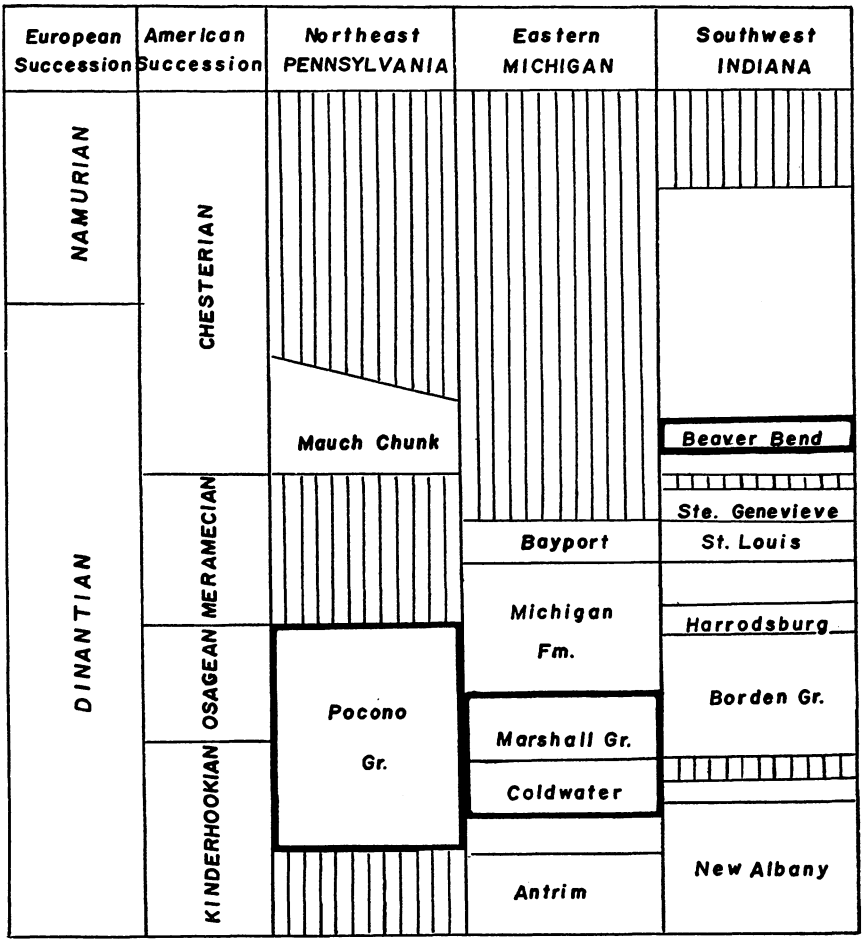

FIG. 1. Diagram showing relationship between some of the principal Mississippian formations of Michigan, Pennsylvania, and Indiana. Those from which megaspores were obtained are heavily outlined. After Weller (1948).

to overmaceration had to be photographed by reflected light (Pl. II, Figs. 1 and 4). The spores from the carbonaceous shale (locality No. 3) were destroyed when treated with Schulze's solution, probably because there had been an incomplete chemical breakdown of the cuticular material of

the megaspore exine during fossilization or a subsequent alteration of the rock. All specimens with thin walls were examined both by transmitted and reflected light.

SPECIFIC DESCRIPTIONS

Triletes angulatus (Zerndt)

(Pl. I, Figs. 1–3)

Type 7, Zerndt 1931, Pl. 3, Fig. 8.
Lagenicula angulata Zerndt 1937, Pls. 14–15, Fig. 8.
Triletes angulata (Zerndt) Schopf, Wilson, and Bentall, 1944, p. 20.
Triletes angulatus Dijkstra 1946, p. 49.

These megaspores were originally more or less spherical, except for an apical prominence which stands out from the rest of the proximal surface. The spore body has an equatorial diameter of about 1000μ (range 800–1420μ, for 13 measured). The contact faces are expanded to form a large pyramidal apical prominence. Where each of the triradiate ridges meets an arcuate ridge, a small triangular outgrowth is developed, which is characteristic of this species. The mean height of the apical prominence (as seen in the flattened spore), measured from the lowest level of the arcuate ridge to the apex, is about 530μ and the mean width 630μ (for 10 measured).The spore wall is 25–30μ thick. Over the surface of the spore body small, irregular blunt appendages are developed, up to 25μ long, and about half as wide, varying considerably in size, shape, and density of coverage (Pl. I, Figs. 1 and 3). They are usually most dense and largest in the area adjacent to the arcuate ridges; in some specimens they are only very sparsely distributed and in a few specimens they are absent. In some spores that have been flattened perpendicular to the long axis, the "dehiscence slits" along the sutures extend as cracks beyond the triradiate ridges (presumably as a result of crushing during the fossilization process) causing the spore to open out into three valves. Zerndt (1937, Pl. 15, Fig. 4) illustrates a specimen in the same condition. Since the splitting is evidently associated with some structural weakness of the spore and is relatively common, it may be regarded as a characteristic feature. In some spores the cracks extend until they meet on the distal face, so that the spore is separated into three equal sections, each of which still shows the triangular flaps at the corners of the contact faces.

Triletes angulatus was obtained from localities No. 1 and No. 3. The only previously recorded occurrence of this spore is from the Namurian of Poland (Zerndt, 1937). Schopf, Wilson, and Bentall (1944, p. 20) give the age of this record as Lower Namurian. At least part of the Namurian is

included in the upper part of the Mississippian (Fig. 1), but the Polish specimens are evidently from much younger strata than are those from Pennsylvania and Michigan.

Triletes subpilosus forma *major* Dijkstra

(Pl. I, Figs. 4–8)

Triletes subpilosus forma *major* Dijkstra 1950, p. 871 (nom.nud.).
Triletes subpilosus (Ibrahim) forma *major* Dijkstra 1952*a*, p. 103.

These megaspores were originally more or less spherical with an apical prominence formed by the expanded contact faces. The spores were obtained from localities No. 1 and No. 2. The populations from the two sources differ slightly in size, but have an aggregate mean diameter of about 1000μ. Those from locality No. 1 had a mean of 980μ, range 740–1180μ for nine specimens; those from locality No. 2, a mean of 1100μ, range 900–1460μ for 11 specimens. The ones from locality No. 1 usually show the apical prominence more clearly (Pl. I, Fig. 5). This prominence is typically about half the spore diameter in height and slightly broader. The spore wall is covered with spines which are longest on the distal spore surface, and shorter, forming a more dense covering, towards the apical prominence. The contact faces that form the apical prominence are without spines, but, occasionally, are covered with small apiculi. The spines are more or less parallel-sided, except at the base where they are slightly swollen (Pl. I, Figs. 6–8).

These spores were compared with transparent preparations of topotype material of this forma from the Kiliç Valley, Turkey, kindly given to me by Dr. S. J. Dijkstra, and with material of Calciferous Sandstone age from Scotland. The Scottish specimens were obtained from a coastal exposure of a coal seam 600 yards east of Pittenweem Harbour, Fifeshire. Details of the spines of two Scottish specimens that show the extremes of variation are illustrated (Pl. I, Figs. 7 and 8) for comparison with the material from Michigan (Pl. I, Fig. 6) and Indiana.

Dijkstra (personal communication, January 26, 1952) recorded *Triletes subpilosus* forma *major* from the Namurian A, B, and C of Turkey. He also obtained it from a ? Namurian coal in Scotland. This species has, therefore, been recorded from:

Turkey: Namurian A, B, and C.

Scotland: ? Namurian of Fifeshire. Dinantian (Calciferous Sandstone Series). See Plate I, Figs. 7–8.

Indiana: Lower Chesterian (Dinantian). See Plate I, Fig. 4.

Michigan: Kinderhookian (Dinantian). See Plate I, Figs. 5–6.

Triletes indianensis, sp. nov.

(Pl. II, Figs. 1–2)

Diagnosis.—Megaspore originally more or less spherical, with a mean equatorial diameter for the flattened spore of 1100μ (range 780–1340μ for 20 specimens). At the point of divergence of the triradiate ridges a more or less spherical prominence is attached to the spore by a constricted neck; average diameter of the prominence 290μ (16 measurements), average height 260μ (11 measurements). Contact faces covering most of the proximal spore surface; enclosed by low arcuate ridges, approximately 10μ high. Triradiate ridges typically 330μ long and up to 20μ high. Spore wall about 35μ thick. Spore surface (except on contact faces) covered with small blunt-ended or, occasionally, more or less pointed projections, that are up to 20μ in length but more typically half as long or less (Pl. II, Fig. 2). In some specimens smaller projections are present on the contact faces.

Occurrence.—Locality No. 2.

Holotype.—No. 31397, Museum of Paleontology, University of Michigan (Pl. II, Fig. 1).

Remarks.—The apical expansion of this spore is very thick-walled and even after intensive maceration it remains opaque. Its shape and structure differ considerably from the relatively thin-walled pyramidal apical prominence of typical members of the Lagenicula section of *Triletes* (cf. *T. angulatus*). In a few specimens this apical structure of *T. indianensis* has split into three segments following dehiscence lines along the triradiate ridges. This suggests that it may have incipient suture lines, although none are visible. This peculiar form of apical outgrowth gives the spores a superficial similarity to *T. splendens* Zerndt (1937), a spore species recorded from the Lower Carboniferous of Europe; Dijkstra (1946) gives its range as "? Dinantian" and Namurian. *Triletes splendens* differs from *T. indianensis* in having a distal-wall decoration of large conical warts, more than 100μ across. On account of the small size of the apical expansion, *Triletes indianensis* should be included in the Aphanozonati *s.s.* (Chaloner, 1953*b*) rather than in the Lagenicula section of *Triletes.*

Triletes echinoides, sp. nov.

(Pl. II, Figs. 3–4)

Diagnosis.—Megaspore originally more or less spheroidal, up to 2.66 mm. in equatorial diameter (the only two whole spores measured 2.66 and 2.00 mm.). Spores covered with long tapering spines up to 960μ in length

and 140μ wide at base; longest spines mainly on distal face of spore; small spines present among the larger ones, more closely spaced and about 70μ in length. Spore wall typically 50μ thick. Lips of the triradiate sutures relatively tall and narrow, fluted, up to 600μ high, diminishing somewhat in height away from the spore apex. Contact faces not clearly delimited from the rest of the spore surface, but the spiny decorations in the area of the contact faces much smaller, or represented by short, blunt processes.

Occurrence.—Locality No. 2.

Holotype.—No. 31400, Museum of Paleontology, University of Michigan (Pl. II, Fig. 4).

Remarks.—This megaspore is superficially similar to *Triletes crassiaculeatus* (Zerndt), but is over 30 per cent larger than the maximum size of that species cited by Zerndt (1937), and its spines are nearly twice as long (some fragments of *T. echinoides* have spines up to 960μ long, cf. Pl. II, Fig. 3). The tall prominent lips are reminiscent of some members of the Zonales section of *Triletes* (cf. *T. superbus*). Although it combines some features of members of the Lagenicula and Zonales sections of *Triletes* (cf. *T. crassiaculeatus* and *T. superbus*), *T. echinoides* sp. nov. lacks both the apical prominence and the marginal flange which are characteristic of these two sections, respectively. It must, therefore, be placed in the Aphanozonati *s.s.* section of *Triletes*. This may be regarded as a repository for such species of *Triletes* as lack the more positive features (marginal flange, apical prominence, or saucer-shaped form) that characterize other more clearly defined sections of the genus.

Triletes cristatus, sp. nov.

(Pl. II, Figs. 5–6)

Diagnosis.—Megaspore originally more or less spherical; mean diameter 1980μ (range 1700–2200μ for five spores measured). Spore wall about 50μ thick, undecorated, with a matte surface; triradiate ridges extending for almost the whole spore radius. Lips of the triradiate sutures heavily decorated with a thick covering of partly fused hairlike outgrowths (Pl. II, Fig. 6) forming a crest up to 200μ high, and of rather greater width, along each of the triradiate markings.

Occurrence.—Locality No. 2.

Holotype.—No. 31401, Museum of Paleontology, University of Michigan (Pl. II, Fig. 5).

Remarks.—This spore is quite unlike any previously described species of *Triletes*. The heavy folding of the spore wall (Pl. II, Fig. 6) coupled

with the more or less circular outline and the varied position of the apex on flattening, suggest an originally more or less spherical rather than a saucer-shaped form (Chaloner, 1953*b*, p. 891). Because it lacks an apical prominence or a zonate flange and because its form is not saucer-shaped, this species belongs in the Aphanozonati *s.s.* section of *Triletes*.

Cystosporites giganteus (Zerndt) Schopf.

(Pl. II, Figs. 7–8)

Triletes giganteus Zerndt 1930, Pls. 9–11.
Cystosporites giganteus (Zerndt) Schopf 1938, p. 39.

A number of spores obtained from localities No. 1 and No. 2 were indistinguishable from specimens of *Cystosporites giganteus* described by Arnold (1950, p. 87) from the Pennsylvanian of Michigan. Of these the large fertile specimens are sac-shaped and from 2.0–8.0 mm. long and 0.7–4.0 mm. wide. They are frequently crumpled or broken, a common occurrence with these large fragile spores (Arnold, 1950, p. 87). The mean length of the seven specimens obtained from locality No. 2 was 4.00 mm. The spore coat is of a matte texture at the apex and is relatively thick there. Towards the distal end it becomes thinner and develops the mesh structure which is characteristic of the genus. The size and structure of the contact faces are rather variable, but the point of confluence of the triradiate ridges is usually elevated to form a small apical projection (Pl. II, Fig. 8; Chaloner 1952, Pl. XXI, Fig. 3). This feature is also described by Arnold in the Pennsylvanian specimens of this species from Grand Ledge, Michigan.

Small spores that agree with the abortive forms of this species described by Dijkstra (1946), Zerndt (1934), and others, were associated with the larger ones. None, however, adhered to the contact faces of the latter (Pl. II, Fig. 7). These ranged from 560 to 760μ in diameter (mean for seven specimens measured, 660μ). They have very much thicker walls than the fertile specimens and unlike them the wall structure is more or less homogeneous. Development of the contact faces is rather variable but they show a strong apical projection corresponding to that of the fertile spore.

Dijkstra (1952*b*, p. 163) gives the previous record of this species as from the "? Dinantian" of Poland to the top of the Westphalian. The species has also been recorded from the Upper Carboniferous of Europe by Kalibova (1950, p. 27), from the Pennsylvanian of the United States by Arnold (1950, p. 87), and from the Lower Carboniferous of Scotland by

Chaloner (1952, p. 572). The present instance is, so far as known, the first record of this species from the Mississippian of North America.

DISCUSSION

Any claim that a spore species is common to Europe and America will always be open to criticism by those who adopt a narrow concept of a megaspore species. For example, Schopf (1949 p. 509) criticized Dijkstra for placing European and American species in synonymy without a comparison of the actual type specimens. It is obviously inadvisable to "lump" two species from the United States and Europe, if the knowledge of one or the other is based on a poor figure or inadequate description. But if good descriptions and illustrations are available, to use a European name for American specimens which are indistinguishable on the basis of published data seems a sensible course, even though the type material is not available for comparison. Likewise, if an American name has priority, it should be applied to European specimens. This course has been taken in three instances in this paper, using for two species the published figures and descriptions and for the third a comparison of topotype material. To establish a new species, when no clear distinction from a previously described species can be cited, simply because type material cannot be brought together, only creates an artificial dissimilarity between contemporary European and American floras.

Of the six species described only *Cystosporites giganteus* has been recorded from above the Namurian. With this exception, no megaspore that has been reported from the Pennsylvanian of this continent was obtained from the three Mississippian localities. With so few species, no significant conclusion can be drawn concerning the age relationship between the three localities in Pennsylvania, Michigan, and Indiana, but the evidence furnished by the megaspores in no way conflicts with the current interpretation of Weller (1948).

The paleobotanical conclusions are perhaps more significant than the stratigraphical ones. Three groups of megaspores are represented in the six species obtained: *Cystosporites* and the Lagenicula and Aphanozonati *s.s.* sections of *Triletes*. The first of these has been correlated with the Lepidocarpaceae and possibly with the genus *Lepidophloios* (Schopf 1941*a*, p. 549). At least three members of the Lagenicula section are believed, with more or less certainty, to have been borne by *Lepidodendron*. At least there is no reliable report of their having been borne by a member of any other lycopod genus. The parent plants of the Aphanozonati *s.s.* are unknown. The absence of members of the Mazospora section

of *Triletes* (borne by *Mazocarpon,* the cone of *Sigillaria,* see Chaloner, 1953*b,* p. 893), which are so common in the Pennsylvanian, is significant. The species of megaspores obtained from these three Mississippian localities suggest, therefore, a contemporary lycopod flora of *Lepidodendron* and, possibly, *Lepidophloios,* but no *Sigillaria.* Jongmans (1937) recorded *Lepidodendron, Lepidodendropsis,* and *Bothrodendron* from the area of locality No. 3, from which the only megaspore obtained was *Triletes angulatus.*

In the Beaver Bend limestone of Indiana and the sandstone from Grindstone City, Michigan (localities No. 1 and No. 2) the megaspores are associated with fragments of coalified wood, although there is no tendency for the spores to adhere to this debris when the matrix is dissolved. Both of these deposits appear to be allocthonous, in contrast to the bituminous coals from which Arnold, Schopf, and others have previously obtained megaspores of Pennsylvanian age. No macrofossils were found associated with the megaspores. This is, in fact, the first record of any fossil plants from either of these localities.

ACKNOWLEDGMENTS

I wish to express my thanks to Dr. G. K. Guennel for drawing my attention to the plant material in the Beaver Bend limestone, and to him and Dr. W. Wayne for help in obtaining samples of it. I am indebted to Prof. C. A. Arnold for lending me the samples from Pennsylvania and Michigan, and for help and criticism in the writing of this paper.

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Submitted for publication March, 1954

EXPLANATION OF PLATE I

PAGE

Triletes angulatus (Zerndt) Schopf, Wilson, and Bentall 26

FIG. 1. From Pottsville Gap, Pennsylvania; locality No. 3. No. 31405, photographed by reflected light. × 50.

FIG. 2. From near Grindstone City, Michigan; locality No. 1. No. 31406, by transmitted light. × 50.

FIG. 3. From locality No. 1. Detail showing decoration of spore wall. No. 31407, by transmitted light. × 200.

Triletes subpilosus forma *major* Dijkstra 27

FIG. 4. From Beaver Bend Limestone, Indiana; locality No. 2. No. 31408, by transmitted light. × 50.

FIG. 5. From near Grindstone City, Michigan; locality No. 1. No. 31409, by transmitted light. × 50.

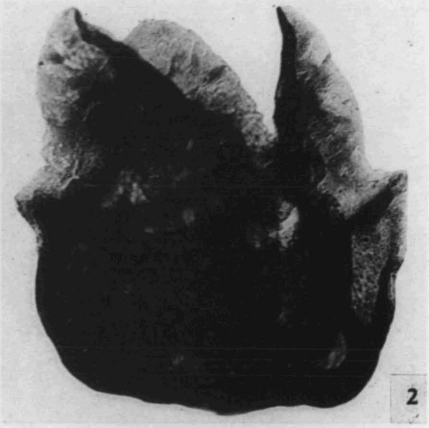
FIG. 6. From near Grindstone City, Michigan; locality No. 1. Detail of the spiny decoration. No. 31409, by transmitted light. × 100.

FIGS. 7–8. From coal seam in Calciferous Sandstone Series (Dinantian) of Scotland, 600 yds. east of Pittenweem Harbour, Fifeshire. Shows extremes of variation in spiny decoration of two spores. No. 31410, by transmitted light. × 100.

Catalogue numbers on plates refer to specimens in the Museum of Paleontology, University of Michigan.

PLATE I


1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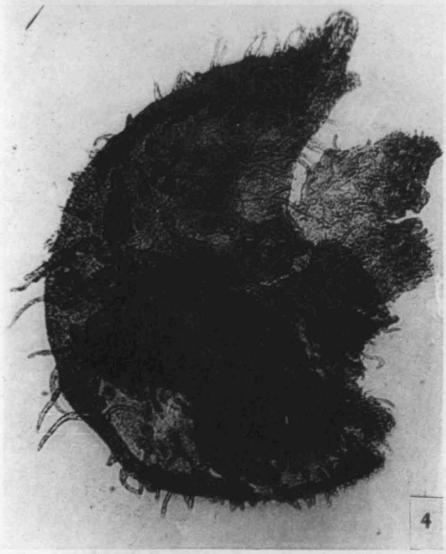
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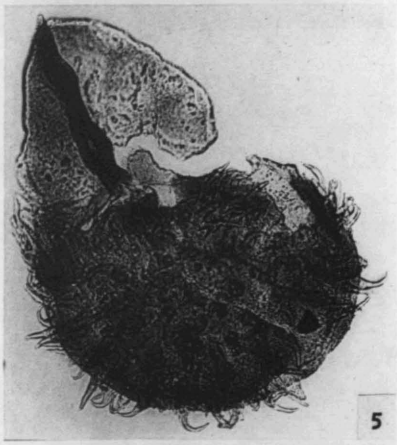
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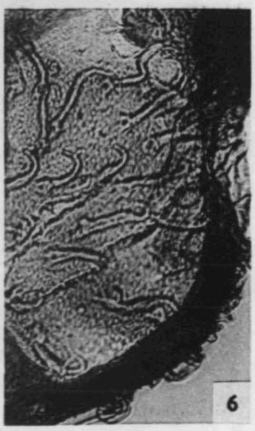
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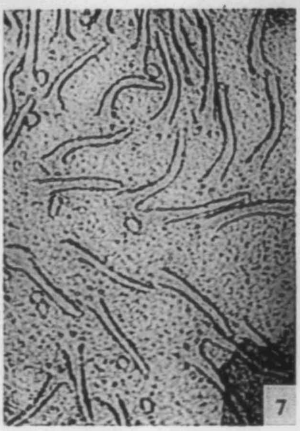
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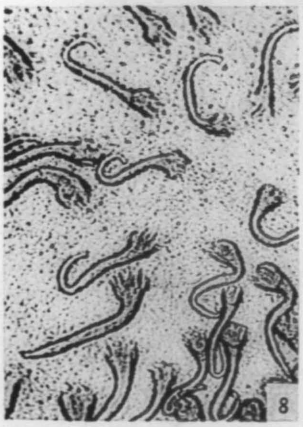
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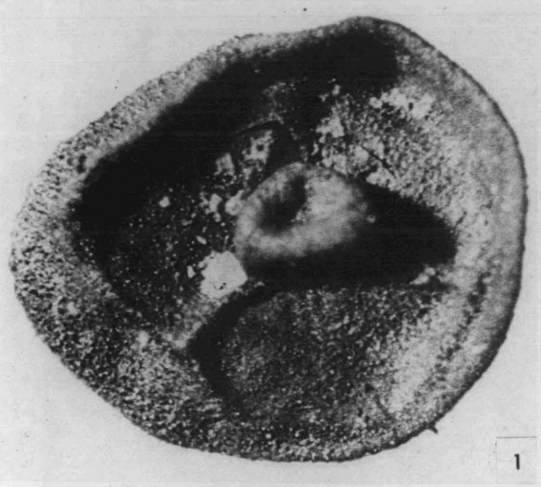

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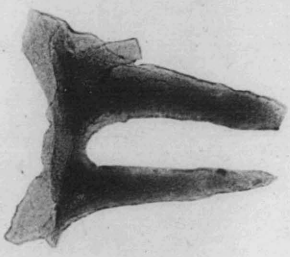

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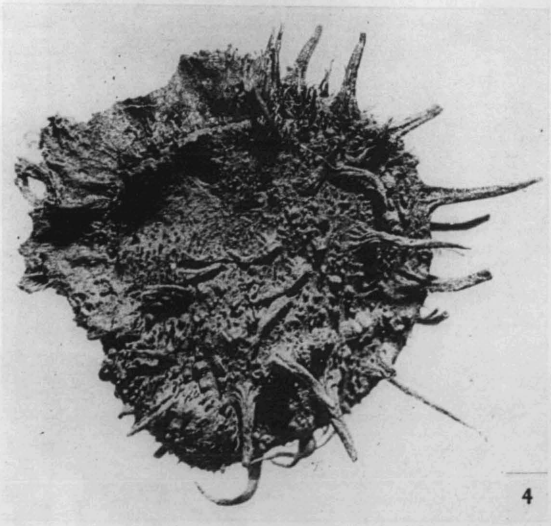

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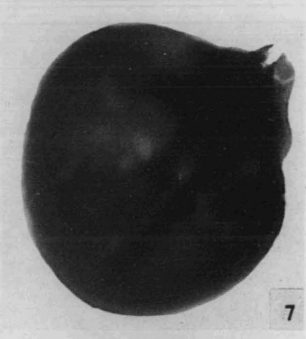

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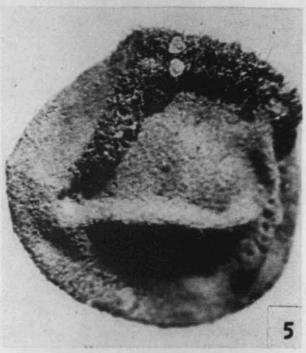

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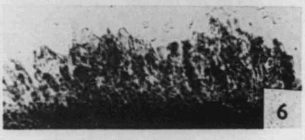

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EXPLANATION OF PLATE II