Annales Societatis Geologorum Poloniae (1988), vol. 58: 287–305
PL ISSN 0208-9068

UPPER VISEAN (BRIGANTIAN) MIOSPORES FROM THE EASTERN PART OF THE LUBLIN COAL BASIN (POLAND), AND THEIR STRATIGRAPHICAL SIGNIFICANCE

Marzena Stempień[1] & Elżbieta Turnau[2]

[1] *Instytut Nauk Geologicznych PAN, Żwirki i Wigury 93, 02-089 Warszawa, Poland*
[2] *Instytut Nauk Geologicznych PAN, Senacka 3, 31-002 Kraków, Poland*

Stempień, M. & Turnau, E. Upper Visean (Brigantian) miospores from the eastern part of the Lublin Coal Basin (Poland), and their stratigraphical significance. *Ann. Soc. Geol. Polon.*, 58: 287–305

Abstract: Nineteen species of Upper Visean miospores derived from three boreholes in the eastern part of the Lublin Coal Basin are described. One of these is a new species. The composition of the miospore assemblages indicates that they belong to the *T. vetustus-R. fracta* (VF) Zone of the standard miospore division. Some of the deposits studied by the authors have been assigned previously, based on their lithology, to the Devonian.

Key words: Visean stratigraphy, miospores, Lublin Coal Basin.

Manuscript received December 1987; accepted December 1987

INTRODUCTION

Carboniferous miospores from the Lublin Coal Basin have been studied for more than twenty years. The first palynological characteristics of the lithostratigraphic units of the Lublin Carboniferous deposits was given by Jachowicz (1966), and the miospore zonal scheme for that area was established by Kmiecik (1979), and then revised by the same author (Kmiecik, 1986, 1987). But out of more than two hundred miospore species known from these deposits only eleven have been described (by Karczewska, 1967), and many of the species recorded have never been illustrated. There are also some stratigraphical problems which mey be elucidated by detailed miospore studies. All palynological work on the Carboniferous deposits of the Lublin basin, which has been done hitherto, has been concerned exclusively with the deposits included in the Carboniferous on lithostratigraphical grounds. But, in spite of the marked unconformity between the Devonian and the Carboniferous existing in the area under discussion, it is difficult to determine the position of the boundary between the two systems without the help of biostratigraphy.

The present study shows that at least in some profiles, some of the deposits included in the Devonian belong to the Visean.

In the taxonomic part of the present paper, we have included the descriptions of nineteen species, one of them new. A few of these have not been recorded before from the aera discussed. Some of them have wide lateral distribution and distinct features, and they may prove in the future to be of stratigraphical importance.

MATERIAL

The miospore assemblages have been recovered from ten samples of claystones and mudstones. Eight of these are derived from the Horodło-1 borehole and the two others from the Busówno IG-1 and Krowie Bagno IG-1 boreholes (Fig. 1). The position of the samples is indicated in Figure 2, depth

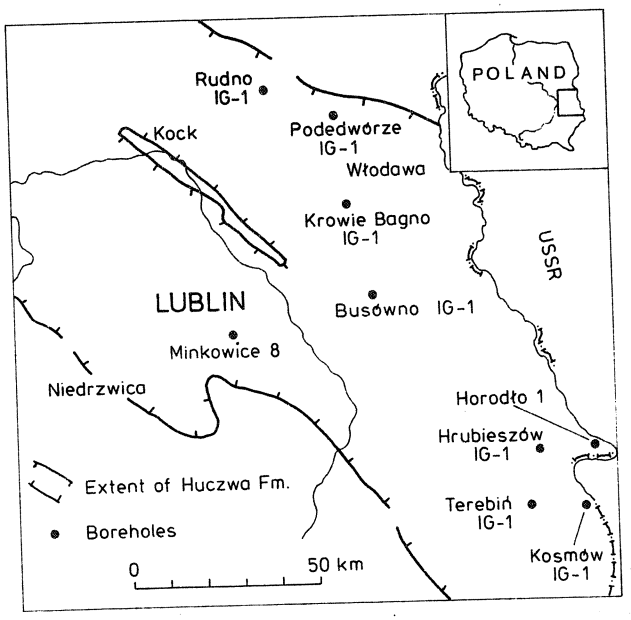


Fig. 1. Map showing position of boreholes mentioned in text and position of the discussed area. Extent of Huczwa Formation (under Mesozoic or Permian deposits) after Żelichowski (1972)

of occurrence is also given in the Table. The laboratory treatment of the samples was standard. Three or more slides from each sample were studied, and the total number of slides studied was 52. The collection is housed in the Institute of Geological Sciences of the Polish Academy of Sciences in Warszawa.

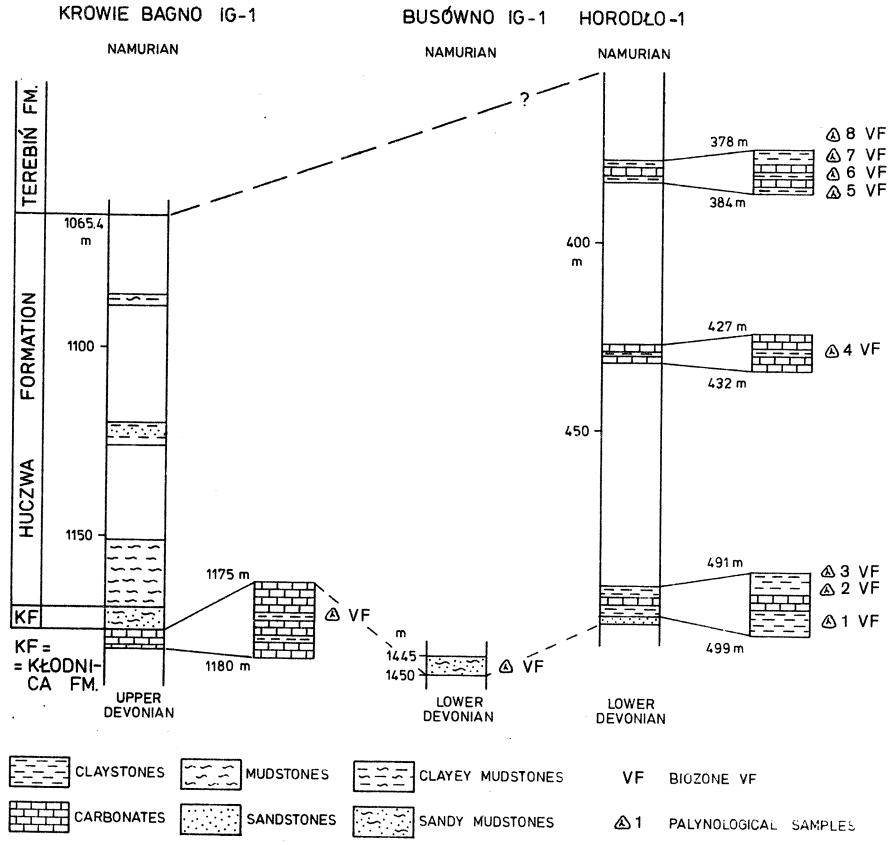


Fig. 2. Position and lithology of palynological samples. Lithostratigraphy of Krowie Bagno IG-1 profile after Żelichowski (1972)

GEOLOGICAL SETTING

The subsurface Carboniferous deposits of the eastern part of the Lublin Coal Basin (Fig. 1) are of Upper Visean to Westphalian B age. They rest unconformably on various units of the Devonian or on older rocks and are overlain by Mesozoic deposits.

LITHOSTRATIGRAPHY

There are three different lithostratigraphical divisions for the Carboniferous deposits of the Lublin basin (Cebulak & Porzycki, 1966; Żelichowski, 1972; Porzycki & Żelichowski, in Porzycki, 1979). In the present paper we use the division of Porzycki and Żelichowski (*op. cit.*).

The lowermost Carboniferous deposits of the Lublin basin concerned in this paper are included in the Kłodnica and the Huczwa Formations.

The Kłodnica Formation includes sandstones and conglomerates intercalated with diabase covers, tuffs and tuffites. These deposits are up to 25 m in thickness. The Kłodnica Formation is fully developed only in the region along the Niedrzwica – Lublin – Kock – Włodawa line, but Żelichowski (1972) included in this unit also the sandstones occurring at the base of the Carboniferous deposits, in some boreholes situated to the east and south-east of this line.

The succeeding Huczwa Formation is represented by paralic deposits including limestones intercalated with subordinate clayey mudstones of marine or continental origin. Sandstone beds occur most commonly within the middle part of the formation. The Huczwa Formation is up to 180 m in thickness in the south-western and central part of the basin, thinning out towards the north and north-east where a few of the lowermost cyclothems are missing.

BIOSTRATIGRAPHY

The Kłodnica Formation is unfossiliferous. The deposits of the Huczwa Formation contain rich and diversified marine fauna. The most frequently recorded index fossils are brachiopods of the genus *Gigantoproductus* (Musiał & Tabor, 1980; Żelichowski *et al.*, 1983) which allows to include the Huczwa Formation in the Upper Visean. So far, there have been no published records of any fossils indicative of the Middle Visean or older age, though, according to Żelichowski (1987) in the south-western part of the basin, the lowermost part of the Huczwa Formation belongs to the Middle Visean.

More precise biostratigraphic data on the Visean deposits of the aera under discussion concern only a few profiles. Visean goniatites have been recorded only from the eastern and central part of the basin. *Goniatities crenistria* (Phillips), the species indicative of the Goα Zone, has been recorded by Korejwo (1987) from vicinity of Lublin. It was found in the Minkowice-8 profile, at a level of about 150 m above the base of the Carboniferous deposits. *Goniatites striatus falcatus* McCoy, the species indicative of the Goβ Zone, has been recorded by Żelichowski (1972) and by Musiał & Tabor (1980), from the Hrubieszów IG-1, Kosmów IG-1 and Terebiń IG-1 bereholes. The representatives of this species occurred about 30 to 120 m above the base of the Carboniferous deposits. The records on conodonts from the deposits under discussion are rare. Skompski & Soboń-Podgórska (1980) included the lowermost Carboniferous deposits from the Rudno IG-1 and Podedwórze IG-2 boreholes in the *Gnathodus mononodosus* or *G. grityi-collinsoni* Zone (corresponding to the Goγ Zone, *cf.* George *et al.*, 1976; Paproth et al., 1983). Thus, there are, so far, no published records on the occurrence, in the Lublin Coal Basin, of any fossils indicative of an age older than the Brigantian.

The faunal data on the deposits from the boreholes discussed in this paper are as follows. The brachiopods and forams from the Huczwa formation from the Krowie Bagno IG-1 borehole are indicative of the Upper Visean age

(Woszczyńska, 1975; Żelichowski, 1975). This fauna includes, among other forms, *Gigantoproductus* ex gr. *latissimus* (Sowerby), *Loebichia ammonoides* (Brady), *Plectogyra excentralis* (Cooper), *Archaediscus karreri* (Brady), and *Howhina bradyana* (Howhin). The macrofauna found in the discussed part of the Carboniferous deposits from the Horodło-1 borehole is as follows: at a depth of 491–497 m – *Orbiculoidea* sp., *Camarotoechia* sp., *Parallelodon* sp. *Phestia sp. Septimyalina sublamellosa* (Etheridge), *Posidona corrugata* (Etheridge); at a depth of 378–389 m, *Linoproducts* sp., *Edmondia* cf. *arcuata, Posidoniella elongata* (Phillips), *Posidonia corrugata, Septimyalina* sp., *Plagioglypta* sp. These are of little stratigraphic value. No Carboniferous fauna has been, so far, recorded from the Busówno IG-1 borehole.

STRATIGRAPHIC PALYNOLOGY

The miospore assemblages from the boreholes under discussion are derived from the lowermost deposits of the Carboniferous, from three boreholes in the eastern and north-eastern part of the Lublin Coal Basin. These are the Horodło-1, Busówno IG-1 and Krowie Bagno IG-1 boreholes. All taxons determined and their vertical distribution are presented in the Table 1.

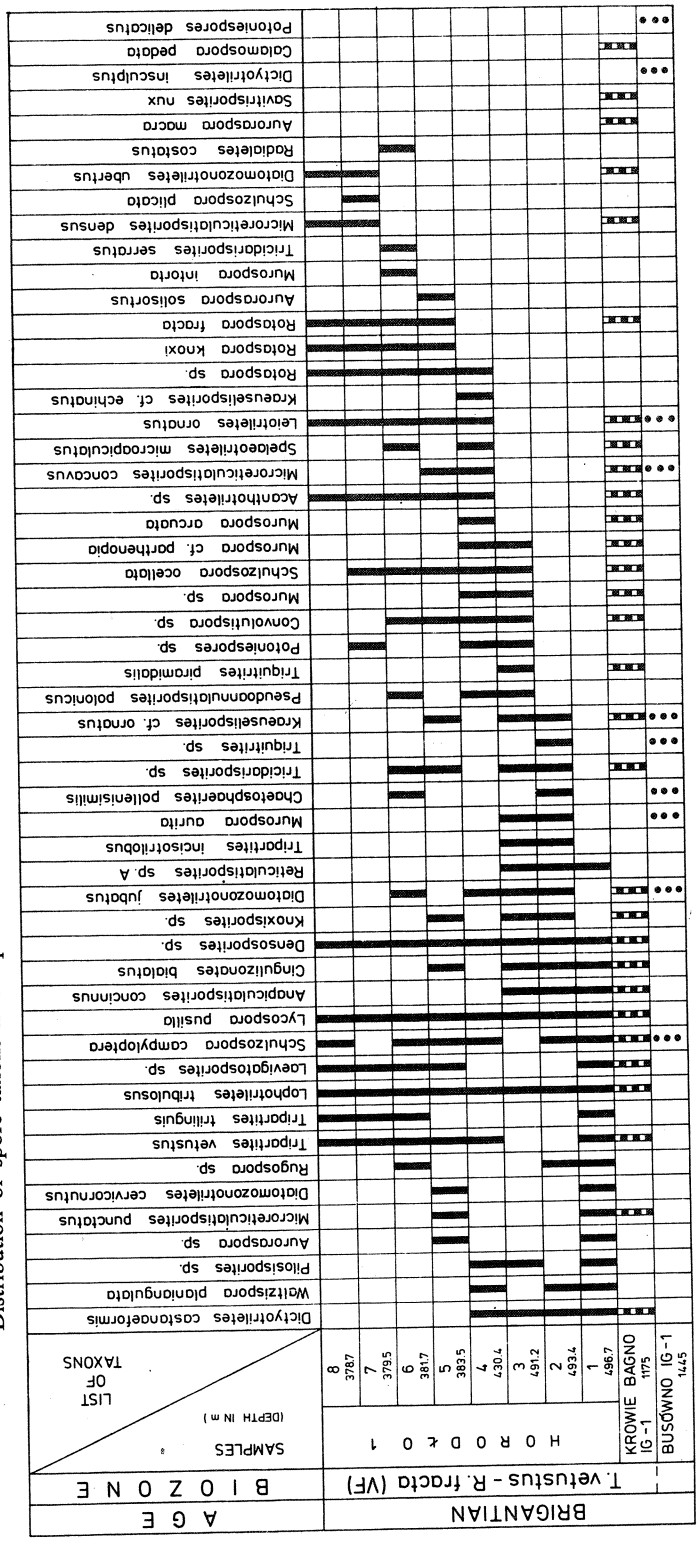
In the case of the Busówno IG-1 and Krowie Bagno IG-1 boreholes, the palynological samples were taken from the deposits included by Miłaczewski (1975, 1984), according to their lithology, in the Lower Devonian and Upper Devonian respectively. The samples from both boreholes yielded miospore assemblages indicative of Upper Visean age, such as *Schulzospora campyloptera* and *Chaetosphaerites pollienisimilis*. The assemblage from the Krowie Bagno IG-1 borehole contained also the nominal species of the *T. vetustus-R. fracta*. This assemblage may well represent the VF Zone, but this can not be assemblage from the Busówno IG-1 borehole was poor in specimens and taxa, which may be responsible for the absence of *Tripartites vetustus* and *Rotaspora fracta*. This assemblage may well represent the VF Zone, but this can be established on the present palynological data.

The palynological samples from the Horodło-1 borehole are derived from an interval about 120 m thick, representing the basal part of the Carboniferous deposits belonging probably to the Huczwa Formation. The successive miospore asseblages from Horodło vary a little in composition, but they all repressent the *T. vetustus-R. fracta* (VF) Zone, which is indicated by the presence of *Tripartites vetustus*. The index species of the consecutive *B. nitidus-R. carnosus* Zone have not been noted.

It follows from the above, that the lowermost Carboniferous deposits from the Krowie Bagno IG-1 and Horodło-1 boreholes are of Brigantian age and those from the Busówno IG-1 borehole are probably of the same age, and are not older than the Asbian. This is consistent with the other biostratigraphical data discussed earlier in the present paper.

Table 1

Distribution of spore taxons in samples from Busówno IG-1, Krowie Bagno IG-1 and Horodło-1 boreholes



In the miospore zonal scheme introduced by Kmiecik (1979) for the Carboniferous deposits of the Lublin Coal Basin, the lowermost Carboniferous deposits are included in the *Murospora aurita* Zone. This is a broad zone corresponding to the *T. vetustus-R. fracta* (VF) Zone and a part of the succeeding *B. nitidus-R. carnosus* (NC) Zone of the standard division. The present authors prefer to use the standard zonation which is more precise and allows direct correlation with the chronostratigraphical division.

SYSTEMATIC PALYNOLOGY

All described and illustrated specimens are housed in the Institute of Geological Sciences, Polish Academy of Sciences in Warszawa.

The terminology used is that recommended by Smith & Butterworth (1967).

Anteturma *Sporites* H. Potonié, 1893
Turma *Triletes* (Reinsch) Dettman, 1963
Suprasubturma *Acavatitriletes* Dettman, 1963
Subturma *Azonotriletes* (Luber) Dettman, 1963
Infraturma *Laevigati* (Bennie & Kidston) Potonié, 1956
Genus *Leiotriletes* (Naumova) Potonié & Kremp, 1954

Leiotriletes ornatus Ishchenko, 1956

Pl. I: 2.

1958 *Leiotriletes tumidus* Butterworth & Williams; p. 359, pl. 1: 56.

Description of specimens: Spores with subtriangular amb, having slightly convex or straigth sides. Laesurae simple, extending almost to spore equator, accompanied by prominent folds. Exine smooth. Size range 32–44 μm (6 specimens)

Occurrence: Poland, Warszawa and Lublin area, Visean (Jachowicz, 1966; Kmiecik & Migier, 1979), Góry Świętokrzyskie Mts., Tournaisian (?) and Visean (Jachowicz, 1962, 1967 a,b), Upper Silesia, Lower Namurian (Dybova-Jachowiczowa & Jachowicz, 1975), England and Scotland, Visean and Namurian (Smith & Butterworth, 1967; Neves *et al.*, 1973). Spitsbergen, Visean (Playford, 1962). France, Visean (Doubinger & Rauscher, 1966). Romania, Dinantian and Namurian (Beju, 1967). USSR, Donetz Basin, Visean and Lower Namurian (Ishchenko, 1956). USA, S. Oklahoma, Lower Carboniferous (Felix & Burbridge, 1967). Nigeria, Visean (Loboziak & Alpern, 1978).

Infraturma *Apiculati* (Bennie & Kidston) Potonié, 1956
Subinfraturma *Nodati* Dybova & Jachowicz, 1957
Genus *Lophotriletes* (Naumova) Potonié & Kremp, 1954

Lophotriletes tribulosus Sullivan, 1964

Pl. I: 3

Description of specimens: Spores with subtrinagular amb, having slightly concave or straight sides and rounded corners. Laesurae simple, two-thirds of radius. Exine ornamented with cones and verrucae varying in size on each specimen. Verrucae up to 3 μm high and wide at base.

The largest elements are grouped at distal pole and in radial regions. Ten to twenty-two elements project at equator. Size range 30–36 μm (10 specimens).

Occurrence: Poland, Western Pomerania, Upper Visean (Turnau, 1979), Lublin area, Visean (present paper). Scotland, Upper Visean (Sullivan, 1964).

Genus *Tricidarisporties* Sullivan & Marshall, 1966

Tricidarisporties serratus (Playford) Sullivan & Marshall, 1966

Pl. I: 8

Description of specimens: Spores with subtriangular amb, having rounded angles and straight or slightly convex sides. Laesurae simple, two-thirds of radius. Distal surface ornamented with closely packed spines. These have bulbous bases and abruptly tapering stems. Outline of spine bases polygonal, width 2–4 μm. Spines reduced in size at angles, well developed at interradial equatorial region where they are up to 6 μm long. Size range 40–44 μm (2 specimens).

Occurrence: Warszawa and Lublin areas, Visean and Namurian (Kmiecik, 1979; Kmiecik & Migier, 1979; present paper), Upper Silesia, Namurian (Jachowicz, 1972; Konior & Turnau, 1974). Spitsbergen, Lower Carboniferous (Playford, 1962). Great Britain, Visean (Smith & Butterworth, 1967). Libya, Lower Carboniferous (Massa *et al.*, 1980).

Infraturma *Murornati* Potonié & Kremp, 1954
Genus *Microreticulatisporites* (Knox) Poronié & Kremp, 1954

Microreticulatisporites concavus Butterworth & Williams, 1958

Pl. I: 10

Description of specimens: Spores with subtriangular amb, having concave sides and broadly rounded angles. Laesurae simple, two-thirds of radius. Exine densely, regularly pitted, pits 2 μm wide. Margin finely crenulate. Size range 30–38 μm (3 specimens).

Occurrence: Poland, Lublin region, Visean (present paper), Góry Świętokrzyskie Mts., Visean (Jachowicz, 1967a). Roumania, Visean (Beju, 1967). Great Britain, Namurian (Butterworth & Williams, 1958; Smith & Butterworth, 1967).

Microreticulatisporites punctatus Knox, 1950

Pl. I: 9

Description of specimens: Spores of circular or oval amb. Laesurae simple, two-thirds of radius. Exine pitted, pits up to 2 μm wide. Margin finely crenulate. Size range 32–44 μm (6 specimens).

Occurrence: Poland, Lublin region, Visean and Namurian (Jachowicz, 1966, present paper) Great Britain, Namurian (Smith & Butterworth, 1967). NW Canada, Visean and Namurian (Braman & Hills, 1977).

Genus *Dictyotriletes* (Naumova) Smith & Butterworth, 1967

Dictyotriletes castanaeformis (Horst) Sullivan, 1964

Pl. I: 5–6

Description of specimens: Spores with subcircular or oval amb. Laesurae simple, about two-thirds of radius, not always visible. Exine ornamented by a reticulum. Lumina polygonal, 5–6 μm in diameter over proximal surfance, up to 10 μm over distal surface. Muri up to 2 μm

high. Appendages up to 3 μm high project from muri junctions. Ten to fifteen muri cross the equator. Size range 28–36 μm (five specimens).

Occurrence: Poland, Western Pomerania, Visean (Turnau, 1979); Upper Silesia, Namurian (Dybova & Jachowicz, 1957; Dybova-Jachowiczowa & Jachowicz, 1975). Great Britain, Namurian and lower part of Westphalian (Smith & Butterworth, 1967).

Subturma *Zonotriletes* Waltz, 1935
Infraturma *Auriculati* (Schopf) Dettmann, 1963
Genus *Triquitrites* (Wilson & Coe) Potonié & Kremp, 1954

Triquitrites piramidalis (Kedo & Jushko) n. comb.

Pl. I: 15–17

Basionym: 1966 *Lophotriletes piramidalis* Kedo & Jushko, in Kedo, p. 60, pl. 2: 55–56.
1967 *Triquitrites microvalvatus* Beju, p. 446, pl. 3: 11.
1967a *Appendicitriletes* gen. nov. Jachowicz, pl. 8: 139–140.

Discription of specimens: Spores of triangular amb, with concave sides and narrow angles. Laesurae accompanied by narrow lips extend to inner margin of radial crassitudes. Radial crassitudes small, smooth and rounded. Exine ornamented by spaced verrucae 1–2 μm wide. In distal polar region, there occur occasionally three larger verrucane about 5 μm wide at basse, 4 μm high. Size range 40–52 μm.

Occurrence: Poland, Lublin region, Visean (present paper), Góry Świętokrzyskie Mts., Visean (Jachowicz, 1967a). Romania, Visean (Beju, 1967). USSR, Pripyat depression and Moscow basin, Lower Carboniferous (Kedo, 1966).

Genus *Tripartites* (Schemel) Potonié & Kremp, 1954

Tripartites vetustus Schemel, 1950

Pl. I: 12, 13.

1957 *Tripartites cristatus* Dybova & Jachowicz, p. 141–142, pl. 36:3, 4.

Description of specimens: Spores with subtriangular amb, having deeply incised sides and rounded angles. Radial crassitudes wide and high, with crenulate margin. Laesurae simple, two-thirds of radius. Exine unornamented. Size range 32–40 μm (5 specimens).

Occurrence: *T. vetustus* occurs widely in Upper Visean and lower Namurian deposits of northern hemisphaere. In well dated deposits its range has been established as Brigantian to part of Arnsbergian (Clayton *et al.*, 1977).

Tripartites incisotrilobus Naumova emend. Karczewska & Turnau, 1974

Pl. I: 14.

non 1958 *Tripartites incisotrilobus* (Naumova) Potonié & Kremp, Butterworth & Williams, p. 373–374, pl. 3: 2–4.
non 1966 *Tripartites incisotrilobus* var. *incisotrilobus* (Butterworth & Williams) Jachowicz, p. 136, pl. 7: 12.
non 1972 *Tripartites incisotrilobus* var. *incisotrilobus* (Butterworth & Williams) Jachowicz, pl. 12: 11.

Discription of specimens: Spores with triangular amb, sides more or less straight. Laesurae simple, extending to inner margin of radial crassitudes. Radial crassitudes prominent, height about one-third of spore radius, outer margin distinctly fluted or indented. They are connected interradially by smooth equatorial flange. Size range 44–48 μm (3 specimens).

Occurrence: Poland, Western Pomerania, Lower Carboniferous (Turnau, 1979), Góry Świętokrzyskie Mts, Lower Carboniferous (Jachowicz, 1967a,b), Lublin region, Visean and

Namurian (Kmiecik, 1979; present paper). USSR, Moscow basin, Lower Carboniferous (Lyuber & Valts, 1938), Donetz basin, Visean (Ishchenko, 1956), Pripyat depression, Visean (Kedo, 1966). Spitsbergen, Lower Carboniferous (Playford, 1962). Canada, Visean (Staplin, 1960).

Infraturma *Tricrassati* Dettmann, 1963
Genus *Diatomozonotriletes* (Naumova) Playford, 1963

Diatomozonotriletes cervicornutus (Staplin) Playford, 1963

Pl. I: 19.

Description of specimens: Spore body with triangular amb, sides slightly concave, angles rounded, narrow. Laesurae accompanied by lips, extending almost to spore equator. Interradial equatorial maring bears distally rooted, radially arranged fimbriae. These taper from base to narrow, rounded tip. They are 2–3 μm wide at base and up to 12 μm long, the longest being situated in the middle of interradial sides. They are discrete interradially and fused close to angles. Distal surface ornamented with cones and spines grouped at angles and at distal pole. Size range 52–68 μm, fimbriae excluded (3 specimes).

Occurrence: Poland, Western Pomerania, Visean (Turnau, 1979), Lublin region, Visean (present paper). USSR, East Europaen platform, Visean (Byvsheva *et al.*, 1985). Great Britain, Visean (Smith & Butterworth, 1967; Neves *et at.*, 1973).

Diatomozonotriletes jubatus (Staplin) Playford, 1963

Pl. I: 25–27.

Description of specimens: Spore body of subtriangular amb, sides deeply concave, angles flattened. Laesurae accompanied by lips extend to spore margin. Exine thickened at interradial margins. These thickenings bear a corona of radially arranged fimbriae. These are discrete, 2–3 μm wide at base, tapering slightly, with simple or forked terminations. Fimbriae longest in the middle of sides (up to 12 μm). Angles ornamented distally by rows of spines, prependićular to laesurae. The rows are extended onto the fimbriae closest to angles. Distal polar region ornamented with cones and verrucae. Proximal surface smooth. Size range 64–72 μm (8 specimens).

Ocurrence: Poland, Lublin region, Visean (Jachowicz, 1966; Kmiecik, 1979); Romania, Moesian platform, Visean (Beju, 1967); Canada, Alberta, Mississippian (Staplin, 1960).
Diatomozonotriletes cf. *jubatus* has been recorded from lowermost Namurian of the Upper Silesia (Jachowicz, 1968).

Diatomozonotriletes ubertus Ishchenko, 1956

Pl. I: 20–21.

Description of specimens: Spores with triangular amb, sides almost straight, angles narrowly rounded. Laesurae extend almost to spore equator. Interradial equatorial margin bears discrete, narrow fimbriae rooted in distal exine. Fimbriae 2 μm wide at base, diminishing in size from center of interradial margin towards equator. Tips of fimbriae bluntly pointed or blunt. Single wart, 8–10 μm in diameter, is situated on the distal pole. Proximally exine unornamented. Size range 44–56 μm (4 specimens).

Occurrence: Poland, Lublin region, Visean–Lower Namurian (Kmiecik, 1979; this paper); Upper Silesia, Namurian (Jachowicz, 1972; Konior & Turnau, 1974; Dybova-Jachowiczowa & Jachowicz, 1975); Góry Świętokrzyskie Mts., Visean (Jachowicz, 1962). USSR, Russian platform, Visean (Brazhnikova *et al.*, 1956; Ishchenko, 1956; Byvsheva *et al.*, 1985). Great Britain, Visean (Smith & Butterworth, 1967).

Infraturma *Cingulati* (Potonié & Klaus) Dettmann, 1963
Genus *Reticulatisporites* (Ibrahim) Neves, 1964

Reticulatisporites sp. A

Pl. II: 1–3.

Description of specimens: Spores of circular amb. Laesurae accompanied by flat, wide lips extend to central area margin. Equatorial cingulum differentiated into three zones. Width of cingulum up to 15 μm. Distal exine bears a thickening of a more or less triangular shape. Size range 80–85 μm (3 specimens).

Comparisons: *R. carnosus* (Knox) Neves (1964, p. 1067) has simple laesurae; *Murospora varia* Staplin (1960, p. 30) is much smaller and has less distinctly differentiated cinculum.

Remarks: Too few specimens have been found to justify the erection of a new species.

Occurrence: Poland, Lublin region, Visean (present paper).

Genus *Rotaspora* Schemel emend. Smith & Butterworth, 1967

Rotaspora knoxi Butterworth & Williams, 1958

Pl. I: 22, 24.

Description of specimens: Spore body subtriangular, sides straight or slightly concave, angles rounded. Laesurae extend almost to body margin. Zona with peripheral rim, widest in interradial areas, narrow at angles. Size range 28–36 μm (6 specimens).

Occurrence: *R. fracta* occurs widely in Upper Visean and Lower Namurian deposits of northern hemisphaere. In well dated deposits its range has been established as Brigantian to part of Arnsbergian (Clayton *et al.*, 1977).

Rotaspora fracta Schemel emend. Smith & Butterworth, 1967

Pl. I: 23.

Description of specimens: Spore body triangular, sides almost straight, angles rounded. Laesurae extend to body margin. Zona with peripheral rim, width of zona more or less constant, in compressed specimens it lies over distal surface of spore body. Size range 32–37 μm (3 specimens).

Occurrence: as *R. knoxi.*

Suprasubturma *Laminatitriletes* Smith & Butterworth, 1967
Subturma *Zonolaminatitriletes* Smith & Butterworth, 1967
Infraturma *Cingulicavati* Smith & Butterworth, 1967
Genus *Murospora* Somers, 1952

Murospora arcuata (Ishchenko) n. comb.

Pl. III: 2, 3.

Basionym: 1956 *Simozonotriletes arcuatus* (Ishchenko in Brazhnikova *et al.*, p. 284, pl. 7: 60. 1966 *Spinozonotriletes brevispinosus* (Waltz) Kedo & Jushko, in Kedo, p. 95, pl. 8: 162–165.

Description of specimens: Spores of subtriangular amb, sides concave, angles broadly rounded. Laesurae simple, extending almost to central area margin. Equatorial cingulum one-fourth to one-third of spore radius wide. Exine ornamented distally and equatorially with cones up to 4 μm long. Proximal surface smooth. Size range 56–60 μm (2 specimens).

Remarks: The species was first named and illustrated (but not described) by Valts (in Lyuber & Valts, 1938, pl. 4: 54). Therefore, Ishchenko's species has priority.

Occurrence: Poland, Lublin region, Visean (present paper); USSR, Russian platform, Visean (Lyuber & Valts, 1938; Brazhnikova *et al.*, 1956; Kedo, 1966; Byvsheva *et al.*, 1985).

Suprasubturma *Cameratitriletes* Neves & Owens, 1966
Subturma *Solutitriletes* Neves & Owens, 1966
Infraturma *Decorati* Neves & Owens, 1966
Genus *Spelaeotriletes* Neves & Owens, 1966

Spelaeotriletes microapiculatus n. sp.

Pl. III: 9–12.

Diagnosis: Spores of subcircular amb. Laesurae simple, often accompanied by folds of exine, extending almost to spore equator. Intexine indistinctly delimited, radius equals have of spore radius. Distal surface and proximal, radial-equatorial regions ornamented by densely and regularly set cones up to 1 μm long and wide at base. Contact faces smooth. Size range 60–68 μm (5 specimens).

Comparisons: *S. arenaceus* Neves & Owens (1966, p. 345–346, pl. 2: 1–3) has coarser and more composite ornamentation, the elements of which range from 1 to 2 μm in length.

Occurrence: Poland, Lublin region, Visean (present paper).

Suprasubturma *Pseudosaccitriletes* Richardson, 1965
Infraturma *Monopseudosacciti* Smith & Butterworth, 1967
Genus *Schulzospora* Kosanke, 1950

Schulzospora campyloptera (Waltz) Hoffmeister, Staplin & Malloy, 1955

Pl. III: 14.

1966 *Schulzospora vetusta* Dybova-Jachowiczowa (part), p. 47–48, pl. 5: 4–5; pl. 6: 1–6; pl. 7: 1.
1979 *Schulzospora elongata* Hoffmeister, Staplin & Malloy; in Kmiecik, pl. 4: 4.

Description of specimens: Spores with elongate-oval amb, shorter sides of saccus often flattened. Proportion of the minimum to maximum diameter of saccus 1:2. Intexine circular or elongate conformably with saccus maximum diameter. Laesurae simple, one halve of intexine radius. Exine microreticulate. Size range 92–104 μm (4 specimens).

Occurrence: Poland, Lublin region, Visean–Lower Namurian (Jachowicz, 1966; Kmiecik, 1979; present paper); Western Pomerania, Visean (Turnau, 1979); Góry Świętokrzyskie Mts., Lower Carboniferous (Jachowicz, 1967a,b). The species is widely distributed in Visean deposits of northern hemisphaere.

Schulzospora ocellata (Horst) Potonié & Kremp, 1956

Pl. III: 15.

1957 *Schulzospora primigenia* Dybova & Jachowicz, p. 208–209, pl. 62: 1, 2.

Discription of specimens: amb of spores egg-shaped. Proportion of the minimum to maximum diameter of the saccus 3:5. Laesurae simple, about one halve of intexine radius; one laesura often shorter than the other two. Intexine circular, oblique, or elongate conformably with the minimum diameter of the saccus. Exine microreticulate. Size range 84–96 μm (4 specimens).

Occurence: Poland, Lublin region, Visean–Namurian (Kmiecik, 1979; present paper); Upper Silesia, Namurian (Jachowicz, 1972); Western Pomerania, Visean (Turnau, 1979). The species is widely distributed in Visean deposits of northern hemisphaere.

CONCLUDING REMARKS

It has been shown above that, in spite of the marked unconformity existing within the Lublin Coal Basin between the Devonian and the Carboniferous, it is, in some cases, difficult to establish the exact position of the boundary between the two systems based solely on lithology. This boundary is lithologically sharp in those profiles where the Devonian rocks contact the fully developed Kłodnica Formation, but not in the other ones, were the carbonates of the Huczwa Formation rest on similar rocks of the Upper Devonian Firley Formation (distinguished by Miłaczewski, 1981). The same concerns the sandstones of the Kłodnica or Huczwa Formations resting on the Lower Devonian Zwoleń Formation. As both Devonian formations are devoid of fauna (at least at the top), the position of the Devonian/Carboniferous boundary should be established based on palynological data.

Acknowledgements

The authors are grateful to professor Krystyna Korejwo for her help in the determination of the macrofauna. The core samples were provided by the Oil Prospecting Enterprise at Wołomin. We acknowledge the financial support of the Polish Academy of Sciences (the research project CPBP 03.04).

REFERENCES

Beju, D., 1967. New contributions to the palynology of Carboniferous strata from Romania. *C. R. Sixiéme Congr. Strat. Geol. Carbon. Sheffield 1967*, 3, pp. 458–486.

Braman, D. R. & Hills, L. V., 1977. Palynology and Paleoecology of the Mattson Formation, northwest Canada. *Bull. Canad. Petrol. Geol.*, 25: 582–630.

Brazhnikova, N. E., Ishchenko, A. M., Ishchenko, T. A., Novik, E. O. & Shulga, P. L., 1956. Fauna and flora of Carboniferous deposits of Galicia-Wołyń Depression (In Russian). *Trudy Inst. Geol. Nauk., Ser. Strat. Palaeont.*, 10: 3–500.

Butterworth, M. A. & Williams, R. W., 1958. The small spore floras of coals in the Limestone Coal Group and Upper Limestone Group of the Lower Carboniferous of Scotland. *Trans. Roy. Soc. Edinburgh*, 63, part II, 17: 353–392.

Byvsheva, T. V., Arkhangelskaya, A. D., Petrosyans, M. A. & Barkhatnaya, I. N., 1985. *Atlas of spores and pollen of oil and gas bearing deposits of the Russian and Turan platforms.* (In Russian). Trudy VNIGNI, 253: 224 pp.

Cebulak, S. & Porzycki, J., 1966. Lithological-petrographic characteristics of the deposits of the Lublin Carboniferous. (In Polish, English summary). *Pr. Inst. Geol.*, 44: 21–54.

Clayton, G., Coquel, R., Doubinger, J., Gueinn, K. J., Loboziak, S. & Streel, M., 1977. Carboniferous miospores of Western Europe: ilustration and zonation. *Meded. Rijks Geol. Dienst*, 29: 1–71.

Doubinger, J. & Rauscher, R., 1966. Spores du viséen marin de Bourbach-le-Haut dans les Vosges du Sud. *Pollen et Spores*, 8 (2): 361–405.

Dybova-Jachowiczowa, S., 1966. The occurrence of sporomorphae saccatae (*Saccites* Erdtman) in the Dinantian and Lower Namurian deposits in Poland. (In Polish, English summary). *Pr. Inst. Geol.*, 36: 1–64.

Dybova, S. & Jachowicz, A., 1957. Microspores of the Upper Silesian Coal Measures. (In Polish, English summary). *Pr. Inst. Geol.*, 32: 1–328.

Dybova-Jachowiczowa, S. & Jachowicz, A., 1975. An outline of miospore stratigraphy of the productive Carboniferous in the vicinity of Klimontów, near Sosnowiec (Upper Silesia). (In Polish, English summary). Inst. Geol. Biul., 282: 227–247.

Felix, C. J. & Burbridge, P., 1967. Palynology of the Springer Formation of southern Oklahoma, U.S.A. *Palaeontology*, 10: 349–425.

George, T. N., Johnson, G. A. L., Mitchell, M., Prentice, J. E., Ramsbottom, W. H. C., Sevastopulo, G. D. & Wilson, R. B., 1976. A correlation of Dinantian rocks in the British Isles. *Geol. Soc. London. Spec. Rep.*, 7: 1–87.

Ishchenko. A. M., 1956. Spores and pollen grains of Lower Carboniferous deposits of western extension of Donbas and their stratigraphical importance. (In Russian). *Trudy Inst. Geol. Nauk., Ser. Strat. Palaeont.*, 11: 1–185.

Jachowicz, A., 1962. Preliminary characteristic of microflora of Lechówek and Zaręby beds. (In Polish, English summary). *Kwart. Geol.*, 6: 403–415.

Jachowicz, A., 1966. Microfloristic characteristic of the deposits of the Lublin Carboniferous. (In Polish, English summary). *Pr. Inst. Geol.*, 44: 103–134.

Jachowicz, A., 1967a. Tournaisian and Upper Visean microfloras of the Święty Krzyż Mountains (central Poland), their stratigraphical and palaeogeographical value. *C. R. Sixiéme Congr. Strat. Geol. Carbon. Sheffield 1967*, 4, pp. 1441–1458.

Jachowicz, A., 1967b. Microflora of the Zaręby beds from the Świętokrzyskie Mountains. (In Polish, English summary). *Pr. Inst. Geol.*, 59: 1–108.

Jachowicz, A., 1968. The occurrence of some *Diatomozonotriletes* species in the marginal beds of the Upper Silesian Coal Basin. (In Polish, English summary). *Pr. Inst. Geol.*, 55: 91–104.

Jachowicz, A., 1972. A microfloristic description and stratigraphy of the productive Carboniferous of the Upper Silesian Coal Basin. (In Polish, English summary). *Pr. Inst. Geol.*, 61: 185–277.

Karczewska, J., 1967. Carboniferous spores from the Chełm 1 boring (eastern Poland). *Acta Geol. Polon.*, 12: 268–345.

Kedo, G. I., 1966. Spores of Lower Carboniferous of the Pripyat depression (In Russian). *Paleont. i Strat. BSSR*, 5: 1–95.

Kmiecik, H., 1979. Spore stratigraphy of the Carboniferous of central-eastern Poland. (In Polish, English summary). *Rocz. Pol. Tow. Geol.*, 48: 369–389.

Kmiecik, H., 1986. Palynostratigraphy of the Carboniferous at the margin of the Polish part of the East-European Platform. *Rev. Palaeobot. Palynol.*, 48: 327–345.

Kmiecik, H., 1987. Carboniferous palynostratigraphy of Polish coal basins. *Prz. Geol.*, 35: 247–259.

Kmiecik, H. & Migier, T., 1979. Phyto- and palynostratigraphy of the Carboniferous of the Warsaw area. (In Polish, English summary). *Kwart. Geol.*, 23: 749–766.

Konior, K. & Turnau, E., 1974. New coal measure sections from boreholes of the south-eastern part of the Upper Silesian Basin. (In Polish, English summary). *Rocz. Pol. Tow. Geol.*, 44: 515–544.

Korejwo, K., 1987. Biostratigraphy of the Carboniferous deposits of the Świdnik blocks (Lublin Coal Basin). *Acta Geol. Polon.*, 36: 337–346.

Loboziak, S. & Alpern, B., 1978. Le bassin houiller viséen d'Agadez (Niger). III: les microspores. *Palinologia*, 1: 55–64.

Lyuber, A. A. & Valts, I. E., 1938. Classification and stratigraphical importance of spores of some Carboniferous localities in the USSR. (In Russian). *Trudy Centr. Nauchn.-Issled. Geol. Razv. Inst.*, 105; 1–46.

Massa, D., Coquel, R., Loboziak, S. & Tougardeau-Lantz, J., 1980. Eassai de synthese stratigraphique et palynologique du carbonifere en Libye occidentale. *Ann. Soc. Geol. Nord.*, 99: 429–442.

Miłaczewski, L., 1975. Devonian. (In Polish only). In: Miłaczewski, L. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego, 25, Krowie Bagno IG-1.* Wyd. Geol., Warszawa, pp. 30–43.

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.

Miłaczewski, L., 1984. Devonian. (In Polish only). In: Harasimiuk, M. (ed.), *Przewodnik LVI Zjazdu Polskiego Towarzystwa Geologicznego, Lublin.* Wyd. Geol., Warszawa, pp. 140–142.

Musiał, Ł. & Tabor, M., 1980. The Carboniferous zoostratigraphy of the Lublin Coal Basin and its correlation with lithostratigraphic members. *Biul. Inst. Geol.,* 328: 75–94.

Neves, R., 1964. *Knoxisporites* (Potonié and Kremp) Neves 1961. *C. R. Congr. Strat. Géol. Carbonif. Paris (1963).* 1, pp. 1063–1069.

Neves, R., Gueinn, K. J., Clayton, G., Ioannides, N. S., Neville, R. S. W. & Kruszewska, K., 1973. Palynological correlations within the Lower Carboniferous of Scotland and Northern England. *Trans. Roy. Soc. Edinburgh,* 69 (2): 23–70.

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

Paproth, E., Conil, R., Bless, M. J. M., Boonen, P., Bouckaert, J., Carpentier, N., Coen, M., Delcambre, B., Deprijck, C., Deuzon, S., Dreesen, R., Groessens, E., Hance, L., Hennenbert, M., Hibu, D., Hahn, G. and R., Hislaire, O., Kasig, W., Laloux, M., Lauwers, A., Lees, A., Lys, M., Op de Beek, K., Overlau, P., Pirlet, H., Poty E., Ramsbottom, W., Streel, M., Swennen, R., Thores, J., Vanguestaine, M., Van Steenwinkel, M. & Vieslet, J. L., 1983. Bioand lithostratigraphic subdivisions of the Dinantian in Belgium, a review. *Ann. Soc. Geol. Belg.,* 106: 185–239.

Playford, G. 1962. Lower Carboniferous microfloras of Spitsbergen, Pt. I. *Palaeontology,* 5: 550–618.

Porzycki, J., 1979. Lithostratigraphy of Carboniferous deposits of Lublin Coal Basin (In Polish only). In: Migier, T. (ed.), *Stratygrafia węglonośnej formacji karbońskiej w Polsce, II Sympozjum.* Wyd. Geol., Warszawa, pp. 19–27.

Skompski, S. & Soboń-Podgórska, J., 1980. Foraminifers and condonts in the Visean deposits of the Lublin Upland. *Acta. Geol. Polon.,* 30: 87–96.

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

Staplin, F. L., 1960. Upper Mississippian plant spores from the Golata Formation, Alberta, Canada. *Palaentographica B,* 107: 1–140.

Sullivan, H. J., 1964. Miospores from the Drybrook Sandstone and associated measures in the Forest of Dean basin, Gloucestershire. *Palaeontology.* 7: 351–392.

Turnau, E., 1979. Correlations of Upper Devonian and Carboniferous deposits of Western Pomerania, based on miospore study. (In Polish, English summary). *Rocz. Pol. Tow, Geol.,* 49: 231–269.

Woszczyńska, S., 1975. Distribution of microfauna in Carboniferous deposits (in Polish only). In: Miłaczewski, L. (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego,* 25, *Krowie Bagno IG-1.* Wyd. Geol., Warszawa, pp. 153–154.

Żelichowski, A. M., 1972. Evolution of the geological structure of the area between the Góry Świętokrzyskie and the river Bug. (In Polish, English summary). *Inst. Geol. Biul.,* 263: 3–97.

Żelichowski, A. M., 1975. Carboniferous – lithology and stratigraphy. (In Polish only). In: Miłaczewski, L., (ed.), *Profile głębokich otworów wiertniczych Instytutu Geologicznego,* 25, *Krowie Bagno IG-1.* Wyd. Geol., Warszawa, pp. 150–153.

Żelichowski, A. M., 1987. Development of the Carboniferous of the SW margin of the East-Europen Platform in Poland. *Prz. Geol.,* 35: 230–237.

Żelichowski, A. M., Chlebowski, R., Grotek, I., Kmiecik, H., Kowalski, W. & Woszczyńska, S., 1983. The Carboniferous deposits in the fault zone of Grójec. (In Polish, English summary). *Biul. Inst. Geol.,* 344: 57–115.

APPENDIX

LIST OF GIVEN SPORE SPECIES

Anapiculatisporites concinnus Playford, 1962
Auroraspora macra Sullivan, 1964
Auroraspora solisortus Hoffmeister, Staplin & Malloy
Calamospora pedata Kosanke, 1950
Chaetosphaerites pollenisimilis (Horst) Butterworth & Williams
Cingulizonates bialatus (Waltz) Smith & Butterworth
Diatomozonotriletes cevicornutus (Staplin) Playford, 1963
Diatomozonotriletes jubatus (Staplin) Playford, 1963
Diatomozonotriletes ubertus Ishchenko, 1956
Dictyotriletes insculptus Sullivan & Marshall, 1966
Dictyotriletes castanaeformis (Horst) Sullivan, 1964
Kraeuselisporites cf. *echinatus* Owens, Mischell & Marshall
Kraeuselisporites cf. *ornatus* (Neves) Owens, Mishell & Marshall
Leiotriletes ornatus Ishchenko, 1956
Lophotriletes tribulosus Sullivan, 1964
Lycospora pusilla (Ibrahim) Somers, 1972
Microreticulatisporites concavus Butterworth & Williams, 1958
Microreticulatisporites densus (Love) Sullivan, 1964
Microreticulatisporites punctatus Knox, 1950
Murospora aurita (Waltz) Playford, 1962
Murospora arcuata (Ishchenko) n. comb.
Murospora interta (Waltz) Playford, 1962
Murospora cf. *parthenopia* Neves & Ioannides, 1974
Potoniespores delicatus Playford, 1963
Pseudoannulatisporites polonicus Karczewska, 1967
Radialates costatus Playford, 1963
Rotaspora fracta Schemel, 1950
Rotaspora knoxi Butterworth & Williams, 1958
Savitrisporites nux (Butterworth & Williams) Smith & Butterworth
Schulzospora campyloptera (Waltz) Potonié & Kremp, 1956
Schulzospora ocellata (Horst) Potonié & Kremp
Schulzospora plicata Butterworth & Williams, 1958
Spelaeotriletes microapiculatus n. sp.
Tricidarisporites serratus (Playford) Sullivan & Marshall, 1966
Triquitrites piramidalis (Kedo & Jushko) n. comb.
Tripartites trilinguis (Horst) Potonié & Kremp, 1956
Tripartites vetustus Schemel, 1950
Tripartites incisotrilobus (Naumova) Karczewska & Turnau, 1967
Waltzispora planiangulata (Horst) Sullivan, 1964

Streszczenie

GÓRNOWIZEŃSKIE (BRIGANCKIE) MIOSPORY ZE WSCHODNIEJ CZĘŚCI LUBELSKIEGO ZAGŁĘBIA WĘGLOWEGO I ICH ZNACZENIE STRATYGRAFICZNE

Marzena Stempień & Elżbieta Turnau

Miospory karbonu Lubelskiego Zagłębia Węglowego były przedmiotem licznych opracowań, z których pierwsze ukazały się drukiem ponad 20 lat temu. Pierwszą charakterystykę mikroflorystyczną jednostek litostratygraficznych karbonu lubelskigo podał Jachowicz (1966), a pierwszy miosporowy schemat stratygraficzny dla tych utworów zaproponowała Kmiecik (1979).

W dość bogatej literaturze palinologicznej dotyczącej karbonu lubelskiego brakuje jednak opracowań taksonomicznych miospor, a wiele gatunków podawanych z tych utworów nigdy nie zostało zilustrowanych. Niniejsza praca ma, choć w nieznacznym stopniu, wypełnić tę lukę. W jej części taksonomicznej podano opisy 19 gatunków, w tym jednego nowego. Obecność niektórych z nich zanotowano w omawianym rejonie po raz pierwszy.

Pewnym brakiem dotychczasowych badań palino-stratygraficznych karbonu lubelskiego jest to, że dotyczą one wyłącznie utworów zaliczonych do karbonu na podstawie danych litostratygraficznych. W niniejszej pracy starano się wykazać, iż granica między utworami karbonu i dewonu na Lubelszczyźnie jest, mimo istniejącej znacznej niezgodności pomiędzy tymi systemami, mniej ostra niż można sądzić, i że w niektórych profilach część utworów zaliczanych do dewonu należy do wizenu.

W niniejszej pracy przedstawiono wyniki badań palinologicznych 10 próbek z otworów Horodło-1, Busówno IG-1 i Krowie Bagno IG-1 (Fig. 1). Położenie prób w profilach przedstawiono na Figurze 2, głębokości podano również w Tabeli. Badane próbki z otworów Busówno i Krowie Bagno pobrano z utworów zaliczonych uprzednio na podstawie litologii do dewonu (Miłaczewski, 1975, 1984).

Prawie wszystkie zbadane próby zawierały zespoły sporowe zony *Tripartites vetustus-Rotaspora fracta* (VF) podziału standardowego (Clayton *et al.*, 1977), o czym świadczy obecność gatunków *Rotaspora fracta* i *Tripartites vetustus*. Wyjątek stanowi próbka z Busówna IG-1 Ubogi zespół spor z tej próbki nie zawierał wymienionych powyżej gatunków. Zbadane utwory z Busówna mogą mimo to, należeć do zony VF. Mogą one też należeć do którejś ze starszych zon, a mianowicie zony *Perotrilites tessellatus-Schulzospora campyloptera* (TC) lub zony *Raistrickia nigra-Triquitrites marginatus* (NM), o czym świadczy obecność gatunków *Schulzospora campyloptera* i *Chaetosphaerites pollenisimilis*. A zatem zbadane utwory należą do brigantu, a utwory z Busówna nie są starsze niż asb (por. George *et al.*, 1976).

Zona VF, do której zaliczono zbadane utwory, odpowiada części zony *Murospora aurita* wyróżnionej przez Kmiecik (1979). Autorki przedkładają nad podział lokalny podział standardowy, który jest bardziej precyzyjny i umożliwia bezpośrednią korelację z podziałem chronostratygraficznym.

EXPLANATIONS OF PLATES

Plate I

All photographs × 500

1 – *Chaetosphaerites pollenisimilis*. Horodło-1, depth 381 m, slide L.I/20
2 – *Leiotriletes ornatus*. Krowie Bagno IG-1, depth 1175–1180 m, slide L.II/33
3 – *Lophotriletes tribulosus*. Horodło-1 depth 491.2 m, slide L.I/11
4 – *Anapiculatisporites concinnus*. Horodło-1, depth 496.7 m, slide L. I/2
5, 6 – *Dictyotriletes castanaeformis*. Horodło-1, depth 4304 m. slide L.I/15; Krowie Bagno IG-1 depth 1175–1180 m, slide L.II/30
7 – *Pilosisporites* sp. Horodło-1, depth 430.4 m, slide L. I/5
8 – *Tricidarisporites serratus*. Horodło-1, depth 381.7 m, slide L.II/22
9 – *Microreticulatisporites punctatus*. Horodło-1, depth 496.7 m, slide L.I/4
10 – *Microreticulatisporites concavus*. Krowie Bagno IG-1, depth 1175–1180 m, slide L., II/23
11 – *Microreticulatisporites densus*. Horodło-1, depth 379.5 m, slide L.II/23
12, 13 – *Tripartites vetustus*. Horodło-1, depth 381.7 m, slide L.II/21
14 – *Tripartites incisotrilobus*. Horodło-1, depth 493.4 m, slide L.I/7
15, 16, 17 – *Triquitrites piramidalis*. Horodło-1, depth 430.4 m, slide L.I/13, Krowie Bagno IG-1, depth 1175–1180 m, slide L. II/33
18 – *Diatomozonotriletes* sp. Krowie Bagno IG-1, 1175–1180 m, slide L.II/33
19 – *Diatomozonotriletes cervicornutus*. Horodło-1, depth 496.7 m, slide L.I/1
20, 21 – *Diatomozonotriletes ubertus*. Horodło-1, Depth 378.7 m, slide L.II/28
22, 24 – *Rotaspora knoxi*. Horodło-1, depth 381.7 m, slide L.I/20
23 – *Rotaspora fracta*. Horodło-1, depth 381,7 m., slide L.I/20
25, 26, 27 *Diatomozonotriletes jubatus*. Horodło-1, depth 430.4 m, slide L.I/12; Krowie Bagno IG-1, depth 1175–1180 m, slide L.II/31

Plate II

All photographs × 500

1, 2 – *Reticulatisporites* sp. A. Horodło-1, depth 496.7 m, slide L.I/2
3a, 3b – *Reticulatisporites* sp. A., proximal and distal focus respectively. Horodło-1, depth 493.4 m, slide L.I/6
4 – *Murospora* sp. Horodło-1, depth 493.4 m, slide L.I/6
5 – *Murospora intorta*. Horodło-1, depth 381.7 m, slide L. I/20
6 – *Murospora* cf. *parthenopia*. Horodło-1, depth 491.2 m, slide L.I/10
7 – *Dictyotriletes* sp. Horodło-1, depth 381.7 m, slide L.I/19
8 – *Auroraspora solisortus*. Horodło-1, depth 383.5 m, slide L.I/16
9 – *Pseudoannulatisporites polonicus*. Horodło-1, depth 381.7 m, slide L.I/19
10 – *Radialetes costatus*. Horodło-1, depth 381.7 m, slide L.I/19
11, 12 – *Kraeuselisporites* cf. *ornatus*. Horodło-1, depth 381.7 m, slide L.I/19

Plate III

All photographs × 500

1 – *Laevigatosporites* sp. Horodło-1, depth 381.7 m, slide L.I/20

2, 3 – *Murospora arcuata*. Horodło -1, depth 430.4 m, slide L.I/14; Krowie Bagno IG-1, depth 1175–1180 m, slide L.II/30

4 – *Cingulizonates bialatus*. Horodło-1, depth 383.5 m, slide L.I/16

5 – *Densosporites* sp. Horodło-1, depth 430.4 m, slide L.I/12

6 – *Kraeuselisporites* cf. *echinatus*. Horodło-1, depth 430.4 m, slide L.I/12

7 – *Potoniespores?* sp. Horodło-1, depth 491.2 m, slide L.I/11

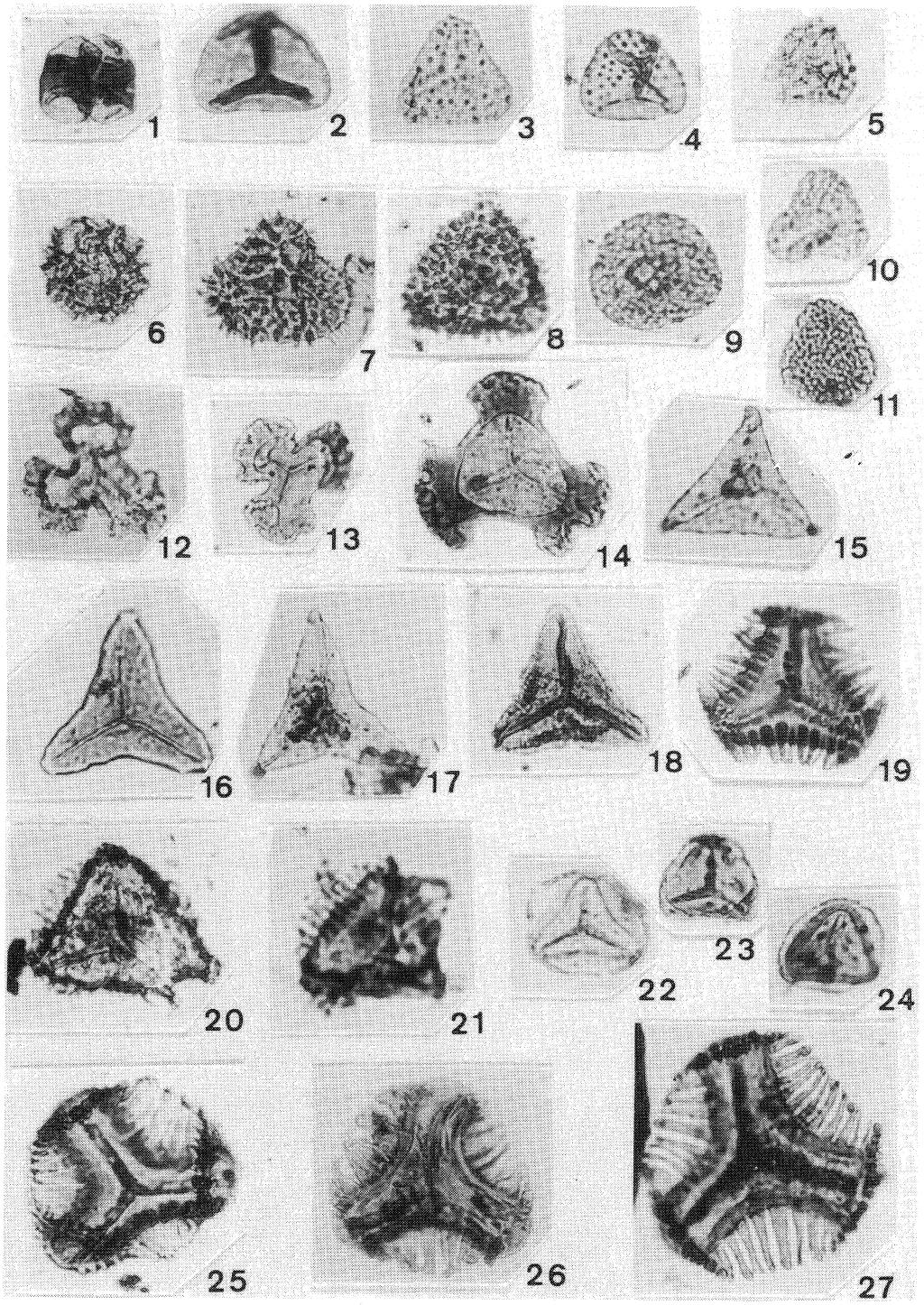
8 – *Discernisporites micromanifestus*. Krowie Bagno IG-1, depth 1175–1180 m, slide L.II/30

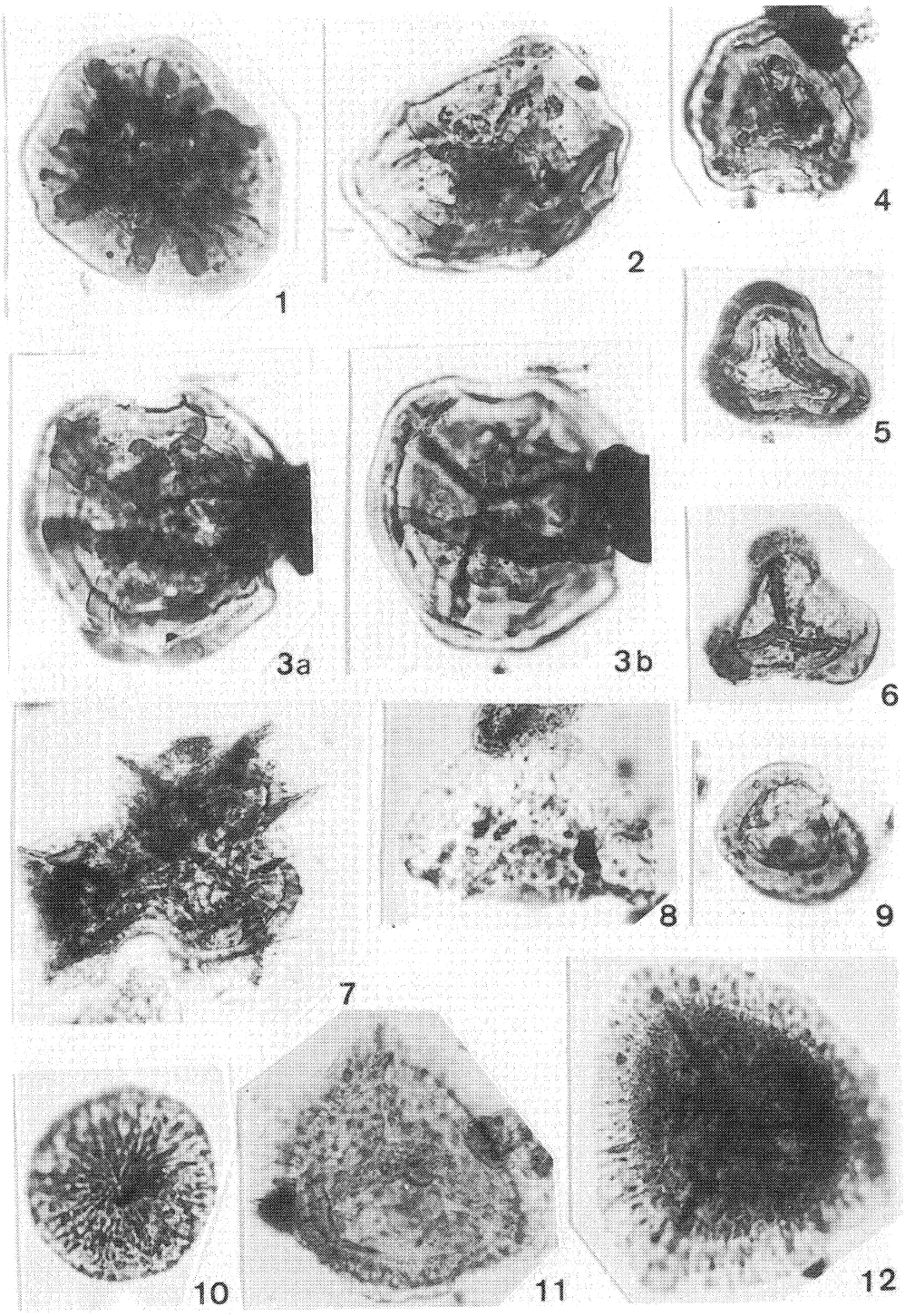
9–12 – *Spelaeotriletes microapiculatus*. 9 – Horodło-1, depth 430.4 m, slide L.I/12; 10, 11 – Horodło-1, depth 381.7 m, slide L.I/19; 12 – holotype. Krowie Bagno IG-1, depth 1175–1180 m, slide L.II/31

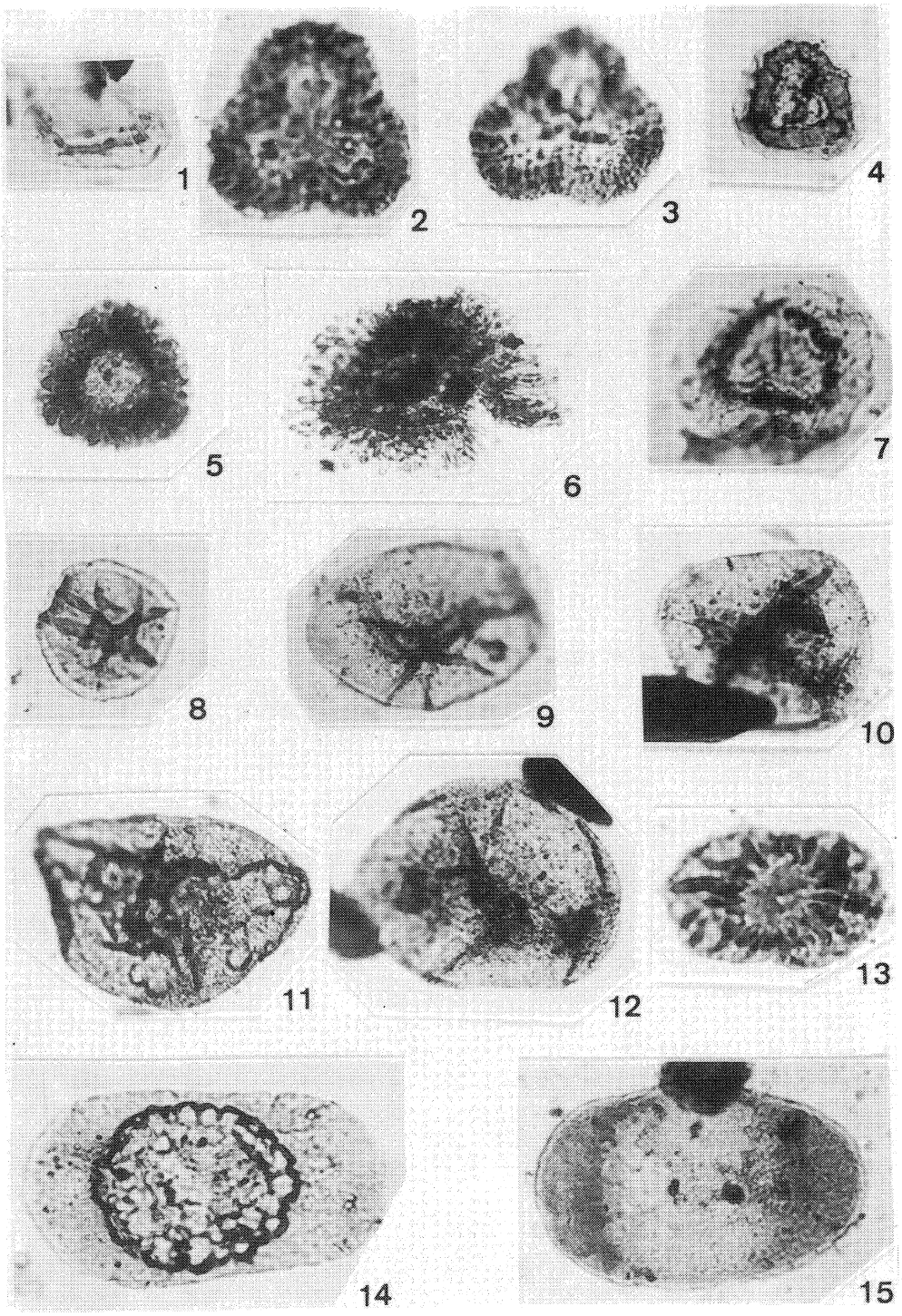
13 – *Schulzospora plicata*. Horodło-1, depth 379.5 m, slide L.II/23

14 – *Schulzospora campyloptera*. Horodło-1, depth 496.7 m, slide L.I/4

15 – *Schulzospora ocellata*. Horodło-1 depth 430.4 m, slide L.I/12


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27


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


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15