Annales Societatis Geologorum Poloniae (1989), vol. 59: 391-416
PL ISSN 0208-9068

EARLY DEVONIAN MIOSPORES AND AGE OF THE ZWOLEŃ FORMATION (OLD RED SANDSTONE FACIES) FROM CIEPIELÓW IG-1 BOREHOLE

Elżbieta Turnau[1] & Lidia Jakubowska[2]

[1]*Instytut Nauk Geologicznych PAN, Senacka 3, 31-002 Kraków, Poland*
[2]*Państwowy Instytut Geologiczny, Rakowiecka 4, 09-975 Warszawa, Poland*

Turnau, E. & Jakubowska, L., 1989. Early Devonian miospores and age of the Zwoleń Formation (Old Red Sandstone facies) from Ciepielów IG-1 borehole. *Ann. Soc. Geol. Polon.*, 59: 391–416

Abstract: Early Devonian spores are described and illustrated from the upper part of the Zwoleń Formation from the borehole Ciepielów IG-1 of the Radom–Lublin area. This formation represents sediments of fluviatile origin. The spore zones *breconensis–zavallatus*, *polygonalis–emsiensis* and *annulatus–sextantii* are recognised. The upper part of the formation is assigned to the upper Gedinnian, Siegenian and Emsian. It is suggested that in the study area, the clastic deposition of the Old Red Sandstone facies began during the Gedinnian, and not during the Siegenian as was supposed before.

The taxonomical section includes descriptions of eleven species. One genus and seven species are new.

Key words: Lower Devonian, spore stratigraphy, spore zones, taxa descriptions, central Poland.

Manuscript received January 1989, accepted January 1989

INTRODUCTION

The Zwoleń Formation, distinguished in the Radom – Lublin area (Fig. 1) by Miłaczewski (1981), has been included by this author in the upper Siegenian and Emsian, basing on its stratigraphic position. Some other authors (Tomczyk *et al.*, 1977; Tomczykowa, 1988) assigned the Emsian age to these deposits.

Fossils are scarce in this formation, and are of little stratigraphic value, except for spores which are abundant in rocks of its upper portion. They were first recorded from the Dorohucza and Ciepielów boreholes by Jakubowska (1968, 1974). Turnau (1986a, b) described Siegenian and Emsian spore assemblages from the upper part of the Zwoleń Formation from the Pionki-1 and Pionki-4 boreholes. The rocks from the lower portion of the formation from Pionki did not yield any spores, but it was suggested that this portion might belong to the Gedinnian *breconensis–zavallatus* Spore Zone as the

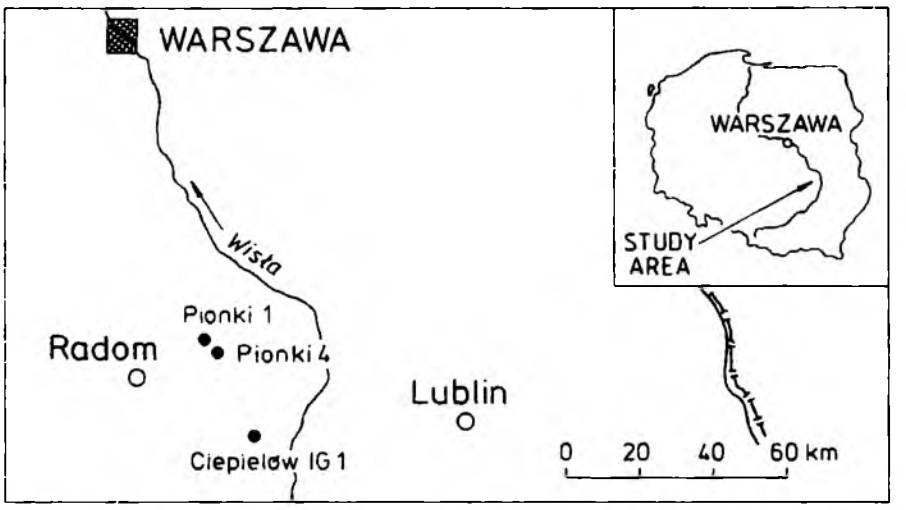


Fig.1. Situation map showing position of boreholes dealt with in the text.

underlying Czarnolas Formation yielded spores of the *micrornatus—newportensis* Zone. The results presented in the present paper corroborate to a certain degree this suggestion.

MATERIAL

Twenty-six samples of grey mudstones and sandy mudstones were processed using standard method. The samples were derived from the upper portion of the Zwoleń Formation (Fig. 2) as the lower portion did not contain rocks suitable for palynological studies. Only ten samples yielded spores.

GEOLOGICAL SETTING

A comprehensive study on the stratigraphy of the Devonian deposits of the Radom—Lublin area is given by Miłaczewski (1981). The biostratigraphy of the Lower Devonian deposits of this area is also discussed in Tomczyk *et. al.* (1977) and Nehring-Lefeld (1985), and reviewed in Turnau (1986a, b) and Tomczykowa (1988).

In this area, the Lower Devonian succession of predominantly clastic rocks is included by Miłaczewski (1981) in three formations. The oldest Sycyna Formation and the succeeding Czarnolas Formation represent a marine sequence of a shallowing environment. The overlying Zwoleń Formation, concerned in this paper, represents fluviatile Old Red Sandstone type deposits.

Turnau (1986a, b), on the basis of spore study, included part of the Sycyna Formation and the Czarnolas formation in the region of Pionki (Fig. 1) to the Gedinnian *micrornatus—newportensis* Spore Zone (of the division by Richardson & McGregor, 1986), and the upper portion of the Zwoleń Formation to the

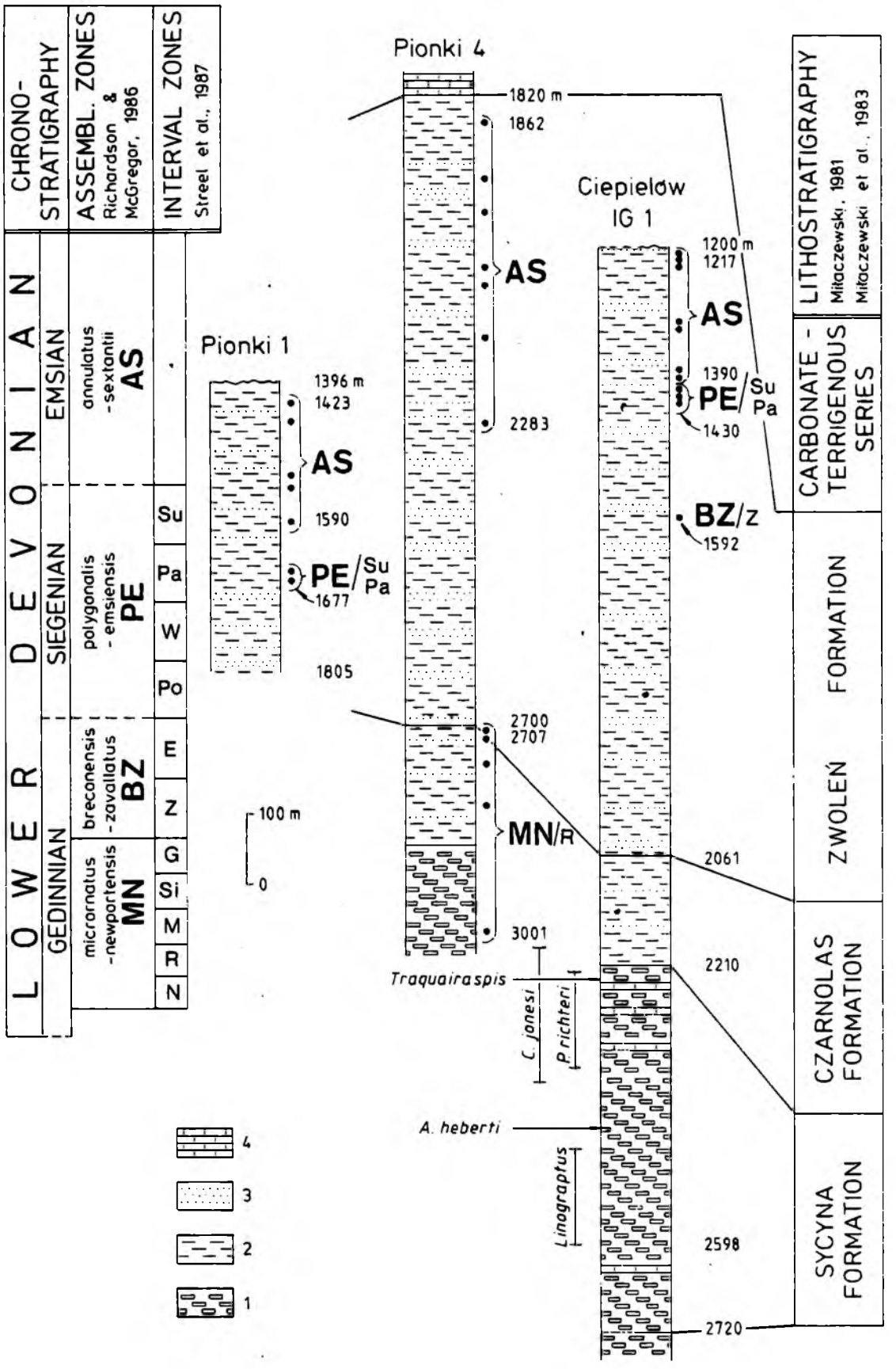


Fig. 2. Lower Devonian spore zonations (left hand side) and stratigraphic extent of spore zones in the Pionki and Ciepielów boreholes. *1* – claystones and siltstones; *2* – mudstones; *3* – sandstones; *4* – carbonates

Siegenian and Emsian *polygonalis—emsiensis* and *annulatus—sextantii* Zones. The assemblages of the *micrornatus—newportensis* Zone from Pionki contained *Chelinospora retorrida* but lacked *Emphanisporites micrornatus* which suggests that the investigated part of the Sycyna Formation and the Czarnolas Formation from Pionki belong to the Interval Zone R of late-early Gedinnian (Streel *et al.*, 1987). This is well in accord with the biostatigraphic data concerning these formations, but, in the same time, quite at variance with the widely accepted opinion that the uppermost part of the Sycyna Formation and the Czarnolas Formation belong to the Siegenian. This opinion was expressed, among others, by Tomczykowa (1974, 1975, 1976, 1988) and by Tomczyk *et al.*, (1977), and repeated by Miłaczewski (1981) and Ziegler (1982).

A discussion concerning a Gedinnian or Siegenian age of deposits may, in some cases, be immaterial, as the limit between these two stages is biostratigraphically not precisely defined, and the uppermost Gedinnian may even ovelap with the lowermost Siegenian, which was discussed by Steemans (1981) and Streel *et al.* (1987). But in the present case, the object of controversy is quite serious as a Siegenian age is assigned to the deposits which in the present authors' opinion belong to the lower Gedinnian. This has been already discussed by Turnau (1986a, b), but the discussion is partly repeated below and some new biostratigraphic data are also added.

The trilobite species recorded by Tomczykowa (1974, 1975, 1976) form the part of the Sycyna formation included in the upper Gedinnian (upper Bostovian) and lower Siegenian (lower Ciepielovian) are either new species or species typical of lower Gedinnian (see data on ranges in Alberti, 1969; Gandl, 1972; Ormiston, 1977). These are *Warburgella rugulosa rugulosa* (Alth), *Acastava patula* Hollard and *Acastella rouaulti* (Tromelin & Lebesconte). Apparently the only species recorded from the Siegenian (of the Armorican Massif — *fide* Tomczykowa, 1976), present in upper part of the Sycyna Formation, is *Parahomalonotus forbesi* (Rouault), but this is a rare species and therefore one may doubt its stratigraphical importance.

The ostracode assemblages from the upper part of the Sycyna Formation included Gedinnian Species such as *Poloniella richteri* (de Koninck) and *Cytherellina jonesi* (De Koninck) (Nehring-Lefeld, 1985).

Chitinozoa from the Silurian and Lower Devonian rocks of the area under discussion were described by Wrona (1980). This author did not make any suggestions as to the age of the deposits he investihated, but it seems significant that the deposits of the Sycyna formation, even of its part included by Tomczyk *et al.* (1977) and Tomczykowa (1988) in the Siegenian, yielded species typical of the Silurian, lowermost Gedinnian and mid Gedinnian of Western Europe (*cf.* Paris, 1981), such as *Sphaerochitina sphaerocephala* (Eisenack)Eisenack, and *Ancyrochitina tomentosa* Taugourdeau & Jekhovsky. There were also present chitinozoans representing probably another Silurian — Lower Gedinnian species *Ancyrochitina ancyrea* (Eisenack) Eisenack, included by Wrona in *A.* cf. *ancyrea.*

BIOSTRATIGRAPHY OF CIEPIELÓW PROFILE

In the Ciepielów IG-1 profile, the marine fauna occurs exclusively in the Sycyna and Czarnolas Formations, and in the underlying Silurian deposits. The Lower part of the Sycyna Formation yielded *Linograptus* sp. and early Gedinnian trilobites *Acastella heberti* Richter & Richter, *Acastava* cf. *patula* Hollard and *Acastella* cf. *rouaulti* Tromelin and Lebesconte (Tomczykowa, 1974). Ostracods occur in the upper part of the Sycyna Formation and in lowermost part pf the Czarnolas Formation, but the taxa of stratigraphical importance do not range, in this section, beyond the former formation. The presence of *Poloniella richteri* (de Koninck) and *Cytherellina jonesi* (de Koninck) at the top of the Sycyna formation date it as being not younger than early Gedinnian. *Traquairaspis* sp., a fish genus restricted to lower Gedinnian (Westoll, 1977) was also recorded from the topmost part of this formation (Tomczykowa, 1988). Chitinozoans from the lower halve of the Sycyna Formation included, among other forms, *Ancyrochitina ancyrea* (Eisenack) Eisenack and *Sphaerochitina spahaerocephala* (Eisenack) Eisenack.

In the Zwoleń Formation, at the depth 1414 m, fin spines assigned to *Machaeracanthus* sp. and *Porolepis* sp. were found. According to Krassowska & Kulczycki (1963) these fish remains are identical with those known from the Emsian deposits of Daleszyce in the Holy Gross Mts.

Jakubowska (1974) determined macroflora from the topmost two-hundred m of this formation, recording *Drepanophycus spinaeformis* Goeppert, *Psilophyton goldschmidti* Halle, *Dawsonites arcuatus* Halle, *Sugambrophyton pilgeri* Schmidt and *Sporogonites exuberans* Halle. From the same beds, this author recorded also *Emphanisporites erraticus* McGregor and *Emphanisporites rotatus* McGregor. An Early Devonian age was suggested basing on the above data.

STRATIGRAPHIC PALYNOLOGY

In the present paper, the Rhenish stage terminology is applied instead of the recommended Bohemian one. This is to simplify the discussion with the present day views on the age of the Sycyna, Czarnolas and Zwoleń formations. These views are contained in several papers in which also the former terminology is applied.

The ranges of the spore taxa recorded from the Zwoleń Formation of the Ciepielów 1G-1 borehole are shown in Fig. 3. Three successive spore zones may be distinguished in the upper part of this formation. They correspond to zones of the spore zonal scheme by Richardson & McGregor (1986). A more detailed zonal scheme for the Devonian of the Ardenne-Rhenish regions has been proposed by Streel *et al.* (1987). Some of the interval zones of this scheme may also be rocognised in the study area (see Figs 2 and 4).

An assemblage representative of the *Breconisporites breconensis—Empha-*

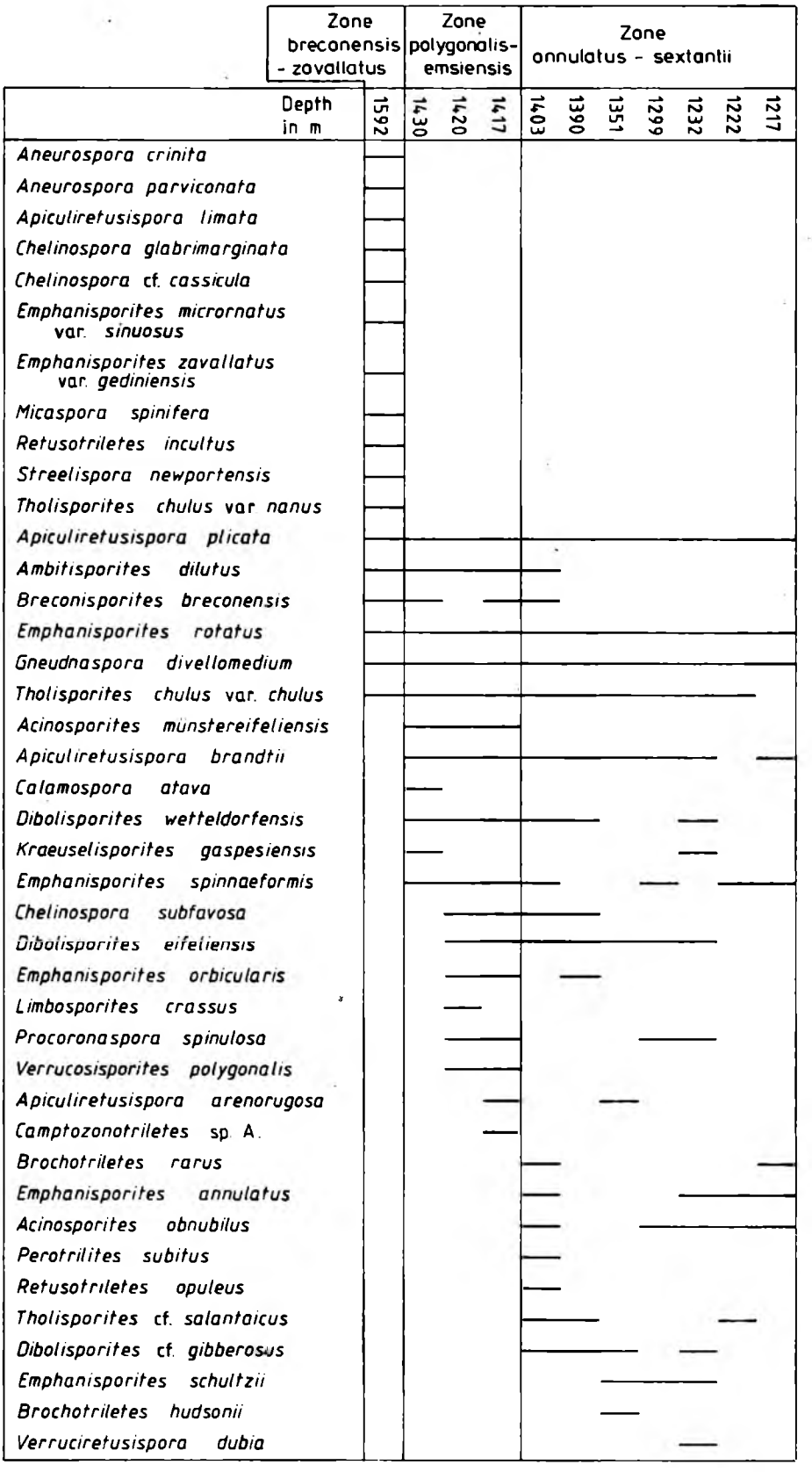


Fig. 3. Stratigraphic ranges of spore species, Ciepielów IG-1 borehole

nisporites zavallatus Zone was recovered from a sample from the depth 1592.4 m. It contained, among other forms, *Breconisporites breconensis* Richardson, Streel, Hassan & Steemans, *Emphanisporites zavallatus* var. *gedinniensis* Steemans & Gerienne, *Emphanisporites micrornatus* Richardson and Lister var. *sinuosus* Steemans & Gerienne, *Streelispora newportensis* (Chaloner & Streel) Richardson & Lister and *Chelinospora* cf. *cassicula* Richardson & Lister. The presence of *S. newportensis* suggests that the assemblage represents the lower part of the *breconensis—zavallatus* zone corresponding to the Interval Zone Z.

Assemblages of the successive *Verrucosisporites polygonalis—Dictyotriletes emsiensis* Zone have been recovered from three samples from the interval between 1430 and 1417 m. They included, among other forms, *Dibolisporites eifeliensis* (Lanninger) McGregor, *D. wetteldorfensis* Lanninger, *Verrucosisporites polygonalis* Lanninger, *Breconisporites breconensis* Richardson, Streel, Hassan & Steemans, and *Apiculiretusispora plicata* Allen. The three first mentioned species do not occur below the base of this zone. The presence of *Acinosporites münstereifeliensis* (Franke) Streel (= *Acinosporites bellus* (Arkhangelskaya) Steemans) suggests the presence of the Interval Zone Pa or Interwal Zone Su.

The assemblages of the *Emphanisporites annulatus—Camarozonotriletes sextantii* Zone have been recovered from six samples from the interval between 1403 and 1212 m. They included, among other species, *Emphanisporites annulatus* McGregor and the species mentioned above, except for *Breconisporites breconensis.*

It may be concluded, on the spore evidence, that the Zwoleń Formation in Ciepielów belongs to a part of Gedinnian, to Siegenian and Lower to mid Emsian.

CORRELATION WITH OTHER REGIONS

The succession of spore assemblages in the Lower Devonian deposits is best recognised in the Ardennes in Belgium (Steemans, 1981, 1982; Streel *et al.*, 1981, 1987; Steemans & Gerienne, 1984). It that area, twelve interval spore zones, some of which are subdivided into sub-zones, have been distinguished (Streel *et al.*, 1987). Most of the species, upon whose first appearances this division is based, have been recorded from the Gedinnian to Emsian deposits of the study area, but, so far, only few of the interval zones have been recognised due to the incompletness of the present data (see Fig. 2).

The correlation of the Sycyna, Czarnolas and Zwoleń formations with the Lower Devonian succession of the type regions in the Ardennes, Rheinisches Schiefergebirge and Podolia is shown in Fig. 4.

It can be estimated, basing on the spore data, that the lower, barren, part of the Zwoleń Formation, which probably corresponds to the Interval Zones M, Si and G, may be correlated with the Oignes Formation and with the Fooz and

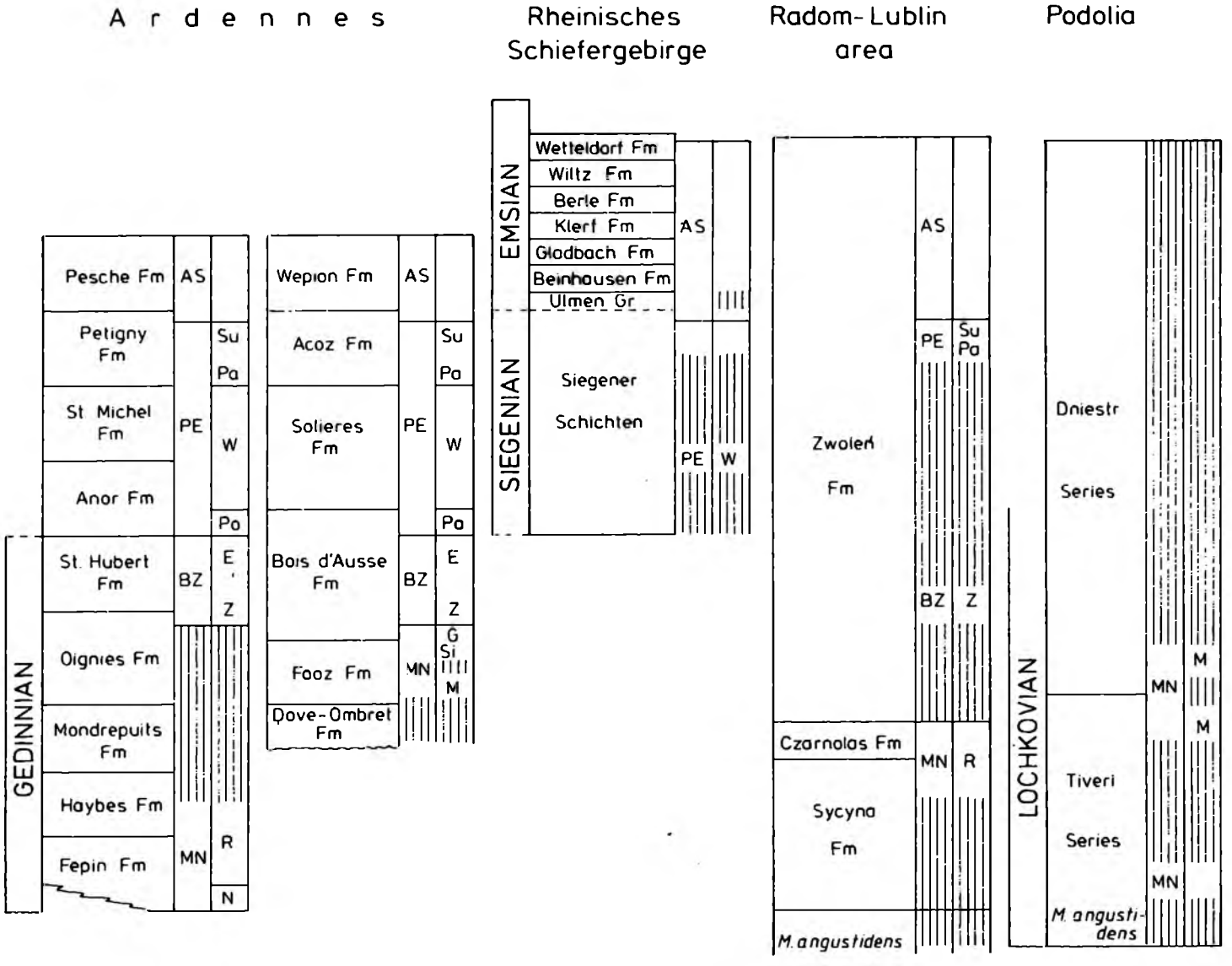


Fig. 4. Stratigraphic extent of spore zones in the Lover Devonian formations of the study area and the type regions of Lower Dewonian stages. Assemblage zones of Richardson & McGregor, 1986 – left hand columns: interval zones of Streel *et al.*, 1987 – right hand columns. Based on data from Arkhangelskaya, 1980; Steemans, 1981, 1982; Streel *et al.*, 1981, 1987; Riegel & Kharathanasopoulos, 1982; Steemans & Gerienne, 1984

basal Bois d'Ausse Formations of the Ardennes. The base of the Zwoleń Formation in the study area (vicinity of Radom) is probably slightly younger than the base of the Dniestr Series in the region of Zaleszczyki in Podolia as the base of the Interval Zone M lies within the Tiveri Series (Arkhangelskaya, 1980). Thus, the beginning of the deposition of the Old Red Sandstone facies began in the Radom – Lublin area and in Podolia roughly in the same time as the deposition of littoral facies in Belgium.

SYSTEMATIC DESCRIPTIONS

Type and figured specimens of the spores described in this paper are housed in the Institute of Geological Sciences of the Polish Academy of Sciences, Kraków.

Most of the species recorded from the Ciepielów profile have been described previously by Turnau (1986a) from Pionki-1 and Pionki-4 boreholes situated in vicinity of Ciepielów. In this chapter, only these taxons are described which have not been dealt with in the paper just mentioned.

Genus *Aneurospora* Streel, emend. Richardson, Streel, Hassan & Steemans, 1982

Aneurospora crinia sp. nov.

Pl. I: 7–11; Pl. II: 1

Holotype. Pl. I:8, slide HCM6/64. Zwoleń Formation, Ciepielów IG-1 at 1592.4.

Diagnosis. An *Aneurospora* having tectate trilete rays and a distal ornament of densely set truncated spines up to 2.5 μm long.

Description. Spores of subtriangular amb. Equatorial region thickened in the form of a dark band 1/5 radius of the spore wide. Trilete rays, bordered by tecta, extend almost to equator. Curvaturae faint. Proximal face unornamented. Distal surface and equatorial margin bear densely set spines. These are up to 2.5 μm long and 1 – 1.5 μm wide at base. They taper gradually from base to truncated or rounded tip, or are bulbous at base and have narrow, tapering stem.

Dimensions. Diameter 33 (36) 43 μm (16 specimens.)

Comparisons. *Aneurospora heterodonta* Streel (in Moreau-Benoit, 1979, p. 29, pl. 3: 3) lacks lips. *A.* sp. (in Steemans, 1981, pl. 1: 10, 11) has shorter elements of ornamentation.

Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis–zavallatus* Zone (Late Gedinnian).

Aneurospora parviconata sp. nov.

Pl. I: 2, 3, 5, 6

Holotype. Pl. I: 3, slide HCM6/64, Zwoleń Formation, Ciepielów IG-1 at 1592.4 m.

Diagnosis. An *Aneurospora* having a distal ornament of minute (less than 0.5 μm long) cones.

Description. Spores of subtriangular amb. Equatorial region thickened in the from of dark band 1/5 radius of the spore, inner margin of the band not always distinct. Trilete rays bordered by tecta high at apex and diminishing in height towards the equator, extending almost to spore margin. Proximal face unornamented, distal surface ornamented by densely set low cones less than 0.5 μm long.

Dimensions. Diameter 28 (32) 35 μm (17 specimens)

Comparisons. This species differs from other aneurosporas by its minute ornament.

Genus *Apiculiretusispora* Streel, emend. Streel, 1967

Apiculiretusispora limata sp. nov.
Pl. II:2

Holotype. Pl. II:2, slide HCM6/65, Zwoleń Formation, Ciepielów IG-1 at 1592.4 m
Diagnosis: A small *Apiculiretusispora* having an ornament of grana, bacula and truncated cones of various sizes on a single specimen.
Description. Spores of subcircular amb. Trilete rays 3/4 radius of spores, simple, often gaping. Exine close to trilete rays darkened. Curvatural ridges well developed. Contact faces smooth. The remaining part of exine ornamented with grana, short bacula and truncated cones 0.5 to 2 μm wide at base, occasionally single elements 3 μm across present. The elements are of variable size on single specimens. They are closely set, but unsculptured patches are often present. Secondary folds common.
Dimensions. Diameter 43 (44) 54 μm (13 specimens).
Comparisons. *Apiculiretusispora plicata* (Allen) Strell (Allen, 1965, p. 695, pl. 94:6–9) is larger and has finer and more regular sculpture.
Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis–zavallatus* Zone (Late Gedinnian).

Genus *Camptozonotriletes* Staplin, 1960

Camptozonotriletes sp. *A.*
Pl. V:10a, b

Description of specimens. Zonate spores of subcircular amb, cup-shaped in equatorial view. Zona 1/5 radius wide, with distinct limbus, projecting from equator at acute angle to the polar axis, inclined towards proximal (?) pole. Trilete mark not distinguishable. Spores proximally apparently smooth, body ornamented distally by closely set low warts and short ridges 4.5 to 6.5 μm wide.
Dimensions. Overall diameter 43 (48) 52 μm (5 specimens).
Remarks. Too few specimens have been found to justify erection of a new species.
Comparisons. *Camptozonotroletes* sp. *A.* Streel *et al.* (1981, pl. 3: 12, 13) has finer sculpture.
Occurrence. Ciepielów IG-1 at 1417.7 m, Zwoleń Formation, *polygonalis–emsiensis* Zone (Siegenian).

Genus *Chelinospora* Allen, 1965

Chelinospora glabrimarginata sp. nov.
Pl. II:9, 10

Holotype. Pl. II:9, slide HCM6/65, Zwoleń Formation, Ciepielów IG-1 at 1592.4 m.
Diagnosis. A *Chelinospora* with distal, dense, imperfect reticulum. Muri sinuous and bending, 2–3 μm wide, delimiting subcircular or irregular-elongated lumina 2–4 μm across. Proximal surface and distal equatorial region smooth.
Description. Spores of subcircular amb. Trilete mark undistinguishable. Contact faces distinctly delimited, very thin, smooth, occupying most of the proximal hemispharer. Distal surface ornamented by imperfect reticulum. Muri 2–3 μm wide, sinuous and bending. Lumina subcircular or irregular-elongated, 2–4 μm across. Distal and proximal equatorial region smooth.
Dimension. 20 (24) 35 μm (11 specimens).
Comparisons. *Chelinospora retorrida* Turnau (1986a, p. 339, pl. 1:1–4) has narrower lumina, tectate trilete rays and is sculptured over the equatorial region; *Ch. subfavosa* Turnau (1986a, p.

339–341, pl. 1:6, 7) has tectate trilete rays and perfect reticulum over the entire surface, except for the contact faces; *Retialetes legionis* Cramer 1966 (in Streel *et. al.*, 1981, pl. 2:13), *Retialetes* sp. McGregor and Owens (1966, pl. 1:2) and *Retialetes* sp. Downie & Lister (1969, pl. 1:K) do not have differentiated contact faces and have finer reticulum.
Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis–zavallatus* Zone (Late Gedinnian).

Genus *Dibolisporites* Richardson, 1965

Dibolisporites confertus sp. nov.
Pl. III:1, 2

1978 *Cymbosporites catillus* Allen; in Rodriquez, pl. 3: 17, 21.
1984 ?*Dibolisporites* sp. *A.*; Richardson, Ford & Parker, pl. 2: 3.
Holotype. Pl. III:2, slide HCM6/64, Zwoleń Formation, Ciepielów IG-1 at 1592.4 m.
Diagnosis. A *Dibolisporites* having an ornament of densely set mammillate-biform elements. The bases of these are often polygonal in outline.
Description. Spores of subcircular amb; trilete rays extend almost to spore margin. They are bordered by tecta which are narrow at apex and widening towards equator. Contact faces well delimited, thin, smooth. Exine outside contact faces ornamented by closely set mamillate processes consisting of bulbous, rapidly tapering base surmounted by a very narrow spine. The processes are subcircular or polygonal in outline, up to 2 μm wide at base.
Dimensions. Diameter 29 (33) 39 μm (7 specimens).
Comparisons. *Verrucosisporites polygonalis* Lanninger (1968, p. 128, pl. 22:19) is ornamented by verrucae; *V.* ?*polygonalis* Lanninger (in McGregor, 1973, p. 37–38, pl. 4:16, 17, 25, 26) is similar in sculpture to *D. confertus* sp. nov., but is larger (up to 79 μm); *Cymbosporites catillus* Allen (in Rodriquez, 1978, pl. 3: 17, 21) and *Dibolisporites* sp. *A.* (Richardson, Ford & Parker, 1984, pl. 2: 3) seem to be identical with the described species, but they are included in the synonymy tentatively, because they have not been described.
Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis – zavallatus* Zone (late Gedinnian). This species may also have been recorded from the San Pedro/Furada Formation (Gedinnian), Cantabrian Mts, Spain (Rodriquez, 1978), and from the Arbuthnott Group (Gedinnian) of the Midland Valley of Scotland (Richardson, Ford, & Parker, 1984).

Genus *Emphanisporites* McGregor, 1961

Emphanisporites micrornatus var. *sinuosus* Steemans & Gerienne, 1984
Pl. III:6, 11

Description of specimens. Spores of subcircular amb. Trilete rays 3/4 radius long, sinuous, tectate, tecta do not reach the apex. Curvatural ridges distinct, narrow. Contact areas ornamented by radially arranged muri, usually 7 in number in each interradial sector. Muri straight or sinuous, tapering gradually towards apex or constricted, some bifurcating towards equator. Length of muri variable, some peter out within sub-equatorial area, some almost reach the apex. Exine outside contact faces ornamented with cones and truncated spines, 0.5 to 1 μm long, usually 2 μm apart.
Dimensions. Diameter 30 (34) 36 μm (5 specimens).
Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis–zavallatus* Zone (late Gedinnian).

Emphanisporites zavallatus var. *gedinniensis* Steemans & Gerienne, 1984

Pl. III:6, 11

Description of specimens. Spores of subcircular amb. Trilete rays 3/4 radius of spores, sinuous, tectate, tecta do not reach the apex. Curvatural ridges distinct, narrow. Contact faces ornamented by radially arranged muri, up to 10 in number in each interradial sector. These taper gradually towards the apex and fuse together forming a thickening situated at some distance from the apex. Some muri bifurcate towards the equator. Exine outside contact faces ornamented by truncated spines up to 1.5 μm long and usually 2 μm apart. These spines taper gradually from base to tip or have slightly bulbous base and tapering stem but typical biform elements have not been observed.
Dimensions. Diameter 35 (37) 42 μm (5 specimens).
Occurrence. Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis—zavallatus* Zone (late Gedinnian).

Genus *Micaspora* gen. nov.

Type species *Micaspora spinifera* sp. nov.

Diagnosis: Radial, alete, zonate sporomorphs of subcircular amb. Contact faces not differentiated. Wall sculptured over the entire surface with radial muri bearing rows of very fine projections.
Remarks: These sporomorphs lack any contact features and tetrad mark and are probably monad cryptospores.
Comparisons: *Micaspora* is superficially very similar to *Qualisaspora* Richardson, Ford & Parker (1984, p. 118) but the latter is azonate and has a double wall.
Derivation of name: Latin mica = tiny, piece, particle.

Micaspora spinifera sp. nov.

Pl. III:7—9

1969 *Emphanisporites* sp., in Downie & Lister, p. 202, pl. 1:D.
Holotype: Pl. III:7, slide HCM6/65, Zwoleń Formation, Ciepielów IG-1 at 1592.4 m
Diagnosis. A *Micaspora* ornamented on both surfaces with radially arranged fine muri, about 50 in number on each surface, bearing acute or blunt spines 1—1.5 μm long, projecting at equator.
Description. Sporomorphs of subcircular amb, vase shaped in equatorial view. Wall very thin, sculptured over the entire surface with fine radial muri bearing spines. Muri straight or slightly wavy, less than 1 μm wide and about 1 μm apart at equator. Spines 1—1.5 μm long, closely spaced, tapering ad acute or parallel sided and blunt, arranged in rows on muri and projecting at equator at muri terminations. Zona situated between the equator and one of the poles, and inclined at acute angle to the polar axis. In polar view, zona up to 1/3 radius wide, often asymmetrical, also often indiscernible.
Dimensions. Overall diameter 28 (33) 37 μm (13 specimens).
Occurrence: Ciepielów IG-1 at 1592.4 m, Zwoleń Formation, *breconensis—zavallatus* Zone (late Gedinnian).

Genus *Procoronaspora* Butterworth & Williams emend. Smith & Butterworth, 1967

Procoronaspora spinulosa sp. nov.
Pl. VI:9–11

1968 *Procoronaspora ambigua* Butterworth & Williams in Schultz, p. 23, pl. 3: 4.
1981 *Diatomozonotriletes devonicus* Naumova, in *Devonian and Carboniferous of the Peribaltic*, pl. 16: 9, 10.
1981 *Apiculiretusispora pygmea* McGregor, in Streel *et al.*, pl. 1: 7, 8, 11, non pl. 1: 9.
Holotype: Pl. VI:10, slide HCM6/30, Zwoleń Formation, Ciepielów IG-1 at 1299.8 m.
Diagnosis. A *Procoronaspora* ornamented distally and proximo-equatorially by acute spines and cones. Elements of ornamentation reduced over radial extremities.
Description. Spores of subtriangular amb. Trilete rays simple, 2/3 spore radius long, exine close to the rays darkened. Contact faces smooth. Curvaturae marked occasionally by linearly arranged spines and cones. Exine outside contact faces ornamented by spines and acute or blunt cones. In interradial equatorial area these elements are closely set, 1–2 μm wide at base, and 2–2.5 μm long. Radial extremities are sculptured by cones 1 μm wide and long, 2–4 μm apart. Distal spines are 1–2 μm wide at base and 2–5 μm apart. Exine uniformly thick at equator or only very slightly thicker interradially.
Dimensions. Diameter 28 (29) 33 μm (13 specimens).
Comparisons. *Camarozonotriletes devonicus* Naumova (1953, p. 89, pl. 14: 9) has thickenings at interradial equatorial regions and its sculpture is finer and denser; cf. *Procoronaspora ambigua* Butterworth & Williams (in Allen, 1976, fig. 2: L) seems to have finer ornamentation; *Procoronaspora ambigua* Butterworth & Williams emend. Smith & Butterworth (1967, p. 163, pl. 6: 25–27) is ornamented by flat-topped, parallel-sided elements, which are of uniform size over the entire sculptured area.
Occurrence. Ciepielów IG-1, between 1420.7 and 1232.3 m, Zwoleń Formation, *polygonalis–emsiensis* and *annulatus–sextantii* Zones (Siegenian–Emsian). This species has been also recorded from the Eifelian of the Baltic region (*Devonian and Carboniferous of the Peribaltic*, 1981), Oignes, St Hubert, Anor, St Michel, Petigny and Peche Formations (mid-upper Gedinnian–lower Emsian) of the Dinant Synclinorium in Belgium (Streel *et al.*, 1981) ad from Klerf Beds (lower Emsian) in Eifel, Bundes Republic of Germany (Schultz, 1968).

Genus *Retusotriletes* Naumova emend. Streel, 1964

Retusotriletes incomptus McGregor, 1973
Pl. IV:1,2

1982 *Retusotriletes ?actinomorphus* Chibrikova, in Graham, Richardson & Clayton, Fig. 4a. b.
Description of specimens. Spores of subcircular amb. Trilete rays 2/3 radius long, accompanied by flat tecta distinguishable only under SEM. Contact faces ornamented by radially arranged striae. Under SEM, contact faces very finely wrinkled. The wrinkles follow an indistinctly radial pattern. Exine thin, occasionally folded, smooth outside contact faces. Curvatural ridges well developed at the ends of the rays.
Dimensions. 43 (45) 46 μm (6 specimens).
Occurrence. Ciepielów IG-1 borehole, Zwoleń Formation, *breconensis–zavallatus* Zone (late Gedinnian). The species has been previously recorded from the Battery Point and Malbaie Formations of Gaspé, Canada (late Emsian–Eifelian) (McGregor, 1973), and from the Old Red Sandstone of Clew Bay, Ireland (Siegenian or Emsian) (Graham, Richardson & Clayton, 1982).

Acknowledgements

The authors want to thank mgr Ewa Starnawska from the Institute of Geological Sciences of the Polish Academy of Sciences in Warszawa for the assistance in taking SEM micrographs, and they acknowledge the support from the Polish Academy of Sciences Programme CPBP 04.03.

REFERENCES

Alberti, G. K. B., 1969. Trilobiten des jüngeren Siluriums sowie des Unter- und Mitteldevons. I. *Abh. Senckenb. Naturforsch. Ges.*, 520:1–691.

Allen, K. C., 1965. Lower and Middle Devonian spores of north and central Westspitsbergen. *Palaeontology*, 8:687–748.

Allen, K. C., 1976. Devonian spores from outer Trondelag, Norway. *Norsk Geol. Tidsskr.*, 56:437–448.

Arkhangelskaya, A. D., 1980. Plant spores of some Lower Devonian sections of western regions of the Russian platform. (In Russian). *Trudy VNIGNI*, 217:26–45, 141–153.

Devonian and Carboniferous of the Peribaltic, 1981. (In Russian). Zinatne, Riga. 502 pp.

Downie, C. & Lister, T. R., 1969. The Sandy's Creek Beds (Devonian) of Farland Head, Ayryshire. *Scott. J. Geol.*, 5, part 3:193–206.

Gandl, J., 1972. Die Acastavinae and Asteropyginae (Trilobita) Keltiberiens (NE Spanien). *Abh. Senckenb. Naturforsch. Ges.*, 530:1–182.

Graham, J. R., Richardson, J. B. & Clayton, G., 1982. Age and significance of the Old Red Sandstone around Clew Bay, NW Ireland. *Trans. Roy. Soc. Edinb.*, 73:245–249.

Jakubowska L., 1968. Palaeobotanical-stratigraphical investigations of the Lower Devonian deposits of Ciepielów and Dorohucza. (In Polish, English summary). *Kwart. Geol.*, 12:507–518.

Jakubowska, L., 1974. Results of palaeobotanical-stratigraphical investigations of Devonian deposits. (In Polish). In: Nemczycka, L. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego, Ciepielów IG-1*, 20, Wyd. Geol., Warszawa, pp. 101–102.

Krassowska, A. & Kulczycki, J., 1963. Devonian system in the Ciepielów vicinity. (In Polish, English summary). *Prz. Geol.*, 1963 (8):394–395.

Lanninger, E. P., 1968. Spore-Gesellschaften aus dem Ems der SW Eifel. *Palaeontographica* B, 122:95–170.

McGregor, D. C., 1973. Lower and Middle Devonian spores of eastern Gespé, Canada. I. Systematics. *Palaeontographica* B, 142:1–77.

McGregor, D. C. & Owens, B., 1966. Illustrations of Canadian fossils: Devonian spores of eastern and northern Canada. *Geol. Surv. Canada, Paper.*, 66–30:1–66.

Miłaczewski, L., 1981. The Devonian of the south-eastern part of the Radom–Lublin area (eastern Poland). (In Polish, English summary). *Pr. Inst. Geol.*, 101:1–90.

Moreau-Benoit, A., 1979. Les spores du Dévonien de Libye. *Cahiers Micropaleont.*, 4–1079:1–58.

Naumova, S. N., 1953. Spore-pollen complexes of the Upper Devonian of the Russian platform and their stratigraphic significance. (In Russian), *Trudy. Inst. Geol. Nauk. SSSR*, 143 (ser. geol. 60):1–204.

Nehring-Lefeld, M., 1985. Biostratigraphy of the Lower Devonian sediments in the Radom–Lublin area on the basis of ostracods and conodonts. (In Polish, English summary), *Pr. Inst. Geol.*, 112:1–58.

Ormiston, A. R., 1977. Trilobites. In: Martinsson, A. (ed.), *The Silurian–Devonian boundary*. Schweitzerbart. Verlagsbuchhandlung, Stuttgart, pp. 65–83.

Paris, F., 1981. Les chitinozoaires dans le Paleozoique du sud-ouest de l'Europe. *Mem. Soc. Géol. Minér. Bretagne*, 26:1–412.

Richardson, J. B. & McGregor, D. C., 1986. Silurian and Devonian spore zones of the Old Red Sandstone Continent and adjacent regions. *Geol. Surv. Canada, Bull.* 364: 1–79.

Richardson, J. B., Ford, J. H. & Parker, F., 1984. Miospores, correlation and age of some Scottish Lower Old Red Sandstone sediments from the Strathmore region (Fife and Angus). *J. Micropalaeont.*, 3:109–124.

Richardson, J. B., Streel, M., Hassan, A. & Steemans, Ph., 1982. A new spore assemblage to correlate between the Breconian (British Isles) and the Gedinnian (Belgium). *Ann. Soc. Géol. Belg.*, 105:135–143.

Riegel, W. & Kharathanasopoulos, S., 1982. Palynological criteria for the Siegenian/Emsian transition in the Rhineland. *Cour. Forsch. Inst. Senckenberg*, 55:199–206.

Rodriquez, R. M., 1978. Mioesporas de la Formación San Pedro/Furada (Silurico Superior–Devónico Inferior), Cordillera Cantábrica, NO de Espana. *Palinologia*, 1:407–433.

Schultz, G., 1968. Eine unterdevonische Mikroflora aus den Klerfer Schichten der Eifel (Rheinisches Schiefergebirge). *Palaeontographica* B, 123:4–42.

Smith, A. H. V. & Butterworth, M. A., 1967. Miospores in the coal seams of the Carboniferous of Great Britain. *Spec. Pap. Palaeontology*, 1:1–324.

Steemans, Ph., 1981. Etude stratigraphique des spores dans les couches de transition "Gedinnien-Siegenien" à Nonceveux et à Spa (Belgique). *Ann. Soc. Géol. Belg.*, 104:41–59.

Steemans, Ph., 1982. Gedinnian and Siegenian spore stratigraphy in Belgium. *Cour. Forsch. Inst. Senckenberg*, 55:165–180.

Steemans, Ph. & Gerienne, Ph., 1984. La micro- et macroflore du Gedinnien de la Gileppe, synclinorium de la Vesdre, Belgique. *Ann. Soc. Géol. Belg.*, 107:51–71.

Streel, M., Fairon-Demaret, M., Otazo-Bozo, N. & Steemans, Ph., 1981. Etudes stratigraphiques des spores du Dévonien inférieur au bord sud du synclinorium de Dinant (Belgique) et leur applications. *Ann. Soc. Géol. Belg.*, 104:173–191.

Streel, M., Higgs, K., Loboziak, S., Riegel, W. & Steemans, Ph., 1987. Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenne-Rhenish regions. *Rev. Palaeobot. Palynol.*, 50:211–229.

Tomczyk, H., Pajchlowa, M. & Tomczykowa, E., 1977. Poland. In: Martinsson, A. (ed.), *The Silurian-Devonian boundary*. Schweitzerbart. Verlagsbuchhandlung, Stuttgart, pp. 65–83.

Tomczykowa, E., 1974. Faunal characteristic and stratigraphy of Gedinnian and lower Siegenian. (In Polish). In: Niemczycka, T. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego, Ciepielów IG-1*, 20. Wyd. Geol., Warszawa, pp. 90–96.

Tomczykowa, E., 1975. Lowermost Devonian (In Polish). In: Miłaczewski, L. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego, Krowie Bagno IG-1*, 25. Wyd. Geol., Warszawa. pp. 106–109.

Tomczykowa, E., 1976. Biostratigraphy of lowermost Devonian. (In Polish). In: Miłaczewski, L. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego, Strzelce IG-1, Strzelce IG-2*, 31. Wyd. Geol., Warszawa, pp. 68–73.

Tomczykowa, E., 1988. Silurian and Lower Devonian biostratigraphy and palaeoecology in Poland. *Biul. Inst. Geol.*, 359:21–41.

Turnau, E., 1986a. Lower to Middle Devonian spores from the vicinity of Pionki (central Poland). *Rev. Palaeobot. Palynol.*, 46:311–354.

Turnau, E., 1986b. Spore zones of Devonian formations in the vicinity of Pionki (central Poland). (In Polish, English summary). *Ann. Soc. Geol. Polon.*, 55:355–374.

Westoll, S., 1977. Devonian fish biostratigraphy. *Spec. Pap. Palaeontology*, 23:341–353.

Wrona, R., 1980. Upper Silurian–Lower Devonian chitinozoa from the subsurface of southeastern Poland. *Palaeontol. Polon.*, 41:103–165.

Ziegler, P, A., 1982. *Geological Atlas of Western and Central Europe*. Shell Int. Petrol. Maatschappij B. V., Hague. 130 pp.

Streszczenie

WCZESNODEWOŃSKIE SPORY I WIEK FORMACJI ZWOLEŃSKIEJ (FACJA OLDREDU) Z OTWORU CIEPIELÓW IG-1

Elżbieta Turnau & Lidia Jakubowska

Głównym celem badań przedstawionych w niniejszej pracy było określenie wieku formacji zwoleńskiej z otworu Ciepielów IG-1, co rzutuje na zagadnienie wieku tej formacji na obszarze jej występowania w rejonie radomsko-lubelskim.

Dotychczas formacji tej przypisywano wiek emski (Tomczyk *et al.*, 1977; Tomczykowa, 1988) lub górnozigeński i emski (Miłaczewski, 1981). Podstawą tych poglądów było zaliczenie przez Tomczykową (1974, 1975, 1976) niżej leżącej formacji czarnoleskiej oraz górnej części formacji sycyńskiej do zigenu, środkowej zaś części tej ostatniej do górnego żedynu.

Spieranie się o zigeński czy żedyński wiek utworów może w niektórych przypadkach dotyczyć jedynie nazwy, gdyż granica obu tych pięter nie jest dostatecznie udokumentowana biostratygraficznie i nie można wykluczyć ich zazębiania się w strefie przygranicznej, co było szczegółowo dyskutowane przez Steemansa (1981) i Streela *et al.* (1987). Ale w przypadku dolnodewońskich formacji z rejonu radomsko-lubelskiego chodzi o konkretny problem, gdyż zigeński wiek przypisany został utworom, które, jak wynika z niżej przedstawionych danych, należą do dolnego żedynu.

Za charakterystyczne dla górnego żedynu (górnego bostowu) uważa Tomczykowa (1988) trylobity *Warburgella rugulosa rugulosa* Alberti. Gatunek ten jest jednak typowy dla dolnego, a nie dla górnego żedynu (por. Ormiston, 1977). Za charakterystyczne dla dolnego zigenu (dolnego ciepielowu) uważa wymieniona autorka, oprócz trylobitów należących do gatunków nowych, także *Acastella rouaulti* Tromelin & Lebesconte i *Parahomalonotus forbesi* (Rouault). *A. rouaulti* jest gatunkiem, którego występowanie ograniczone jest do dolnego żedynu (Gandl, 1972; Ormiston, 1977). *Parahomalonotus forbesi* jest gatunkiem o wąskim zasięgu geograficznym, stąd jego znaczenie stratygraficzne można uznać za niewielkie. Należy dodać, że w górnej części formacji sycyńskiej, która ma reprezentować dolny zigen, nadal występuje *Ozarkodina remscheidensis remscheidensis*, a także żedyńskie małżoraczki *Poloniella richteri* (de Koninck) i *Cytherellina jonesi* (de Koninck) (Nehring-Lefeld, 1985). Dolnożedyński wiek górnej części formacji sycyńskiej potwierdzają również badania Wrony (1980), który zanotował obecność w tej części formacji chitinozoów *Sphaerochitina sphaerocephala* (Eisenack) Eisenack i *Ancyrochitina tomentosa* Taugourdeau & Jekhovsky,

których występowanie ograniczone jest w Europie Zachodniej do utworów dolnego żedynu (Paris, 1981).

Przedstawione powyżej dane sugerują, że formacja sycyńska należy do dolnego żedynu.

Wyżej leżąca formacja czarnoleska (prawie nie zawierająca fauny) zaliczona została przez Turnau (1986a,b), na podstawie spor, do nienajwyższego żedynu. Żedyńskie małżoraczki występują w dolnej części tej formacji (Nehring-Lefeld, 1985).

Przedstawione powyżej dane na temat wieku formacji sycyńskiej i czarnoleskiej są zgodne z wynikami badań nad zespołami spor z formacji zwoleńskiej otworu Ciepielów IG-1. W górnej części badanej formacji stwierdzono obecność zespołów spor najwyższego żedynu, zigenu i nienajwyższego emsu.

W połowie wysokości badanej formacji (Fig. 2) napotkano zespół spor zony *breconensis—zavallatus*. Zespół ten zawierał między innymi *Breconisporites breconensis* Richardson, Streel, Hassan & Steemans, i *Emphanisporites zavallatus* var. *gedinniensis* Steemans. Pojawienie się tych gatunków wyznacza podstawę tej zony (Richardson & McGregor, 1986). W zespole tym zanotowano również obecność gatunku *Streelispora newportensis* (Chaloner & Streel) Richardson & Lister, co sugeruje obecność zony interwałowej Z (Steemans, 1982; Streel *et al.*, 1987) odpowiadającej wysokiemu żedynowi.

Zespoły kolejnej zony *polygonalis—emsiensis* zawierały, między innymi, gatunki *Dibolisporites wetteldorfensis* Lanninger, *Dibolisporites eifeliensis* (Lanninger) McGregor, *Verrucosisporites polygonalis* Lanninger i *Breconisporites breconensis*. Trzy pierwsze z wymienionych gatunków nie występują poniżej dolnej granicy tej zony (Richardson & McGregor, 1986). Obecność w omawianych zespołach gatunku *Acinosporites münstereifeliensis* (= *A. bellus* (Arkhangelskays) Steemans) wskazuje na występowanie górnej części zony *polygonalis—emsiensis* odpowiadającej zonom interwałowym Pa lub Su, wieku późnozigeńskiego.

W najwyższym odcinku badanej formacji (Fig. 2) napotkano zespoły zony *annulatus—sextantii*. Zawierały one nieomal wszystkie gatunki zony poprzedzającej (por. Fig. 3) oraz gatunek *Emphanisporites annulatus* McGregor. Na tej podstawie najwyższą część formacji zwoleńskiej w badanym otworze można zaliczyć do dolnego i środkowego emsu.

Utwory formacji sycyńskiej, czarnoleskiej i zwoleńskiej z rejonu Ciepielowa i Pionek skorelowano, na podstawie spor, z utworami dolnego dewonu rejonów typowych żedynu, zigenu i emsu w Europie Zachodniej oraz rejonu parastratotypowego granicy pridoli/loszkow na Podolu (Fig. 4). Jak wynika z tej korelacji, w badanym regionie sedymentacja utworów facji oldredu rozpoczęła się w zbliżonym czasie co sedymentacja osadów tego samego typu (seria dniestrowska) na Podolu, oraz litoralne osady formacji Oignes i Fooz w Ardenach.

EXPLANATION OF PLATES

Plate I

Spores from Ciepielów IG-1 borehole, at 1592.4 m, *breconensis—zavallatus* Zone. All figures × 1000, except when indicated

1, 4 — *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, slide HCM6/64
2, 3, 5, 6 — *Aneurospora parviconata* sp. nov., 2 — fragment of exine, × 2000, 3 — holotype, slide HCM6/64, 5, 6 — slide HCM6/64
7—11 — *Aneurospora crinita* sp. nov., 7 — slide HCM6/65, 8 — holotype, slide HCM6/64, 9 — slide HCM6/64

Plate II

Spores form Ciepielów IG-1 borehole, at 1594.4 m, *breconensis—zavallatus* Zone. All figures × 1000, except when indicated

1 — *Aneurospora crinita* sp. nov., fragment of exine, × 2500
2 — *Apiculiretusispora limata* sp. nov., holotype, slide HCM6/65
3 — *Breconisporites breconensis* Richardson, Streel, Hassan & Steemans, slide HCM6/64
4, 7 — *Cymbosporites* sp., the same specimen, proximal and distal focus, slide HCM6/64
5, 8 — ?*Cymbosporites* sp. the same specimen, distal and proximal focus, slide HCM6/64
6 — *Cymbosporites proteus* McGregor & Camfield, slide HCM6/64.
9, 10 — *Chelinospora glabrimarginata* sp. nov., 9 — holotype, slide HCM6/65, 10 — slide HCM6/64
11 — *Chelinospora* cf. *cassicula* Richardson & Lister, slide HCM6/64

Plate III

Spores from Ciepielów IG-1 borehole at 1592.4 m, *breconensis—zavallatus* Zone. All figures × 1000, except when indicated

1, 2 — *Dibolisporites confertus* sp. nov., 1 — slide HCM6/64, 2 — holotype, slide HCM6/64
3 — *Dictyotriletes* sp., slide HCM6/64.
4, 5, 12 — *Emphanisporites micrornatus* var. *sinuosus* Steemans & Gerienne, slide HCM6/64
6, 11 — *Emphanisporites zavallatus* var. *gedinniensis* Steemans & Gerienne, slide HCM6/64
7, 8, 9 — *Micaspora spinifera* sp. nov., 7 — holotype, slide HCM6/65, 8—9 — slide HCM 6/65, 9 — lateral view
10 — *Emphanisporites* sp.

Plate IV

Spores from Ciepielów IG-1 borehole, at 1592.4 m, *breconensis—zavallatus* Zone. All figures × 1000, except when indicated

1, 2 — *Retusotriletes incomptus* McGregor, slide HCM6/64
3, 4 — Zonate spore, 3 — slide HCM6/64, × 500, 4 — slide HCM6/65, × 500
5 — Diad
6 — *Streelispora newportensis* (Chaloner & Streel) Richardson & Lister, slide HCM6/64
7 — indetermined, slide HCM6/65, × 500
8 — *Tholisporites chulus* var. *nanus* Richardson & Lister
9 — *Tholisporites chulus* var. *chulus* Richardson & Lister, slide HCM6/64
10 — *Retusotriletes* sp., slide HCM6/64

Plate V

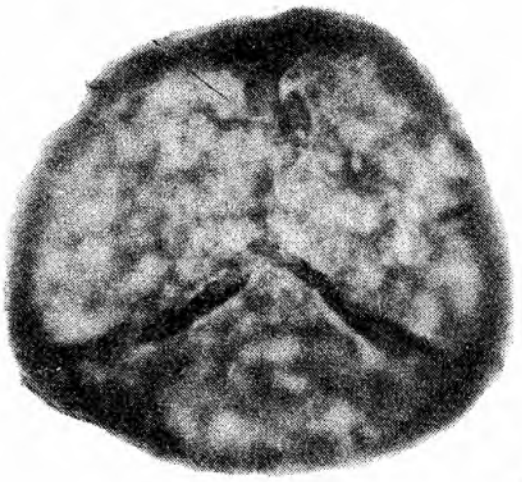
Spores from Ciepielów IG-1 borehole, *polygonalis—emsiensis* and *annulatus—sextantii* Zones. All figures × 500, except when indicated

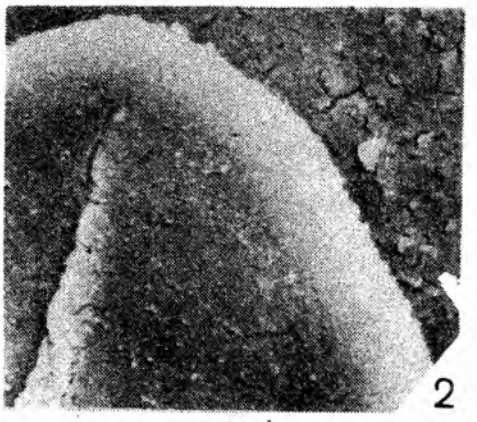
1 – *Apiculiretusispora* cf. *brandtii* Streel. depth 1217.0 m. slide HCM6/28
2 – *Apiculiretusispora plicata* (Allen) Streel. depth 1390 m. slide HCM6/44
3 – *Acinosporites münstereifeliensis* (Franke) Streel, depth 1420.7 m, slide HCM6/56
4 – *Brochotriletes* sp., depth 1417.7 m, slide HCM6/52
5 – *Brochotriletes hudsonii* McGregor & Camfield, depth 1351 m, slide HCM6/42
6 – *Brochotriletes rarus* Arkhangelskaya. depth 1403 m. slide HCM6/50
7, 12 a,b – *Camptozonotriletes* sp. *A*., depth 1390 m. slide HCM6/44. 12a – × 1000
8 – *Chelinospora subfavosa* Turnau, depth 1403 m, slide HCM6/47, × 1000
9 – *Breconisporites breconensis* Richardson, Streel, Hassan & Steemans, depth 1430.3 m, slide HCM6/63
10 – *Cymbosporites* sp., depth 1390.7 m. slide HCM6/45. × 1000
11 – *Clivosispora* sp., depth 1417.7 m. slide HCM6/52
13 – ?*Cymbosporites* sp., depth 1217.0 m, slide HCM6/28

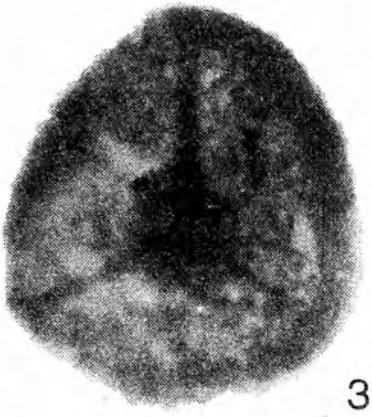
Plate VI

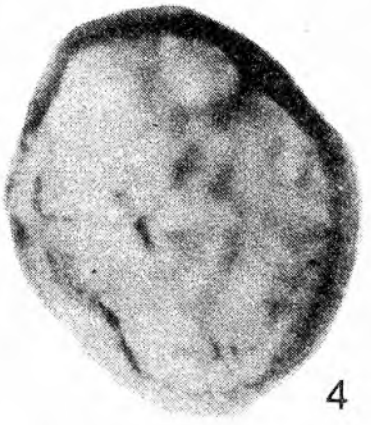
Spores from Ciepielów IG-1 borehole, *polygonalis—emsiensis* and *annulatus—sextantii* Zones. All figures × 500, except when indicated

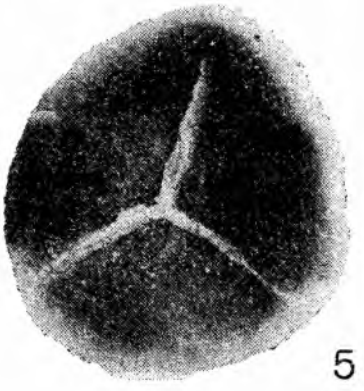
1 – *Dibolisporites* cf. *echinaceus* (Eisenack) Richardson, depth 1217 m, slide HCM6/28
2 – *Dibolisporites eifeliensis* (Lanninger) McGregor, depth 1420.7 m, slide HCM6/56
3, 4 – *Dibolisporites wetteldorfensis* Lanninger, depth 1390 m, slide HCM6/44
5 – *Emphanisporites rotatus* McGregor, depth 1403 m, slide HCM6/47
6 – *Emphanisporites annulatus* McGregor. depth 1217 m. slide HCM6/27
7 – *Emphanisporites* sp., depth 1217 m, slide HCM/27
8 – *Kraeuselisporites gaspesiensis* McGregor. depth 1217 m. slide HCM6/27
9–11 – *Procoronaspora spinulosa* sp. nov., 9 – depth 1217 m, slide HCM6/27, × 1000, 10, 11 – depth 1299.8 m, slide HCM6/30, × 1000, 10 – holotype
12 – *Tholisporites* cf. *Archaeozonotriletes salantaicus* Arkhangelskaya, depth 1390 m, slide HCM6/44
13 – *Verrucosisporites polygonalis* Lanninger, depth 1420.7 m, slide HCM6/56
14 – *Gneudnaspora divellomedium* (Chibrikowa) Balme, depth 1217 m, slide HCM6/25

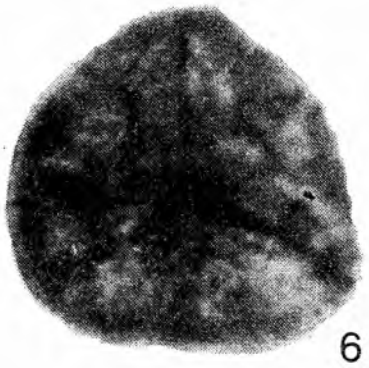

1

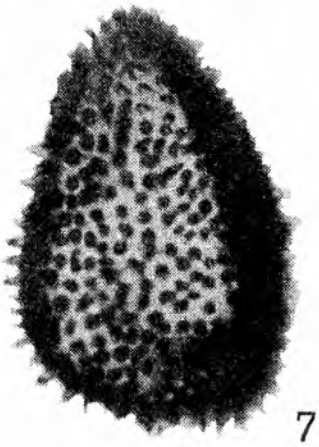

2

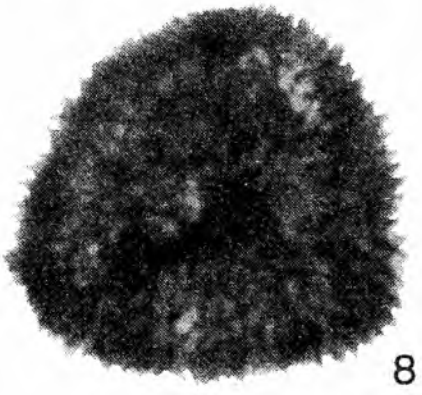

3

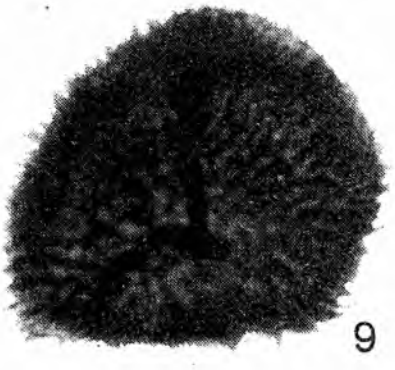

4

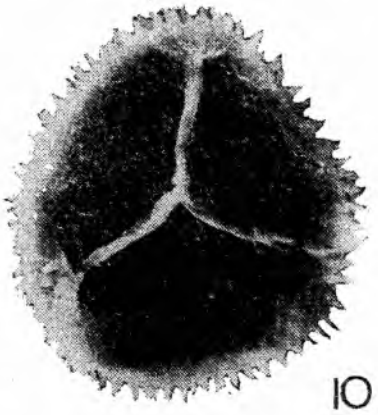

5

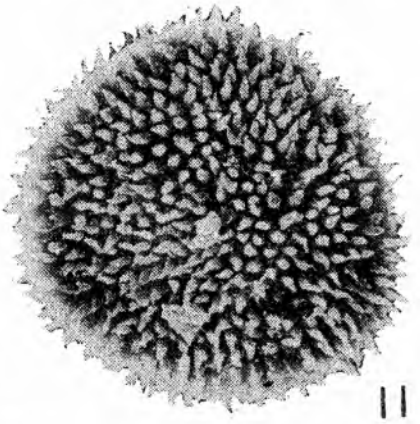

6

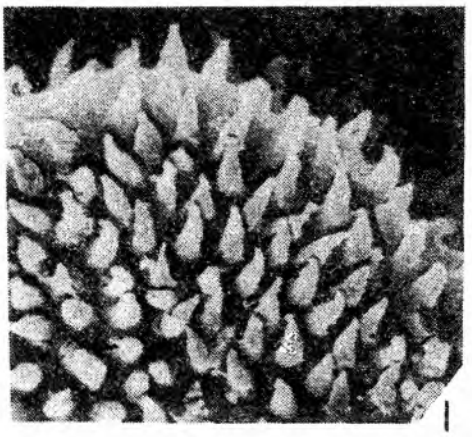

7

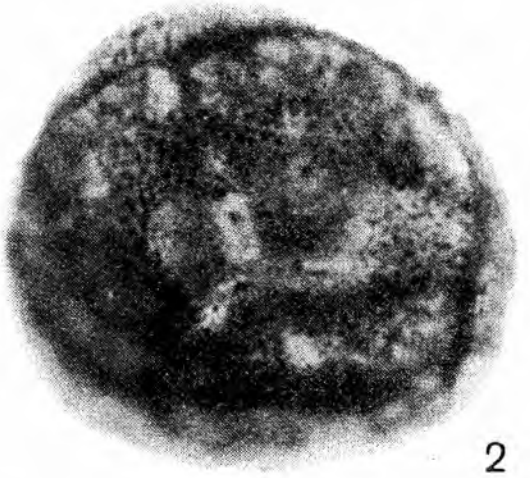

8

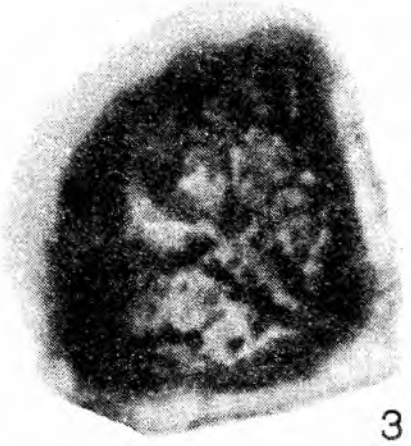

9

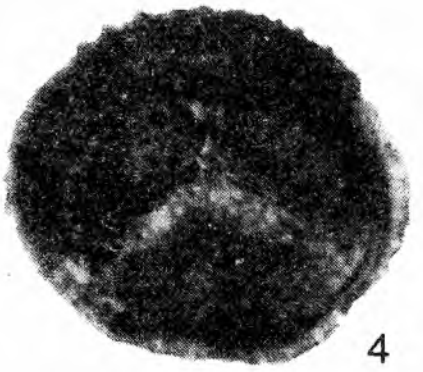

10

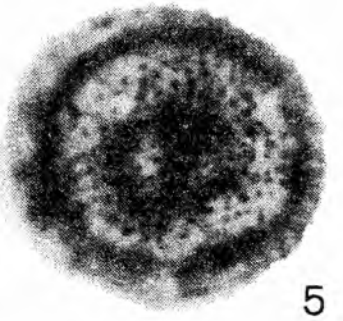

11

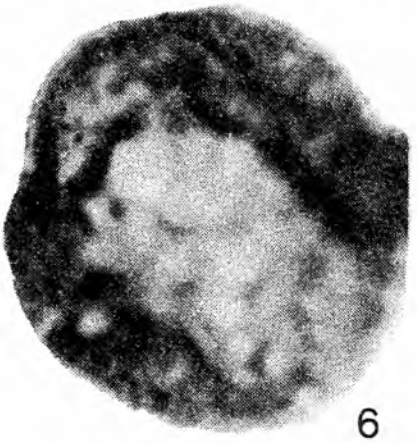

1

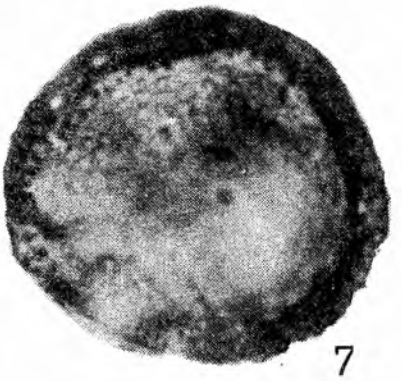

2

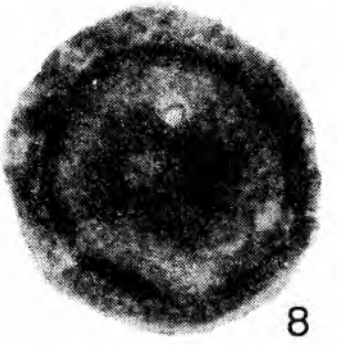

3

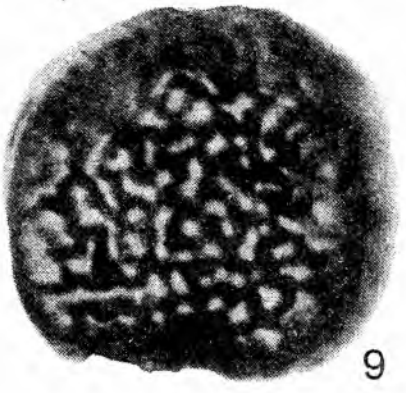

4

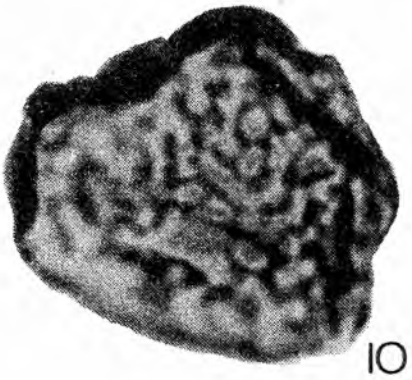

5


6

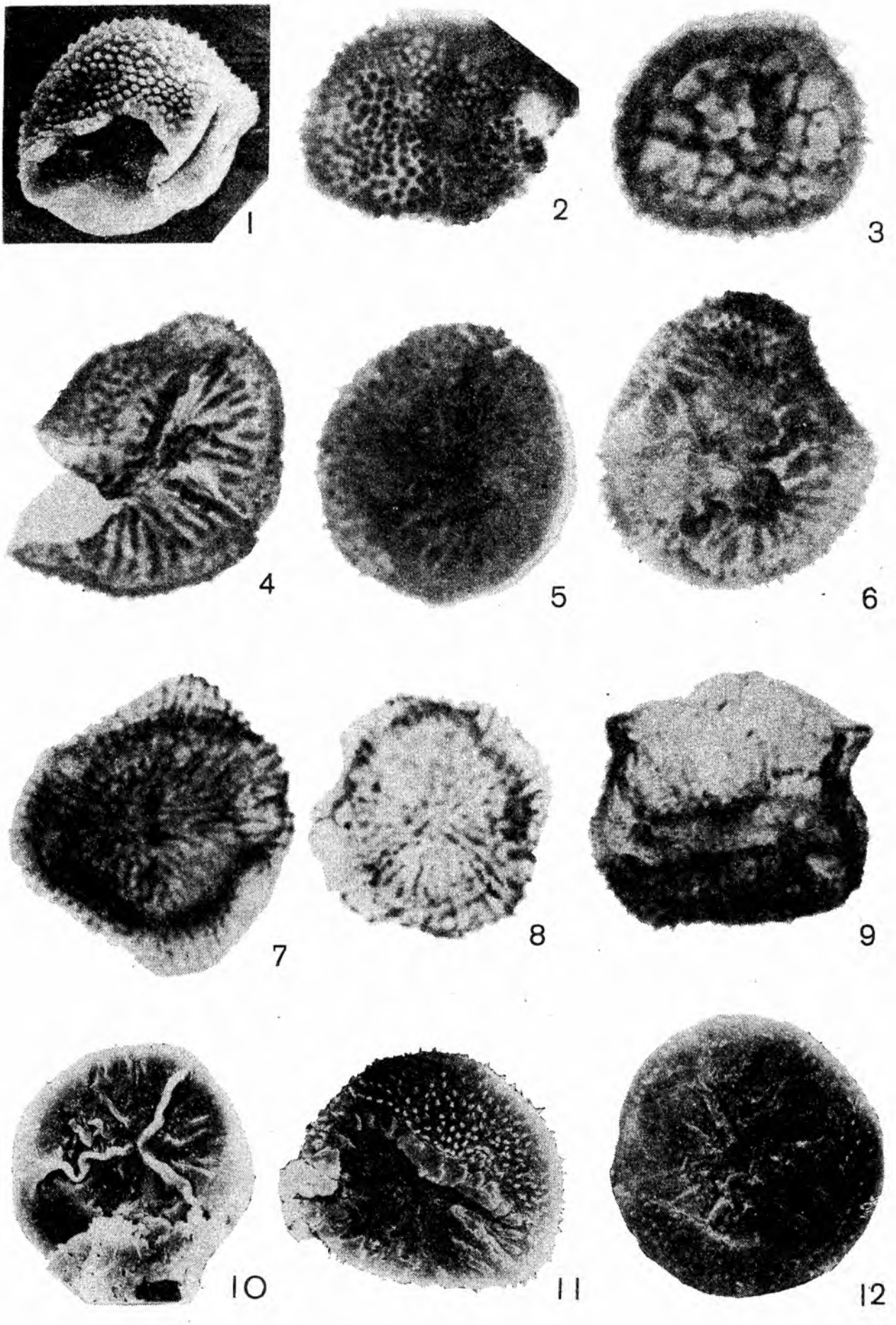

7

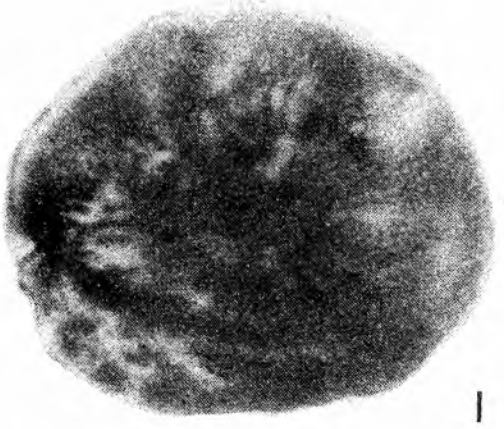

8

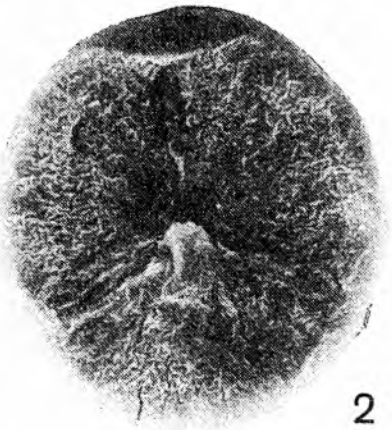

9

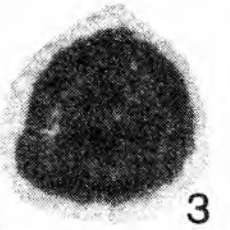

10

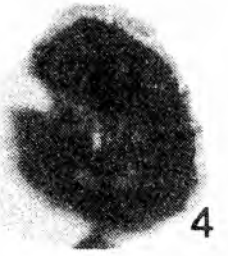

11

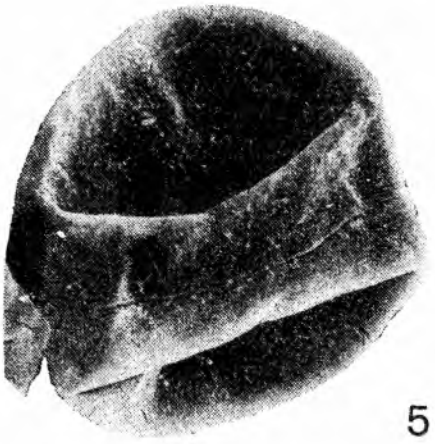

1
2
3
4
5
6
7
8
9
10
11
12

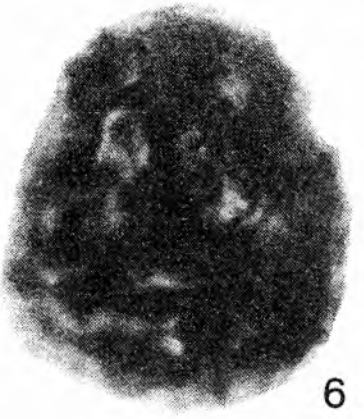

1

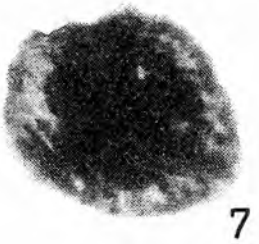

2

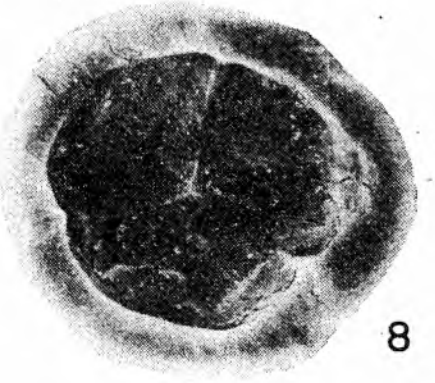

3

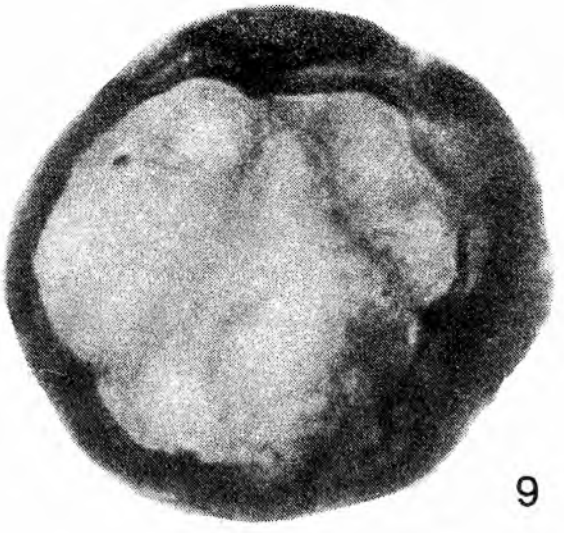

4

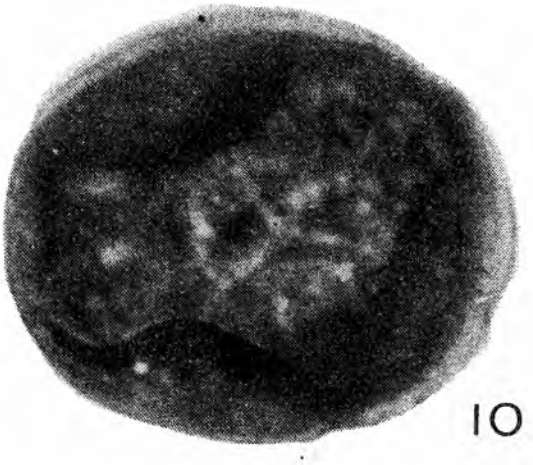

5

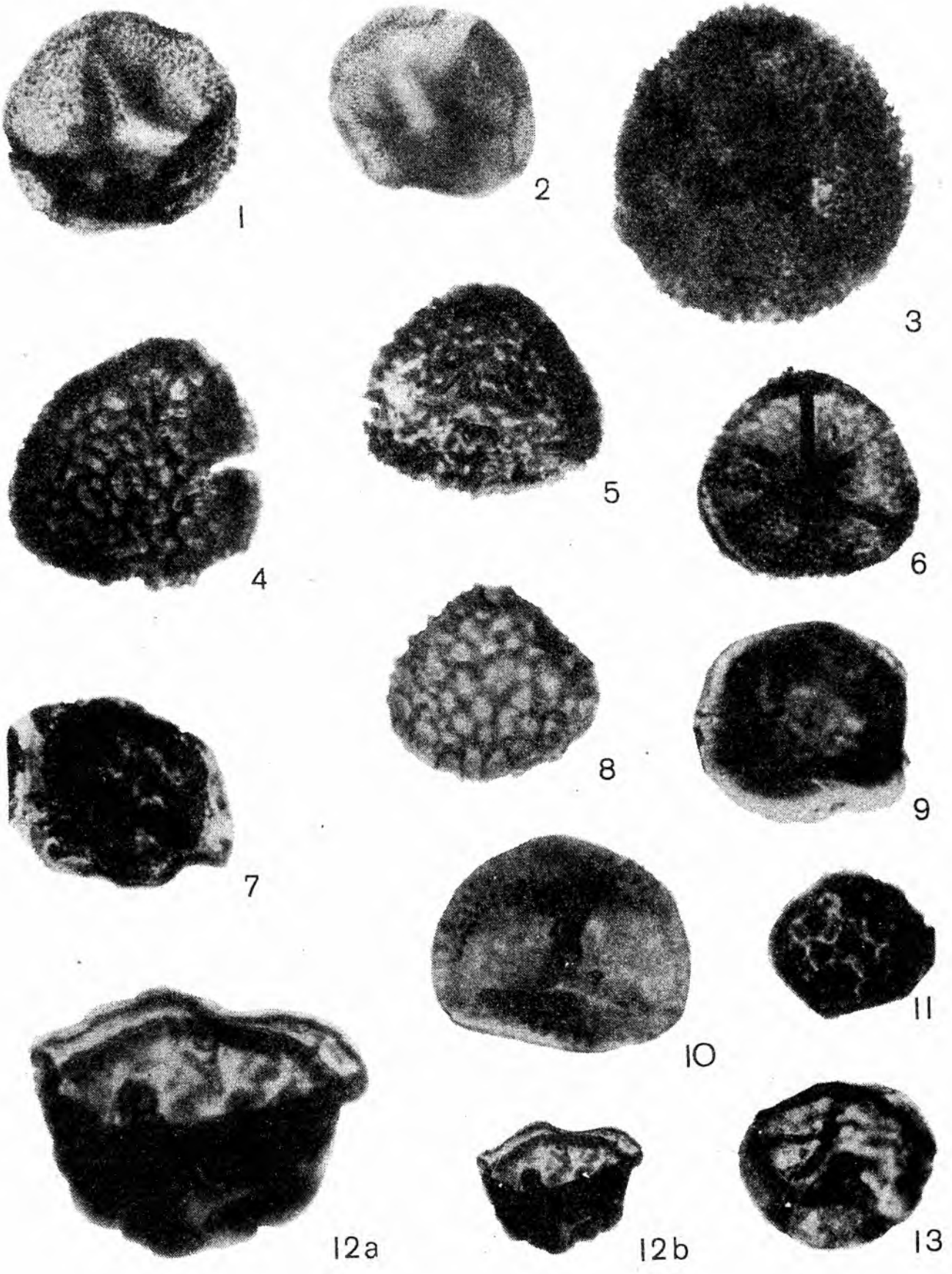

6

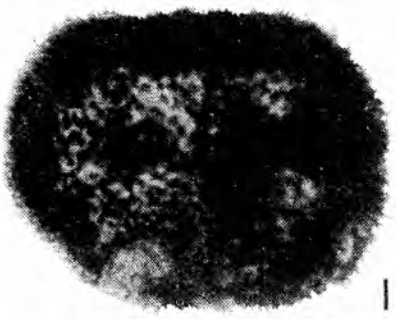

7


8

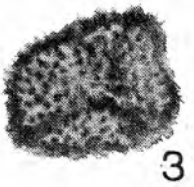

9


10

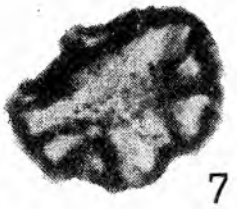

1
2
3
4
5
6
7
8
9
10
11
12a
12b
13

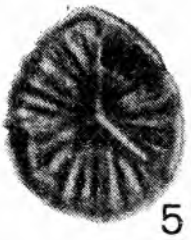

1

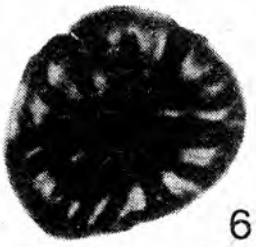

2

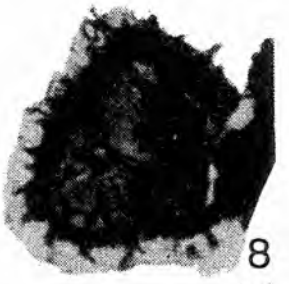

3

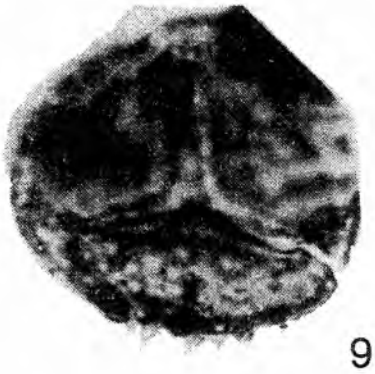

4

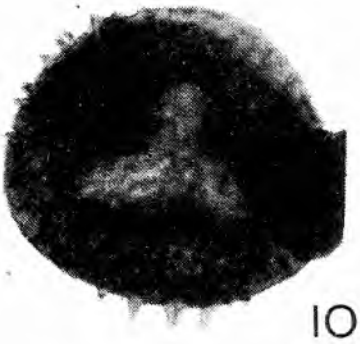

7


5

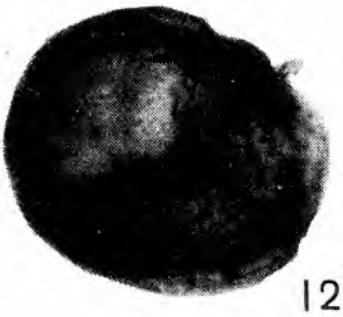

6


8

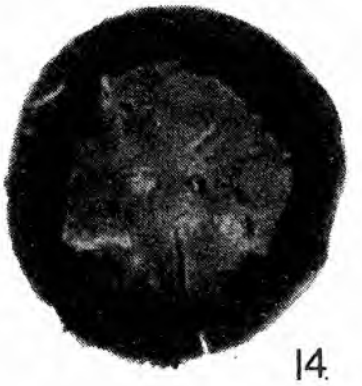

9


10


11


12


13


14