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MICROFLORA FROM CORE SAMPLES OF SOME PALAEOZOIC SEDIMENTS FROM BENEATH THE FLYSCH CARPATHIANS (BIELSKO-WADOWICE AREA, SOUTHERN POLAND)

(Pl. I—V and 3 Figs.)

Mikroflora pewnych utworów paleozoicznych podłoża Karpat fliszowych (Rejon Bielska-Wadowic)

(Tabl. I—V i 3 fig.)

Abstract. Sporomorphs and some algal (?) remains are described from an subsurface terrigenous sequence considered as Early Devonian in age, from the area of Bielsko—Wadowice. Different systems of spore classification are discussed. Three new spore species are described. Two different assemblages of palynomorphs are distinguished. A late Emsian age is suggested for the upper assemblage.

GEOLOGIC SETTING

This paper describes some of the most common plant spores and other microfossils, the latter probably of algal origin, from a sequence of sandstones, siltstones and conglomerates discovered in deep boreholes in the area of Bielsko—Wadowice (text-fig. 1). These rocks lack fossil organisms other than some "Psilophyton-flora", occurring occasionally in the uppermost part of the sequence, and the microflora (Konior and Turnau, 1973).

Konior (1965, 1966, 1968, 1969) assumed an Emsian Age for these deposits on the basis of lithological similarity to the Lower Devonian deposits of the Holy Cross Mountains. This author (op. cit. and also Konior and Turnau, 1973) divided these deposits, on the grounds of lithology, into three units: upper, middle and lower.

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The upper unit includes unequigranular sandstones, conglomerates and siltstones, locally with "Psilophyton-flora", which is now being worked on by Danuta Z d e b s k a of the Institute of Botany, Jagiellonian University, Kraków. The deposits of this unit vary in thickness between 15 m and 127 m in various boreholes.

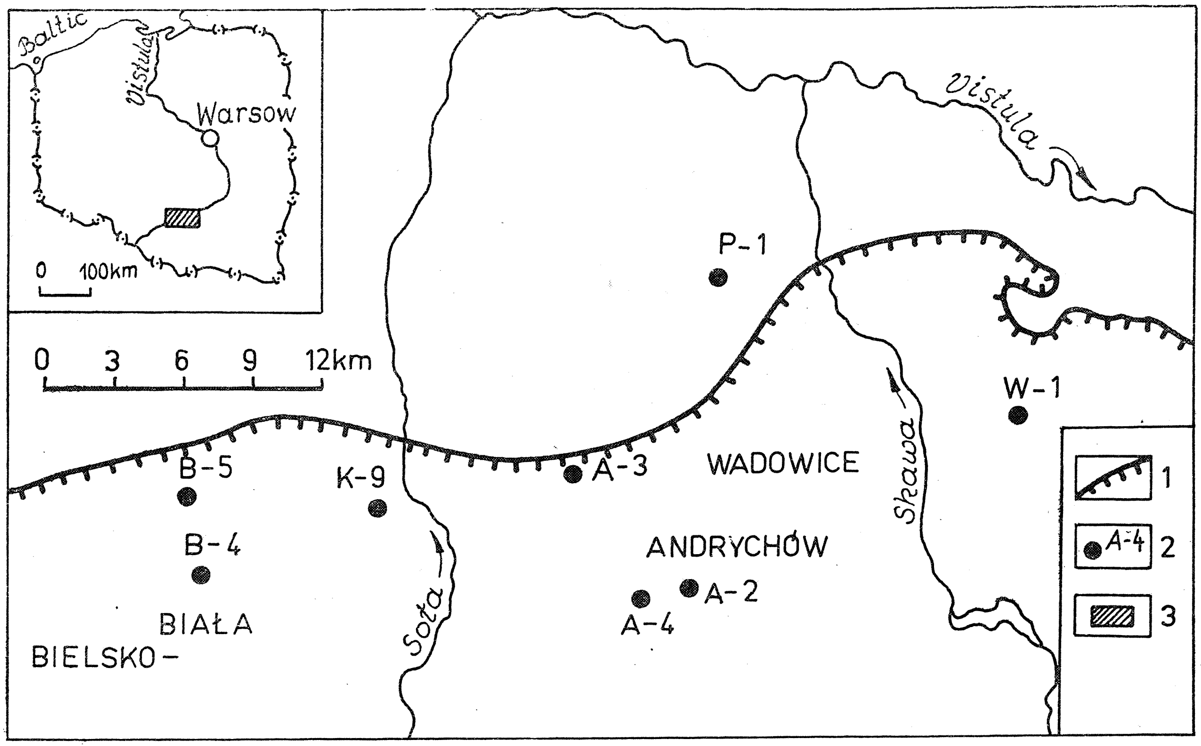

Fig. 1. Sketch map of the area studied with location of boreholes referred to in the text. 1 — northern limit of the Carpathians; 2 — boreholes; B — Bielsko; K — Kęty; A — Andrychów; P — Piotrowice; W — Wysoka; 3 — studied area.

Fig. 1. Mapa schematyczna badanego obszaru z lokalizacją otworów wiertniczych. 1 — północny brzeg Karpat; 2 — otwory wiertnicze; B — Bielsko; K — Kęty; A — Andrychów; P — Piotrowice; W — Wysoka; 3 — badany obszar

Recent investigations (K o t a s, 1973) have revealed Cambrian Trilobites in the Goczałkowice IG 1 borehole, located west of the studied area, occurring in the deposits corresponding with the middle unit of the Bielsko-Wadowice area. Although no marked unconformity between the upper and middle units has been observed it is possible that the middle and lower units, previously assigned to the Lower Devonian, may be pre-Devonian. A full discussion of this question will not be possible untill all the palaeontological and geological data on the Goczałkowice IG 1 borehole are published.

MATERIAL AND METHODS

Seventy samples of siltstones and sandstones with silty intercalations have been taken from the Boreholes Bielsko 4, 5, Andrychów 2, 3, 4, Kęty 9, Piotrowice 1 ond Wysoka 1, mostly from the upper unit, but the boreholes Kęty 9 and Andrychów 3 have been sampled in all three units.

The methods for obtaining spores were those employed commonly for Devonian rocks, involving hydrofluoric acid and heavy liquid flotation. Three methods were used in oxidising the organic material; the samples were either treated with cold fuming nitric acid for 15 minutes, boiled in fuming nitric acid for a few minutes, or put in Schulze solution for one to two hours.

Information concerning the location of the productive samples is given in table 1 and in page. 162.; the data on all, productive and unproductive, samples can be found in Konior and Turnau, 1973.

All type and other figured specimens here described are housed in the Laboratory of Geology of Mineral Resources, Institute of Geological Sciences, Polish Academy of Sciences in Kraków. All figured specimens are referred to by slide numbers and 'E—W' and 'N—S' microscope readings. These are based on a Zeiss NfPk microscope, No. 410559 at the same institution.

SYSTEMATIC PALYNOLOGY

The microflora recovered from the Devonian (and Cambrian?) clastic deposits from the boreholes of Bielsko—Wadowice area is poor in number of specimens and taxa and is also ill preserved. Although about seventy samples were studied only seven yielded appreciable numbers of spores.

No attempt has been made here to describe all forms of spores present in the assemblages. The bad state of preservation makes it impossible to distinguish many of the simple spore forms. Thus some spores probably belonging to *Leiotriletes, Punctatisporites, Retusotriletes* and *Calamospora* are not described in this paper. Also some spore forms with distinct features but represented only by one or two specimens have been excluded from this part of the paper but are listed in table 1 and figured in plates I—V.

The system of classification used in this work is that introduced by R. Potonié and Kremp (1954, 1955, 1956) and R. Potonié (1956, 1958, 1960, 1966, 1970), subsequently expanded by Dettman (1963) and Richardson ,1965). The other systems proposed for Palaeozoic spores are those by Neves and Owens (1966) and by Smith and Butterworth (1967). Both these systems consider different states of the intexine detachment as a feature of the taxonomic value, no matter whether this is an original and permanent feature of a spore group or a secondary one resulting from fossilization or chemical treatment. However, it is known by those who work on spores from sporangia, recent or fossil, that even in spores from a single sporangium the exine layers may be separated in various degrees or not separated at all. This has been clearly shown by Pettitt (1966), who demonstrates occassional and variable intexine detatchment in spores of some Pteriodophytes.

According to this author (p. 234—235) "within a single microsporangium of *Isoetes* spores can be found that could be classified when dispersed as either cavate or not so, if the current definition for this structural condition was applied to them."

Therefore the systems of spore classification mentioned above have not been used in this paper. Being not satisfactory in some respects these systems are also impractical for biostratigraphic studies involving only the use of the light microscope by which the nature of intexnie detachment is not always easy to detect.

Anteturma Proximegerminantes R. Potonié, 1970
Turma Triletes Reinsch, 1891
Subturma Azonotriletes Luber, 1935
Infraturma Laevigati (Bennie and Kidston) R. Potonié and Kremp, 1954

Genus *Retusotriletes* (Naumova) Richardson, 1965
Type species. *R. pychovii* Naumova, 1953

Retusotriletes frivolus Chibrikova

Plate I, figs. 4, 5

1959 *Retusotriletes frivolus* sp. nov. Chibrikova, Akad. Nauk SSSR, Bashkirskij Filial, p. 55—56, pl. VI, fig. 9.

Description of specimens. Spores trilete; amb subcircular or subtriangular with convex sides and rounded apices. Sutures split open in all observed specimens, length approximately half spore radius. Arcuate ridges perfect but weak. Exine thin, smooth, secondary folds present occasionally.

Remarks. According to Chibrikova (1959, p. 55) exine of the proximal radial region is thinner than elsewhere which causes splitting of the sutures.

Dimensions. (eleven specimens) Equatorial diameter 22 µm to 45,5 µm (mean 30,5 µm).

Occurrence. USSR, Bashkir (Chibrikova, 1959), Takatinskije Beds (Eifelian). The area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.

Infraturma Apiculati (Bennie and Kidston) R. Potonié, 1956
Subinfraturma Nodati Dybova and Jachowicz, 1957

Genus *Apiculiretusispora* (Streel) Streel, 1967
Type species. *A. brandtii* Streel, 1964.

Apiculiretusispora plicata (Allen) Streel

1965 *Cyclogranisporites plicatus* sp. nov. Allen, Palaeontology, 8, 4, p. 695, pl. 94, figs. 6—9.

1972 *Apiculiretusispora ? plicata* (Allen) Streel; McGregor and Uyeno, Geol. Surv. Canada Paper 71—13, pl. 1, fig. 3.
1973 *Apiculiretusispora plicata* (Allen) Streel; McGregor, Palaeontographica B, 142, 1—3, p. 25, pl. 2, figs. 13—14.
1973 *Perotrilites — Cyclogranisporites* type; Konior and Turnau, Ann. Soc. Geol. Pol. XLIII, table 1, pl. I, figs. 3, 4.

Occurrence. Spain (Cramer, 1967; 1969), late Eifelian to Givetian, Vestspitsbergen (Allen, 1965; 1967), Gedinian to Givetian, Belgium (Streel, 1967), Siegenian to Emsian, Canada (McGregor, 1972, McGregor and Uyeno, 1972), Siegenian to early Givetian, the area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.
Dimensions. (twenty-one specimens) Equatorial diameter 45,5 μm to 95,5 μm (mean 65 μm).
Remarks. In these spores the outermost wall layer, which seems to consist solely of sculptural elements, tends to separate from the inner one; this layer may represent the exoexine, as suggested by McGregor (1973), but it may also be of perisporal origin.

Spores with the separated outer wall layer bear a superficial resemblance to spores of *Perotrilites,* but they differ from most species assigned to this genus in being not completely enveloped by the outer membranous layer which exists only outside the contact areas. With regard to this the species *Perotrilites microbaculatus* Richardson and Lister (1969) and *Perotrilites mutabilis* Lele and Streel (1969) should be excluded from *Perotrilites.*

Apiculiretusispora parvula sp. nov.

Plate I, figs. 12—15

1973 *Perotrilites* aff. *mutabilis* Lele and Streel; Konior and Turnau, Ann. Soc. Geol. Pol. XLIII, table 1.

Diagnosis. Spores trilete; amb subtriangular, circular or oval. Sutures distinct, straight, length half to three-quarters spore radius. Arcuate ridges perfect but weak. Exine ornamented with tightly packed, more or less circular grana with rounded apices, less than 1 μm in diameter. Contact faces smooth.
Description. Spores very often partly or completely striped of sculptural elements. Proximal radial region often darkened.
Dimensions. (thirteen specimens) Equatorial diameter 24 μm to 41 μm (mean 33 μm).
Holotype. Plate I, fig. 12, slide BA/15, 7.55 3.116.
Locus typicus. The borehole Kęty 9, a depth between 1586, 7 — 1591,8 m, the area of Bielsko—Wadowice, south Poland, probably uppermost Emisian.
Remarks. The spores tend to loose sculptural elements which come

off separately (they do not form a continuous leyer as in the case of *Apiculiretusispora plicata* (Allen) Streel.

Comparison. *Retusotrilets verruculatus* Naumova (in Lanninger, 1968, p. 116—117, pl. 21, fig. 10) and *Retusotriletes domanicus* Naumova (in Schulz, 1968, p. 13, pl. 1, figs. 13, 13a) are larger. *Perotrilites mutabilis* Lele and Streel (1969, p. 100—101, pl. 3, figs. 54—57) is closely similar to *A. parvula* sp. nov. but it differs in ornamentation consisting of bacula or pila.

Genus *Procoronaspora* Butterworth and Williams, 1958
Type species. *P. ambigua* Butterworth and Williams, 1958

Remarks. In spores belonging to this genus the equatorial spines appear longer than the distal ones. In most cases the difference in the spine length is only superficial; it results from different position of the spines as the distal ones are flattened from the top and bent. This remark concerns also the genus *Tricidarisporites* Sullivan and Marshall (1966).

Procoronaspora luteola sp. nov.

Plate I, fig. 8

1967 *Anapiculatisporites* sp. C. Streel, Ann. Soc. Géol. Belg. 90, 1, p. B32, pl. II, figs. 24—25.

1968 *Procoronaspora ambigua* Butterworth and Williams; Schulz, Palaeontographica B, 123, 1—6, p. 23, pl. 3, fig. 4.

1973 *Procoronaspora* — *Anapiculatisporites* type. Konior and Turnau, Ann. Soc. Geol. Pol. XLIII, table 1, pl. 1, fig. 8.

Diagnosis. Spores trilete; amb more or less triangular with broadly rounded apices. Sutures simple, straight to slightly sinuous, length approximately two-thirds spore radius. Distal surface and the interradial equatorial region of the spores ornamented with coni less than 2 μm long, 4 μm apart; proximal surface smooth.

Description. Exine close to the triradiate mark often darkened but typical lips not developed. Secondary folds of distal exine parallell to interradial margins commonly present.

Dimensions. (nine specimens) Equatorial diameter 24—43,5 μm (mean 29,5 μm).

Holotype. Plate I, fig. 8, slide BA/78 1.39 0.100.

Locus typicus. The borehole Piotrowice 1, a depth between 2364,0 m—2368,5 m, the area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.

Occurrence: W. Germany (Schulz, 1968) — Lower Emsian, Belgium (Streel, 1967) — Emsian.

Comparison. In *Procoronaspora ambigua* Butterworth and Williams (1958, p. 384, pl. IV, figs, 1—3) the ornament consists of minute bacula or coni instead of spines, *Procoronaspora* sp. (McGregor, Sandford and Norris, 1970, pl. II, figs. 1—2) has denser ornamentation.

Genus *Dibolisporites* Richardson, 1965

Type species *D. echinaceus* (Eisenack) Richardson, 1965

Dibolisporites echinaceus (Eisenack) Richardson, 1965

Plate I, fig. 20

1973 *Dibolisporites echinaceus* (Eisenack) Richardson; McGregor, Palaeontographica B, 142, 1—3, p. 29—30, pl. 3, figs. 8—10, 12, 13, cum synonimis.

Dimensions. (thirty-three specimens) Equatorial diameter 84,5 μm to 180 μm (mean 128 μm).

Remarks. Among the Bielsko—Wadowice specimens of *D. echinaceus the* forms with processes longer than 5 μm have not been observed; in other aspects the spores are closely comparable to those from Scotland. The study of the Bielsko—Wadowice material indicates that no sharp limit between *D. echinaceus* and *D.* cf. *gibberosus* var *major* (Kedo) Richardson can be drawn, which was noted earlier by McGregor (1973, p. 30); this is not at variance with the data given by Richardson (op. cit.) since the given dimensions of sculptural elements in these two specimens overlap.

Occurrence. The species is widespread in Upper Lower to Upper Devonian rocks of the northern hemisphere. In the Bielsko—Wadowice area, south Poland, it was found in probably uppermost Emsian rocks.

Dibolisporites sp. A.

Plate II, fig. 2

cf. 1968 *Retusotriletes antiquus* Kedo; Lanninger, Palaeontographica B, 122, 1—6, p. 111—112, pl. 20, fig. 22.

1973 *Dibolisporites* sp. cf *Retusotriletes antiquus* Kedo; Konior and Turnau, Ann. Soc. Geol. Pol. XLIII, table 1.

Description of specimens. Spores trilete; amb subcircular. Sutures distinct, accompanied by sinuous lips 3 μm wide, length two-thirds spore radius. Contact faces more or less smooth, outside contact faces exine covered with densly set biform elements; length of processes 6,6 μm to 10,5 μm, basis width 3—6 μm. Spinose tips of the processes often brocken off, than the elements flattened or concave in profile.

Dimensions. (fifteen specimens) Equatorial diameter 87 μm to 145,5 μm (mean 111 μm).

Occurrence. ? W. Germany (Lanninger, 1968) — uppermost Emsian. The area of Bielsko—Wadowice, south Poland — probably uppermost Emsian.

Remarks. Although numerous specimens of this form have been found in the studied material nevertheless the preservation is not sufficiently good to permit erecting a new species. The spores determined by Lanninger (1968, p. 111—112, pl. 20, fig. 22) as *Retusotriletes antiguus* Kedo seem to be identical with *Dibolisporites* sp. A. The biform processes in *Dibolisporites echinaceus* (Eisenack) Richardson (1965, p. 568, pl. 89, figs. 5—6) are of similar length, but they are slimmer and not so densely packed.

Genus *Hystricosporites* McGregor, 1960

Type species *H. delectabilis* McGregor, 1960

Hystricosporites spp.

Remarks. Spores belonging to *Hystricosporites* were present in the samples in small quantities and were poorly preserved. The dimensions of the spores and the shape and size of the bifurcate processes suggest that at least two species are present one of which may be *H. corystus* Richardson (plate II, fig. 3).

Infraturma Murornati R. Potonié and Kremp, 1954

Genus *Acinosporites* Richardson, 1965

Type species. *A. acanthomamillatus* Richardson, 1965

Acinosporites sp. A.

Plate I, figs. 18, 19

1968 *Acinosporites parviornatus* Richardson; Lanninger, Palaeontographica B, 122, 4—6, p. 134, pl. 23, fig. 10.

Description of specimens. Spores trilete; amb subtriangular with convex sides and rounded apices. Sutures distinct, straight, reaching almost to the equator, accompanied by narrow lips less than 1 μm wide. Arcuate ridges perfect, strong, up to 3 μm wide, appearing as a narrow cingulum. Exine ornamented distally with dense reticulum of irregular ridges ca 1 μm wide, bearing small spines ca 1,5 μm long.

Dimensions. Equatorial diameter of one complete specimen 43 μm, diameter of ten corroded forms 35 μm to 54 μm (mean 43,5 μm).

Remarks. Only one complete specimen has been found; in the same slide numerous spores occur the features of which are closely comparable to those described above but the spores lack ornamentation. Some of these specimens still bear small areas of spiny-reticular ornament (cf. plate I, fig. 19). It seems that these spores apparently representing a different genus (*Aneurospora*) belong to *Acinosporites* sp. A.

Occurrence. W. Germany (Lanninger, 1968) — upper Emsian, the area of Bielsko—Wadowice, probably uppermost Emsian.

Subturma Pseudosaccitriletes Richardson, 1965

Remarks. Neves and Owens (1966) rejected *Pseudosaccitriletes* and proposed *Cameratitriletes* to include camerate spores possessing a solid flange or cingulum. However, it seems doubtful whether such spores really exist. What appears to be a solid flange in spores of *Spinozonotriletes* Haquebard (1957) and *Ancyrospora* Richardson (1960) is in fact a flattened equatorial pseudosaccus, which can be observed in brocken specimens (cf. plate II, fig. 6 and plate IV, fig. 3) and sometimes in spore sections (cf. Dettman and Playford, 1962, pl. 96, figs. 8, 9). It is also disputable whether a narrow equatorial cavity developed in various degrees in spores of *Vallatisporites Haquebard* (1957) is a primary feature of the taxonomic value (the intexine in these spores is folded, i.e. it has shrinked — cf. Sullivan, 1964, p. 371, text-fig. 3).

Infraturma Extrornati Butterworth and Williams, 1958

Genus *Ancyrospora* Richardson, 1960 (non Richardson, 1962)

Type species. *A. grandispinosa* Richardson, 1960

Extended diagnosis. Trilete, pseudo-saccate spores in which the exoexine is attached to the intexine on both proximal and distal surfaces (cf. text-fig. 2), Equatorial outline circular, subcircular, triangular, subtriangular to scalloped irregular. Exoexine ornamented distally with bifurcate processes. Intexine of variable thickness.

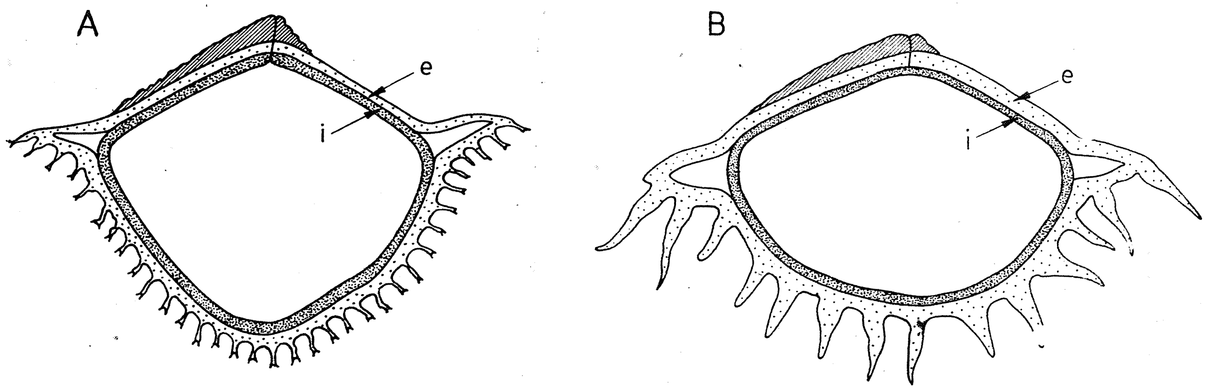

Fig. 2. Diagramatic reconstructions in polar sections. *A. Ancyrospora kedoae, B. Spinozonotriletes* cf. *naumovii;* e — exoexine; i — intexine

Fig. 2. Rekonstrukcja przekroju biegunowego spor. *A. Ancyrospora kedoae, B. Spinozonotriletes* cf. *naumovii;* e — eksoeksyna; i — inteksyna

Remarks. Richardson (1962) considered the equatorial "flange" in *Ancyrospora* to be a solid extension of the exoexine on the grounds of interpretation of spore sections. However, it is known that in strongly compressed spores the camera is not always to be seen in thin sections — cf. Allen (1965, pl. 104, fig. 11). Moreover, it can be observed in brocken specimens of *Ancyrospora* (plate IV, fig. 3) that the „flange" is double and so it represents the compressed pseudosaccus. Thus the original diagnosis of *Ancyrospora* (Richardson, 1960) was correct though the relation between the exine and the intexine was not clearly defined.

Ancyrospora kedoae (Riegel) nov. comb.

Plate IV, figs. 1—3, 6, 7

1968 *Hymenozonotriletes argutus* Naumova; Lanninger, Palaeontographica B, 122, 4—6, p. 144, pl. 24, fig. 15.

1969 *Calyptosporites argutus* (Naumova) new. comb. Cramer, Pollen and Spores, XI, 2, p. 436—437, pl. III, fig. 33.

1973 *Hymenozonotriletes kedoae* sp. nov. Riegel, Palaeontographica B, 142, p. 94, pl. 15, figs. 1—3.

1973 *Hymenozotriletes argutus* Naumova; Konior and Turnau, Ann. Soc. Geol. Pol. XLIII, table 1, pl. II, fig. 3.

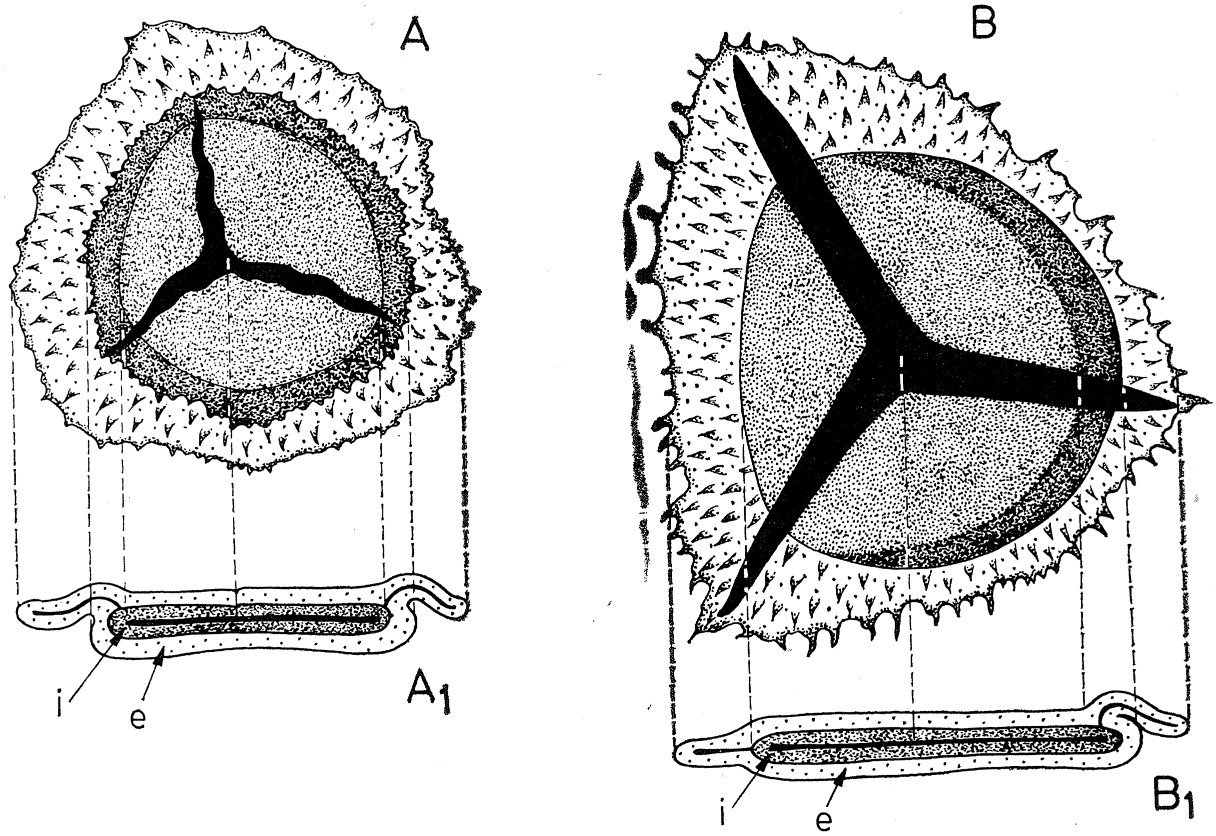

Fig. 3. Structural features of spores in surface and sectional views. *A. Samarisporites symmetricus*, *B. Ancyrospora kedoae*; e — exoexine; i — intexine

Fig. 3. Cechy strukturalne spor, widok powierzchniowy oraz przekrój. *A. Samarisporites symmetricus*, *B. Ancyrospora kedoae;* e — eksoeksyna; i — inteksyna

Description of specimens. Spores trilete, pseudosaccate; amb subtriangular with slightly convex or straight sides and pointed apices, central body subcircular. Exoexine separated from the intexine at equator forming contrifugal pseudosaccus. In profile distal surface of the spores strongly convex, and bluntly conical in shape (plate IV, fig. 7). In polar compression pseudosaccus wider at apices, narrower at sides. Laesurae distinct, sinuous, lips elevated, 5 µm broad, 8 µm high at the apex, reaching central body margin. Broad folds of the exoexine often accompany laesurae extending beyond the central body margin. Exoexine minutely wrinkled, distal surface of the spores ornamented with bifurcate spines 4—6 µm long but occasionally up to 12 µm long, often fused at their bases forming discontinuous rodges. Spores usually flattened obliquely due to the shape of the distal surface.

Dimensions. (twenty-six specimens) Equatorial diameter 95 µm to 195 µm (mean 143 µm), central body 82 µm to 130 µm (mean 89 µm).

Remarks. These spores often appear asymmetric in polar view because they are compressed somewhat obliquely with the distal hemisphaere pushed to one side (cf. text-fig. 3).

Occurrence. W. Germany (Lanninger, 1968, Riegel, 1973) — upper Emsian to lower Eifelian, Spain (Cramer, 1969) — probably Givetian. The area of Bielsko-Wadowice, south Poland — probably uppermost Emsian.

Ancyrospora aff. kedoae (Riegel) nov. comb.

Plate IV, fig. 4

Description of specimens. Spores trilete, pseudosaccate; amb triangular with pointed apices and convex sides, central body subcircular. Laesurae distinct, with elevated lips, reaching to the central body margin; exinal folds accompanying laesurae, reaching to the margin of the spores, often present. Exoexine minutely wrinkled, ornamented distally with bifurcate spines up to 4 µm long. In equatorial plane pseudosaccus narrow interradially, wider at apices where it is more than one-third spore body radius wide. Spores usually flattened obliquely.

Dimensions. (eleven specimens) Equatorial diameter 69,5 µm to 119,5 µm (mean 100,5 µm), central body 61 µm to 95,5 µm (mean 69,5 µm).

Remarks. These spores are similar in every aspect to *Ancyrospora kedoae* (Riegel) nov. comb. except in size and spore/body ratio. They occur in all samples containing *A. kedoae* and it seems possible that they are immature or abortive spores of this species.

Ancyrospora ? loganii McGregor

Plate III, fig 1, 3

? 1966 *Ancyrospora* sp.; McGregor and Owens, Geol. Surv. Canada Paper 66—30, pl. VIII, fig. 2, 5.

? 1966 *Ancyrospora ? grandispinosa*. McGregor and Owens, Ibid. pl. VIII, fig. 3.

? 1966 *Ancyrospora* cf. *A. grandispinosa* Richardson; McGregor and Owens, Ibid. pl. VIII, fig. 4.

? 1973 *Ancyrospora loganii* n. sp. McGregor, Palaentographica B, 142, 1—3, p. 65, pl. 9, figs. 6, 7, 10—12.

Description of specimens. Spores trilete, pseudosaccate; amb subtriangular with convex sides and rounded apices, conformable with the spore body outline. Pseudosaccus more than half radius of the spore body wide. Laesurae not longer than the spore body radius, broad folds of the exine accompanying laesurae extend to the equator. Exoexine minutely wrinkled, ornamented distally with stout bifurcate processes 8 µm to 22 µm long 6,1 µm to 10 µm maximum basal diameter. Spores usually flattened obliquely.
Dimensions (sixteen specimens) Equatorial diameter 71,5 µm to 160 µm (mean 108,5 µm), central body 59,5 µm to 106,6 µm (mean 82,5 µm).
Occurrence. ? Canada (McGregor and Owens, 1966, McGregor, 1973) — late Emsian to Middle Devonian, the area of Bielsko—Wadowice, south Poland — probably uppermost Emsian.
Remarks. Ancyrospora loganii McGregor (1973) is considerably larger but in other respects it is identical with the Bielsko—Wadowice species.

Genus *Spinozonotriletes* Haquebard, 1957

Type species. *S. uncatus* Haquebard, 1957

Remarks. This genus was emended by Neves and Owens (1966) and included to *Grandispora* Hoffeister, Staplin and Malloy by McGregor (1973). Neither of this seems to be satisfactory. Neves and Ovens (op. cit.) suggested that *Spinozonotriletes* is characterized by the presence of an equatorial cavity plus an equatorial solid flange, which is not correct. Sections of specimens belonging to *Spinozonotriletes uncatus* Haquebard (cf. Dettman and Playford, 1962, pl. 96, figs. 6—9) and also brocken specimens of *Spinozonotriletes* cf. *naumovii* (plate II, fig. 6) indicate that *Spinozonotriletes* includes spores possessing an equatorial pseudosaccus (text.-fig. 2). McGregor (1973) included *Spinozonotriletes* to *Grandispora* Hoffmeister, Staplin and Malloy (1915) giving a wide diagnosis to enclose also species assignable to *Calyptosporites* Richardson (1962) and *Samarisporites* Richardson (1965). The suggestion of fusing *Spinozonotriletes* and *Grandispora* is sound; these two genera seem to have the same structural organisation and sculpture i. e. they posses an equatorial pseudosaccus and distal spinose ornamentation. On the other hand *Calyptosporites* differs distinctly in having a pseudosaccus detached from the central body in equatorial and distal region, the feature easy to observe in specimens with secondary folds of the distal exoexine. As for *Samarisporites,* it includes species with spinose or verrucose ornament the elements of which are fused in regular rows or irregular convolute groups. Retaining the distinction between *Spinozonotriletes* and *Grandispora* on one hand and *Calyptosporites* and *Samarisporites* on the other may be also useful for stratigraphic purposes.

In consequence the original diagnosis of *Spinozonotriletes* has been adopted in the present paper to avoid perfunctory emendation when a thorough revision of Devonian and Carboniferous pseudosaccate spores by a group of specialists is obviously required.

Spinozonotriletes cf. *naumovii* (Kedo) Richardson, 1965

Plate II, figs. 5, 6

Description of specimens. Spores trilete, pseudosaccate; amb subtriangular, conformable with the central body outline. Trilete mark not distinct, sutures do not extend beyond the central body margin; exinal folds accompanying sutures, reaching to the equator, present occasionaly. Pseudosaccus more than half radius of the central body wide. Exoexine minutely wrinkled, ornamented distally with stout spines up to 11 μm long, ca 4 μm wide at the base, approximetely 8 μm apart.
Dimensions. (twenty-three specimens) Equatorial diameter 89 μm to 152 μm (mean 122 μm), central body 69,5 μm to 93,5 μm (mean 81,5 μm).
Occurrence. ? U.S.S.R., Bielorussia, (Kedo, 1955) — Givetian, Scotland (Richardson, 1965) — Givetian, W. Germany (Lanninger, 1968) — uppermost Emsian, Saudi Arabia (Hamer and Nygreen, 1967) — Middle Devonian, USA and Canada (McGregor, 1973, McGregor and Owens, 1966, McGregor, Sanford and Norris, 1970, Peppers and Damberger, 1969) — late Emsian to Middle Devonian, the area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.
Remarks. The length of the spines is much less than that given by Richardson (op. cit., p. 583) due to poor preservation of our specimens with apparently brocken and corroded spines.

Spinozonotriletes sp. A.

Plate III, figs. 2a, 2b, 4

Description of specimens. Spores trilete, pseudosaccate, saccus equatorial; amb subtriangular with convex sides, central body circular. Sutures distinct, lips elevated, sinuous, extending beyond the central body margin. Exoexine homogenous, proximal surface smooth, distal surface ornamented with biform spines 5 μm long, 1,5 μm wide at basis. Secondary folds of distal exine often present.
Dimensions. (ten specimens) Equatorial diameter 76 μm to 106 μm (mean 83 μm), central body 52—78 μm (mean 65 μm).
Occurrence. The area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.
Remarks. This species is very much alike *Perotrilites eximus* Allen (1965, p. 731, pl. 102, figs. 11—13) except in size.

Genus *Samarisporites* Richardson, 1965
Type species. *S. orcadensis* (Richardson) Richardson, 1965

Samarisporites symmetricus sp. nov.

Plate III, figs. 5, 6

1968 *Hymenozonotriletes praetervisus* Naumova; Lanninger, Palaeontographica B, 122, 4—6, p. 146, pl. 25, fig. 2.
1973 *Hymenozonotriletes praetervisus* Naumova; Konior and Turnau, Ann. Soc. Geol. Pol., table 1.

Diagnosis. Spores trilete, pseudosaccate, saccus equatorial; amb subtriangular with convex sides and broadly rounded apices, conformable in outline with the central body. In profile spores cup-shaped (cf. plate III, fig. 6) with the distal surface flattened at the top. In polar compression pseudosaccus one-fourth to one-third central body radius wide. Laesurae distinct, sinuous, lips elevated, reaching to the central body margin. Exine of the distal surface spinose; spines spaced or fused, forming irregular ridges. Length of spines 4 μm, maximum basal diameter 1,5 μm. Proximal surface of the spores smooth, exoexine minutely wrinkled.
Description. Spores usually flattened in exactly equatorial plane due to their flat distal surface. Central body often ringed at equator; the nature of this ring is shown in text-fig. 3.
Dimensions. (seventeen specimens) Equatorial diameter 70 μm to 108,5 μm (mean 95 μm), central body 63 μm to 78 μm (mean 70 μm).
Holotype. Plate III, fig. 5, slide BA/77, 3.50 3.102.
Locus typicus. The borehole Piotrowice 1, a depth between 2364,0—2368,5 m, the area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.
Previous records. W. Germany (Lanninger, 1968). — uppermost Emsian.
Comparisons. The spores assigned by Lanninger to *Hymenozonotriletes praetervisus* Naumova are identical in every aspect with our new species. On the other hand *Hymenozonotriletes praetervisus* Naumova (in Naumova, 1953, p. 40—41, pl. IV, fig. 8) lacks the dark ring of the central body which in *S. symmetricus* is a constant feature due to the morphology of the spores. *Samarisporites concinnus* Owens (1971, p. 45—46, pl. XII, figs. 7—9, pl. XIII, figs. 1—3) possesses a bizonate flange (?); *Hymenozonotriletes praetervisus* Naumova (in Raucher and Doubinger, 1969, p. 153, pl. fig. 13), *H. ponceti* Raucher and Doubinger (1969, p. 155, pl. figs. 14—15), *Densosporites devonicus* Richardson (1960, p. 57—58, pl. 14, figs. 10—11) and *D. orcadensis* Richardson (1965, p. 580—581, pl. 92, figs. 1, 2.) are much larger.

Samarisporites sp. A.

Plate V, figs. 1, 2

Description of specimens. Spores trilete, pseudosaccate, saccus equatorial; amb circular or subcircular, conformable in outline with the central body. Pseudosaccus approximately half radius of the central body wide. In profile the distal hemisphaere rounded. Exoexine ornamented distally with coni and spines ca 4 μm wide at the basis, spaced on pseudosaccus, crowded, often fused, on central body. Spores often flattened obliquely.

Dimensions. (twenty-two specimens) Equatorial diameter 87 μm to 137 μm (mean 101 μm), central body 58,5 μm—97,5 μm (mean 72,5 μm).

Occurrence. The area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.

Remarks. These spores are very similar in size, shape, spore/body ratio and ornamentation to *Samarisporites* sp. D. (Streel, 1967, p. B40—B41, pl. V, figs. 60—61) but our specimens are to poorly preserved to allow an unquestionable identification.

Incertae sedis

Palynomorpha (Protoleiosphaeridium) sp. A.

Plate V, fig. 7

Description of specimens. Palynomorphs alete, pale yellow, outline subcircular, wall very thin, psilate, folded irregularly all over the surface.

Dimensions. (twenty specimens) Diameter 18,5 μm to 24 μm (mean 21,5 μm).

Occurrence. The area of Bielsko—Wadowice, south Poland, Lower Devonian? or Cambrian?

Palynomorpha (Leiosphaeridia?) sp. B.

Plate V, fig. 5

Description of specimens. Palynomorphs alete, brown; outline subcircular. Wall thin, more or less smooth, secondary folds present.

Dimensions. (Fifteen specimens) Diameter 28 μm to 39 μm (mean 33 μm).

Occurrence. The area of Bielsko—Wadowice, south Poland, probably uppermost Emsian and also the older rocks (Lower Devonian? or Cambrian?)

Palynomorpha (Leiosphaeridia?) sp. C.

Plate V, fig. 4

Description of specimens. Palynomorphs alete, brown; outline subcircular, wall thin, scabrate, wrinkled.

Dimensions. (Eleven specimens) Diameter 48 μm to 121,5 μm (mean 80 μm).
Occurrence. The area of Bielsko—Wadowice, south Poland, Lower Devonian? or Cambrian?

Palynomorpha sp. D.

Plate V, fig. 6

Description of specimens. Palynomorphs alete, colour pale yellow, outline subcircular. Wall thin, ornamented with hair-like processes up to 5 μm long. Secondary folds common.
Dimensions. (Twelve specimens) Diameter 24 μm to 43,5 μm (mean 31,5 μm).
Occurrence. The area of Bielsko—Wadowice, south Poland, Lower Devonian? or Cambrian?

Palynomorpha sp. E.

Plate V, fig. 8

Description of specimens. Palynomorphs alete, colour pale yellow, outline circular. Wall thin, without secondary folds, ornamented with hair-like processes with swollen tips, 2 μm long.
Dimensions. (ten specimens) Diameter 10,8 μm to 17,5 μm (mean 14 μm).
Occurrence. The area of Bielsko-Wadowice, south Poland, Lower Devonian? or Cambrian?

Algae?

In several slides, beside sporomorphs, cuticules and tracheides, some organic threads have been observed, which may be of algal origin. Three types of threads have been recognized which are as follows:

Type A.

Plate V, fig. 10

Description. Pale, thin walled, simple threads ca 8 μm wide, up to 100 μm long, wrinkled, without septa.
Occurrence. The area of Bielsko-Wadowice, south Poland, Lower Devonian? or Cambrian?

Type B.

Plate V, fig. 9

Description. Multilocular, thin-walled, branched threads of uneven width (6 μm to 8,5 μm), up to 420 μm long. Cells elongated, more than 85 μm long, wall smooth.

Occurrence. The area of Bielsko—Wadowice, south Poland, probably uppermost Emsian.

Type C.

Plate V, fig. 11

Description. Opaque or semiopaque threads, 2,2 μm wide up to 50 μm long; parts of threads swollen forming bladders ca 8 μm wide and 12 μm long, which resemble the airbladders of some Phaeophyceae. Walls partly smooth, in places ornamented with minute coni.
Occurrence. The area of Bielsko-Wadowice, south Poland, probably uppermost Emsian.

AGE OF ASSEMBLAGES

Two distinctly different assemblages are distinguishable in the sequence of the Bielsko—Wadowice area.

The first (upper) assemblage occurred exclusively in samples of the upper unit (as divided by Konior, 1969). The second (lower) assemblage was recovered from a few samples of the middle unit.

The first assemblage, containing appreciable numbers of large forms of *Dibolisporites* and also pseudosaccate and bifurcate spiny spores, is closely comparable to those known from Middle Devonian rocks of Europe and North America (Allen, 1965, 1967, Archangelskaja, 1963, Cramer, 1969, Eisenack, 1944, Kedo, 1955, Lele and Streel, 1969, McGregor, 1967, 1973, McGregor and Owens, 1966, Naumova, 1953, Ovens, 1971, Raskatova, 1966, Raucher and Doubinger, 1969, Richardson, 1960, 1965, Riegel, 1968, 1973, Streel, 1964, Vigran, 1964), but has very little in common with assemblages older than Upper Emsian. A precise age determination of the first assemblage is difficult since the palynological study of well dated Lower/Middle Devonian sections, still scarce, does not indicate any marked change between the spore assemblages of Upper Emsian and Lower Eifelian deposits (cf. McGregor and Uyeno, 1972; Riegel, 1973; Streel, 1970).

However, it should be pointed out that there is a remarkable resemblance between the first assemblage of the Bielsko—Wadowice area and the Upper Emsian microflora of the Eifel region described by Lanninger (1968). Of the twenty species determined or newly described in the present paper as many as twelve are comparable to, or conspecific with, the species described by that author. These are as follows:

The Bielsko—Wadowice area	The Eifel region
Verruciretusispora robusta Owens	*Retusotriletes infragranulatus* var. *macrotuberculatus* Schulz
	? *Retusotriletes multituberculatus* Lanninger
Dibolisporites echinaceus (Eisenack) Richardson	*D. echinaceus* (Eisenack) Richardson
	Retusotriletes gibberosus var. *major* Kedo
Dibolisporites sp. A.	*Retusotriletes antiquus* Kedo
Hystricosporites cf. *corystus* Richardson	*H. corystus* Richardson
Acinosporites sp. A.	*Acinosporites parviornatus* Richardson
Emphanisporites rotatus McGregor	*E. rotatus* McGregor
Emphanisporites annulatus McGregor	*E. annulatus* McGregor
Ancyrospora kedoae (Riegel) nov. comb.	*Hymenozonotriletes argutus* Naumova
Ancyrospora ? loganii McGregor	*Ancyrospora ancyrea* var. *ancyrea* Richardson
Spinozonotriletes naumovii Richardson	*Spinozonotriletes naumovii* Richardson
Samarisporites symmetricus sp. nov.	*Hymenozonotriletes praetervisus* Naumova
Calyptosporites velatus (Eisenack) Richardson	*Calyptosporites velatus* (Eisenack) Richardson

It is also noteworthy that both discussed assemblages, that of the Bielsko—Wadowice area and that of the Eifel region, lack *Rhabdosporites langii* (Eisenack) Richardson, which is a widespread Middle Devonian species. In the Eifel region this form appears in the Lauch Schichten, lowermost Eifelian, and is abundant in the Nohn Schichten, Lower Eifelian, (Riegel, 1973).

Thus, it is most probable that the upper unit of the succession studied is of a late Emsian Age.

The relative proportions of the spore types in the uppermost Emsian assemblages of the Eifel region and those in the assemblage discussed are different as the Eifel ones contain up to 50% of pseudosaccate spores and as much as 10% of *Emphanisporites* while in our assemblage these spore types do not exceed 7% and 0,5% respectively. This can be explained by differences in the depositional environments in both regions.

The other records of the uppermost Emsian microfloras from well dated strata are those from Canada, by McGregor, Sanford and Norris, (1970), McGregor and Uyeno, (1972) and the ones from Belgium, by Streel, (1967). Those assemblages are generally similar to the discussed first assemblage but a closer comparison is not possible since the Belgian material is very poor in species and both Canadian papers give only brief data on the assemblages and few photographs.

Table 1

Spore distribution in samples containing the first assemblage. Constituent species are recorded as percentages, based on a count of 200 specimens. X indicates that a species is present in a sample, but not in the actual count

Rozprzestrzenienie spor w próbkach zawierających pierwszy zespół. Udział poszczególnych gatunków zanotowano jako procenty na podstawie przeliczenia 200 okazów. X wskazuje na obecność gatunku w próbce bez uwzględnienia udziału ilościowego

SAMPLES / SPOROMORPHS	BIELSKO 5 1503,5 - 1505,7m	BIELSKO 4 1865,8 - 1870,3m	KĘTY 9 1564,8 - 1570,8m	KĘTY 9 1586,7 - 1591,5m	ANDRYCHÓW 4 2245,8 - 2250,8m	ANDRYCHÓW 2 2300,8 - 2306,6m	PIOTROWICE 1 2351,1 - 2355,7m	PIOTROWICE 1 2364,0 - 2368,5m	WYSOKA 1 2033,9 - 2038,2m
LEIOTRILETES SP.		3		5,5	+			1,5	+
CALAMOSPORA SP.	+	22		6	+			+	
RETUSOTRILETES SP.	+	10	+	7	+		+	5,3	
RETUSOTRILETES FRIVOLUS	+	1,5			+				
APICULIRETUSISPORA PLICATA	+	5,5		0,5		+		7	
APICULIRETUSISPORA PARVULA		5		+		+			
APICULIRETUSISPORA ? SP.						+		3	
VERRUCIRETUSISPORA ROBUSTA						+			
PROCORONASPORA LUTEOLA				+		+		2	
DIBOLISPORITES ECHINACEUS	+	13	+	21	+	+	ca 60	14,5	+
DIBOLISPORITES SP. A	+	3,5	+	1,5		+	+	+	
HYSTRICOSPORITES CF. CORYSTUS		+							
HYSTRICOSPORITES SP.			+	+	+	+			
ACINOSPORITES SP. A								13	
EMPHANISPORITES ROTATUS		+		+	+	+			
EMPHANISPORITES ANNULATUS		0,5		+					
ANCYROSPORA KEDOAE	+	2		3					
ANCYROSPORA ? LOGANII	+	2	+	3		+			
ANCYROSPORA ANCYREA		1,5		+					
ANCYROSPORA AFF. KEDOAE	+	2		+					
SPINOZONOTRILETES CF. NAUMOVII		+	+	1		+		1	+
SPINOZONOTRILETES SP. A				+		+			
SAMARISPORITES SYMMETRICUS								10	
SAMARISPORITES SP. A		+							76
CALYPTOSPORITES VELATUS	+			+					
PROTOLEIOSPHAERIDIUM TYPE B.		4,5	+	11	+			4	+

The only microfossils, other than spores, accompanying the first assemblage have been fragments of plant tissues, algal (?) threads and simple palynomorphs probably of algal origin. No open-sea microfossils such as chitinozoa, acritarcha or hystrichosphaeridia have been found, which suggests littoral-lagoonal or fresh water conditions in which the sediments of the upper unit were being deposited. The presence of threads resembling some algae belonging to Phaeophyceae (plate V, fig. 11) favours the littoral rather than the fresh water conditions.

The second assemblage was present in a few samples from the middle unit, namely in eight samples from the Kęty 9 borehole from an interval between 1617,0 m to 1646,0 m, in one sample from the Andrychów 3 borehole, from a depth between 2248,7 m to 2251,5 m, in one sample from the Piotrowice 1 borehole, from a depth between 2410,4 m to 2413,6 m and in one sample from the Wysoka 1 borehole, from a depth between 2043,2 m to 2046,5 m.

As was said earlier, the stratigraphical position of this unit is not quite clear. The sporomorph evidence is, unfortunately, not conclusive. The dominant constituent of this assemblage is a simple sphaeromorph assignable to *Protoleiosphaeridium*. There are also some forms of the *Leiosphaeridia* type and some other ones bearing a fine hairy ornament (plate V, figs. 6, 8). Simple palynomorphs of this type have but little stratigraphical value. Such forms have been recorded from Precambrian and early Palaeozoic rocks (Michniak, 1959; Shepeleva, 1963; Timofeev, 1966) but they can also be a dominant constituent of younger assemblages. Chibrikova (1970) recorded as much as 85% of simple sphaeromorphs in the Lower Devonian assemblages of West Bashkir and Ural. Combaz (1967) reported an occurrence of 80% of Leiosphaeridae and Protoleiosphaeridaceae in the Upper Silurian assemblages of the Sahara. Also some Lower Devonian assemblages of Germany described by Franke (1965) were dominated by sphaeromorphs.

The lack of land plant spores in the second assemblage favours some earlier age rather than the Devonian, but this kind of negative evidence is not reliable.

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STRESZCZENIE

Treść: W środkowej i górnej części serii terrygenicznej utworów uważanych za dolnodewońskie, nawierconych w rejonie Bielska—Wadowic, występują sporomorfy oraz prawdopodobnie szczątki glonów. W artykule opisano niektóre formy w tym 3 nowe gatunki sporomorf. Wyróżniono dwa kolejne zespoły sporomorf sugerując późno-emski wiek górnego zespołu.

Artykuł zawiera opisy paleontologiczne mikroflory oraz wnioski stratygraficzne dotyczące terrygenicznych utworów z wierceń obszaru Bielsko—Wadowice. Utwory te zaliczył K. Konior (1965, 1966, 1968, 1969) na podstawie litologii do dolnego dewonu i podzielił je na trzy jednostki lito-facjalne: górną, środkową i dolną.

Miospory opisane są według klasyfikacji Potoniégo i Krempa (1954, 1955, 1956) oraz Potoniégo (1956, 1958, 1960, 1966, 1970); nowsze systemy, zaproponowane przez Nevesa i Owensa (1966) oraz przez Smitha i Butterworth (1967), bazują na rozszczepianiu się eksyny. Jak wiadomo jednak, warstwy eksyny mogą niekiedy rozszczepiać się w wyniku fossylizacji lub obróbki chemicznej; takie rozszczepienie nie może być uważane za cechę o wartości taksonomicznej.

Opisana mikroflora zawiera trzy nowe gatunki spor, a mianowicie: *Apiculiretusispora parvula, Procoronaspora luteola* oraz *Samarisporites symmetricus.* Podwójna natura „zony" u spor z rodzajów *Ancyrospora* Richardson 1960 (non Richardson, 1962) oraz *Spinozonotriletes* Haquebard, 1957 jest pokazana na tablicy II, fig. 6 oraz na tablicy IV, fig. 3. „Zona" jest więc równikowym workiem powietrznym (cf. rekonstrukcja fig. 2). Asymetria spor a także centryfugalne „zgrubienie" ciała centralnego u innych spor jest wynikiem różnego zachowania się części dystalnej spor przy ich zgniataniu (fig. 3).

Mikroflora występująca w omawianej serii pozwala na wydzielenie dwu wyraźnie różnych zespołów.

Zespół pierwszy (wyższy) występuje w górnej jednostce omawianej serii. Lista form i próbki, z których pochodziły, jest przedstawiona na tabeli 1. W zespole tym dużą rolę odgrywają wielkie spory z rodzaju *Dibolisporites* oraz spory pseudoworkowe (pseudosaccate) i spory z kotwicowatymi wyrostkami, podobnie jak w innych zespołach opisanych ze środkowego dewonu Europy i Ameryki Północnej (Allen, 1965; 1967, Archangelskaja, 1963; Cràmer, 1969; Eisenack, 1944; Kedo, 1955; Lele i Streel, 1969; McGregor, 1967; 1973; McGregor i Owens, 1966; Naumova, 1953; Owens, 1971; Raskatova, 1966; Raucher i Doubinger, 1969; Richardson, 1960; 1965; Riegel, 1968; 1973; Streel, 1964; Vigran, 1964). Najwięcej jednak wspólnych cech posiada omawiany pierwszy zespół z mikroflorą najwyższego emsu rejonu Eiflu opisaną przez Lanningera (1968). Aż dwanaście, spośród oznaczonych dwudziestu, gatunków występujących w rejonie Bielska—Wadowic podawane jest również przez Lanningera. Natomiast zarówno w pierwszym zespole, jak i w najwyższym emsie Eiflu brak spor *Rhabrosporites langii* (Eisenack) Richardson, formy o dużym znaczeniu stratygraficznym, gdyż jest ona szeroko rozprzestrzeniona w utworach środkowego dewonu Europy i Ameryki Północnej. W rejonie Eifel gatunek ten pojawia się w najniższym Eiflu. Tak więc należy przypuszczać, że utwory górnej jednostki omawianej serii są wieku późnoemskiego.

Zespół drugi (niższy), występujący w próbkach jednostki środkowej (wymienionych na stronie 162), różni się bardzo wyraźnie od zespołu pierwszego. Występują tu jedynie palynomorfy pochodzenia algowego, a mianowicie gładkie sferomorfy typu *Protoleiosphaeridium* i *Leiosphaeridia* oraz nieliczne formy z delikatną skulpturą (tablica V, fig. 6, 8). Brak tu natomiast zupełnie spor roślin lądowych. Skład zespołu drugiego nie daje podstaw do określenia wieku jednostki środkowej, gdyż tego rodzaju proste palynomorfy nie mają stratygraficznego znaczenia. Podobne formy były opisywane z prekambru i wczesnego paleozoiku (Michniak, 1959; Shepeleva, 1963; Timofeev, 1966), lecz mogą one występować w obfitości również w utworach syluru czy dolnego dewonu (Combaz, 1967; Chibrikova, 1970; Franke, 1965).

Pracownia Geologii Złóż
Zakładu Nauk Geologicznych PAN, Kraków

EXPLANATION OF PLATES
OBJAŚNIENIE TABLIC

Plate — Tablica I

All figures × 500 except when indicated; from unretouched negatives (Wszystkie figury w powiększeniu 500 × z wyjątkiem tych, przy których podano inne powiększenie; z nie retuszowanych negatywów).

Fig. 1. *Leiotriletes* sp. Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, slide (preparat) BA/78, 1.45 9.105
Fig. 2. *Leiotriletes* sp. Kęty 9, depth (głębokość) 1586,7—1691,5 m, slide (preparat) BA/20, 4.33 0.100
Fig. 3. *Leiotriletes* sp. Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/17
Fig. 4, 5. *Retusotriletes frivolus* Chibrikova, Bielsko 5, depth (głębokość) 1503,5—1505,7 m, slide (preparat) BA/70, 0.40 10.102, 8.51 5.96
Fig. 6. *Retusotriletes* sp. Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide (preparat) BA/67, 3.42 9.114
Fig. 7. *Retusotriletes* sp. Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, slide (preparat) BA/78, 4.45 0.97
Fig. 8. *Procoronaspora luteola* spec. nov., holotype, Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, slide (preparat) BA/78, 4.41 9.108. × 1000
Fig. 9. *Anapiculatisporites* sp. Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, slide (preparat) BA/77, 2.35 3.107
Fig. 10. *Apiculiretusispora plicata* (Allen) Streel. Kęty 9, depth (głębokość) 1586,7—1591,7 m, slide (preparat) BA/15, 3.33 6.120
Fig. 11. *Apiculiretusispora* sp. Andrychów 2, depth (głębokość) 2300,8—2306,6 m, slide (preparat) BA/54, 4.106 0.40
Fig. 12—15. *Apiculiretusispora parvula* sp. nov., Kęty 9, depth (głębokość) 1586,7—1591,6 m, fig. 12 — holotype, slide (preparat) BA/15, 7.55 3.116, fig. 13, slide (preparat) BA/15, 0.34 8.121, fig. 14. (preparat) BA/17, 0.31 5.97, fig. 15, slide (preparat) BA/15, 5.37 2.114
Fig. 16. *Emphanisporites annulatus* McGregor, Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/18, 8.51 0.102

Fig. 17. *Emphanisporites rotatus* McGregor, Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/17, 4.51 6.111

Fig. 18, 19. *Acinosporites* sp. A. Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, fig. 18 — slide (preparat) BA/78, 2.37 3.114, fig. 19 — specimen striped of sculptural elements (okaz pozbawiony elementów skulptury), slide (preparat) BA/77, 9.42 3.105

Fig. 20. *Dibolisporites echinaceus* (Eisenack) Richardson, Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/19, 1.44 0.104

Fig. 21. *Verruciretusispora robusta* Owens Andrychów 2, depth (głębokość) 2300,8—2306,6 m, slide (preparat) BA/55, 0.41 7.110

Plate — Tablica II

All figures × 500 except when indicated; from unretouched negatives (Wszystkie figury powiększone 500 × z wyjątkiem tych, przy których podano inne wartości; z nie retuszowanych negatywów)

Fig. 1. *Hystricosporites* sp., lateral view (widok boczny), Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/17, × 350

Fig. 2. *Dibolisporites* sp. A., Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide (preparat) BA/67, 1.36 4.104

Fig. 3. *Hystricosporites* cf. *corystus* Richardson, Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide (preparat) BA/61, 4.36 9.116, × 350

Fig. 4. *Calyptosporites* sp., Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide (preparat) BA/80, 5.51 7.116

Fig. 5, 6. *Spinozonotriletes* cf. *naumovii* (Kedo) Richardson, Wysoka 1, depth (głębokość) 2033,9—2038,2 m, slide (preparat) BA/81, fig. 5 — 5.51 3.114, fig. 6 — specimen showing double nature of the „zona" (okaz pokazujący podwójną naturę „zony"), 7.36 4.103, ×350

Plate — Tablica III

All figures × 500 except when indicated; from unretouched negatives (Wszystkie figury powiększone 500 × z wyjątkiem tych, przy których podano inne wartości; z nie retuszowanych negatywów).

Fig. 1, 3. *Ancyrospora loganii* McGregor. Bielsko 4, depth (głębokość) 1865,8—1870,3 m, fig. 1 — oblique compression (spłaszczenie skośne), slide (preparat) BA/66, 9.51 9.117, × 350, fig. 3 — oblique compression (spłaszczenie skośne), slide (preparat) BA/61

Fig. 2a, 2b, 4. *Spinozonotriletes* sp. A. Figs 2a and 2b — proximal and distal focus respectively, the distal focus shows secondary folds of both exoexine and intexine (ostrość proksymalna i dystalna widoczne wtórne fałdy części dystalnej obejmujące eksoeksynę i inteksynę), Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/21, fig. 4 — specimen with laesurae obscured by mineral crystals (okaz ze znakiem zrostowym zakrytym przez kryształy mineralne), Andrychów 2, depth (głębokość) 2300,8—2306,6 m, slide (preparat) BA/55, 8.51 8.105

Fig. 5, 6. *Samarisporites symmetricus* sp. nov. Piotrowice 1, depth (głębokość) 2364,0—2368,5 m, slide BA/77, fig. 5 — holotype, 3.50 3.102, fig. 6 — equatorial view (widok boczny), 8.36 4.109

Plate — Tablica IV

All figures × 500 except when indicated; from unretouched negatives (Wszystkie figury powiększone 500 × z wyjątkiem tych, przy których podano inne wartości; z nie retuszowanych negatywów).

Fig. 1, 2, 3. *Ancyrospora kedoae* (Riegel) nov. comb., Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/18, 3.49 3.113, fig. 2 — spore fragment showing bifurcate spines, × 1000, fig. 3 — spore fragment showing double nature of the „zona", × 1000

Fig. 4. *Ancyrospora* aff. *kedoae*. Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide BA/62, 4.38 9.107

Fig. 5. *Calyptosporites velatus* (Eisenack) Richardson. Kęty 9, depth (głębokość) 1586,7—1591,5 m, slide (preparat) BA/16, 4.45 0.110, × 350

Fig. 6, 7. *Ancyrospora kedoae* (Riegel) nov. comb. Kęty 9, depth (głębokość) 1586,7—1591,5 m, fig. 6 — slide (preparat) BA/18, 8.51 0.102, fig. 7 — equatorial view showing strongly convex and bluntly pointed distal surface (widok boczny ukazujący silnie wypukłą i tępo szpiczastą dystalną powierzchnię), slide (preparat) BA/20, 6.38 1.104

Plate — Tablica V

All figures × 500 except when indicated; from unretouched negatives (Wszystkie figury powiększone 500 × z wyjątkiem tych, przy których podano inne wartości; z nie retuszowanych negatywów).

Fig. 1, 2. *Samarisporites* sp. A. Wysoka 1, depth (głębokość) 2033,9—2038,2 m, fig. 1 — slide (preparat) BA/81, 9.54 4.107, × 350, fig. 2 — oblique compression (spłaszczenie skośne), slide (preparat) BA/82, 1.34 0.100, × 350

Fig. 3. *Ancyrospora ancyrea* Richardson. Bielsko 4, depth (głębokość) 1865,8—1870,3 m, slide (preparat) BA/86, 4.38 4.114

Fig. 4. *Palynomorpha* (*Leiosphaeridia?*) sp. C. Kęty 9, depth (głębokość) 1630,9—1635,7 m, slide (preparat) BA/36, 8.45 6.116

Fig. 5. *Palynomorpha* (*Leiosphaeridia?*) sp. B. Kęty 9, depth (głębokość) 1630,9—1635,7 m, slide (preparat) BA/38, 2.39 8.112, × 1000

Fig. 6. *Palynomorpha* sp. D., Kęty 9, depth (głębokość) 1630,9—1635,7 m, slide (preparat) BA/36, 5.31 1.112, × 1000

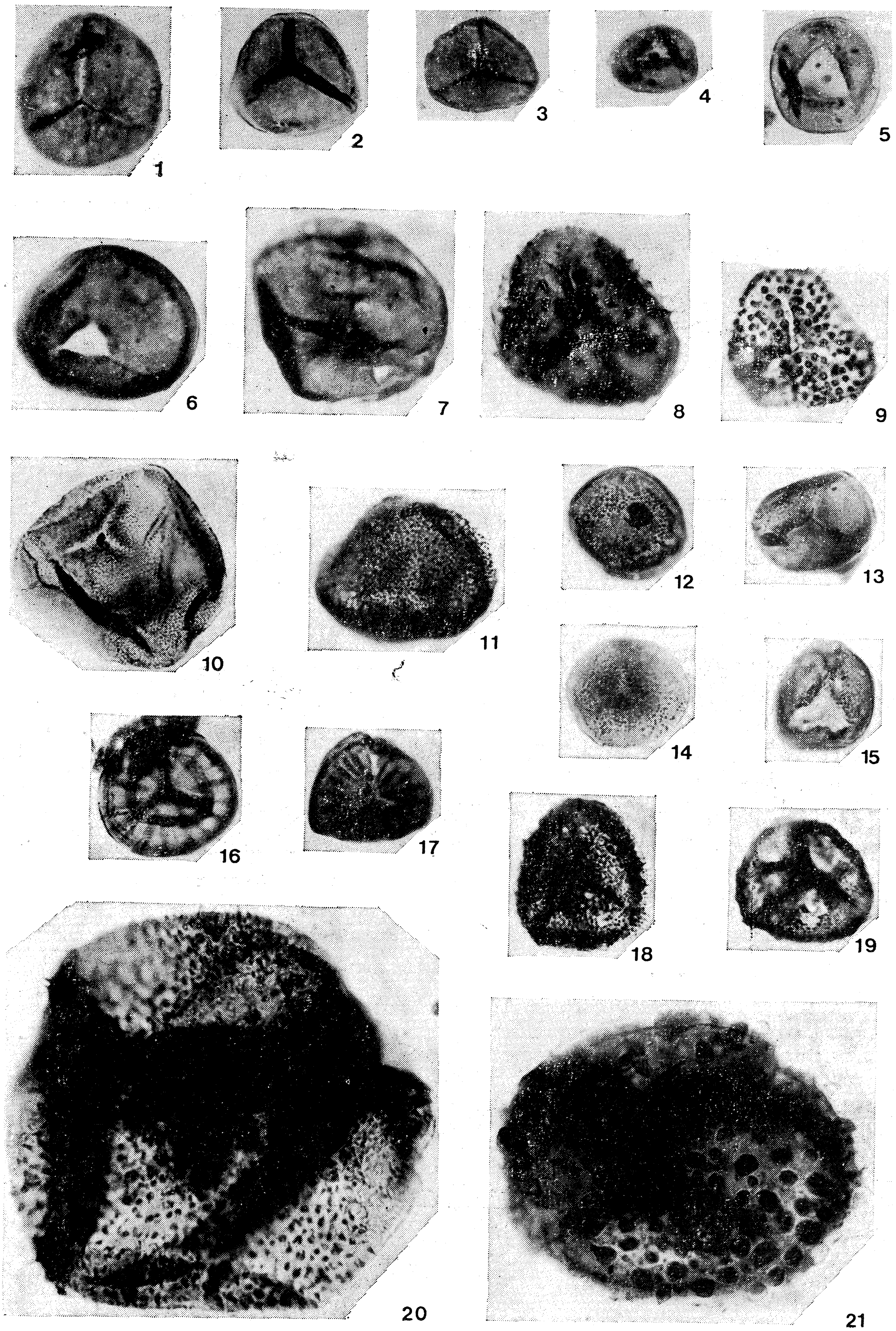
Fig. 7. *Palynomorpha* (*Protoleiosphaeridium*) sp. A. Kęty 9, depth (głębokość) 1630,9—1635,7 m, slide (preparat) BA/38, 3.40 8.112, × 1000

Fig. 8. *Palynomorpha* sp. E., Kęty 9, depth (głębokość) 1630,9—1635,7 m, slide (preparat) BA/38, 4.41 2.113, × 10 000.

Fig. 9. *Alga?* type *B*. Fragment of thread (fragment nitki), Andrychów 2, depth (głębokość) 2300,8—2306,6 m, slide (preparat) BA/59, 8.40 2.112

Fig. 10. *Alga?* type *A*. Fragment of thread (fragment nitki), Kęty 9, depth (głębokość) 1630,9—1635,7, slide (preparat) BA/38, 1.46 3.105

Fig. 11. *Alga* ? type *C*. Fragment of thread (fragment nitki) Andrychów 2, depth (głębokość) 2300,8—2306,6 m, slide (preparat) BA/57, 2.39 9.122



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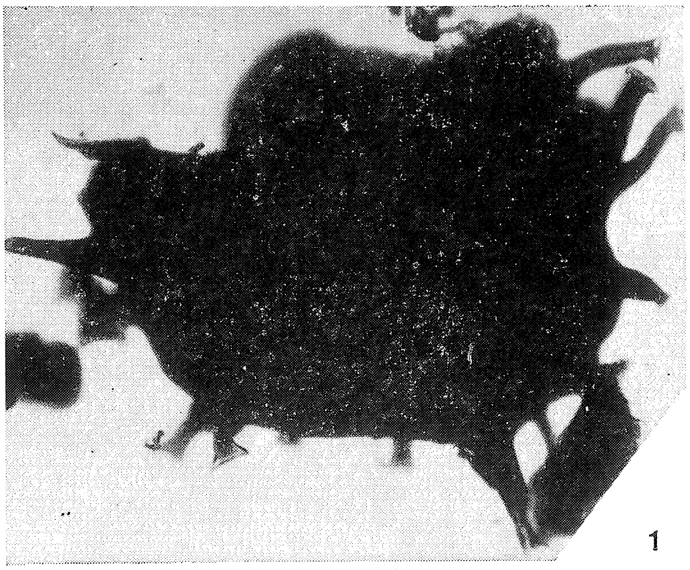

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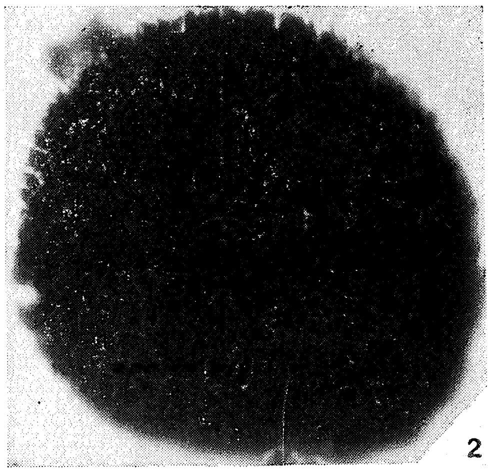

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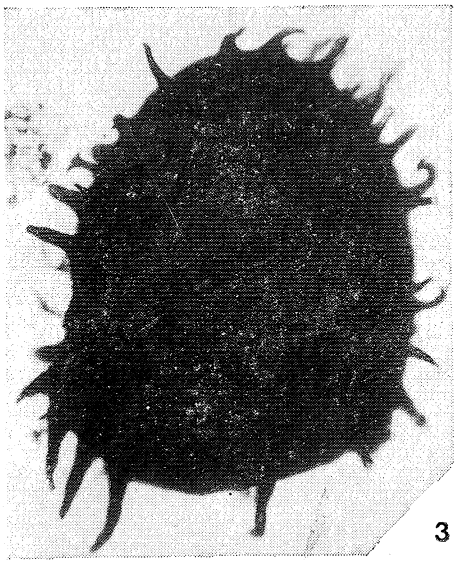

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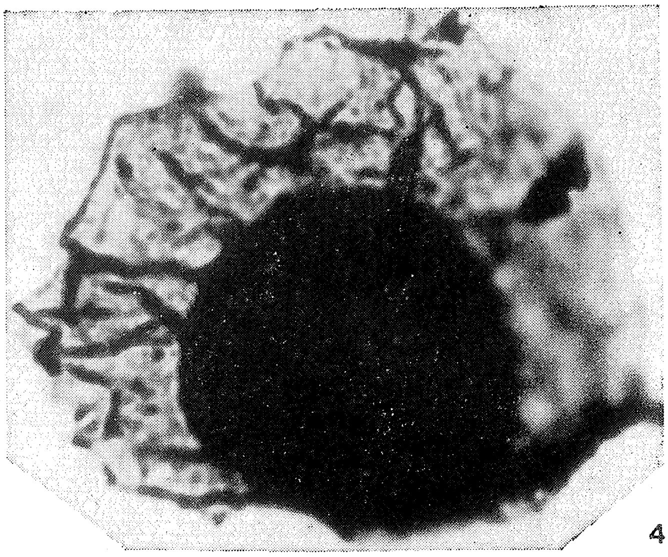

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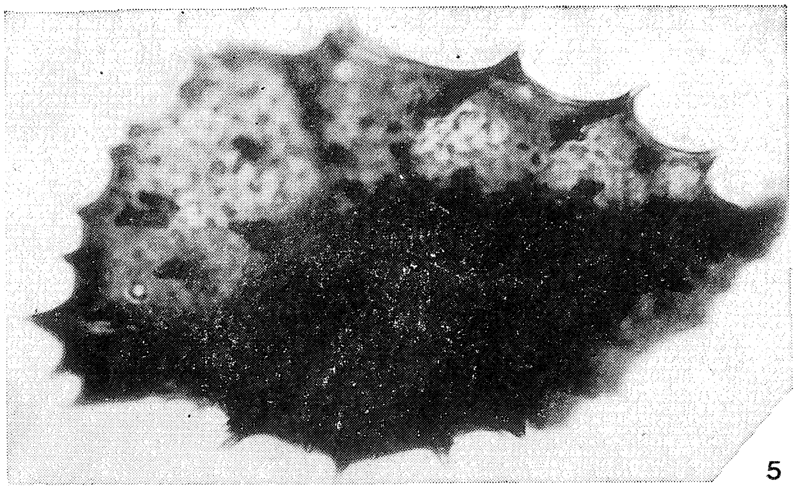

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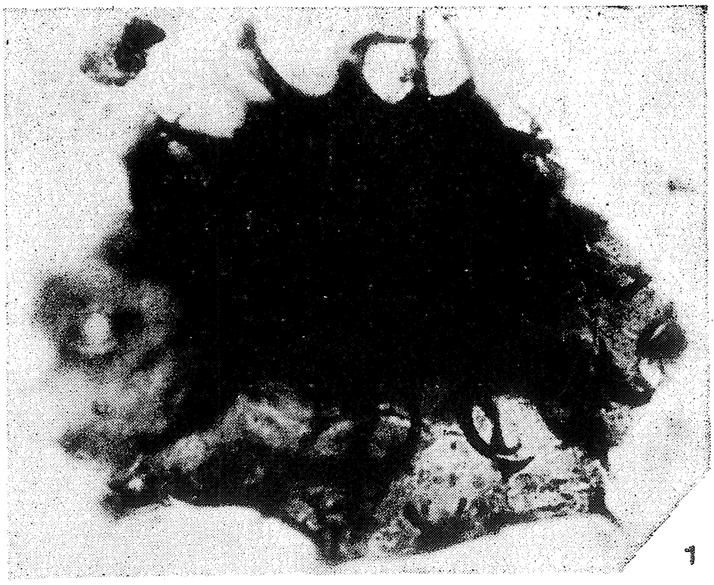
Tabl. III



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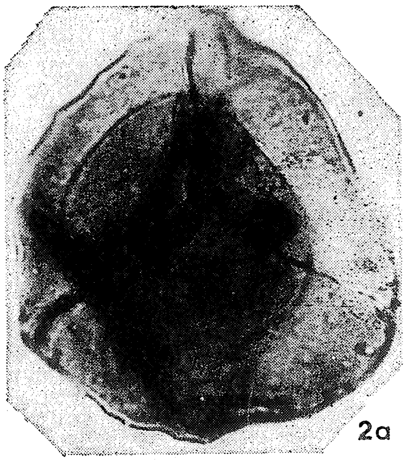

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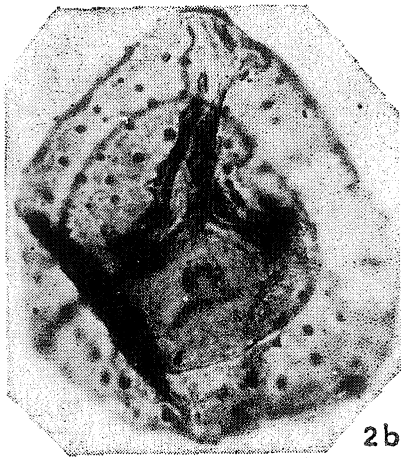

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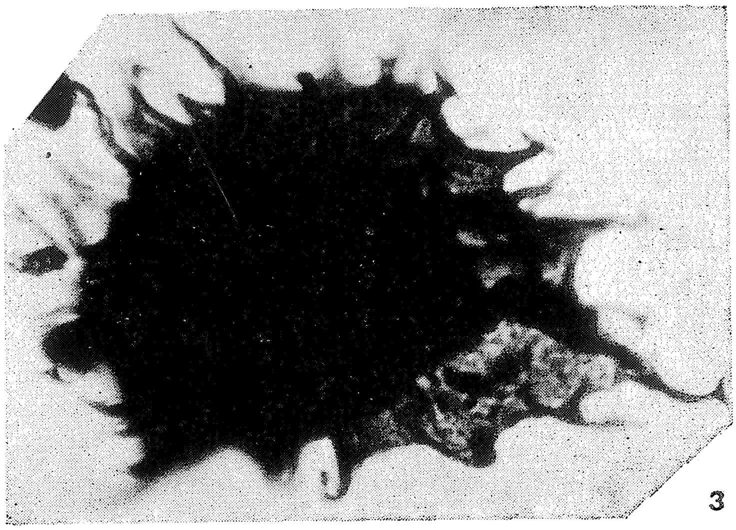

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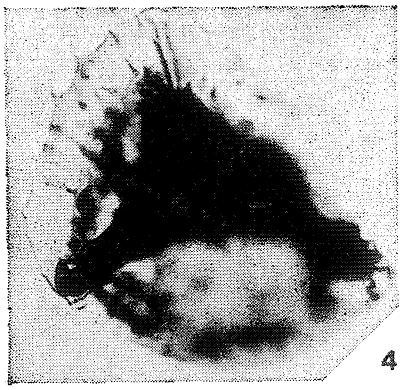

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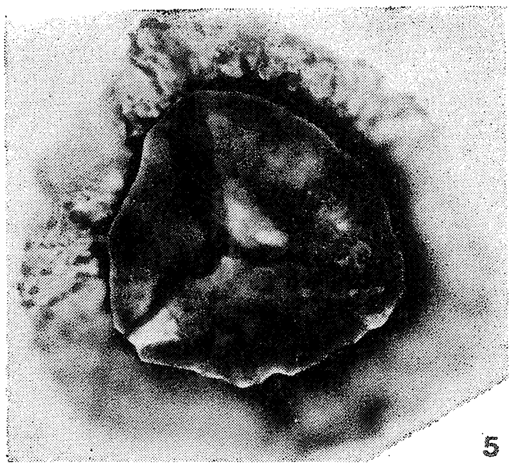

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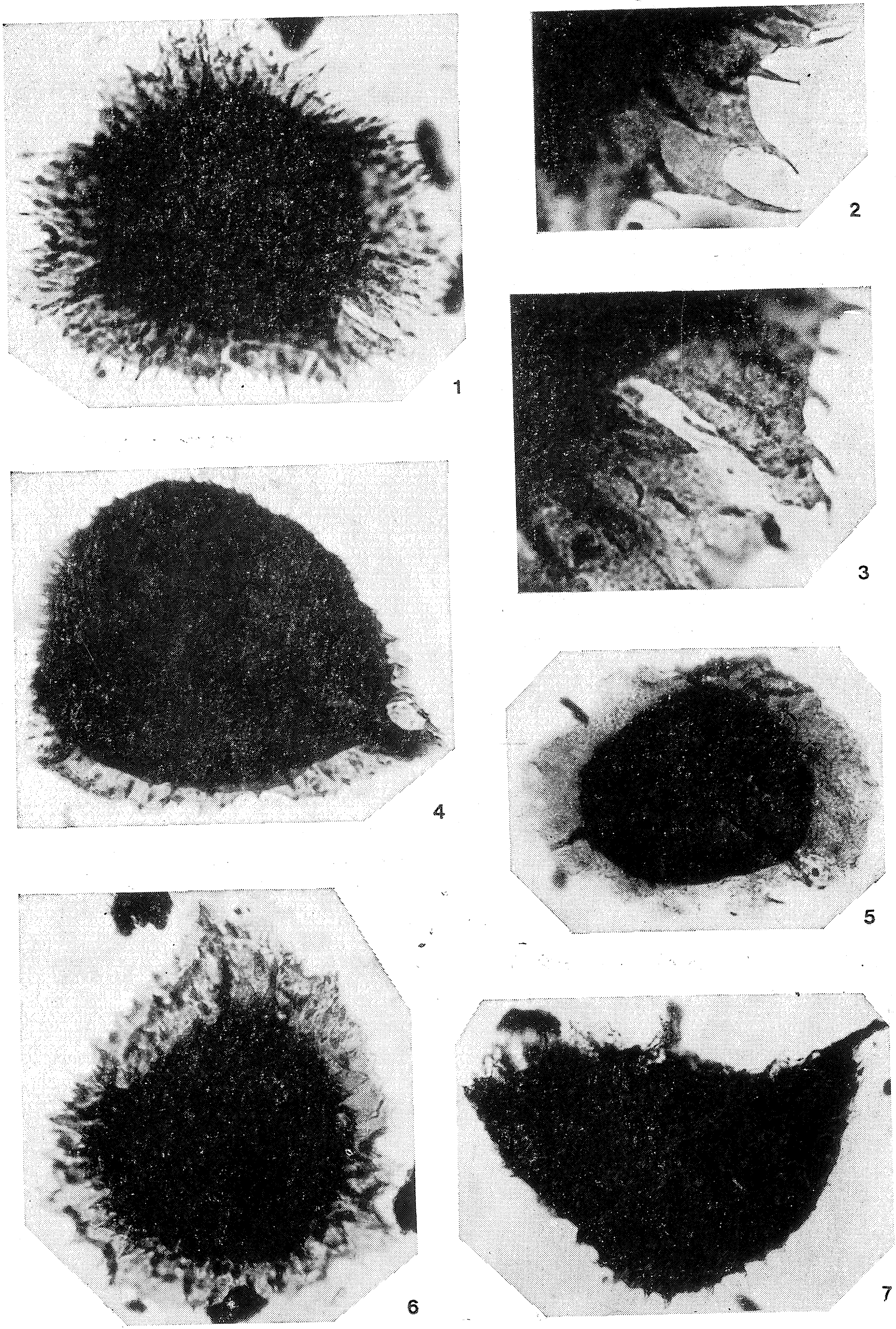

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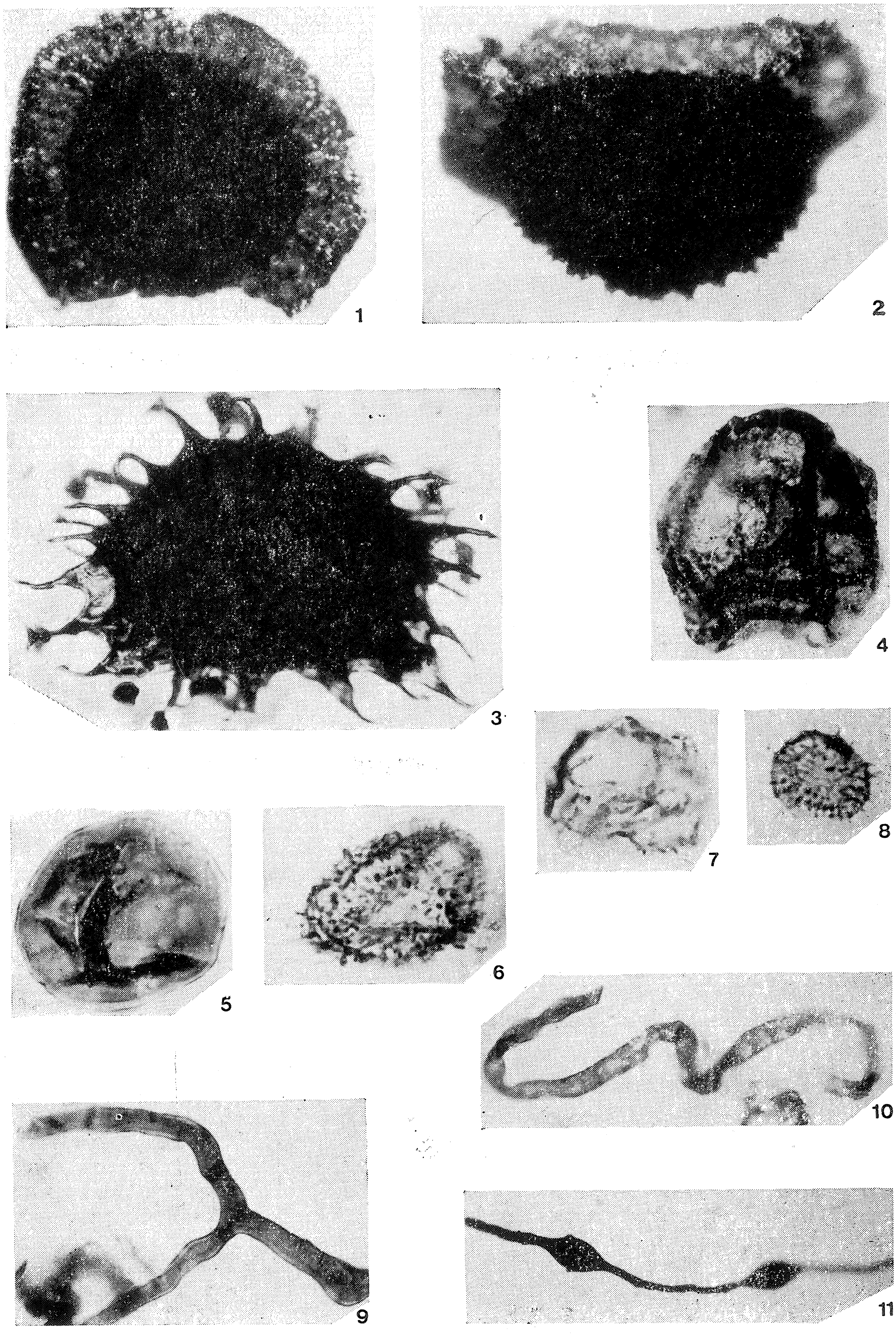

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