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NATURE OF ORNAMENTATION IN MEGASPORES OF THE GENUS *VERRUTRILETES*

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The study on the structure of sporodermis and elements of ornamentation in megaspores of the genus *Verrutriletes* (Van der Hammen 1954) Potonié 1956 revealed that the verrucae are part of the perine sculpture.

Key words: megaspores, *Verrutriletes*, morphology, internal wall structure, structure of ornamentation elements.
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INTRODUCTION

The verruca is one of numerous forms of wall ornamentation processes in spores and pollen. But elements of similar appearance which are not related to the spore wall have also been observed. Such bodies occurring in recent pollen grains have been described by Goldstein (1960) and Skvarla and Anderegg (1972) while those found in fossil material have been dealt with by Moore (1963), Srivastava (1976) and Marcinkiewicz (1979).

In the present paper the nature of verrucate structures in spores of the Mesozoic genus *Verrutriletes* (Van der Hammen 1954) Potonié 1956 is discussed. The material for the study is derived from the Cretaceous deposits of the Człuchów IG 1 and Tuchola IG 1 boreholes drilled by the Geological Survey in the Polish Lowlands, and also from the outcrops of the Jurassic deposits in Łuków. The spore collection is housed in the

Museum of the Geological Survey in Warsaw (abbreviated IG) and in the Institute of Geology of the Warsaw University (abbreviated IGP).

The SEM micrographs have been made using the facilities of the Geological Survey, by L. Giro, and the TEM micrographs have been made in the Institute of Geology by P. Dzierżanowski.

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EARLIER OPINIONS ON NATURE OF VERRUCATE OBJECTS

Goldstein (1960) studied verrucate objects in recent spores and pollen grains. In his opinion they represented fungi belonging to *Phycomycetes*. Skvarla and Anderegg (1972: figs. 5, 6, 7) described verrucate structures in recent pollen grains of *Cedrus*. They belonged to *Rhizophidium* (*Phycomycetes*). The TEM micrographs presented by these authors op. cit.: figs.: 3—9) show distinctly the internal structure of the attacking fungus.

Moore (1963: pl. 54: 1—17; pl. 55: 1—12; pl. 56: 1—10) described and illustrated morphologically similar structures in fossil material. Single or beaded globular objects of various sizes were often observed on the surface of various Carboniferous spores. According to this author they represented saprophytic organisms such as fungi or bacteria. In the photographs presented by this author one can clearly see the degradation of the spora wall caused by the activity of these organisms.

Srivastava (1976: pl. 1: 1—14; pl. 2: 1—20) described spherules found in the Jurassic pollen grains *Exipollenites tumulus* Balme and *Classopollis classoides* Pflung, which represented fungi included in the new genus *Annella* Srivastava. The successive phases of development of these objects can be traced in photographs presented in the paper mentioned. The baccillary hyphae develop into beaded hyphae and then into spherules 1—2 μm in diameter.

Marcinkiewicz (1979) influenced by the work by Srivastava (op. cit.) considered the verrucae occurring in the Mesozoic genus *Verrutriletes* (Van der Hammen) Potonié to be fungi-like forms.

MICROSTRUCTURE OF MEGASPORES OF THE GENUS *VERRUTRILETES*

In the present paper the morphologic terminology concerning the layers of the sporodermis is that proposed by Kempf (1970, 1971a, b). This author studied by transmission electron microscopy the ultra thin sections of the sporodermis of Recent (*Azolla*, *Salvinia*, *Selaginella*) and fossil (*Horstis-*

porites, *Banksisporites*, *Margaritatisporites*, *Istisporites*, *Nathorstisporites*) megaspores and modified the terminology introduced by Manten (1970). In the interpretation of Kempf the sporodermis consists of multi-layered perine (corresponding to the former ectexine or perine+ectexine), single--layered exine (former endexine) and intine. These layers are the product of different parts of the spore cell plasma.

Potonié (1973) remarking on this division stated that the homology of the outermost wall layer of the megaspores of aquatic ferns (*Azolla*, *Salvinia*), *Selaginella* and fossil plants is uncertain.

The megaspores of the genus *Verrutriletes* are of oval amb. The tetrad mark is well developed, the trilete rays extend almost to equator. The arcuate ridges are indistinct, the perine is smooth (pl. 11: 3*a*), porous (pl. 12: 1*c*) or spongy (pl. 12: 2*b*). The spore surface bears irregularly distributed verrucae. In some specimens they occur almost over the entire spore surface (pl. 11: 4*a*) while in other ones they form irregular clusters (pl. 11: 3*a*, *b*). In most species of *Verrutriletes* the verrucae are of more or less uniform size, for instance in *V. imitatus* (Dijkstra) Waksmundzka 1981 (pl. 11: 4*a*, *b*), but in some forms the verrucae are of various sizes. The larger verrucae may be irregularly distributed or confined to certain areas, for instance to the radial part of the equatorial region, like in *V. guttatus* Marcinkiewicz 1971 (pl. 11: 3*a*, *b*).

In the TEM micrographs (pl. 14: 1, 2, 3, 4, 5, 6) the microstructure of the perine *sensu* Kempf is very clear while the exine is not visible. The perine consits of regularly distributed so called sporopollenin threads (see Kempf) of vermiculate shape, 0.4 to 0.8 μm long. In places, sporopollenin threads pass continuously into verrucae (pl. 14: 1, 3, 4, 5). These consist of dense sporopollenin (pl. 14: 1, 2, 3, 4, 5). The verrucae are connected with the perine with whole bases (pl. 13: 3*c*) or in a few points (pl. 12: 1*b*, *c*; pl. 13: 3*b*). They are smooth (pl. 11: 3*b*), occasionally slightly porous (pl. 12: 1*b*), yellow or red.

THE SYSTEMATIC POSITION OF MEGASPORES WITH VERRUCATE ORNAMENTATION

In the present author's opinion the fact that there is a continuous transition between the spore wall and the verrucae, which can be observed by SEM (pl. 12: 1*c*; pl. 13: 3*c*) as well as the continuous transition between the internal structure of the sporodermis and the internal structure of the verrucae, which can be seen by the use of TEM (pl. 14: 1, 3, 4, 5) demonstrates that the verrucae are the elements of spore ornamentation. Thus, the megaspores with this type of ornamentation should be included in *Verrutriletes* (Van der Hammen) Potonié, and not in sculpture-less *Trileites murrayi* (Harris) Gry (Marcinkiewicz, 1979, Jiduan and Suying 1982).

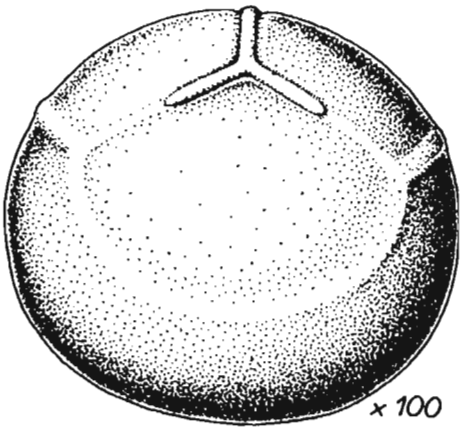

Fig. 1. *Trileites murrayi* (Harris) Gry, after Harris 1961.

The ornamented spores may loose the ornamentation elements due to sedimentary or post-sedimentary processes or during the laboratory treatment (Kampmann 1983, pl. 6: 1, pl. 8: 3). Spores which have lost the ornamentation are superficially smooth which hampers the correct determination. It is possible that various spores included in *Trileites* may represent ornamented forms stript of ornamentation processes, but this is difficult to prove.

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MARTA WAKSMUNDZKA

CHARAKTER ORNAMENTACJI U MEGASPOR Z RODZAJU *VERRUTRILETES*

Streszczenie

Jednym z elementów ornamentacji spor i ziarn pyłku są wyrostki brodawkowate. Wyrostki te, podobnie jak i inne elementy ornamentacji są wyrostkami zewnętrznej warstwy błony spory czy ziarna pyłku. W literaturze palinologicznej znane są jednak przypadki opisywania struktur brodawkowatych nie wykazujących bezpośredniego związku z samym zarodnikiem. Ostatnio ukazał się szereg prac dotyczących tej tematyki. Na uwagę zasługują tu prace Goldsteina (1960) oraz Skvarla and Anderegga (1972), którzy opisują struktury brodawkowate na współczesnych ziarnach pyłku, które należą do pasożytujących grzybów. Moore (1960), Srivastava (1976), Marcinkiewicz (1979) opisują podobne morfologicznie struktury na materiale kopalnym.

W niniejszej pracy przedyskutowano problem pochodzenia struktur brodawkowatych u mezozoicznego rodzaju *Verrutriletes*. Przy opisie mikrostruktury ścian spor i elementów ornamentacji przyjęto terminologię Kempfa (1970, 1971*a*, *b*). Zdaniem autorki ciągłe przejście powierzchni spory w powierzchnię brodawki, widoczne dzięki zdjęciom wykonanym w SEM-ie (pl. 12: 1*c*; pl. 13: 3*c*), jak i ciągłe przejście struktury wewnętrznej ściany spory w strukturę wewnętrzną brodawki, widoczne dzięki zdjęciom wykonanym w TEM-ie (pl. 14: 1, 3, 4, 5, 6) są wystarczającym dowodem na uznanie brodawek za elementy ornamentacji.

EXPLANATIONS OF PLATES 11—14

Plate 11

1. *Verrutriletes* sp. 1: specimen IGP 1/84, Łuków, Jurassic; general view, SEM.
2. *Verrutriletes imitatus* (Dijkstra) Waksmundzka: specimen IG MW 2/4, Tuchola IG 1 borehole, Cretaceous, proximal surface, transmitted light.
3. *Verrutriletes guttatus* Marcinkiewicz: specimen IG MW 2/7, Człuchów IG 1 borehole, Cretaceous; 3*a* proximal surface, 3*b* perine fragment, SEM.
4. *Verrutriletes imitatus* (Dijkstra) Waksmundzka: specimen IG MW 2/3, Człuchów IG 1 borehole, Cretaceous; 4*a* proximal surface, 4*b* perine fragment, SEM.

1, 3*a*, 4*a* ×60; 3*b*, 4*b* ×350

Plate 12

1. *Verrutriletes* sp. 2: specimen IGP 2/84, Łuków, Jurassic: 1*a* distal surface, 1*b* contact of verruca with porous surface of perine, 1*c* continuous transition between the spore surface and the verruca, SEM.
2. *Verrutriletes* sp. 3: specimen IGP 3/84, Łuków, Jurassic: 2*a* fragment of spongy spore surface with verrucae, 2*b* fragment of spongy perine surface, SEM.

1*a* ×68; 2*a* ×440; 1*b* ×1300; 2*b* ×2800; 1*c* ×3600; 2*c* ×7200

Plate 13

1, 2. *Verrutriletes imitatus* (Dijkstra) Waksmundzka: specimens IG MW 2/5, 6, Człuchów IG 1 borehole, Cretaceous; contact of verruca with spore surface; in transmitted light (peel section).

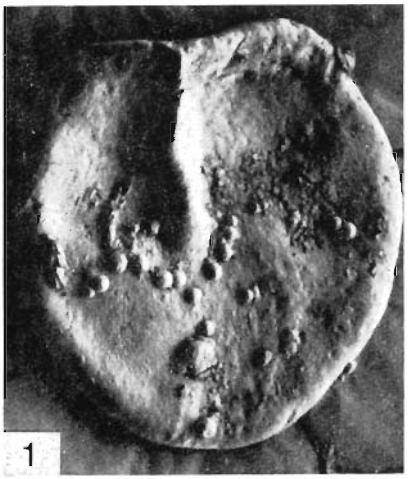
3. *Verrutriletes* sp. 4: specimen IGP 4/84, Łuków, Jurassic; 3*a* fragment of spore surface, 3*b* contact of verruca with spore surface, 3*c* continuous transition between verruca and spore surface; SEM.

1, 2 ×1000; 3*a* ×540; 3*b* ×3100; 3*c* ×5700

Plate 14

1, 2, 3, 4, 5, 6. *Verrutriletes imitatus* (Dijkstra) Waksmundzka: specimens IG MW 2/5, 6, Człuchów IG-1 borehole, Cretaceous; *1—5* continuous transition between the spore wall internal structure and the verruca internal structure, *6* fragment of perine; TEM.

1, *2*, *3*, *4*, *5*, ×2600; *6* ×7200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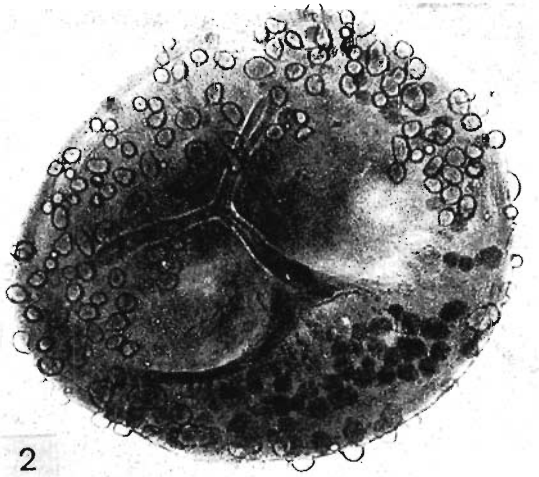
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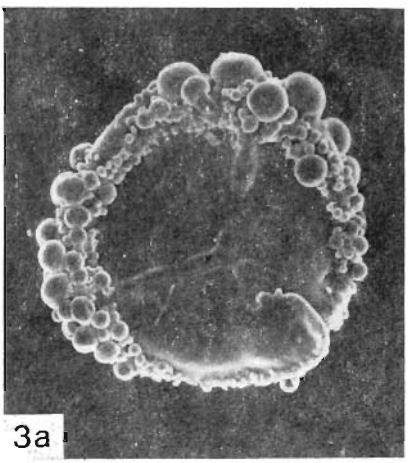
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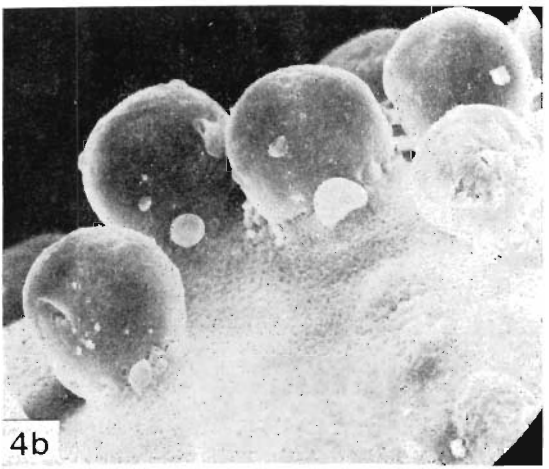
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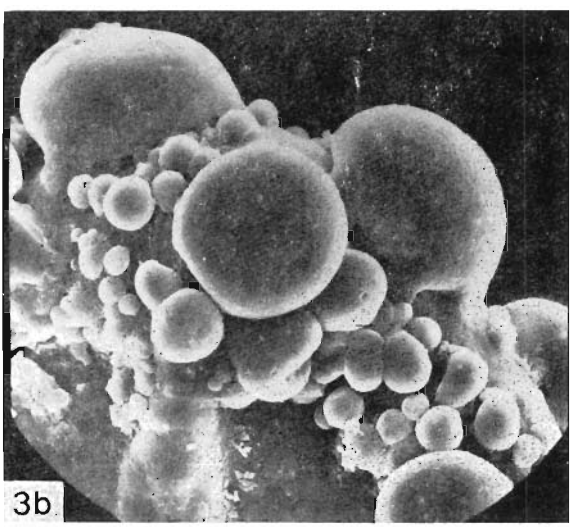
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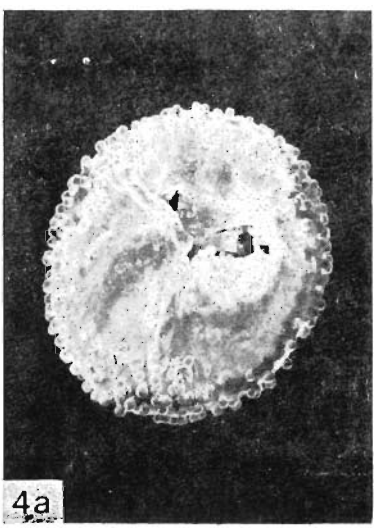
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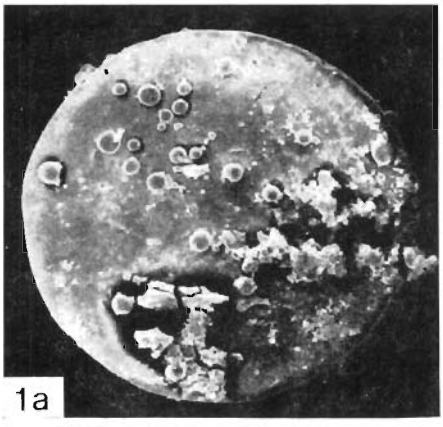
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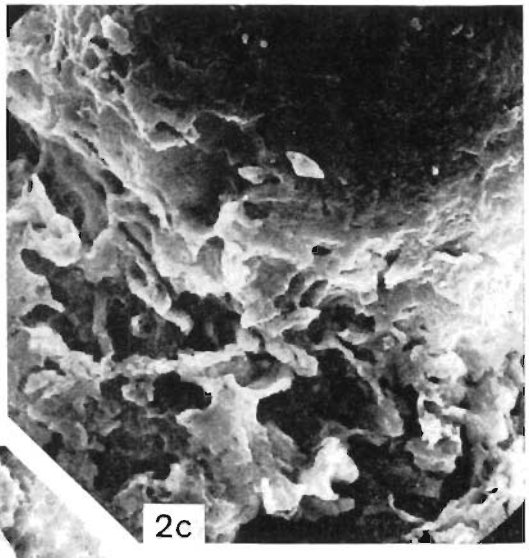
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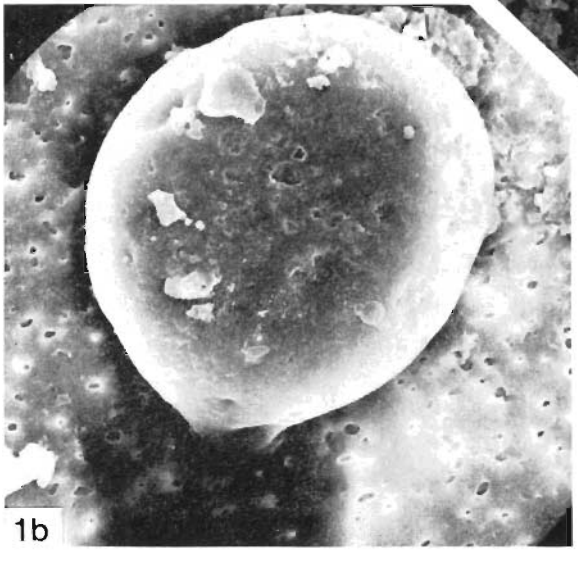
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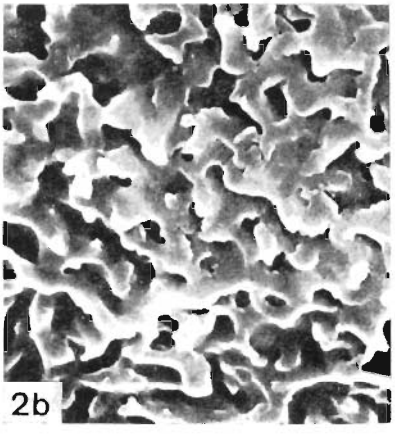
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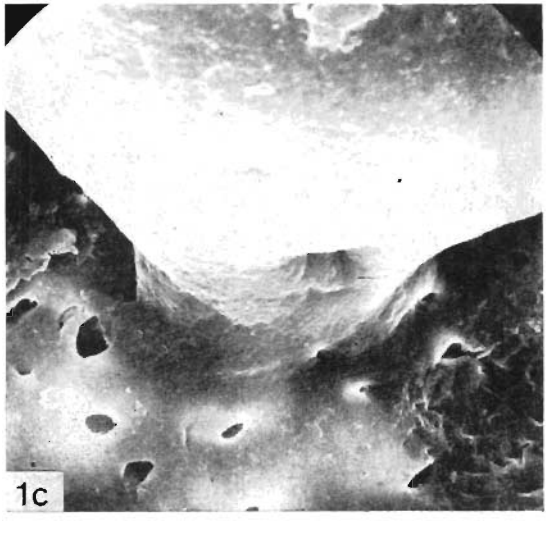
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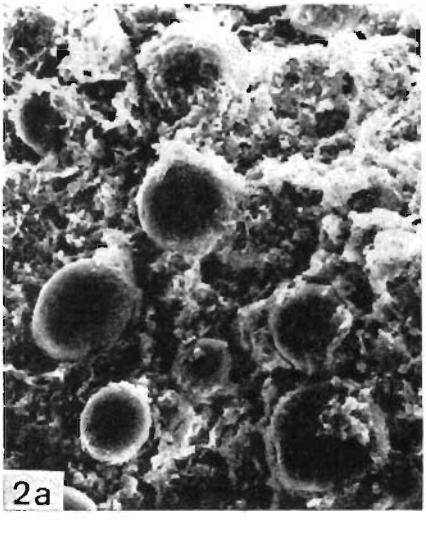
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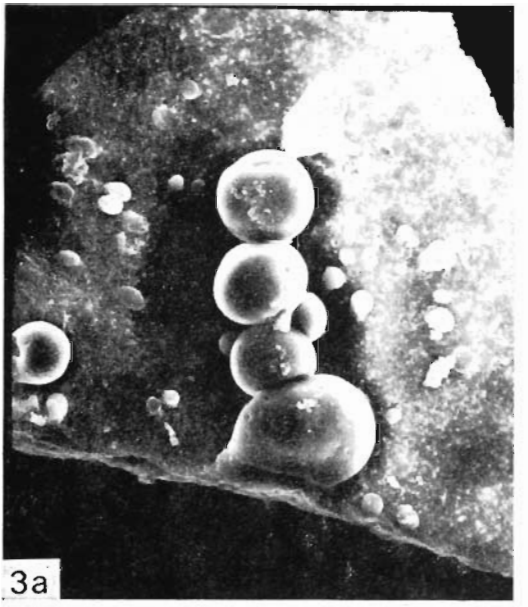
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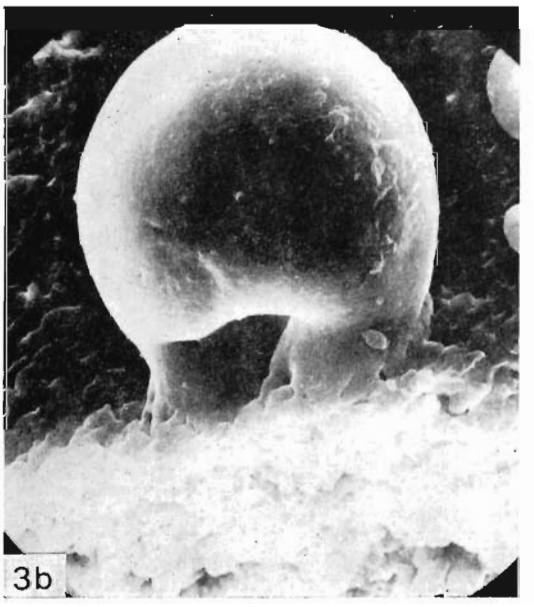
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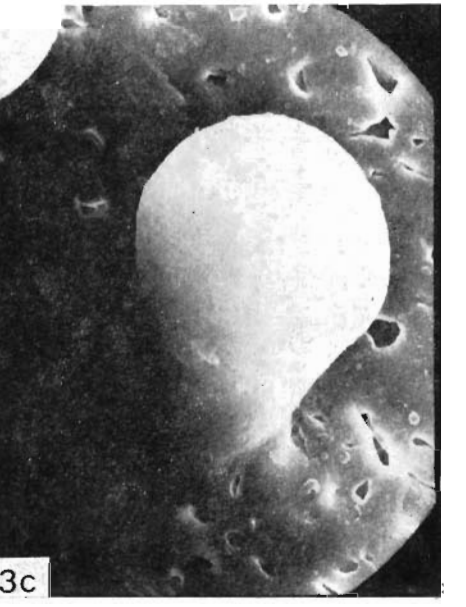
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