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# THE LOWER CARBONIFEROUS *PROLYCOSPORA CLAYTONII* ZONE OF WESTERN POMERANIA AND ITS EQUIVALENTS IN BELORUSSIA AND NORTHWESTERN EUROPE

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A b s t r a c t : The upper boundary of the *Prolycospora claytonii* (Cl) Zone of Western Pomerania is defined at the first appearance of *Lycospora pusilla* Somers. Spore assemblages from this zone are compared with those from the equivalent deposits of Belorussia, and stratigraphical correlations between Belorussia, Poland and northwestern Europe are attempted. The palynological, conodont and other biostratigraphical data suggest that the zone spans the uppermost part of the Hastarian Stage and the Ivorian Stage. Taxonomic relationships between some important miospore taxa are discussed, and one new combination is proposed. *Schopfites claviger* Sullivan, *Raistrickia clavata* (Haquebard) Playford, and *Spelaeotriletes pretiosus* (Playford) Neves & Belt are recorded from Belorussia for the first time.

K e y w o r d s : Palynostratigraphy, spore taxonomy, Lower Carboniferous, Belorussia, Poland.

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## INTRODUCTION

The *Prolycospora claytonii* (Cl) Interval Zone has been distinguished by Turnau (1978) in the Tournaisian deposits of Western Pomerania in northern Poland (Fig. 1). The base of the zone was established on the first appearance of *Prolycospora claytonii* Turnau which is the principal diagnostic species for the zone. The upper boundary of the zone was not defined because the deposits included in the zone had an erosional upper boundary. The results of further palynological studies in that area allow to define this boundary on the first appearance of *Lycospora pusilla* (Ibrahim) Somers. The Cl Zone was previously subdivided into 3 subzones (lower, middle and upper Cl), but the

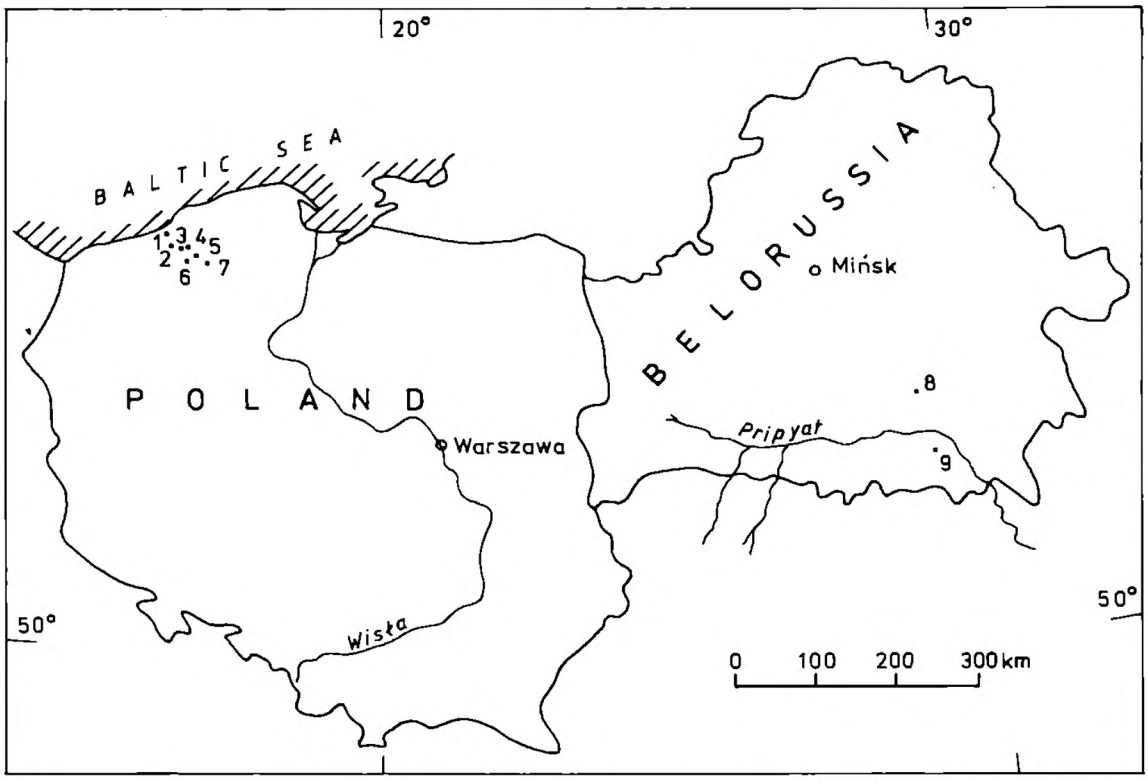



Fig. 1 Map of Poland and Belorussia showing location of boreholes discussed in text. 1 – Sarbinowo 1, 2 – Biesiekierz 1, 3 – Kłanino 1, 4 – Karsina 1, 5 – Drzewiany 1, 6 – Chmielno 1, 7 – Biały Bór 1, 8 – Oktyabrskaya 30, 9 – Zaozernaya 32

Mapa Polski i Białorusi przedstawiająca lokalizację otworów wiertniczych dyskutowanych w tekście. Objaśnienia numerów - patrz wyżej

results of a subsequent palynological work suggest that only two subzones can be distinguished. The redefinition of the Cl subzones is presented herein.

The miospore assemblages of the Cl Zone include several species of wide geographical distribution and well established stratigraphical ranges which has permitted correlation with the miospore successions in the British Isles at some stratigraphical levels (Clayton & Turnau, 1990).

Joint studies by the authors on the material from Belorussia and Poland have elucidated the taxonomic relationships between several important miospore taxa. It appears that the late Tournaisian miospore assemblages of the two regions share more common species than previously thought. Some of them are also known from northwestern Europe which permits some degree of correlation between the miospore zonal schemes for late Tournaisian of the three regions.

## LITHOLOGICAL DESCRIPTIONS

The informal lithostratigraphical division of the Lower Carboniferous deposits of Western Pomerania was introduced by Żelichowski (1983) and Żeli-

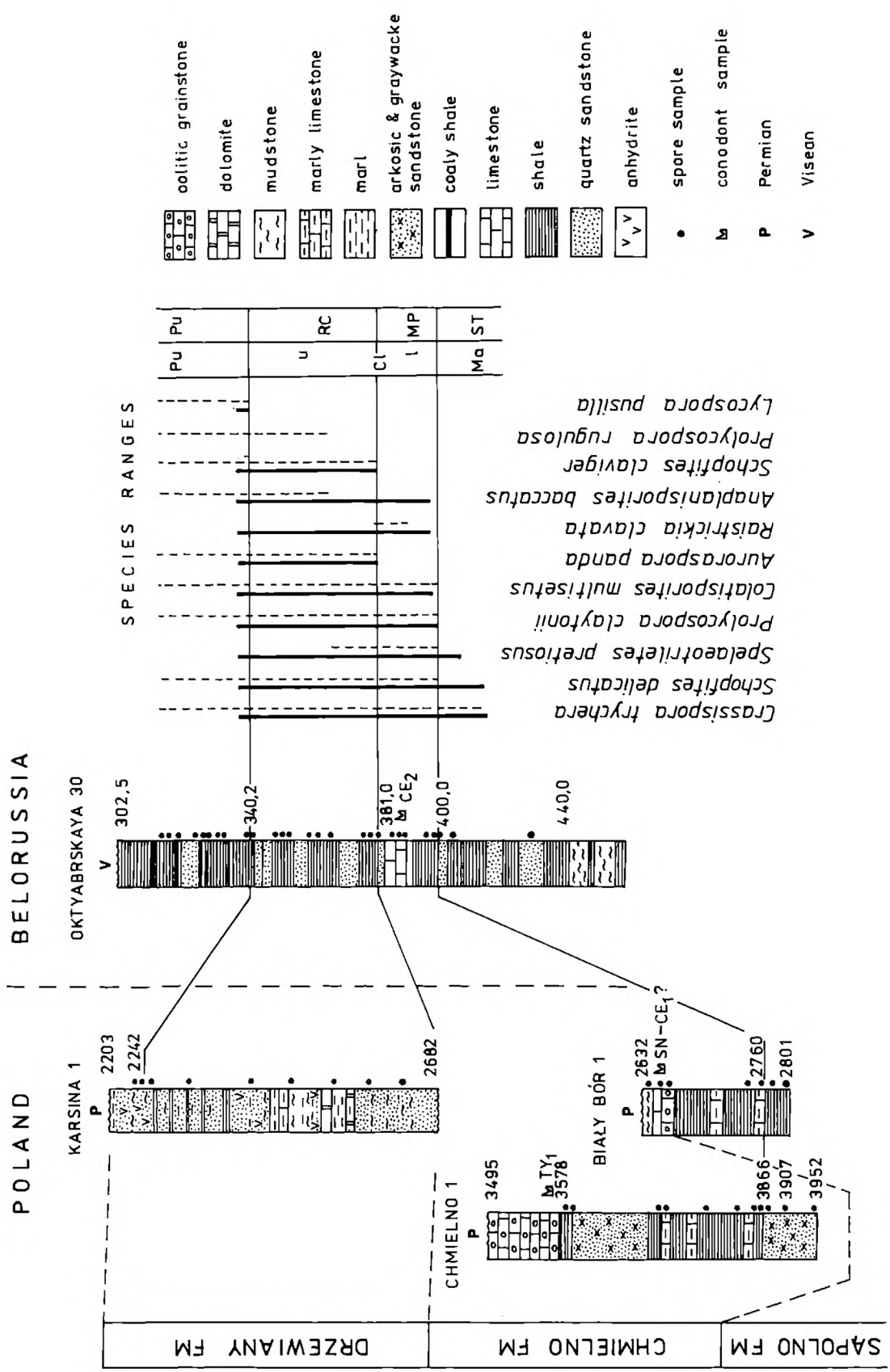
chowski & Łoszewska (1987), who distinguished several units called "complexes". In this paper they are informally called formations for simplicity reason. The *P. claytonii* Zone has been distinguished in the uppermost part of the Sąpolno Formation, in the Chmielno Formation and in the lower part of Drzewiany Formation (Fig. 2). The Sąpolno Formation consists chiefly of alternating marly shales and marly limestones. The succeeding Chmielno Formation includes arkosic sandstones and greywackes, marly shales, oolitic oncoidal grainstones and marls. The overlying Drzewiany Formation is chiefly composed of alternating quartz sandstones and mudstones. Marine faunas described by Matyja (1976), and Korejwo (1979, 1993) are common in the Sąpolno and Chmielno formations but rare in the Drzewiany Formation. The deposits described above were deposited in the marginal part of a shallowing marine basin.

In Belorussia, strata assignable to the *P. claytonii* Zone occur in the eastern and northern part of the Pripyat Depression (Fig. 1). These strata are chiefly composed of alternating clayey shales and quartz sandstones. Coal layers occur within shales in the upper part of these deposits, and limestones bearing marine fauna are a subordinate component of the lower part of these sequences.

## INDEPENDENT BIOSTRATIGRAPHICAL CONTROL

In Western Pomerania, deposits included in the *P. claytonii* Zone contain macrofauna which was described by Korejwo (1979, 1993). The known stratigraphical ranges of bivalve and brachiopod species recorded by this author are either Tournaisian or Tournaisian-Visean. Korejwo (1993) ascribed an early Visean age to deposits included in the Cl Zone from the Karsina 1 borehole above the depth 2320 m, and from two other boreholes (Drzewiany 1 and Gozd 2). This assignement disagress with the miospore data and is not corroborated unequivocally by the macrofaunistic evidence.

Conodonts *Polygnathgus* cf. *purus purus* Voges were found (Matyja, 1976) in the Biały Bór 1 borehole (Fig. 1) at a level above the base of the Cl Zone (Fig. 2), which may suggest that this base is not younger than the Lower *crenulata* Zone. This, however, must be considered with caution because of the poor preservation and uncertain determination of the conodonts. Conodonts of the *typicus* Zone, including, among other, *Cladagnathus unicornis* Rhodes, Austin & Druce, *Gnathodus cuneiformis* Mehl & Branson, *Pseudopolygnathus multistriatus* Mehl & Thomas and *Polygnathus communis carina* Hass were found in the Chmielno 1 and Drzewiany 1 boreholes (H. Matyja, personal information, 1992) in association with spore assemblages of a lower part of the Cl Zone (but above the base of the zone). In the Kłanino 1 borehole miospore assemblages indicative of the (new) Upper *P. claytonii* Subzone occur in association with assemblages of benthic ostracods characterised by


oolitic grainstone
dolomite
mudstone
marly limestone
marl
arkosic & graywacke sandstone
coaly shale
limestone
shale
quartz sandstone
anhydrite
spore sample
conodont sample
Permian
Visean
Pu
RC
MP
ST
u
l
Cl
Ma
SPECIES RANGES
Crassispora trychera
Schopfites delicatus
Spelaeotriletes pretiosus
Prolycospora claytonii
Colatisporites multisetus
Auroraspora panda
Raistrickia clavata
Anapiculisporites baccatus
Schopfites clavigera
Prolycospora rugulosa
Lycospora pusilla
BELORUSSIA
POLAND
OKTYABRSKAYA 30
302,5
340,2
381,0
CE2
400,0
440,0
KARSINA 1
2203
2242
2682
CHMIELNO 1
3495
TY1
3578
BIAŁY BÓR 1
2632
SN-CE1?
2760
2801
3866
3907
3952
DRZEWIANY FM
CHMIELNO FM
SAPOLNO FM

the presence of *Glyptopleura ruegensis* Blumenstengel and *Carbonita fabulina* Jones & Kirkby (B. Żbikowska, personal information, 1992). These ostracod assemblages contain species known from uppermost Tournaisian and Visean of Germany and Great Britain.

It may be concluded that the *P. claytonii* Zone in Western Pomerania is representative of the uppermost part of the Hastarian Stage and the Ivorian Stage.

In Belorussia, conodonts and miospore assemblages were found (Kruchek *et al.*, 1981) in the borehole Oktyabrskaya 30 (Figs 1, 2). The conodont assemblage includes *Polygnatus parapetus* Druce, *P. inornatus* Branson, *P. lobatus* Branson & Mehl, *Clydagnathus cavusformis* Rhodes, Austin & Druce, *C. gilvernensis* Rhodes, Austin & Druce, *Patrognathus variabilis* Rhodes, Austin & Druce (= *P. andersoni* Klapper), *Bispathodus stabilis* (Branson & Mehl), *B. plumulus* Rhodes, Austin & Druce, *B. anteposicornis* (Scott). Considering the ranges of these species on the Russian Platform, Kruchek *et al.* (1981) suggested that this assemblage represents the Upper *crenulata* Zone.

## CHARACTERISTIC OF THE NEW *P. CLAYTONII* (CL) ZONE, REDEFINITION OF THE SUBZONES AND OF THE BASE OF THE SUCCEEDING *L. PUSILLA* (PU) ZONE

### Base of the P. claytonii (Cl) zone

The base of the *P. claytonii* (Cl) Interval Zone is defined on the first appearance of *Prolycospora claytonii* Turnau. *Corbulispora margodentata* (Turnau) Ravn appears at the base of the zone, and *Spelaeotriletes pretiosus* (Playford) Neves & Belt appears close to this base (either just above or just below the base in various boreholes). Several other species appear above, but very close, to the base of the zone. These are: *Acanthotriletes socraticus* Neves and Ioannides, *Anaplanisporites baccatus* (Hoffmeister, Staplin & Malloy) Smith & Butterworth, *Colatisporites multisetus* (Luber) comb. nov., *Dictyotriletes membranireticulatus* Bertelsen, and *Raistrickia clavata* (Haquebard) Playford.

Fig. 2 Range chart of selected spore species occurring in the samples studied from some boreholes from Poland (continuous lines) and Belorussia (dashed lines). The conodont zones identified are also shown

Zasięgi stratygraficzne wybranych gatunków miospor występujących w próbkach z kilku otworów wiertniczych z Polski (linie ciągłe) i Białorusi (linie przerywane). Pokazano również stwierdzone zony konodontowe

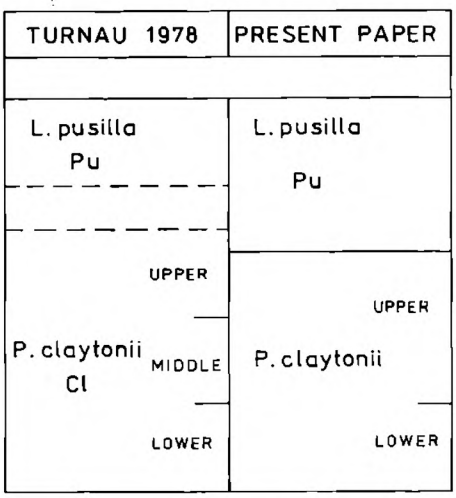



Fig. 3 Correlation of the redefined P. claytonii (Cl) Zone with previous zonation scheme

Korelacja nowej zony P. claytonii (Cl) z poprzednim schematem zonalnym

## Redefinition of the *P. claytonii* subzones

The Cl Zone was originally subdivided into three subzones (Turnau, 1978). Subsequent work showed however, that it was not possible to distinguish between the middle and the upper subzones. This is because the base of the upper subzone was established on the first appearance of *Rugospora minuta* Neves & Ioannides but later it was discovered that this species ranges from the base of the zone. The *P. claytonii* Zone is now subdivided into two subzones – the lower Cl subzone and the upper Cl subzone. The new upper subzone is the equivalent of the former middle subzone and the part of the former upper subzone up to the level of the first appearance of *L. pusilla* (Fig. 3).

The lower Cl subzone is characterised by the concurrence of the species first appearing at its base (see above) and *Convolutispora major* (Kedo) Turnau, *T. raritubercula*ta (Luber) Potonie & Kremp, and *T. ordinaria* Staplin & Jansonius which become extinct at the top of the subzone.

The base of the new upper Cl subzone is marked by the first appearance of *Schopfites claviger* Sullivan emend. Higgs, Clayton & Keegan, *Auroraspora panda* Turnau, *Auroraspora cf. solisortus* Hoffmeister, Staplin & Malloy and *Cinturasporites multiplicabilis* (Kedo) Byvsheva. *Prolycospora claytonii*, *Anaplanisporites baccatus*, *Crassispora trychera* Neves & Ioannides, *Colatisporites multisetus* and *Raistrickia corynoges* Sullivan are very common components of the miospore assemblages of this subzone.

## Base of *L. pusilla* (Pu) Zone

The *L. pusilla* (Pu) Zone is an informal zone distinguished by Turnau (1979) in the Sarbinowo 1 borehole. In this well, the deposits included in the Pu Zone rest unconformably on some Ordovician strata, and therefore the base of the zone was not defined. The zone was probably equivalent to upper part of the Pu Zone *(sensu* Neves *et al.*, 1963).

The base of the (new) Pu Zone is defined on the appearance of *Lycospora pusilla* Somers. The reference section of this boundary is the borehole Karsina 1 in which *L. pusilla* appears at the depth 2242 m (Fig. 2).

Turnau (1978) stated that *L. pusilla* occurs throughout the Cl Zone. This untrue notion was based on the fact that this species associated with *P. claytonii* was found in the Biesiekierz 1 borehole at a depth between 2887 and 2893 m (cf. Turnau, 1979). The miospore assemblage from this depth was restricted in composition, and did not contain species diagnostic of any the Cl subzones. It was thought to represent a lower Cl Zone because of the position of the sample only 77 m above the level of the highest assemblage of the preceding *C. major* (Ma) Zone. It is now clear that this assemblage comes from a level much higher than the lower Cl subzone because a benthic ostracod assemblage indicative of a latest Tournaisian or Visean age (Żbikowska, personal information, 1992) was found in the Biesiekierz 1 borehole just below the level under discussion. It may be added that in the Klanino 1 borehole this ostracod assemblage is associated with well preserved and diversified miospore assemblages typical of the (new) upper Cl subzone.

## EQUIVALENTS OF THE *P. CLAYTONII* ZONE IN BELORUSSIA

The miospore material from the Pripyat Depression in Belorussia concerned in the present paper has been derived from the archive slide collection of the late Galina I. Kedo. The miospore assemblages from this collection were discussed by Kedo (1963, 1966) and by Kedo & Golubtsov (1981). In the latter paper, it was suggested that these assemblages came from the Tournaisian-Visean boundary beds.

The reexamined material was derived from the Oktyabrskaya 30 and Zaozernaya 32 boreholes. The miospore succession representing the equivalent of the complete Cl Zone is produced in the Octyabrskaya 30. The composition of miospore assemblages, and ranges of important species have been studied in detail, and two new local miospore zones have been established by the first author of the present paper. These are the *Colatisporites multisetus - Spelaeotriletes pretiosus* (MP) Zone and *Tumulispora rarituberculata - Schopfites claviger* (RC) Zone. They are interval zones but they are named using two species names in accord with the Belorussian terminology.

The base of the MP Zone is defined on the first appearance of *Colatisporites multisetus* (Luber) comb. nov, *Spelaeotriletes pretiosus* (Playford) Neves & Belt and *Prolycospora claytonii* Turnau (Fig. 2).

The characteristic association of species of the MP Zone includes *Verrucosisporites nitidus* Playford, *Crassispora trychera* Neves & Ioannides, *Vallatisporites verrucosus* Haquebard and *Auroraspora macra* Sullivan. These species occur in considerable quantities. *Lophozonotriletes excisus* Naumova disappears below the base of the MP Zone.

The succeeding RC Zone is characterised by the first appearance of *Schopfites claviger* Sullivan. *Tumulispora rarituberculata* (Luber) Potonie & Kremp is present, for the last time in considerable numbers. The characteristic association of species includes *Cincturasporites multiplicabilis* (Kedo) Byvsheva, *Anaplanisporites baccatus* Hoffmeister, Staplin & Malloy, *Prolycospora rugu-*

*losa* (Butterworth & Spinner) Turnau, *Simozonotriletes sublobatus* (Waltz) Potonie & Kremp, and *Trilobozonotriletes incisotrilobus* (Naumova) Byvsheva. *Prolycospora claytonii*, *Colatisporites multisetus*, and *Auroraspora macra* Sullivan are abundant. The upper boundary of this zone is defined by the first appearance of *Lycospora pusilla* (Ibrahim) Somers. This boundary is the lower boundary of the *Lycospora pusilla* (Pu) Zone.

## CORRELATION WITH NORTHWESTERN EUROPE

The correlation between the late Tournaisian miospore zonations of Poland and Belorussia discussed above and that used in northwestern Europe (Clayton *et al.*, 1978) is shown in Fig. 4. In Western Pomerania, *Spelaeotriletes pretiosus* (Playford) Neves and Belt appears in a few borcholes just above the base of the Cl Zone but just below this base in the Chmielno 1 borchole. At present, it can only be stated that in Pomerania the levels of the first appearances of *P. claytonii* and *S. pretiosus* are close. In Belorussia, in Oktyabrskaya 30, both species appear at the same level. The bases of the MP Zone and the Cl Zone are considered to be coinciding with each other. This level is close to, or coinciding with, the base of the *Spelaeotriletes pretiosus - Raistrickia clavata* (PC) Zone of the British Isles defined by Clayton *et al.* (1978). The bases of the RD Zone and the Upper Cl Zone are considered equivalent of the base of the *S. claviger - A. macra* (CM) Zone basing on the first appearance of *Schopfites claviger* Sullivan. The first appearance of *Lycospora pusilla* Somers marks the base of the *L. pusilla* (Pu) zone in the three regions under comparison.

The independent biostratigraphical data on the zones discussed for Belorussia (Kruchek *et al.*, 1981), Ireland (Clayton *et al.*, 1978) and Belgium (Higgs *et al.*, 1992) are in agreement. According to these data (discussed in the section "Independent biostratigraphical control") the base of the MP and PC zones corresponds to a level within the Upper *S. crenulata-isosticha* Conodont Zone. The suggestion that in Western Pomerania the base of the Cl Zone is not younger than the Lower *S. crenulata* Zone is based on very poor evidence and should be disregarded at present.

The independent biostratigraphical data suggest that the upper boundary of the Cl Zone in Western Pomerania and the CM Zone in Ireland (Phillips & Clayton, 1980) corresponds to a level close to the Tournaisian-Visean boundary.

## TAXONOMIC NOTES

In this section, we are concerned mainly with the specific identity of some species which occur in Western Pomerania and Pripyat Depression but have been, until now, known under different names, or have been recorded for the

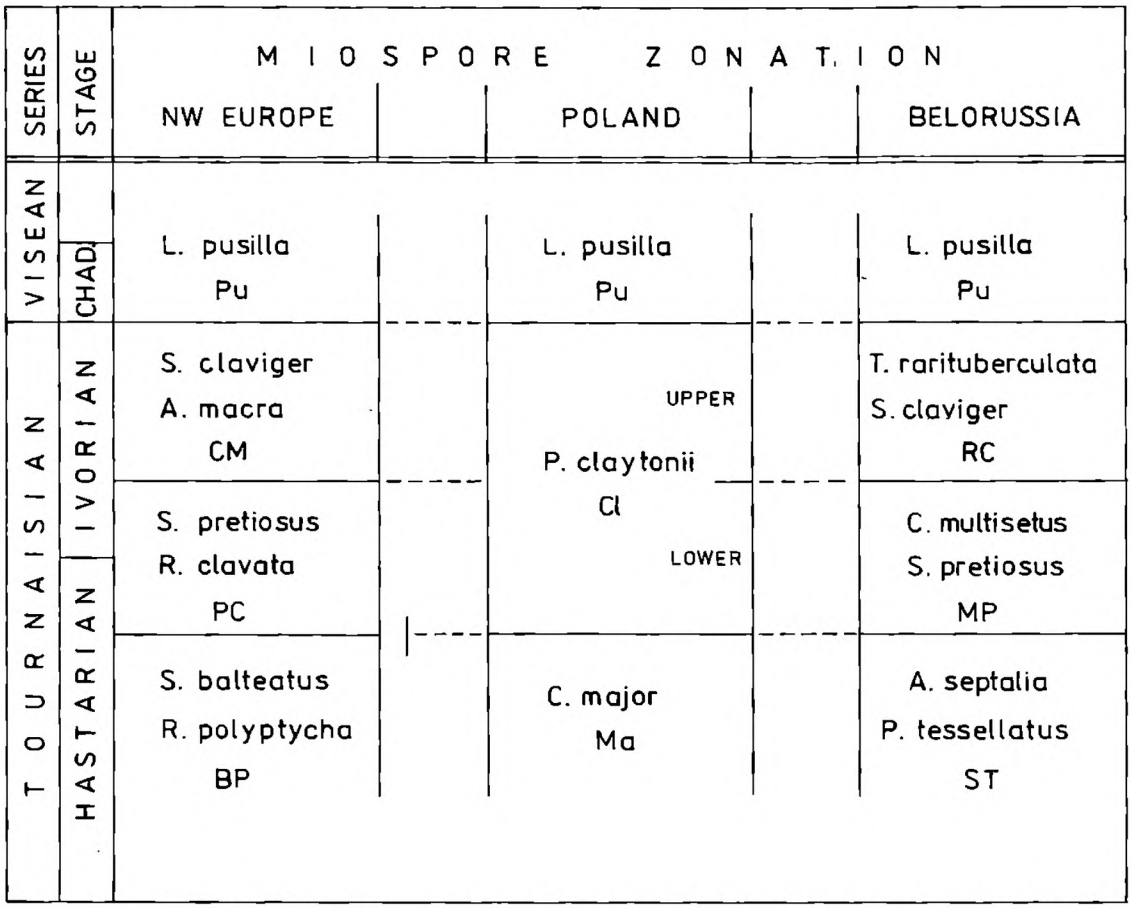



Fig. 4 Correlation of miospore zonation schemes from northwestern Europe, Poland and Belorussia

Korelacja miosporowych schematów stratygraficznych północno-zachodniej Europy, Polski i Białorusi

first time during the present investigation. The synonymy lists concern, with few exceptions, only the material examined by the present authors. The illustrated material is housed in Bel NIGRI, Minsk, and the Institute of Geological Sciences, Polish Academy of Sciences, Kraków. In the explanations of the Plate I the specimens from the Pripyat Depression are designated Bel NIGRI, and those from Western Pomerania are designated ING PAN.

Genus *Colatisporites* Williams in Neves *et al.*, 1973
*Colatisporites multisetus* (Luber) n. comb.
Pl. I: 8 - 10

Basionym: *Azonotriletes multisetus* Luber 1938 in Luber and Waltz, Trudy Centralnogo Nauchno-Issledovatelskogo Geologo-Razvedochnogo Instituta, 105: p. 23, pl. 5, 61.
1963 *Acanthotriletes multisetus* (Luber) Kedo, p. 43, pl. 2, 51, 52.
1966 *Azonotriletes multisetus* (Luber) Kedo, p. 56, pl. 1, 36-38.

1973 *Colatisporites denticulatus* Neville in Neves *et al.*, p. 41-42, pl. 2, 14-16.
1978 *Apiculiretusispora multiseta* (Luber) Butterworth & Spinner in Turnau, p. 6, pl. 1, 22, 23.
1979 *Apiculiretusispora multiseta* (Luber) Butterworth & Spinner in Turnau, pl. 1, 7, 8.
1990 *Colatisporites denticulatus* Neville in Clayton & Turnau, p. 51, pl. 1, 2, 3.
Description (specimens from the Pripyat Depression): Spores of subcircular amb, ornamented distally and proximo-equatorially by closely set spines about 1 µm wide at base and 2 µm long. Trilete mark indistinct, rays 1/2 to 2/3 spore radius long. Intexine smooth, not always distinct, radius about 5/6 of spore radius.
Size range: 35 (48) 60 µm (16 specimens).
Remarks: Luber (in Luber & Waltz, 1938) considered *A. multisetus* to be an acamerate species. *Colatisporites denticulatus* was erected to accommodate camerate spores having identical sculpture as *A. multisetus*. In populations of *C. multisetus* from Western Pomerania and Pripyat Depression, both camerate and apparently acamerate but otherwise identical specimens have been observed. We believe that the ornamentation of very crowded spines often obscures the intexine margin and we consider *A. multiseta* and *C. denticulatus* to be synonyms.

## Genus *Schopfites* Kosanke, 1950
## *Schopfites claviger* Sullivan emend Higgs, Clayton & Keegan, 1988
## Pl. I: 1 - 4

1963 *Acanthotriletes dominans* Kedo (part), p. 43, pl. 2: 54, non 53.
NON 1978 *Apiculiretusispora dominans* (Kedo) Turnau, p. 6, pl 1: 11.

Description (specimens from the Pripyat Depression): Spores of subcircular amb, compressed in various positions (proximo-distal, oblique or lateral). Trilete mark invisible to barely perceptible, trilete rays 2/3 spore radius long. Intexine appressed to exoexine or detached over distal hemisphere. Ornamentation distal and proximo-equatorial, consisting of pila, rounded bacula, and blunt conical processes. Elements of ornamentation 2-4 µm high, 1.5-4 µm wide, 1-6 µm apart.
Size range: 40 (43) 48 µm (7 specimens)
Remarks: Playford & Satterthwait (1986) included *S. claviger* in *Raistrickia* (Schopf, Willson & Bentall) Potonie & Kremp. However, *Raistrickia* is ornamented mainly with bacula while *S. claviger* is pilate - verrucate.

The examination of the slides from the Kedo's collection marked as those containing *Acanthotriletes dominans* revealed that they contained specimens typical of *S. claviger* and other ones similar to *S.* cf. *delicatus* Higgs (Higgs, Clayton & Keegan, 1988). It can be judged from Kedo's illustrations (Kedo, 1963, pl. 2: 53, 54) that the concept of *A. dominans* is wider than that of *S. claviger* (Sullivan) emend Higgs, Clayton & Keegan, and that it includes *S. claviger* and *S.* cf. *delicatus*.

The specimens of *S. claviger* from the type material described by Sullivan (1968) are acamerate and have no trilete mark, but Clayton (1971) noted the presence of intexine and trilete mark in some specimens from Scotland.

## Genus *Prolycospora* Turnau, 1978
## *Prolycospora claytonii* Turnau, 1978
## Pl. I: 11, 12

NON 1953 *Lophotriletes minutissimus* Naumova, p. 56, pl.7: 11.
1963 *Lophotriletes minutissimus* Naumova; Kedo, p. 49-50, pl. 3, 76, 77.
1966 *Lophotriletes minutissimus* Naumova; Kedo, p. 49, pl. 2, 41-43.

Description (type material): Spores of rounded triangular or subcircular amb, margin slightly wavy. Trilete mark distinct to indistinct, trilete rays straight, extending to the cingulum,

accompanied by fine lips, each 1 μm wide, ornamented by minute grana; this ornamentation continues over the poleward portion of cingulum. Cingulum 1/6 to 1/5 radius of spores, distinctly to indistinctly delimited from the central area. Distal spore surface ornamented by discrete, closely spaced (about 1 μm apart) verrucae 1-4.5 μm in basal width, low, rounded in profile. Bases of varrucae subcircular to irregular. Seven to eleven verrucae may be counted at each interradial margin of the spore body. Exine of contact faces ornamented by densely spaced grana (0.5 μm in diameter). Proximal side of cingulum smooth or granulate over its poleward part.

Size range: 19.5 (28) 35 μm (28 specimens).

Remarks: *Lophotriletes minutissimus* Naumova (1953, p. 56, pl. 7, fig. 11) from the Middle and Upper Devonian of the Russian Platform has no cingulum and has shorter trilete rays, thus, it can not be considered conspecific with *L. minutissimus* Naumova *sensu* Kedo (1963).

## Genus *Spelaeotriletes* Neves and Owens, 1966
## *Spelaeotriletes pretiosus* (Playford) Neves and Belt, 1970
## Pl. I: 17

Remarks: The specimens of this species from Western Pomerania which are up to 84 μm in diameter are smaller from those described by Playford (1964) and by Higgs *et al.* (1988), who recorded the size ranges 98-195 μm and 68-110 μm respectively. The ornament in both Polish and Belorussian specimens consists of verrucae and mamillate verrucae which are 2-4 μm in basal width while those in the Canadian and Irish specimens are 2-8 μm. Otherwise, the morphography of the Polish and Belorussian specimens of *S. pretiosus* conforms to the original diagnosis.

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## REFERENCES

Clayton, G., 1971. A Lower Carboniferous miospore assemblage from the Calciferous Sandstone Measures of the Cockburnspath region of eastern Scotland. *Pollen et Spores*, 12: 577 – 600.

Clayton, G. & Turnau, E., 1990. Correlation of the Tournaisian miospore zonations of Poland and the British Isles. *Ann. Soc. Geol. Polon.*, 60: 45 – 58.

Clayton, G., Higgs, K., Keegan, J. B. & Sevastopulo, G. D., 1978. Correlation of the palynological zonation of the Dinantian of the British Isles. *Palinologia*, 1: 137 – 147.

Higgs, K., Clayton, G. & Keegan, J. B., 1988. Stratigraphic and systematic palynology of the Tournaisian rocks of Ireland. *Geol. Surv. Ireland, Spec. Pap.* 7: 1 – 93.

Higgs, K., Dreesen, R., Dusar, M. & Streel, M., 1992. Palynostratigraphy of the Tournaisian (Hastarian) rocks in the Namur Synclinorium, West Flanders, Belgium. *Rev. Palaeobot. Palynol.*, 72: 149 – 158.

Kedo, G. I., 1963. Spores of Tournaisian Stage of Pripyat Depression and their stratigraphical value (in Russian). *Paleontologiya i Stratigrafiay BSSR*, 4: 3 – 121.

Kedo, G. I., 1966. Spores of Lower Carboniferous of Pripyat Depression. *Paleontologiya i Stratigrafiya BSSR*, 5: 3 – 143.

Kedo, G. I. & Golubtsov, V. K., 1981. On the age of kaoline beds of the Lower Carboniferous of Pripyat Depression (in Russian). In: Garetsky, R. G. (Editor), *Geologiya zapada Vostochno-Evropeiskoy platformy. Nauka i Tekhnika*, Minsk. pp. 92 – 102.

Korejwo, K., 1979. Biostratigraphy of the Carboniferous sediments from the Wierzchowo area (Western Pomerania). *Acta Geol. Polon.*, 29: 457 – 473.

Kruchek, S. A., Barekov, I. S. & Alekseev, A. S., 1981. Conodonts of Carboniferous deposits of Pripyat Depression (in Russian). In: *Materiyaly po stratigrafii Belorusii. Nauka i Tekhnika*, Minsk, pp. 76 – 77.

Lyuber, A. A. & Waltz, I. E., 1938. Classification and stratigraphical importance of spores from some Carboniferous sites in the USSR. *Trudy Centralnogo Nauchno-Issledovatelskogo Geologo-Razvedochnogo Instituta*, 105: 1 – 46.

Matyja, H., 1976. Biostratigraphy of the Devonian-Carboniferous passage beds from some selected profiles of NW Poland. *Acta Geol. Polon.*, 26: 489 – 539.

Naumova, S. N., 1953. Spore-pollen assemblages of upper Devonian of Russian Platform and their importance in stratigraphy. *Trudy Instituta Geologicheskikh Nauk*, 143: 1 – 197.

Neves, R. & Belt, E. S., 1970. Some observations on Namurian and Visean spores from Nova Scotia, Britain and northern Spain. *Compte Rendu 6e Congr. Intern. Stratigr. Geol. Carbonifére Sheffield.* I., *Ernest v. Aelst*, Maastricht. pp.1233 – 1242.

Neves, R., Gueinn, K.J., Clayton, G., Ioannides, N. & Kruszewska, K., 1973. Palynological correlations within the Lower Carboniferous of Scotland and Northern England. *Trans. Roy. Soc. Edinb.*, 69: 23 – 70.

Neves, R. & Owens, B., 1966. Some Namurian camerate miospores from the English Pennines. Pollen et Spores, 8: 337 – 360.

Phillips, W. E. A. & Clayton, G., 1980. The Dinantian clastic succession of Clare Island, Co. Mayo. *J. Earth Sci. R. Dubl. Soc.*, 2: 115 – 135.

Playford, G., 1964. Miospores from the Mississippian Horton Group, eastern Canada. *Geol. Surv. Canada Bull.*, 107: 1 – 47.

Playford, G. & Satterthwait, D. F., 1986. Lower Carboniferous (Visean) spores of the Bonaparte Gulf Basin, northwestern Australia: part two. *Palaeontogr. B.* 200: 1 – 32.

Sullivan, H., 1968. A Tournaisian spore flora from the Cementstone Group of Ayrshire, Scotland. *Palaeontology*, 11: 116 – 131.

Turnau, E., 1978. Spore zonation of uppermost Devonian and Lower Carboniferous deposits of Western Pomerania (N. Poland). *Meded. Rijks Geol. Dienst*, 30: 1 – 30.

Turnau, E., 1979. Correlation of Upper Devonian and Carboniferous deposits of Western Pomerania, based on spore study (in Polish, English summary). *Ann. Soc. Geol. Polon.*, 49: 231 – 269.

Żelichowski, A. M., 1983. Carboniferous of Western Pomerania (in Polish, English summary). *Przegl. Geol.*, 31 (6): 356 – 354.

Żelichowski, A. M. & Łoszewska, Z., 1987. Carboniferous (in Polish, English summary). *Prace Inst. Geol.*, 119: 26 – 51.

## Streszczenie

# ZONA *PROLYCOSPORA CLAYTONII* DOLNEGO KARBONU POMORZA ZACHODNIEGO I JEJ ODPOWIEDNIKI W BIAŁORUSI I EUROPIE PÓŁNOCNO-ZACHODNIEJ

**Wioletta Awchimowicz & Elżbieta Turnau**

Zredefiniowano zonę *Prolycospora claytonii* (Cl) wyróżnioną wcześniej przez Turnau (1978) w utworach Turneju Pomorza Zachodniego (Fig. 1). Dolną granicę tej zony stanowi poziom pierwszego pojawienia się gatunku *Prolycospora claytonii* Turnau. Górna granica zony Cl nie została , w momen-

cie jej ustanowienia, określona gdyż nie znano wtedy profilu, w którym obserwowano by przejście między zoną Cl a zoną następną. Obecnie górna granica zony Cl została zdefiniowana, przebiega ona w poziomie pierwszego pojawienia się *Lycospora pusilla* Somers. Stratotypem tej granicy są utwory formacji Drzewiańskiej w otworze Karsina 1, w których *L. pusilla* pojawia się po raz pierwszy na głębokości 2242 m (Fig. 2).

Zona Cl, w momencie jej ustanowienia, podzielona została na trzy podzony (dolną, środkową i górną). Późniejsze badania wykazały iż podział ten jest niepraktyczny, gdyż gatunek *Rugospora minuta* Neves & Ioannides, którego pojawienie się wyznaczało dolną granicę górnej podzony, w niektórych otworach występuje od podstawy zony Cl. Obecnie zredefiniowano podzony zony Cl. Zona Cl podzielona została na dwie podzony (dolną i górną). Dolna podzona pozostaje niezmieniona w stosunku do poprzedniej, górna podzona zawiera dawną środkową oraz część dawnej górnej podzony (do poziomu pierwszego pojawienia się *L. pusilla*, patrz Fig. 3). Postawy tego podziału zilustrowano na Fig. 2.

Zespoły miospor zony Cl zawierają wiele gatunków wspólnych z zespołami tego samego wieku znanymi z depresji Prypeci w Białorusi oraz z Europy północno-zachodniej, co umożliwia korelację schematów sporowych. Próbę takiej korelacji przedstawiono na Fig. 4. Korelacja ta sugeruje, że zona Cl obejmuje wyższy Hastar i Iwor.

## EXPLANATION OF PLATE

Plate I

All magnifications x 500, except when indicated otherwise

1-4 — *Schopfites dominans* (Kedo) n. comb., 1, Zaozernaya 32, depth 498.0 m; 2-4, Zaozernaya 32, depth 484.0 m, Bel NIGRI.

5 — *Raistrickia clavata* (Haquebard) Playford, Karsina 1, depth 2535.3 m, ING PAN.

6 — *Crassispora trychera* Neves and Ioannides, Wierzchowo 9, depth 3424.0 m, ING PAN.

7 — *Anaplanisporites baccatus* (Hoffmeister, Staplin & Malloy) Smith & Butterworth, Oktyabrskaya 30, depth 397.5 m, Bel NIGRI.

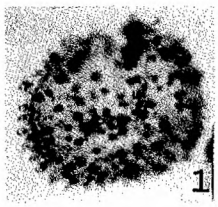
8-10 — *Colatisporites multisetus* (Lyuber) n. comb., Zaozernaya 32, depth 484.0 m, Bel NIGRI.

11-13 — *Prolycospora claytonii* Turnau, 11, Karsina 1, depth 2242.1 m, ING PAN, x 1000; 12. Zaozernaya 32, depth 484.0 m, Bel NIGRI, x 1000; 13, Niekłonice 1, depth 2527.5 m, ING PAN, x 1000;

14 — *Lycospora pusilla* (Ibrahim) Somers, Oktyabrskaya 30, depth 315 m, Bel NIGRI.

15-16 — *Auroraspora panda* Turnau, 15, Wierzchowo 9, depth 3424.0 m, 16, Karsina 1, 2242.1 m, ING PAN.

17 — *Spelaeotriletes pretiosus* (Playford) Neves & Belt, Oktyabrskaya 30, depth 383.5 m, Bel NIGRI.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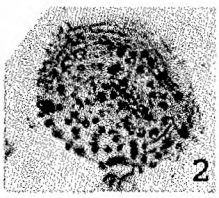
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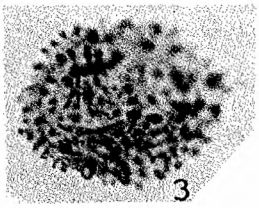
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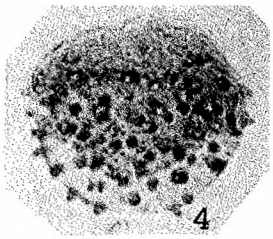
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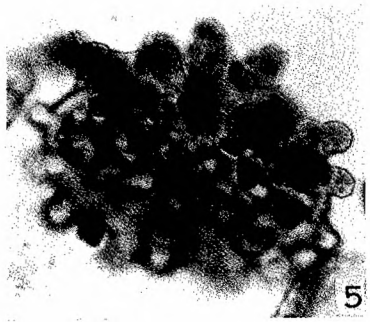
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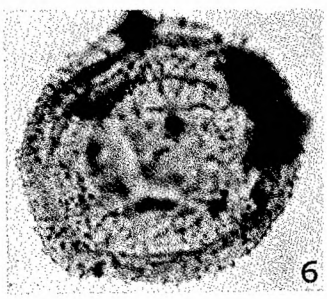
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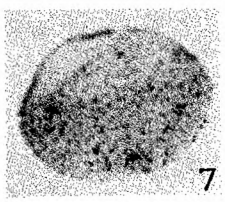
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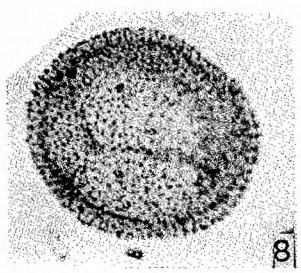
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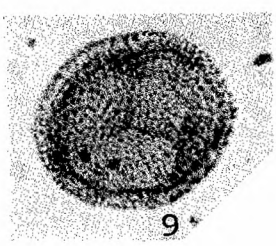
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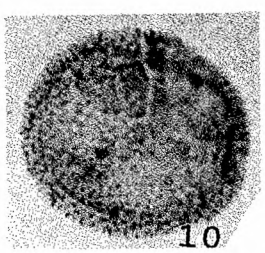
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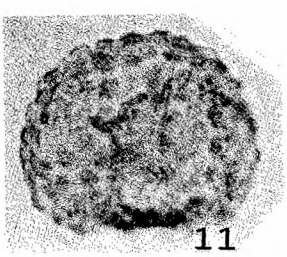
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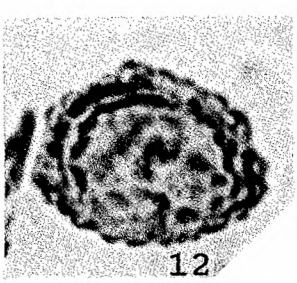
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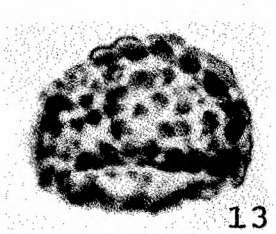
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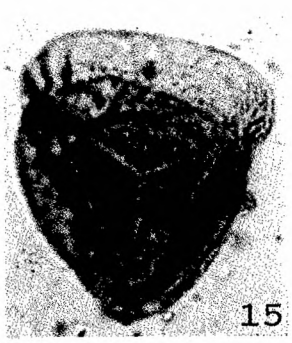
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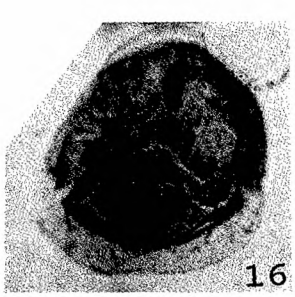
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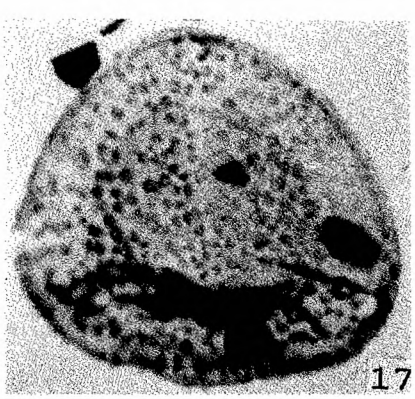
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