Geological Quarterly, 2007, **51** (1): 39–56

Palynological constraints on the age of the Carboniferous clastic succession of SW Poland (Fore-Sudetic area) based on miospore data

Anna GÓRECKA-NOWAK

Górecka-Nowak A. (2007) — Palynological constraints on the age of the Carboniferous clastic succession of SW Poland (Fore-Sudetic area) based on miospore data. Geol. Quart., **51** (1): 39–56. Warszawa.

New palynological studies of the Carboniferous clastic deposits of SW Poland from six deep boreholes have provided diverse, but poorly preserved miospore assemblages. Probably all of these are mixed, consisting of taxa typical of the interval from the Famennian to the Namurian. Namurian A deposits have been identified in the Paproć 29 and Katarzynin 2 boreholes. The stratigraphic position of rocks from other profiles, where miospores were more badly preserved, has been established in a more general way. In the Objezierze IG 1 borehole the rocks were dated as not older than late Viséan while rocks from the Kalisz IG 1, Dankowice IG 1 and Dymek IG 1 boreholes are considered as not older than Viséan. The abundance of reworked miospores in rocks from the Paproć 29 and Katarzynin 2 boreholes is proof that cannibalization of older rocks containing miospores took place in this sedimentary basin in the early Namurian. Source rocks belonged either to the Famennian–Tournaisian and Viséan or to a Viséan interval containing Famennian–Tournaisian reworked miospores. Some observations on the limitations of the stratigraphical interpretation of those mixed and poorly preserved miospore assemblages are provided.

Anna Górecka-Nowak, Institute of Geological Sciences, University of Wrocław, Cybulskiego 30, PL-50-205 Wrocław, Poland; e-mail: agor@ing.uni.wroc.pl *(received: March 30, 2006; accepted: January 23, 2007).*

Key words: palynostratigraphy, Namurian, reworked miospores, redeposition.

INTRODUCTION

The Carboniferous sedimentary succession of SW Poland is buried under a thick cover of Permo-Mesozoic and Cenozoic deposits of the Polish Basin. The southwestern part of this basin belongs to the Fore-Sudetic Monocline, called also the Fore-Sudetic Homocline (Mazur *et al*., in press). The rocks analyzed here form the basement of this geological unit. The Carboniferous succession is known from over 200 deep boreholes; in most of them, however, it was sparsely cored. This monotonous rock succession consists of sandstones and mudstones with intercalations of conglomerates and claystones, interpreted as turbidites. Mazur *et al*. (2003) distinguished in this sequence three major clastic facies associations, controlled by gravity flows, density currents and pelagic sedimentation respectively.

The total thickness remains unknown. The maximal thickness of about 2.5 km was recorded in the Marcinki IG 1 borehole, although the base of the succession was not reached there. Other boreholes penetrated thicknesses ranging from tens to several hundreds of metres. The only boreholes in which the bottom of the interval was reached were located on the Wolsztyn-Leszno High, where this succession is thinner.

This Carboniferous succession is usually considered as the infill of a Variscan foreland basin, being part of the Rhenohercynian Zone (Fig. 1 A). Its probable prolongation outcrops in the Moravo-Silesian Zone, that lies mainly in the Czech Republic, though partly in Poland in the vicinity of Toszek and in the Eastern Sudetes (Grygar and Trzepierczyński, 1995). The Carboniferous succession there is 4.7 to 7.5 km thick and consists of Viséan and lowermost Namurian clastic rocks (Hartley and Otava, 2001; Trzepierczyńska, 2003).

Despite over 40 years of intensive study the stratigraphy of this succession is still far from being properly understood. The results of biostratigraphic research, based on faunal macrofossils and miospore assemblages, seem to indicate the presence of rocks representing the time span from the Tournaisian to the Stephanian. However, results of palynostratigraphic studies in several cases contradicted ages provided by macrofaunal studies and, in certain cases, the results of palynostratigraphic studies of the same rocks, obtained by

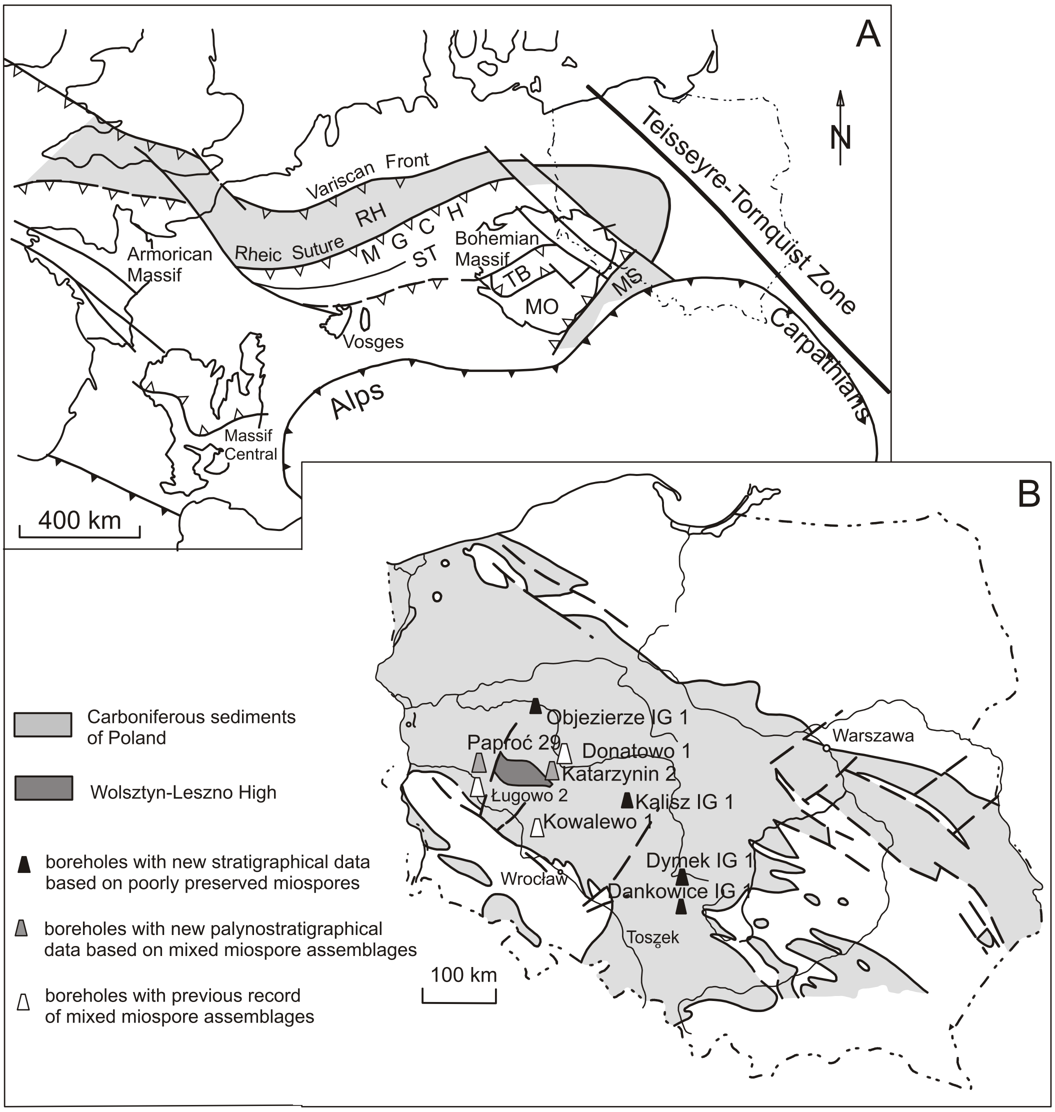


Fig. 1. A — tectonic sketch of the European Variscan Belt (from Mazur *et al.*, 2006); B — distribution of the Carboniferous rocks in Poland (from Żelichowski, 1983) with location of the studied and other boreholes

MGCH — Mid-German Crystalline High, MO — Moldanubian, MS — Moravo-Silesian, RH — Rhenohercynian, ST — Saxothuringian, TB — Tepla-Barrandian

different authors, contradicted each other. Hence, this new palynostratigraphical study was undertaken.

The study here focuses on rock samples of grey mudstones, claystones and fine-grained sandstones from six boreholes: Dymek IG 1, Dankowice IG 1, Kalisz IG 1, Objezierze IG 1, Paproć 29 and Katarzynin 2 (Figs. 1B and 2). Some of the profiles had been previously investigated biostratigraphically. Although recognition of the stratigraphy was the main purpose of these studies, the colour of miospores, reflecting thermal maturity, was also observed. The purpose of these observations was determination of the source rocks for the hydrocarbons. The colours were assessed according to the Batten's scale (1984) on specimens of *Lycospora*, which are present in all the assemblages recognized.

The results obtained from these Carboniferous rocks enables a new stratigraphical interpretation. The generally poor preservation of the miospores and the mixed character of the miospore assemblages are recognized as the source of the difficulty which led to inconsistency in the past.

PREVIOUS BIOSTRATIGRAPHIC RESULTS

Although investigations of these Carboniferous rocks have been carried out since 1960, no lithostratigraphic division has yet been proposed. The stratigraphic position of the upper Viséan and lower Namurian rocks is considered as defined with considerable certainty, because of the occurrence of late Viséan and, in places, early Namurian fossils of marine macrofauna,

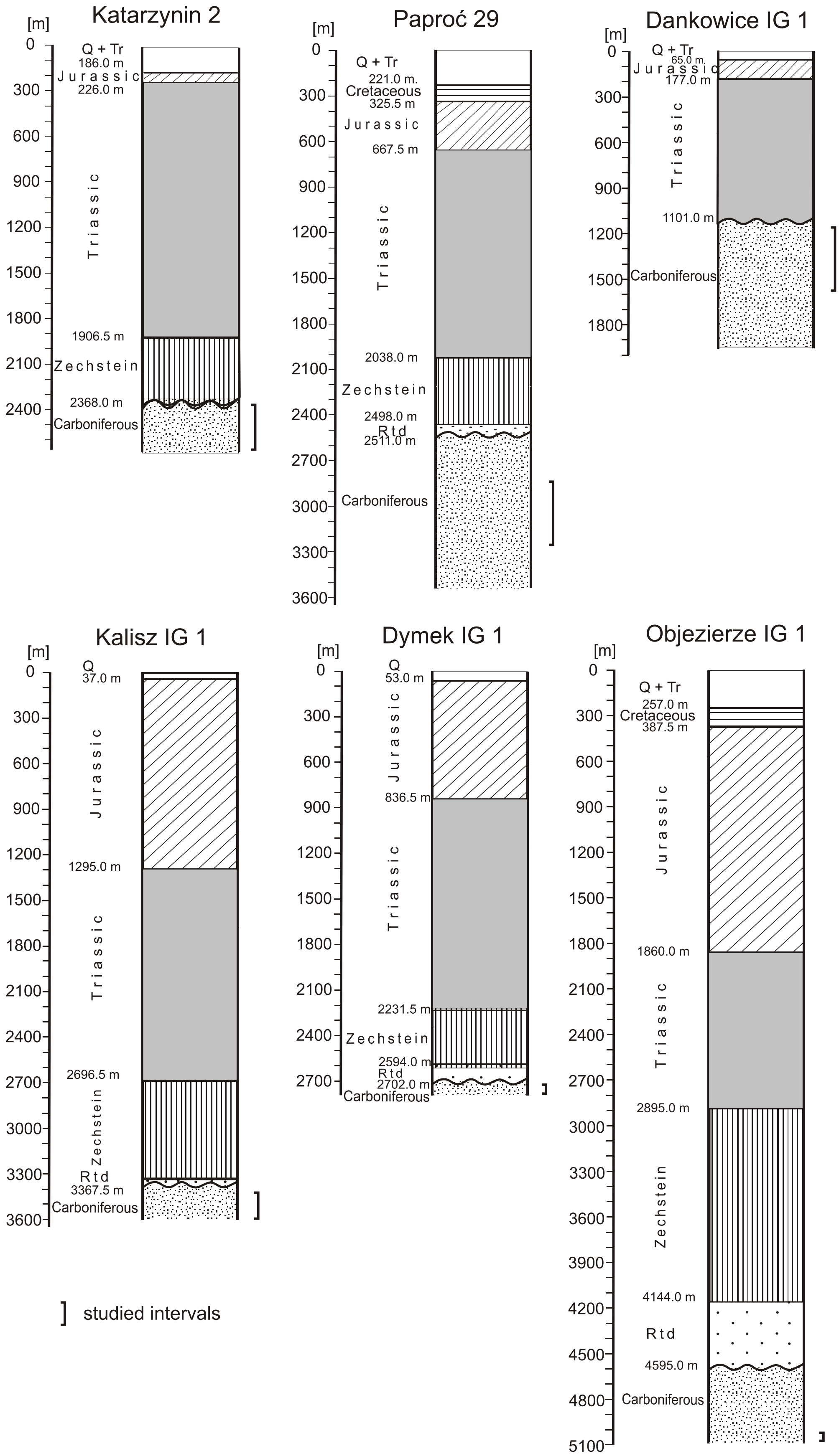


Fig. 2. Geological profiles of the boreholes studied

Q + Tr — Cenozoic, Mk — Muschelkalk, Rtd — Rotliegend including goniatites (Korejwo and Teller, 1966, 1973; Bojkowski, 1973; Kłapciński *et al.*, 1978; Kłapciński and Muszer, 1987, 1995; Witkowski and Żelichowski, 1981; Żelichowski, 1995; Muszer, 1999).

The results of previous palynologic studies have been widely, and these provided published a wide range of conclusions. In many cases these conclusions were very general. More precise conclusions suggested that the rocks under dispute may represent a time span from the Tournaisian to the Stephanian (Górecka, 1972, 1991; Krawczyńska-Grocholska, 1975, 1978; Krawczyńska-Grocholska and Grocholski, 1976; Jerzykiewicz, 1977; Górecka *et al.*, 1977*a*, *b*, 1978, 1994, 1998, 2000; Górecka and Parka, 1978, 1980; Karnkowski and Rdzanek, 1982*a*, *b*; Ślusarczyk, 1980; Parka and Ślusarczyk, 1988).

The quality of miospore documentation of individual parts of the Carboniferous sequence varies. Palynologic documentation of the Tournaisian and Viséan rocks is very poor. Namurian A rocks have been palynologically recognized in several boreholes and Namurian B and C deposits have been documented in a few. As regards Westphalian deposits, their younger part is much better documented with miospores than is the older part. Stephanian rocks have also been recorded in some boreholes.

Miospore assemblages containing abundant reworked specimens have been recognized in rocks from the Donatowo 1 (Krawczyńska-Grocholska, 1975; Karnkowski and Rdzanek, 1982 *a*, *b*), Kowalewo 1 (Krawczyńska-Grocholska, 1978) and Ługowo 2 (Ślusarczyk, 1980) boreholes (Fig. 1 B). Their stratigraphic interpretation has not always been correct.

Moreover, results of previous biostratigraphic results for the same section, obtained by different authors, appear contradictory in several cases. Stratigraphic interpretation of macrofaunal versus palynologic data as well as conclusions drawn from different palynologic studies commonly appear consistent.

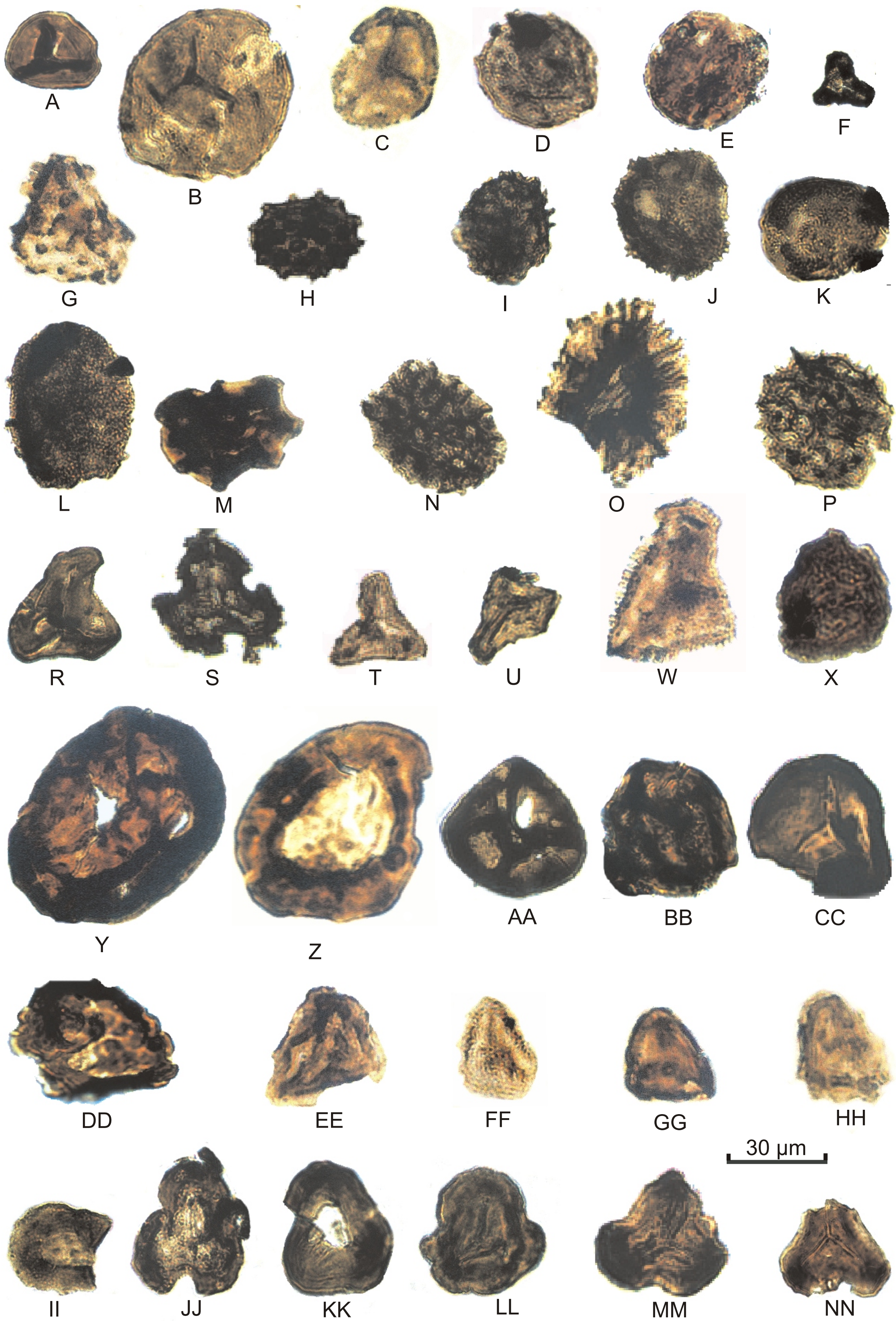
An additional complication relates to flawed lithological correlation in the case of palaeontologically barren rocks. Taking all this information into account, recapitulation of the previous results of stratigraphic studies on this Carboniferous succession poses no simple task. Wierzchowska-Kicułowa (1984) and Parka and Ślusarczyk (1988), considered that the Carboniferous succession under dispute contains probably a complete profile of this system, from the Tournaisian to the Stephanian. Żelichowski (1983, 1995) and Kmiecik (1995, 2001), discounting or questioning parts of the previous palynostratigraphic conclusions, suggested the presence of two rock successions of different ages: an older one comprising Lower Carboniferous and lower Namurian rocks and a younger succession consisting of upper Westphalian and Stephanian rocks.

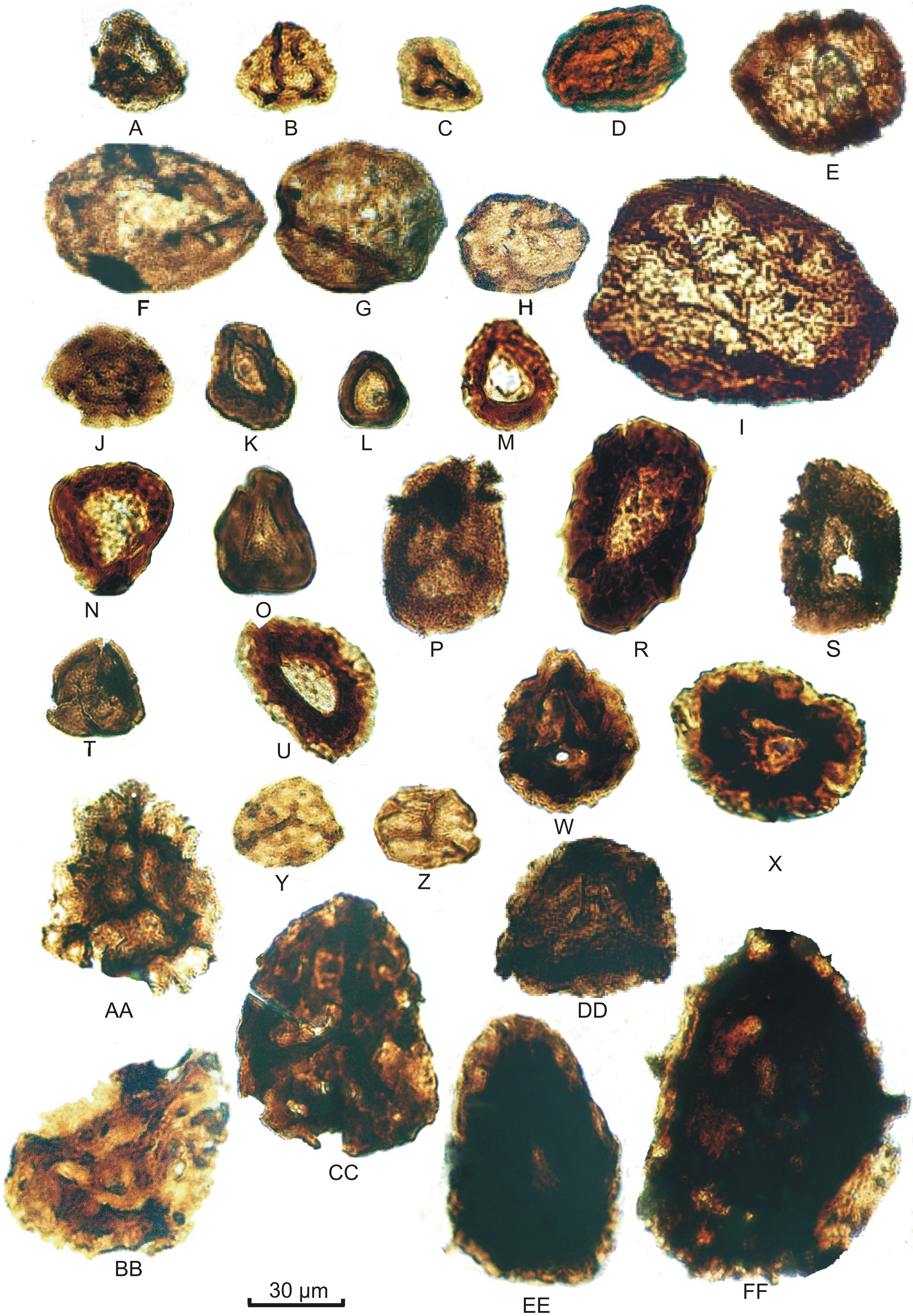
PRESENT RESULTS

Twenty rock samples from six boreholes provided abundant and diverse miospore assemblages (Appendix) and many stratigraphically important species were recorded in them (Figs. 3–5). Miospores found in the rocks are generally poorly

Fig. 3. Miospores from the Carboniferous succession of SW Poland

A — *Leiotriletes tumidus* Butterworth and Williams, 1958; borehole Paproć 29, depth 3238.0–3242.0 m, slide P4/1, F26/2-F27/1; **B** — *Punctatisporites aerarius* Butterworth and Williams, 1958; borehole Paproć 29, depth 3238.0–3242.0 m, slide P4/1, C18/2; **C** — *Plicatispora scolecophora* (Neves and Ioannides) Higgs, Clayton and Keegan, 1988; borehole Paproć 29, depth 3390.0–3397.0 m, slide P5/1, M23/3, (r); **D** — *Verrucosisporites cerosus* (Hoffmeister, Staplin and Malloy) Butterworth and Williams, 1958; borehole Paproć 29, depth 2969.0–2974.0, slide P 2/2, M 32; **E** — *Verrucosisporites baccatus* Staplin, 1960; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, R 26/2, (r); **F** — *Waltzispora* sp., borehole Objezierze IG 1, depth 5021.0–5025.5 m, slide Ob. 4/1, Y 44; **G** — *Pustulatisporites papillosus* (Knox) Potonié and Kremp, 1955; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/1, Z 31; **H** — *Pustulatisporites gibberosus* (Hacquebard) Playford, 1964; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, O 32/4, (r); **I** — *Acanthotriletes castanea* Butterworth and Williams, 1958; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, V 42,3; **J** — *Acanthotriletes hastatus* Sullivan and Marshall, 1966; borehole Katarzynin 2, depth 2466.5 m, slide K 3/1, M 11/1; **K** — *Convolutispora cerebra* Butterworth and Williams, 1958; borehole Paproć 29, depth 2969.0–2974.0 m, slide P 2/1, T 9/2; **L** — *Convolutispora ampla* Hoffmeister, Staplin and Malloy, 1955; borehole Paproć 29, depth 2969.0–2974.0 m, slide P 2/2, G 36; **M** — *Dictyotriletes vitilis* Sullivan and Marshall, 1966; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4, 1, L 8; **N** — *Dictyotriletes sagenoformis* Sullivan, 1964, borehole Paproć 29, depth 2969.0–2974.0 m, slide P 2/1, A 15/3, (r); **O** — *Dictyotriletes pactilis* Sullivan and Marshall, 1966; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, K 10/3, (r); **P** — *Dictyotriletes fragmentimurus* Neville, 1973; borehole Paproć 29, depth 2969.0–2974.0 m, slide P 2/1, A 37/4, (r); **R** — *Ahrensisporites guerickei* (Horst) Potonié and Kremp, 1954; borehole Katarzynin 2, depth 2466.5 m, slide K 3/1, R 9/4; **S** — *Tripartites vetustus* Schemel, 1950; borehole Objezierze IG 1, depth 5076.0–5085.5 m, slide Ob 5/2, O 58/1; **T** — *Triquitrites piramidalis* (Kedo and Jushko) Stempień and Turnau, 1988; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4, 1, S 50/1; **U** — *Triquitrites comptus* Williams, 1973; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, N 23,3; **W** — *Diatomozonotriletes trilinearis* Playford, 1963; borehole Paproć 29, depth 3390.0–3397.0 m, slide P5/1, T 19/4; **X** — *Bascaudaspora canipa* Owens, 1983; borehole Katarzynin 2, depth 2434.5 m, slide K 2/1, G 51,4; **Y** — *Gorgonispora crassa* (Wilsow) Higgs, Clayton and Keegan, 1988; borehole Katarzynin 2, depth 2558.5 m, slide K 5/1, E 63/3, (r); **Z** — *Reticulatisporites carnosus* (Knox) Neves, 1964; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/1, N 6/2; **AA** — *Knoxisporites seniradiatus* Neves, 1961; borehole Katarzynin 2, depth 2969.0 m, slide K 2/1, S 45; **BB** — *Lophozonotriletes concentricus* (Byvsheva) Higgs, Clayton and Keegan, 1988; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, Z 52/3, (r); **CC** — *Stenozonotrilees triangulus* Neves, 1961; borehole Katarzynin 2, depth 2466.5 m, slide K 3/1, Y 34/3; **DD** — *Secarisporites remotus* Neves, 1961; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, X 30,1; **EE** — *Savitrisporites nux* (Butterworth and Williams) Smith and Butterworth, 1967; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, H 22/4; **FF** — *Bellispores nitidus* (Horst) Sullivan, 1964; borehole Paproć 29, depth 2969.0–2974.0 m, slide P5/1, M 8,3; **GG** — *Rotaspora knoxi* Butterworth and Williams, 1958; borehole Paproć 29, depth 3390.0–3397.0 m, slide P 5/1, Z 47/2; **HH** — *Rotaspora ergonulii* (Agrali) Sullivan and Marshall, 1966; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/1, O 43/3, (r); **II** — *Tumulispora* sp. ; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/2, P 8/1, (r); **JJ** — *Simozonotriletes intortus* (Waltz) Potonie and Kremp, 1954; borehole Paproć 29, depth 3238.0–3242.0 m, slide P/2, E 32/2; **KK** — *Simozonotriletes intortus* (Waltz) Potonie and Kremp, 1954; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, W 12/4; **LL** — *Murospora aurita* (Waltz) Playford, 1962; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, Y 21/1, (r); **MM** — *Murospora aurita* (Waltz) Playford, 1962; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, B 39, (r); **NN** — *Murospora sublobata* (Waltz) Playford, 1962; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, K 17/3, (r); (r) — reworked specimen


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
R
S
T
U
W
X
Y
Z
AA
BB
CC
DD
EE
FF
GG
HH
30 µm
II
JJ
KK
LL
MM
NN


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
R
S
T
U
W
X
Y
Z
AA
BB
CC
DD
EE
FF
30 µm

preserved but in the Paproć 29 and Katarzynin 2 profiles their preservation was sufficient to recognize most of them. The miospore colour is generally dark with local variations. This indicates that the main factor degrading the miospores was palaeotemperature, which varied across the area. In the case of the best quality palynological data the standard miospore zonation scheme of the Namurian has been applied (Fig. 6) and the stratigraphic position of the rocks could be defined precisely.

Most specimens from the Paproć 29 and Katarzynin 2 boreholes were identified, but part of these only to genus level, whereas the rest were too poorly preserved to be recognized. The miospore preservation within assemblages varied greatly. In the Paproć 29 profile, orange-brown to dark brown specimens of *Lycospora* were recorded and their thermal maturation index assessed at the level of 3–4/5. Specimens of this genus from the Katarzynin 2 profile are generally brown to dark brown and their thermal maturation index amounts to 4–5. It should be stressed that in all miospore assemblages from these two profiles abundant very dark brown and even black miospores were observed, but there were no specimens of *Lycospora* among these. More badly preserved and less numerous miospore assemblages were obtained from the Objezierze IG 1 borehole. Miospores here are of dark or very dark brown colour and their thermal maturation index is 5–6/7. Only some of these were determinable. In rocks from the Dymek IG 1, Dankowice IG 1 and Kalisz IG 1 boreholes miospores occur in small number and are extremely poorly preserved. As a result of advanced thermal alteration miospores are black or very dark brown in colour (thermal maturation index 6–7) and barely determinable or even completely indeterminable. These data were partly used in the identification of source rocks for hydrocarbons (Nowak, 2003).

PAPROĆ 29

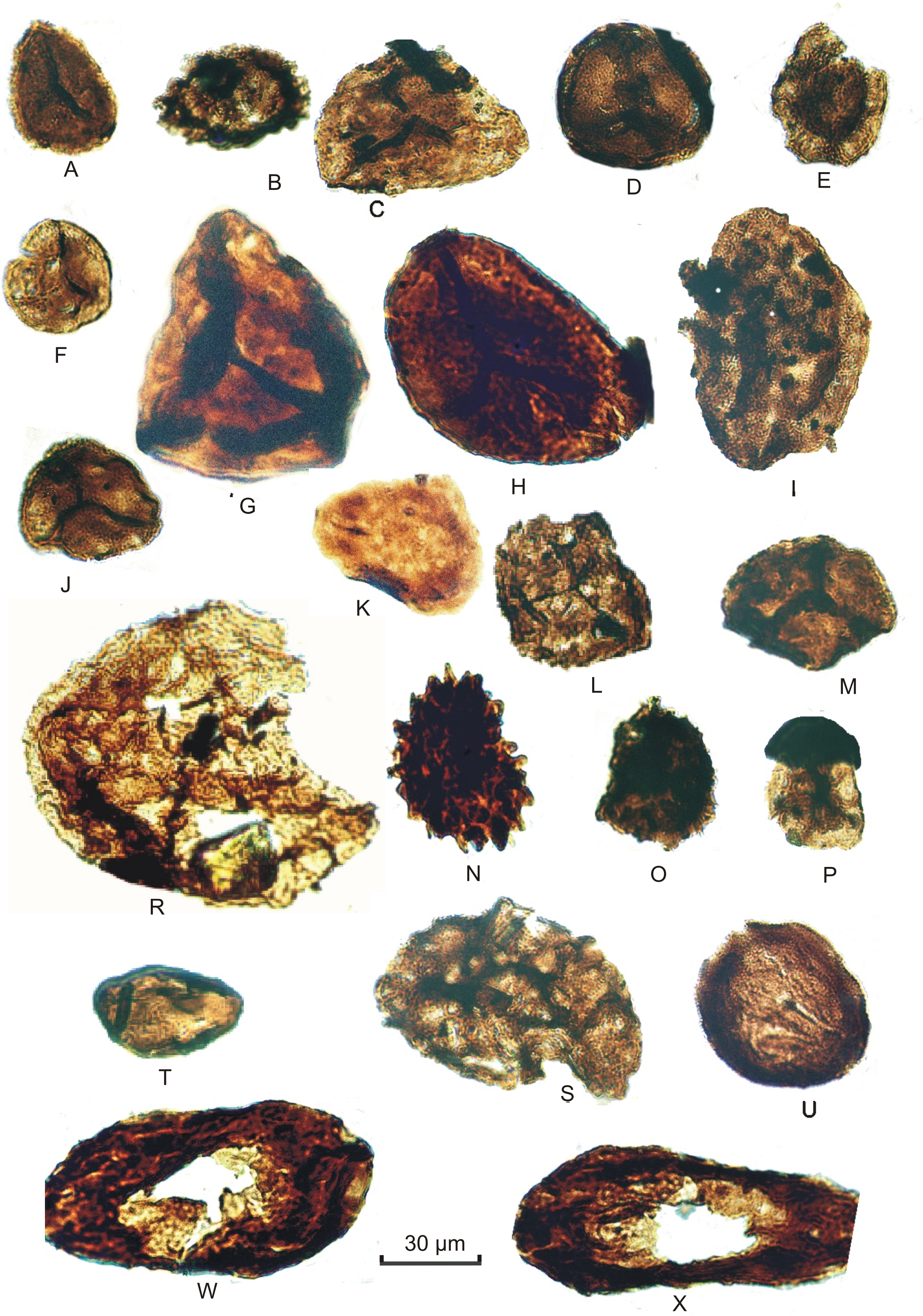
There exist no published results of biostratigraphic studies of the Carboniferous deposits from the Paproć 29 borehole. Earlier interpretations on their stratigraphy are based only on lithological criteria.

Taxonomically diverse miospore assemblages with abundant specimens were determined in rocks from the depth interval 2969.0–3522.0 m. Two hundred and nineteen miospore taxa were recorded altogether and the more important of them are listed in Appendix. An important feature of this assemblage is the abundance of *Densosporites* with related genera: *Radiizonates*, *Cristatisporites*, *Cingulizonates* and *Pseudoannulatisporites*, as well as *Lycospora*. Analysis of the stratigraphic ranges of the miospore taxa indicates that this assemblage is of a mixed character and consists of taxa typical of the time interval from the Late Devonian to the Late Carboniferous. They are divided into three age groups, which are marked in the Appendix.

The miospore assemblages do not reveal any prominent vertical differentiation and may be treated as a unity. For the stratigraphical interpretation only the youngest miospore taxa could be used. In this group the following species were recorded: *Microreticulatisporites concavus*, *Triquitrites marginatus*, *Tripartites vetustus*, *Reticulatisporites carnosus*, *Bellispores nitidus*, *Rotaspora knoxi*, *Crassispora kosankei*, *C. maculosa*, *Cingulizonates* cf. *capistratus*, *Kraeuselisporites echinatus*, *Remysporites magnificus*, *Rugospora corporata*, *Schulzospora camplyoptera* and

Fig. 4. Miospores from the Carboniferous succession of SW Poland

A — *Potoniespores delicatus* Playford, 1963; borehole Katarzynin 2, depth 2511.5 m, slide K 4/1, W 62/4, (r); **B** — *Potoniespores delicatus* Playford, 1963; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, W 45/1, (r); **C** — *Potoniespores interitorsus* (Horst) Kmiecik, 2001; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, Q 22/1; **D** — *Grumosisporites inaequalis* (Butterworth and Williams) Smith and Butterworth, 1967; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, Y 17/3; **E** — *Crassispora kosankei* (Potonié and Kremp) Bharadwaj, 1957; borehole Katarzynin 2, depth 2434.5 m, slide K 2/, Q 40/3; **F** — *Crassispora kosankei* (Potonié and Kremp) Bharadwaj, 1957; borehole Paproć 29, depth 2969.0–2974.0 m, slide P 2/1, H 46/4; **G** — *Crassispora kosankei* (Potonié and Kremp) Bharadwaj, 1957; borehole Katarzynin 2, depth 2466.5 m, slide K 3/2, A 13/1; **H** — *Crassispora kosankei* (Potonié and Kremp) Bharadwaj, 1957; borehole Paproć 29, depth 3390.0–3397.0, slide P 5/1, K 20/2; **I** — *Crassispora maculosa* (Knox) Sullivan, 1964; Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, T 45/2; **J** — *Tholisporites decorus* Bharadwaj and Venkatachala, 1961; borehole Paproć 29, depth 2969.0–2974.0 m, slide 2/1, V 21/2; **K** — *Pseudoannulatisporites polonicus* Karczewska 1967; Paproć 29, depth 312.0–3125.0 m, slide P 3/A, P 62.1; **L** — *Densosporites anulatus* (Loose) Smith and Butterworth, 1967; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, V 38/4; **M** — *Densosporites pseudoannulatus* Butterworth and Williams, 1958; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, T 36/2; **N** — *Densosporites triangularis* Kosanke, 1950; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, Q 41/1; **O** — *Densosporites triangularis* Kosanke, 1950; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, M 43/4; **P** — *Densosporites spitsbergensis* Playford, 1963; borehole Paproć 29, depth 2969.0–2974.0 m, slide P2/2, S 1/1, (r); **R** — *Densosporites regalis* (Bharadwaj and Venkatachala) Smith and Butterworth, 1967; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, S 55/3 (r); **S** — *Densosporites* sp.; Paproć 29, depth 2969.0–2974.0 m, Y 14; **T** — *Lycospora pusilla* (Ibrahim) Somers, 1972; borehole Katarzynin 2, depth 2466.5 m, slide K 3/1, H 52/4; **U** — *Cingulizonates bialatus* (Waltz) Smith and Butterworth, 1967; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, O 44; **W** — *Cingulizonates* cf. *capistratus* (Hoffmeister, Staplin and Malloy) Staplin and Jansonius, 1964; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, J 16/4; **X** — *Cingulizonates* cf. *capistratus* (Hoffmeister, Staplin and Malloy) Staplin and Jansonius, 1964; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, Z 9/2; **Y** — *Prolycospora claytonii* Turnau, 1978; borehole Paproć 29, depth 3520.0–3522.0, sidle P 7/1, W 44, (r); **Z** — *Prolycospora claytonii* Turnau, 1978; borehole Paproć 29, depth 3120.0–3125.0 m, sidle P 3/A, K 14 (r); **AA** — *Kraeuselisporites ornatus* (Neves) Owens, Mishell and Marshall, 1976; borehole Katarzynin 2, depth 2511.5 m, slide K 4/1, H 16/4; **BB** — *Kraeuselisporites ornatus* (Neves) Owens, Mishell and Marshall, 1976; borehole Katarzynin 2, depth 2637.4 m, slide K 7/2, D 20; **CC** — *Kraeuselisporites ornatus* (Neves) Owens, Mishell and Marshall, 1976; borehole Katarzynin 2, depth 2466.5 m, slide K 3/1, M 36/1; **DD** — *Kraeuselisporites hibernicus* Higgs, 1975; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, D 22/1, (r); **EE** — *Kraeuselisporites echinatus* Owens, Mishell and Marshall, 1976; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/, H 43,1; **FF** — *Kraeuselisporites echinatus* Hacquebard, 1957; borehole Katarzynin 2, depth 2434.5 m, slide K 2/2, X 31; (r) — reworked specimen


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
R
S
T
U
W
X
30 μm

Schulzospora ocellata. These are considered as typical of the *Bellispores nitidus-Reticulatisporites carnosus* (NC) Biozone, correlated with the uppermost Viséan and the lowermost Namurian A (Clayton *et al*., 1977; Owens *et al*., 1977). In the revised zonation of the Namurian (Owens *et al*., 2004) the equivalent of this biozone is named the *Cingulizonates capistratus-Bellispores nitidus* (CN) Biozone, and is divided into two sub-biozones: *Cingulizonates capistratus* (Cc) and *Verrucosisporites morulatus* (Vm). This division enables the use of the miospores for establishing the boundary between the Viséan and the Namurian rocks. Attention should be paid to presence of *Reticulatisporites carnosus*, which occurs together with *Crassispora kosankei* and the relatively high frequency of *Cingulizonates* cf. *capistratus* whose stratigraphic range is limited to the entire *Cingulizonates capistratus-Bellispores nitidus* (CN) Biozone. The first appearance of *C. kosankei* at the base of the *Verrucosisporites morulatus* (Vm) Sub-Biozone indicates that the rocks studied belong just to this biozone, correlated with the lowermost part of the Namurian A (Fig. 6).

Rocks of the same age have been palynologically documented in the Moravian-Silesian Zone. Trzepierczyńska (2003) determined abundant and diverse miospore assemblages from Toszek Castle Hill, where the uppermost part of the Carboniferous succession crops out. The stratigraphic position of these rocks was established as the upper part of the *nitidus-carnosus* Biozone (Clayton *et al*., 1977; Owens *et al*., 1977), which is now correlated with the *Verrucosisporites morulatus* (Vm) Sub-Biozone (Owens *et al*., 2004).

The definition of the stratigraphic position of the rocks studied indicates that all of the miospore taxa whose tops of stratigraphic ranges are located below the base of the Namurian should be considered as reworked. Those miospores are very abundant and taxa of different stratigraphic ranges are included there (Appendix). The oldest taxa are typical of the Famennian and/or the Tournaisian, although some are known from the Viséan. *Retusotriletes incohatus, Plicatispora scolecophora*, *Verrucosisporites nitidus*, *Anapiculatisporites hystricosus*, *Anaplanisporites atheticus*, *Acanthotriletes socraticus*, *Convolutispora vermiformis*, *Lophozonotriletes concentricus*, *Tumulispora malavkensis*, *Murospora dubitata*, *Crassispora trychera*, *Prolycospora claytonii*, *Kraeuselisporites hibernicus*, *K. mirtatus*, *Vallatisporites microspinosus*, *V. pusillites*, *V. vallatus*, *Auroraspora corporiga*, *A. evanida*, *A. macra*, *Spelaeotriletes microspinosus*, *Grandispora acuta*, *G. echinata*, *Rugospora minuta*, *R. polyptycha* belong to this group. Among the reworked miospores numerous typically Viséan taxa were also recorded, for example: *Dictyotriletes pactilis*, *Camptotriletes cristatus*, *Knoxisporites triradiatus*, *Diatomozonotriletes hughesii, Murospora aurita*, *Potoniespores delicatus*, *Colatisporites decorus*, *Cribrosporites cribellatus* and *Discernisporites micromanifestus*. Some of these are only slightly older than the taxa assigned to the youngest miospore group and their separation is frequently uncertain. Many of them are characteristic of the Brigantian.

It should be noticed that the colour of the Famennian and the Tournaisian miospores is generally very dark compared to the Viséan and the Namurian taxa. This difference is not reflected by the thermal maturity index measured on *Lycospora* specimens, because these are absent among the oldest miospores.

KATARZYNIN 2

Published results of previous biostratigraphic studies of the Carboniferous rocks from this borehole are scarce. Kłapciński and Muszer (1995) used floral remnants (*Mesocalamites* sp. and *Sphenophyllum* sp.) as a basis to include these rocks in the Namurian.

Palynostratigraphic studies provided abundant and taxonomically diverse miospore assemblages from all samples from the depth interval 2434.5–2650.0 m. In all assemblages specimens of various colours were observed. A typical feature is high frequency of dark coloured specimens comparing to the number of lighter coloured miospores. In all samples one hundred and thirty five miospore taxa were determined and the more important of these are listed in Appendix. Analysis

Fig. 5. Miospores from the Carboniferous succession of SW Poland

A — *Vallatisporites microspinosus* Higgs, Clayto and Keegan, 1988; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, Z 14/3, (r); **B** — *Vallatisporites* sp.; borehole Katarzynin 2, depth 2434.5 m, slide K 2/2, U 16/2 (r); **C** — *Discernisporites micromanifestus* (Hacquebard) Sabry and Neves, 1971; borehole Katarzynin 2, depth 2511.5 m, slide K 4/1, H 62/4, (r); **D** — *Geminospora* sp.; borehole Paproć 29, depth 2969.0–2974.0 m, slide P2/2, J 6, (r); **E** — *Auroraspora evanida* (Kedo) Avchimovich, 1988; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, H 24/3, (r); **F** — *Auroraspora macra* Sullivan, 1964; borehole Paproć 29, depth 3120.0–3125.0 m, slide P 3/A, K 19/1, (r); **G** — *Remysporites magnificus* (Horst) Butterworth and Williams, 1958; borehole Paproć 29, depth 3390.0–3397.0 m, slide P 5/1, B 17/3; **H** — *Spelaeotriletes arenaceous* Neves and Owens, 1966; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, S 53; **I** — *Spelaeotriletes arenaceous* Neves and Owens, 1966; borehole Paproć 29, depth 2969.0–2974.0 m, slide P2/2, T 2/3; **J** — *Spelaeotriletes microspinosus* Neves and Ioannides, 1974; borehole Katarzynin 2, depth 2466.5 m, slide K 3/2, S 33/4, (r); **K** — *Cribosporites cribellatus* Sullivan, 1964; borehole Paproć 29, depth 3120.0–3125.0, slide P 3/1, D 20, (r); **L** — *Grandispora echinata* Hacquebard, 1957; borehole Katarzynin 2, depth 2591.5 m, slide K 6/1, C 24/3, (r); **M** — *Grandispora spinosa* Hoffmeister, Staplin and Malloy, 1955; borehole Katarzynin 2, depth 2511.5 m, slide K 4/1, K 35; **N** — *Grandispora acuta* (Kedo) Byvscheva, 1980; borehole Paproć 29, depth 3238.0–3242.0 m, slide P 4/1, Q 60/3, (r); **O** — *Grandispora acuta* (Kedo) Byvscheva, 1980; borehole Katarzynin 2, depth 2511.5 m, slide K 4/1, B 55,4, (r); **P** — *Retispora staplinii* (Gupta and Boozer) Ravn and Fitzgerald, 1982; borehole Katarzynin 2, depth 2466.5 m, slide K4/1, B 62; **R** — *Rugospora corporata* Neves and Owens, 1966; Katarzynin 2, depth 2969.0 m, sidle K 3/1, K 25; **S** — *Rugospora corporata* Neves and Owens, 1966; borehole Paproć 29, depth 3238.0–3242.0 m, sidle P 4/1, M 55/1; **T** — *Laevigatosporites vulgaris* (Ibrahim) Potonié and Kremp, 1956; Katarzynin 2, depth 2969.0 m, slide K 3/1, D, 14/1; **U** — *Colatisporites denticulatus* Neville in Neves *et al*., 1973; borehole Katarzynin 2, depth 2466.5 m, slide K 3/2, N 63, (r); **W** — *Schulzospora campyloptera* (Waltz) Hoffmeister, Staplin and Malloy, 1955; borehole Paproć 29, depth 3238.0–3242.0 m, sidle P 4/1, N 32/1; **X** — *Schulzospora campyloptera* (Waltz) Hoffmeister, Staplin and Malloy, 1955; borehole Paproć 29, depth 3238.0–3242.0 m, sidle P 4/1, J 10/1; (r) — reworked specimen

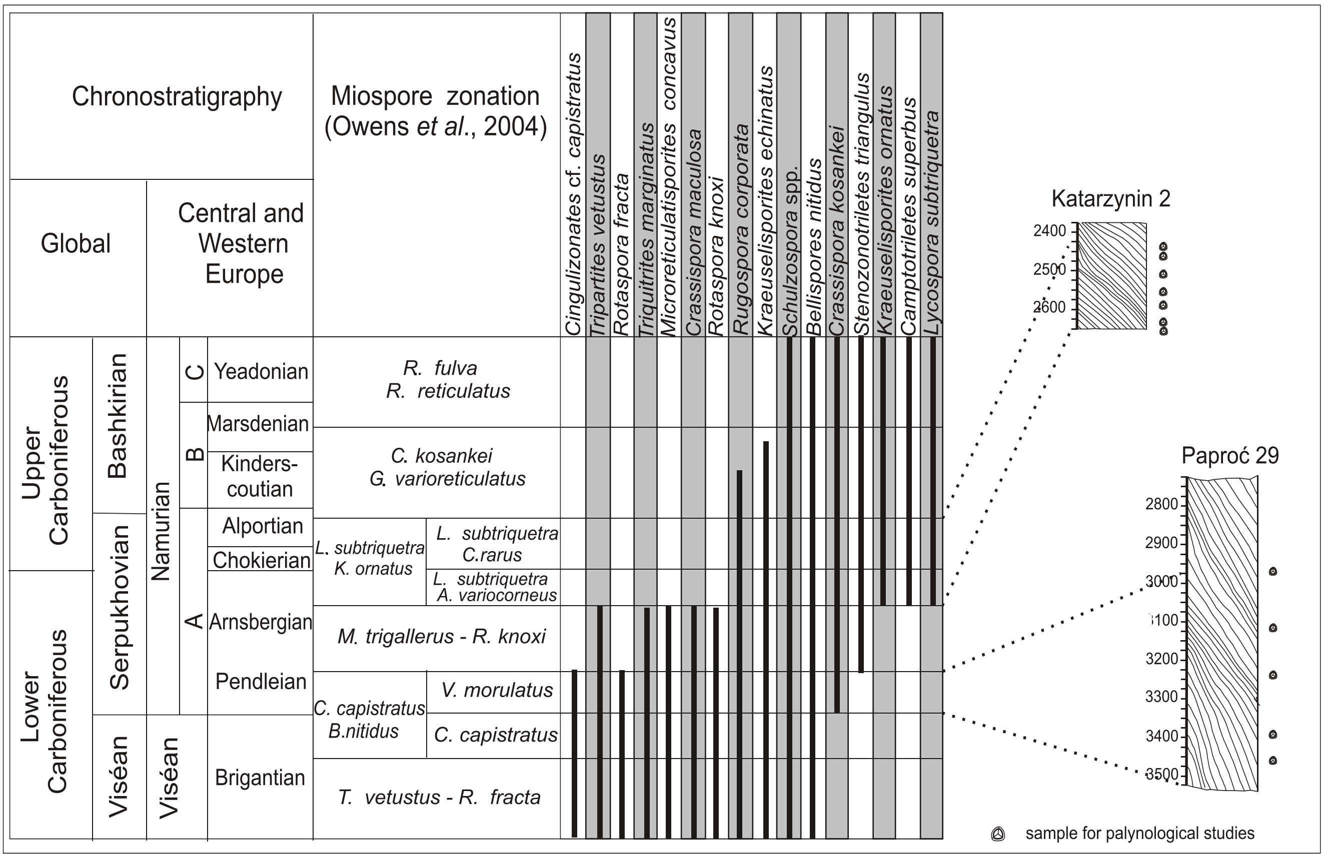


Fig. 6. Miospore zonation of the Namurian and stratigraphical position of the rocks studied from the Paproć 29 and Katarzynin 2 boreholes

of miospore assemblage composition indicates that they consist of miospores typical of the Late Devonian to the Late Carboniferous. Among taxa of long stratigraphic ranges there occur species typical of short, but different, time intervals. An important feature of the assemblage is its mixed character (Appendix).

There is no prominent vertical differentiation to be noticed and the entire profile probably represents the same biozone. Stratigraphic interpretation of this assemblage was based on a diverse group of the youngest taxa. The presence of *Crassispora kosankei* implies that the rocks under study are not older than the Namurian. The occurrence of *Stenozonotriletes triangulus*, *Camptotriletes superbus*, *Lycospora subtriquetra* and *Kraeuselisporites ornatus* indicates that they belong to the *Lycospora subtriquetra-Kraeuselisporites ornatus* (SO) Biozone corresponding to the upper Namurian A (Clayton *et al.*, 1977; Owens *et al.*, 1977). This biozone was recently divided into two sub-biozones: *Lycospora subtriquetra-Apiculatisporis variocorneus* (SV) and *Lycospora subtriquetra-Cirratriradites rarus* (SR) and the boundary between these corresponds to the Lower/Upper Carboniferous boundary (Owens *et al.*, 2004). On the basis of obtained miospore data it is neither possible to apply the new miospore zonation (Owens *et al.*, 2004), nor to determine the affinity of rocks to the Lower or Upper Carboniferous (Fig. 6).

The miospore recorded assemblage contains many taxa older than the *Lycospora subtriquetra-Kraeuselisporites ornatus* (SO) Biozone and all of these were assigned to the reworked miospores. It should be stressed that they are very common in the samples studied (Appendix). This group consists of miospore taxa characteristic of the Late Devonian to the early Namurian A. Two taxa groups of different ages may be distinguished with in it. The older one contains taxa typical of the Famennian and/or the Tournaisian and *Cyclogranisporites palaeophytus*, *Retusotriletes incohatus*, *Emphanisporites* sp., *Apiculiretusispora multisaeta*, *Lophozonotriletes concentricus*, *Radiizonates mirabilis*, *Prolycospora claytonii*, *Kraeuselisporites hibernicus*, *K. mirtatus*, *Vallatisporites verrucosus*, *Auroraspora macra*, *Grandispora acuta*, *G. echinata*, *Diducites mucronatus*, *Rugospora minuta*, *R. polyptycha* and *Velamisporites caperatus* belong to this group. The younger group of the reworked miospores consists of taxa typical of the upper Viséan and the lowermost Namurian. *Verrucosisporites baccatus*, *Microreticulatisporites concavus*, *Stenozonotriletes coronatus*, *Ahrensisporites duplicatus*, *Tripartites distictus*, *Cingulizonates* cf. *capistratus*, *Colatisporites denticulatus*, *Discernisporites micromanifestus*, and *Potoniespores delicatus* were recorded in this group.

THE REMAINING PROFILES

Miospores found in rocks from all remaining profiles were extremely poorly preserved. Many specimens were undeterminable, others were determined only to genus level and only some of the miospores were assigned to particular species. Therefore it was impossible to prove that these miospore assemblages contained reworked miospores. The interpretation of these assemblages allows one to draw only very general conclusions pertaining to their stratigraphic position. More precise stratigraphical interpretation is uncertain because of the possible mixed nature of these miospore assemblages.

In the well Objezierze IG 1, where late Viséan marine faunal fossils had been recognized earlier (Żelichowski, 1995), thermally overmatured miospores, containing *Waltzispora* sp., *Acanthotriletes echinatus*, *Microreticulatisporites concavus*, *Tripartites vetustus* and *Schulzospora* sp. were recorded in the depth interval 5021.0–5085.5 m. They indicate that the rocks studied are not older than late Viséan. In deposits from the wells Kalisz IG 1 (depth 3418.0–3595.5 m), Dymek IG 1 (depth 2709.0–2796.5 m), and Dankowice IG 1 (depth 1160.0–1573.0 m) very scarce and very poorly preserved miospores of a very dark brown to black colour were found. The stratigraphic position of these rocks established on the basis of the occurrence of *Dictyotriletes* sp., *Tripartites* sp., *Stenozonotriletes* sp., *Lycospora* sp. and *Densosporites* sp. may be defined only very generally as not older than Viséan.

MIXED MIOSPORE ASSEMBLAGES AND THEIR INTERPRETATION

Occurrence of reworked miospores had been recorded earlier from a few profiles of the Carboniferous succession studied (Krawczyńska-Grocholska, 1975, 1978; Ślusarczyk, 1980; Karnkowski and Rdzanek, 1982*a*, *b*). The new palynostratigraphic results have revealed the common occurrence of reworked miospores. These were very abundant in all samples from the Katarzynin 2 and Paproć 29 boreholes. Very poor preservation of the miospores means that assessment of the mixed nature of miospore assemblages from the remaining profiles (Objezierze IG 1, Kalisz IG 1, Dymek IG 1 and Dankowice IG 1) is not possible. Reworked miospores were also abundant in other recently studied profiles: Siciny IG 1, Marcinki IG 1 and Września IG 1 (Górecka-Nowak, in prep.). Their common presence in many assemblages and previous record from other profiles indicate that mixed miospore assemblages occur commonly or always in the deposits under study.

The main criterion of reworked miospores identification is an analysis of stratigraphical ranges, based on the occurrence of particular taxa in different regions in Europe (Neves, 1961; Neves and Owens, 1966; Sullivan and Marshall, 1966; Neves and Dolby, 1967; Smith and Butterworth, 1967; Neves *et al*., 1972, 1973; Neves and Ioannides, 1974; Clayton *et al*., 1977; Welsh and Owens, 1983; Owens, 1983; Higgs *et al*., 1988, 1992, 2000; Clayton and Turnau, 1990; Riley, 1993; Owens *et al*., 2004). Compiled data from Poland (Kmiecik, 2001) were complemented by those from recently published papers (Oliwkiewicz-Miklasińska, 1995, 2001; Trzepierczyńska 2001, 2003; Stempień-Sałek, 2002; Górecka-Nowak and Majewska, 2002; Filipiak, 2004; Turnau *et al*., 2005). As reworked are considered all the species whose tops of stratigraphic ranges are below the base of the biozone to which the studied rocks were assigned. In the case of taxa much older than the rocks recognition of their reworked nature is easy. It is more difficult when reworked miospores are only slightly older than the rock.

An additional criterion of reworked miospore recognition is colour, which depends on the thermal maturity of organic matter. Miospore assemblages found in the rocks studied consist of specimens of diverse colours. It is evident that the older miospores have generally darker colours. One should not, however, use this criterion to decide whether an individual specimen belongs to reworked or unreworked miospore groups, because the resistance of different miospore taxa exines to thermal alteration varies. Another reason is that markedly differences in miospore colour occur only when their thermal history markedly differs. Applying this criterion as an additional one may help in the recognition of reworking phenomena record.

The stratigraphical interpretation of mixed assemblages, containing abundant reworked miospores, is difficult, especially when miospore preservation is poor, as witnessed by some earlier incorrect interpretations of the palynological data from the succession studied (Krawczyńska-Grocholska, 1975, 1978). Only the youngest taxa here have stratigraphic value and all older specimens should be discounted. These stratigraphically important youngest taxa are usually not numerous among older, reworked miospores, because the latter group of miospores may approach 100% of the miospore assemblage (Streel and Bless, 1980). Reliable stratigraphic interpretation of mixed assemblages requires really abundant miospores. When there are too few specimens it is easy to interpret the age of a miospore assemblage incorrectly. An additional difficulty is that only the first appearance of taxa may be a stratigraphic criterion. Its disappearance cannot be used for this purpose because of the common occurrence of older, reworked miospores. A disregard for these principles probably explains the many contradictory palynostratigraphical results obtained by previous studies of this Carboniferous succession.

The mixed nature of the miospore assemblages determined is closely connected with the turbiditic origin of the deposits studied. The presence of these reworked miospores in the Namurian A rocks is a proof of the reworking of older rock material in the early Namurian, and of the cannibalization of previously deposited sediments. Analysis of the stratigraphic ranges of the reworked miospores allows determination of the stratigraphical position of the source rocks. The reworked miospores may be divided into two groups. A older group, consisting of taxa typical of the Famennian and/or Tournaisian, was recorded in all miospore assemblages from the Paproć 29 and Katarzynin 2 profiles. A group of younger taxa, recognized in miospore assemblages from the Paproć 29 profile, consists of Viséan taxa. In assemblages from the Katarzynin 2 profile, a group of younger reworked miospores contains Viséan and earliest Namurian taxa. This may indicate that the reworked miospores originated from source rocks of different ages, i.e. Famennian–Tournaisian and Viséan (or Viséan–lowermost Namurian). Another possibility is that Viséan (or Viséan–lowermost Namurian) source rocks contained reworked miospores of Famennian–Tournaisian age. It is not yet possible to judge which interpretation is more plausible, and so it is premature to invoke complex or secondary reworking (Streel and Bless, 1980).

CONCLUSIONS

Palynological constraints on the age of the Carboniferous clastic succession of SW Poland are influenced by the commonly poor preservation of the miospores, resulting mainly from thermal alteration, and the mixed nature of their assemblages. The precision of the age interpretation is limited by the quality of the palynological data.

The rocks studied from the Paproć 29 and Katarzynin 2 boreholes were assigned to the Namurian A, correlated with the Serpukhovian. Older deposits were documented from the Paproć 29 profile and these were included in the *V. morulatus* Sub-Biozone, corresponding to the lowermost Namurian A and limited to the Pendleian (Owens *et al*., 2004). They may be correlated with the uppermost part of the Lower Carboniferous rock succession outcropping at Toszek Castle Hill in the Moravian-Silesian Zone (Trzepierczyńska, 2003). Rocks from the Katarzynin 2 profile were assigned to the *Lycospora subtriquetra-Kraeuselisporites ornatus* Biozone, correlated with the upper Namurian A and the upper part of the Arnsbergian, the Chokierian and the lower part of the Alportian (Owens *et al*., 2004).

The stratigraphic positions of rocks from the Objezierze IG 1 borehole were dated as not older than late Viséan and, from the Kalisz IG 1, Dymek IG 1 and Dankowice IG 1 profiles, as not older than Viséan.

The occurrence of mixed miospore assemblages in the rocks studied is very common. They are evidence of the cannibalization of Famennian–Tournaisian and Viséan rocks during the early Namurian. It is also possible that the source rocks belonged to the Viséan but contained Famennian–Tournaisian reworked miospores.

Acknowledgements. The author thanks Dr. J. Haydukiewicz for discussion and constructive comments on the manuscript. Many thanks are due to Prof. E. Turnau and to Prof. M. Narkiewicz, whose constructive and helpful comments and corrections have substantially improved this paper. This research was supported by the Polish Committee for Scientific Research and the Ministry of the Environment (project PCZ-007-21 “Palaeozoic Accretion of Poland”).

REFERENCES

BATTEN D. J. (1984) — Pollen/spore colour standard. Munsell Colour Standard (Matte Finish). Vers. 2.

BOJKOWSKI K. (1973) — Das Oberkarbon (Silesium) in Polen in Lichte faunistischer Untersuchungen. C. R. 7 Congr. Int. Stratigr. Geol. Carbon. Krefeld, **4**: 159–165.

CLAYTON G., COQUEL R., DOUBINGER J., GUEINN K. J., LOBOZIAK S., OWENS B. and STREEL M. (1977) — Carboniferous miospores of Western Europe: illustration and zonation. Meded. Rijks Geol. Dienst, **29**: 1–71.

CLAYTON G. and TURNAU E. (1990) — Correlation of the Tournaisian miospore zonations of Poland and the British Isles. Ann. Soc. Geol. Pol., **60** (1–4): 45–59.

FILIPIAK P. (2004) — Miospore stratigraphy of Upper Famennian and Lower Carboniferous deposits of the Holy Cross Mountains (central Poland). Rev. Palaeobot. Palynol., **128** (3–4): 291–322.

GÓRECKA T. (1972) — Preliminary information on the existence of Upper Carboniferous on the Presudetic Monocline (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc., 8. Stud. Mat., **8**: 35–51.

GÓRECKA T. (1991) — Silesian deposits on the Sudety Mts. and Polish Lowland in the light of palynostratigraphical investigations (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc**., 61.** Monografie, **28**.

GÓRECKA T., CYGAN J. and CZERSKI K. (1994) — Palinostratygraficzna analiza skał karbońskich z otworów wiertniczych Zbąszyń 3, Zbąszyń 5 i Zbąszyń 6. Pr. Nauk. Inst. Górn. Polit. Wr., 76. Stud. Mat., **24**: 87–94.

GÓRECKA T., CZERSKI K. and CYGAN J. (1998) — Palinostratygraficzne badania skał karbońskich z otworu wiertniczego Sadlno 1. Pr. Nauk. Inst. Górn. Polit. Wroc., 85, Studia i Materiały, **27**: 33–37.

GÓRECKA T., CZERSKI K. and CYGAN J. (2000) — Niektóre wyniki badań palinologicznych złoża gazu ziemnego „Paproć” (monoklina przedsudecka). Pr. Nauk. Inst. Górn. Polit. Wroc., 87. Studia i Materiały, **28**: 13–18.

GÓRECKA T., JUROSZEK C., KARWOWSKI L., KŁAPCIŃSKI J., LORENC S., MIERZEJEWSKI M., SACHANBIŃSKI M. and ŚLUSARCZYK S. (1977*a*) — The crystalline rocks and Carboniferous deposits of the Foresudetic Monocline, the Żary Pericline and the adjacent part of the Foresudetic Block (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc., **22**. Monografie, **9**.

GÓRECKA-NOWAK A. and MAJEWSKA M. (2002) — Remarks on palynostratigraphy of the Namurian Wałbrzych Formation in the northern part of the Intrasudetic Basin (SW Poland). Geol. Quart., **46** (2): 101–115.

GÓRECKA T., PARKA Z., ŚLUSARCZYK S. and TEMPLIN L. (1977) — Results of the palynostratigraphical studies of the pre-Permian deposits of the south-eastern part of the Fore-Sudetic Monocline (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wr., 24. Stud. Mat., **12**: 29–55.

GÓRECKA T. and PARKA Z. (1978) — Age of the pre-Permian deposits on the basis of the palynological studies (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc., 32, Stud. Mat., **15**: 84–88.

GÓRECKA T. and PARKA Z. (1980) — Stratigraphy of the Carboniferous deposits taken from the drill-hole elaborated on the basis of palynological tests (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc., 35, Stud. Mat., **16**: 3–35.

GÓRECKA T., PARKA Z., ŚLUSARCZYK S. and TEMPLIN L. (1978) — Wiek osadów podpermskich na podstawie badań palinologicznych. Pr. Nauk. Inst. Górn. Polit. Wroc., **25**. Monografie, **11**.

GRYGAR R. and TRZEPIERCZYŃSKI J. (1995) — Pozycja tektoniczna i rozwój formacji fliszowej strefy morawsko-śląskiej. Międzynarodowa Konferencja Naukowa: “Sedymentologia i tektonika kulmu w zachodnim obrzeżeniu Górnośląskiego Zagłębia Węglowego”, 5–8. 10. 1995. Mat. Konfer.: 7–18.

HARTLEY A. J. and OTAVA J. (2001) — Sediment provenance and dispersal in a deep marine foreland basin: the Lower Carboniferous Culm Basin, Czech Republic. J. Geol. Soc. London, **158**: 137–150.

HIGGS K. T., AVCHIMOVITCH V. I., LOBOZIAK S., MAZIANE-SERRAJ N., STEMPIEŃ-SAŁEK M. and STREEL M. (2000) — Systematic study and stratigraphic correlation of the Grandispora complex in the Famennian of northwest and eartern Europe. Rev. Paleobot. Palynol., **112**: 207–228.

HIGGS K., CLAYTON G. and KEEGAN J. B. (1988) — Stratigraphic and Systematic Palynology of the Tournaisian Rocks of Ireland. Geol. Sourv. Ireland. Spec. Paper, **7**.

HIGGS K., DREESEN R., DUSAR M. and STREEL M. (1992) — Palynostratigraphy of the Tournaisian (Hastarian) rocks in the Namur Synclinorium, West Flanders, Belgium. Rev. Palaeobot. Palynol., 7**2**: 149–158.

JERZYKIEWICZ J. (1977) — The results of the palynological investigations of Carboniferous and Permian deposits of the Foresudetic Monocline (in Polish with English summary). Pr. Nauk. Inst. Górn. P. Wr., 24. Stud. Mat., **12**: 3–27.

KARNKOWSKI P. H. and RDZANEK K. (1982*a*) — Górny karbon (Stefan) w wierceniu Donatowo-1. Prz. Geol., **30** (1): 32–33.

KARNKOWSKI P. H. and RDZANEK K. (1982*b*) — Some remarks on basement of the Permian in the Wielkopolska region (in Polish with English summary). Kwart. Geol., **26** (2): 327–339.

KŁAPCIŃSKI J. and MUSZER J. (1987) — Age of the pre-Permian rocks from chosen boreholes of eastern part of the Fore-Sudetic Monocline (in Polish with English summary). Geol. Sud., **22**: 91–100.

KŁAPCIŃSKI J. and MUSZER J. (1995) — Age of sediments of older basement from chosen boreholes of central part of the Fore-Sudetic Monocline (in Polish with English summary). Acta Univ. Wratislav. no. 1607. Pr. Geol. Miner., **44**: 29–46.

KŁAPCIŃSKI J., HAYDUKIEWICZ J. and LORENC S. (1978) — Utwory serii podłoża podpermskiego południowej części rejonu poznańskiego z wybranych otworów wiertniczych. Arch. Univ. Wrocł.

KMIECIK H. (1995) — The Carboniferous system in Poland (eds. A. Zdanowski and H. Żakowa) . Pr. Państw. Inst. Geol., **148**: 70–85.

KMIECIK H. (2001) — Budowa geologiczna Polski. 3. Atlas skamieniałości przewodnich i charakterystycznych. Młodszy paleozoik, Karbon. Flora (ed. M. Pajchlowa): 572–582. Pol. Inst. Geol.

KOREJWO K. and TELLER L. (1966) — Lower Carboniferous of the Eastern Part of the Fore-Sudetic Monocline. Bull. Acad. Pol. Sc. Ser. Sc. Geol. Geogr., **14**: 243–245.

KOREJWO K. and TELLER L. (1973) — Stratygrafia serii karbonu. In: Marcinki IG 1 (ed. Gajewska I). Prof. Głęb. Otw. Wiert. Inst. Geol., **8**: 35–37.

KRAWCZYŃSKA-GROCHOLSKA H. (1975) — Palinological studies on the Carboniferous of the north-western Poland (in Polish with English summary). Prz. Geol., **23** (1): 34–35.

KRAWCZYŃSKA-GROCHOLSKA H. (1978) — Karbon w podłożu zachodniej części monokliny przedsudeckiej. Przew. 50 Zjazdu Pol. Tow. Geol., Zielona Góra: 113–118.

KRAWCZYŃSKA-GROCHOLSKA H. and GROCHOLSKI W. (1976) — Deeper geological substratum of the Poznań area in the light of the studies from the years 1973–1975 (in Polish with English summary). Prz. Geol., **24** (9): 520–525.

MAZUR S., ALEKSANDROWSKI P., KRYZA R. and OBERC-DZIEDZIC T. (2006) — The Variscan Orogen in Poland. Geol. Quart., **50** (1): 89–118.

MAZUR S., ALEKSANDROWSKI P., MASTALERZ K., GÓRECKA-NOWAK A., KUROWSKI L., KRZEMIŃSKI L., KRZYWIEC P., ŻELA NIEWICZ A., TURNIAK K. and FANNING M. (2007) — Variscan external fold-thrust belt or locally deformed foreland basin – the dilemma of the tectonic setting for the Carboniferous clastic succession of western Poland (in press).Geol. Magaz.

MAZUR S., KUROWSKI L., ALEKSANDROWSKI P. and ŻELA NIEWICZ A. (2003) — Variscan Fd Fold-Thrust Belt of Wielkopolska (W Poland): new Structural and Sedimentological Data. Geolines, **16**: 71–73.

MUSZER J. (1999) — Nowa dokumentacja faunistyczna wizenu w podłożu monokliny przedsudeckiej (Jezierzyce 1). Wybrane zagadnienia stratygrafii, tektoniki i okruszcowania Dolnego Śląska. Inst. Geol. Sc. Wrocław Univ.: 120–121.

NEVES R. (1961) — Namurian plant spores from the Southern Pennines, England. Palaeontology, **4**: 247–279.

NEVES R. and DOLBY G. (1967) — An assemblage of miospores from the Portishead Beds (upper Red Sandstone) of the Mendip Hills, England.: Pollen et Spores **9** (3): 607–615.

NEVES R., GUEINN K. J., CLAYTON G., IOANNIDES N. S. and NEVILLE R. S. (1972) — A scheme of miospore zones from the British Dinantian. C. R. 7 Congr. Int. Strat. Geol. Carbon. Krefeld, 971. **1**: 347–353.

NEVES R., GUEINN K. J., CLAYTON G., IOANNIDES N. S., NEVILLE R. S. and KRUSZEWSKA K. (1973) — Palynological Correlations within the Lower Carboniferous of Scotland and Northern England. Trans. Royal Soc. Edinburgh., **69** (2): 33–70.

NEVES R. and IOANNIDES N. (1974) — Palynology of the Lower Carboniferous (Dinantian) of the Spilmersford Borehole, East Lothian, Scotland. Bull. Geol. Surv. Great Britain, **45**: 73–97.

NEVES R. and OWENS B. (1966) — Some Namurian camerate miospores from the English Pennines. Pollen et Spores, **8** (2): 337–360.

NOWAK G. J. (2003) — Petrologia materii organicznej rozproszonej w późnopaleozoicznych skałach osadowych południowo-zachodniej Polski. Czas. Nauk. Techn. Górn. Rud CUPRUM, **4** (29): 3–209.

OLIWKIEWICZ-MIKLASIŃSKA M. (1995) — Note on the succession of miospore assemblages in the Namurian and lowermost Westphalian in the vicinity of Jaworzno (Upper Silesia Coal Basin). Stud. Geol. Pol., **108**: 203–219.

OLIWKIEWICZ-MIKLASIŃSKA M. (2001) — New distinctive miospore species from the Namurian of the Upper Silesia Coal Basin, Poland. J. Micropalaeont., **20**: 169–177.

OWENS B. (1983) — Bascaudaspora gen. nov., a new reticulate miospore genus from the Namurian of Northern England. Rep. Inst. Geol. Sc., **83** (10): 45–49.

OWENS B., MC LEAN D. and BODMAN D. (2004) — A revised palynozonation of British Namurian deposits and comparisons with eastern Europe. Micropaleontology, **50**: 89–103.

OWENS B., NEVES R., GUEINN K. J., MISHELL D. R. F., SABRY H. S. and WILLIAMS J. E. (1977) — Palynological division of the Namurian of northern England and Scotland. Proc. York. Geol. Soc., **41**: 381–398.

PARKA Z. and ŚLUSARCZYK S. (1988) — Stratigraphy of the Carboniferous deposits of Foresudetic Monocline basement (in Polish with English summary). Pr. Nauk. Inst. Górn. Polit. Wroc., **43**. Monografie, **20**.

RILEY N. J. (1993) — Dinantian (Lower Carboniferous) biostratigraphy and chronostratigraphy in the British Isles. J. Geol. Soc., London, **150**: 427–446.

SMITH A. H. V. and BUTTERWORTH M. A. (1967) — Miospores of the coal seams of the Carboniferous of Great Britain. Spec. Pap. Palaeont., **1**.

STEMPIEŃ-SAŁEK M. (2002) — Miospore taxonomy and stratigraphy of Upper Devonian and lowermost Carboniferous in Western Pomerania (NW Poland). Ann. Soc. Geol. Pol., **72** (2): 163–191.

STREEL M. and BLESS M. (1980) — Occurrence and significance of reworked palynomorphs. Meded. Rijks Geol. Dienst., **32** (10): 69–80.

SULLIVAN H. J. and MARSHALL A. E. (1966) — Viséan spores from Scotland. Micropaleontology, **12** (3): 265–285.

ŚLUSARCZYK S. (1980) — Wyniki badań palinologicznych prób z wybranych otworów wiertniczych rejonu wyniesienia wolsztyńsko-pogorzelskiego. Pr Nauk. Inst. Górn. Polit. Wroc., 35, Studia i Materiały, **16**: 47–73

TRZEPIERCZYŃSKA A. (2001) — Lower Carboniferous miospore associations in the Tarnawa 1 borehole section. Pr. Państw. Inst. Geol., **147**: 67–80.

TRZEPIERCZYŃSKA A. (2003) — Palynostratigraphy of the Culm deposits of the Moravian-Silesian zone (Poland) at Toszek Castle Hill. Geol. Quart., **47** (4): 373–380.

TURNAU E., TRZEPIERCZYŃSKA A. and PROTAS A. (2005) — Palynostratigraphy of the Mississippian Łobżonka Formation of the Western Pomerania (NW Poland). Geol. Quart., **49** (1): 93–99.

WELSH and OWENS B. (1983) — Early Dinantian miospore assemblages from the Caldon Low borehole, Staffordshire, England. Pollen et Spores, **25** (2): 253–264.

WIERZCHOWSKA-KICUŁOWA K. (1984) — Budowa geologiczna utworów podpermskich monokliny przedsudeckiej. Geol. Sud., **29** (1): 121–139.

WITKOWSKI A. and ŻELICHOWSKI A. M. (1981) — Budowa geologiczna utworów podpermskich monokliny przedsudeckiej północnej. Arch. Inst. Geol. Warszawa.

ŻELICHOWSKI A. M. (1983) — Charakterystyka utworów karbońskich. Przedpole Sudetów. In: Geological map of Poland and neighbouring countries without Cenozoic, Mesozoic and Permian deposits, 1:1 000 000 (eds. W. Pożaryski and Z. Dembowski): 1–8. Wyd. Geol.

ŻELICHOWSKI A. M. (1995) — The Carboniferous System in Poland. (eds. A. Zdanowski and H. Żakowa). Pr. Państw. Inst. Geol., **148**: 148–151.

APPENDIX

Distribution of the more important miospore taxa in samples from the Paproć 29 and Katarzynin 2 boreholes

Taxa	Paproć 29						Katarzynin 2						
	2969.0–2974.0	3120.0–3125.0	3238.0–3242.0	3390.0–3397.0	3451.0–3458.0	3520.0–3522.0	2434.5 m	2466.5 m	2511.5 m	2558.5 m	2591.5 m	2637.4 m	2650.0 m
Acanthotriletes baculatus Neves, 1961			•								•		
Acanthotriletes castanea Butterworth et Williams, 1958	•		•										
Acanthotriletes echinatus (Knox) Potonié et Kremp, 1955						•							
Acanthotriletes falcatus (Knox) Potonié et Kremp, 1955	•			•								•	
Acanthotriletes hastatus Sullivan et Marshall, 1966								•	•				
Acanthotriletes pilus Neves, 1961							•						
Acanthotriletes socraticus Neves et Ioannides, 1974						∇							
Ahrensisporites duplicatus Neville, 1973										Δ			
Ahrensisporites guerickei (Horst) Potonié et Kremp, 1954		•				•	•	•		•			
Anapiculatisporites hispidus Butterworth et Williams, 1958		•											
Anapiculatisporites hystricosus Playford, 1964		∇											
Anaplanisporites atheticus Neves et Ioannides, 1974						∇							
Anaplanisporites baccatus (Hoffmeister, Staplin et Malloy) Sm.et Butt., 1967	•	•	•	•		•			•	•	•	•	
Apiculiretusispora fructicosa Higgs, 1975					∇								
Apiculiretusispora multisaeta (Luber) Butterworth et Spinner, 1966							∇						
Auroraspora corporiga Higgs, Clayton et Keegan, 1988						∇							
Auroraspora evanida (Kedo) Avchimovich, 1988			∇										
Auroraspora macra Sullivan, 1964	∇	∇				∇					∇		
Bascaudaspora canipa Owens, 1983	•						•				•		
Bascaudaspora collicula (Playford) Higgs, Clayton et Keegan, 1988								∇		∇			
Bellispores nitidus (Horst) Sullivan, 1964	•			•									
Camptotriletes cristatus Sullivan et Marshall, 1966		Δ											
Camptotriletes superbus Neves, 1961							•		•				
Cingulizonates cf. *capistratus* (Hoffmeister, Staplin et Malloy) Stapl. et Jans., 1964	•	•	•	•	•	•	Δ	Δ	Δ	Δ	Δ		
Cingulizonates bialatus (Waltz) Smith et Butterworth, 1967	•	•	•	•	•	•		•		•			
Colatisporites decorus (Bharadwaj et Venkatachala) Williams in Neves *et al*., 1973	Δ												
Colatisporites denticulatus Neville in Neves *et al*., 1973								Δ					
Convolutispora ampla Hoffmeister, Staplin et Malloy, 1955	•								•				
Convolutispora cerebra Butterworth et Williams, 1958	•												
Convolutispora florida Hoffmeister, Staplin et Malloy, 1955		•											
Convolutispora vermiformis Hughes et Playford, 1961		∇											
Crassispora kosankei (Potonié et Kremp) Smith et Butterworth, 1967	•	•	•	•		•	•	•	•		•	•	
Crassispora maculosa (Knox) Sullivan, 1964	•		•										
Crassispora trychera Neves et Ioannides, 1974				∇									
Cribrosporites cribellatus Sullivan, 1964		Δ	Δ	Δ		Δ							
Cristatisporites menendezii (Menendez et Azucy) Playford, 1978							∇				∇		
Cristatisporites sp.		•	•	•	•	•							
Cyclogranisporites commodus Playford, 1964	Δ												
Cyclogranisporites minutus Bharadwaj, 1957		•		•		•	•			•		•	
Cyclogranisporites palaeophytus Neves et Ioannides, 1974										∇			
Cymbosporites sp.				∇									
Densosporites anulatus (Loose) Smith et Butterworth, 1967	•	•	•	•									
Densosporites bacatus (Dybova et Jachowicz) Agrali, 1972		•		•									
Densosporites coronatus (Dybova et Jachowicz) Loboziak, 1971						•							
Densosporites coronarius (Dybova et Jachowicz) Loboziak, 1971		•											
Densosporites duplicatus (Naumova) Potonié et Kremp, 1956		Δ											

Appendix continued

Taxa	Paproć 29						Katarzynin 2						
	2969.0–2974.0	3120.0–3125.0	3238.0–3242.0	3390.0–3397.0	3451.0–3458.0	3520.0–3522.0	2434.5 m	2466.5 m	2511.5 m	2558.5 m	2591.5 m	2637.4 m	2650.0 m
Densosporites intermedius Butterworth et Williams, 1958	•	•								•			
Densosporites parvus Hoffmeister, Staplin et Malloy, 1955			Δ										
Densosporites pseudoannulatus Butterworth et Williams, 1958		•											
Densosporites regalis (Bharadwaj et Venkatachala) Smith et Butterworth, 1967	Δ	Δ	Δ	Δ		Δ							
Densosporites sphaerotriangularis Kosanke, 1950		•		•		•							
Densosporites spinifer Hoffmeister, Staplin et Malloy, 1955	•	•	•		•	•	•				•		
Densosporites spitsbergensis Playford, 1963	Δ												
Densosporites triangularis Kosanke, 1950	•	•	•	•									
Diatomozonotriletes cervicornutus (Staplin) Playford, 1963		Δ											
Diatomozonotriletes hughesii Playford, 1963		Δ											
Diatomozonotriletes trilinearis Playford, 1963				•									
Dictyotriletes castanaeformis (Horst) Sullivan, 1964	•												
Dictyotriletes equigranulatus Neville, 1968			Δ										
Dictyotriletes flavus Keegan, 1977		Δ						Δ					Δ
Dictyotriletes fragmentimurus Neville, 1973	Δ	Δ		Δ	Δ	Δ							
Dictyotriletes pactilis Sullivan et Marshall, 1966		Δ	Δ	Δ									
Dictyotriletes sagenoformis Sullivan, 1964	Δ												
Dictyotriletes vitilis Sullivan et Marshall, 1966			•										
Diducites mucronatus (Kedo) Van Veen, 1981								∇					
Discernisporites irregularis Neves, 1958										•			
Discernisporites micromanifestus (Hacquebard) Sabry et Neves, 1971		Δ							Δ				
Emphanisporites sp.									∇				
Emphanisporites cf. *annulatus* McGregor, 1961				∇									
Geminospora sp.	∇												
Gorgonispora crassa (Wilsow) Higgs, Clayton et Keegan, 1988		∇								∇			
Gorgonispora sp.									∇	∇			
Grandispora acuta (Kedo) Byvscheva, 1980			∇						∇				
Grandispora cf. *distincta* (Naumova) Avkhimovitch, 1993										∇			
Grandispora echinata Hacquebard, 1957	∇	∇							∇	∇	∇		
Grandispora famenensis (Naumova) Streel var. minuta Nekriata, 1974				∇									
Grandispora gracilis (Kedo) Higgs et al., 2000				∇		∇							
Grandispora cf. *lupata* Turnau, 1975		∇											
Grandispora spinosa Hoffmeister, Staplin et Malloy, 1955							•						
Grumosisporites inaequalis (Butterworth et Williams) Smith et Butterworth, 1967		•											
Knoxisporites triradiatus Hoffmeister, Staplin et Malloy, 1955	Δ												
Knoxisporites literatus (Waltz) Playford, 1963											•		
Knoxisporites seniradiatus Neves, 1961							•						
Kraeuselisporites echinatus Owens, Mishell et Marshall, 1976			•				•		•		•		
Kraeuselisporites cf. *echinatus* Owens, Mishell et Marshall, 1976													
Kraeuselisporites hibernicus Higgs, 1975			∇							∇	∇		
Kraeuselisporites mirtatus Higgs, 1975		∇	∇					∇			∇		
Kraeuselisporites ornatus (Neves) Owens, Mishell et Marshall, 1976							•	•	•			•	
Kraeuselisporites cf. *ornatus* (Neves) Owens, Mishell et Marshall, 1976										•			
Laevigatosporites vulgaris (Ibrahim) Alpern et Doubinger, 1973							•						
Laevigatosporites sp.	•	•		•									
Leiotriletes densus Neves, 1961			•										
Leiotriletes inermis (Waltz) Ishchenko, 1952		•				•							

Appendix continued

Taxa	Paproć 29						Katarzynin 2						
	2969.0–2974.0	3120.0–3125.0	3238.0–3242.0	3390.0–3397.0	3451.0–3458.0	3520.0–3522.0	2434.5 m	2466.5 m	2511.5 m	2558.5 m	2591.5 m	2637.4 m	2650.0 m
Leiotriletes ornatus Ishchenko, 1956							●						
Leiotriletes tumidus Butterworth et Williams, 1958	●	●	●	●		●	●						
Lophotriletes labiatus Sullivan, 1964	Δ	Δ		Δ									
Lophotriletes microsaetosus (Loose) Potonié et Kremp, 1955		●	●				●	●					
Lophotriletes tribulosus Sullivan, 1964		Δ		Δ		Δ							
Lophozonotriletes concentricus (Byvsheva) Higgs, Clayton et Keegan, 1988		∇									∇		
Lycospora noctuina Butterworth et Williams, 1958		●	●	●			●	●					
Lycospora orbicula (Potonié et Kremp) Smith et Butterworth, 1967	●	●	●	●		●							
Lycospora pusilla (Ibrahim) Somers, 1972	●	●	●	●		●	●	●	●		●		
Lycospora subtriquetra (Luber) Potonié et Kremp, 1956							●	●		●			
Microreticulatisporites concavus Butterworth et Williams, 1958	●			●			Δ						
Microreticulatisporites microreticulatus Knox, 1950										●			●
Microreticulatisporites punctatus Knox, 1950		●									●		
Murospora aurita (Waltz) Playford, 1962	Δ	Δ	Δ										
Murospora dubitata Higgs, 1975		∇											
Murospora margodentata Beju 1970		Δ		Δ									
Murospora sublobata (Waltz) Playford, 1962		Δ											
Neoraistrickia inconstans Neves, 1961								●					
Plicatispora scolecophora (Neves et Ioannides) Higgs, Clayton et Keegan, 1988		∇		∇									
Potoniespores delicatus Playford, 1963		Δ		Δ					Δ	Δ			
Potoniespores interitorsus (Horst) Kmiecik, 2001		●		●		●							
Procoronaspora serrata (Playford) Smith et Butterworth, 1967				Δ									
Prolycospora claytonii Turnau, 1978		∇		∇		∇				∇			
Pseudoannulatisporites polonicus Karczewska, 1967	●	●		●									
Punctatisporites aerarius Butterworth et Williams, 1958			●										
Punctatisporites fissus Hoffmeister, Staplin et Malloy, 1955			Δ										
Punctatisporites giganteus Neves, 1961	●												
Punctatisporites irrasus Hacquebard, 1957				∇									
Punctatisporites minutus Kosanke, 1950					●				●				
Punctatisporites nitidus Hoffmeister, Staplin et Malloy, 1955	●	●	●										
Punctatisporites platirugosus (Waltz) Sullivan, 1964			Δ										
Punctatisporites punctatus Ibrahim, 1933									●				
Pustulatisporites papillosus (Knox) Potonié et Kremp, 1955		●											
Pustulatisporites gibberosus (Hacquebard) Playford, 1964								∇		∇	∇		
Radiizonates mirabilis Phillips et Clayton, 1980											∇		
Remysporites magnificus (Horst) Butterworth et Williams, 1958				●									
Reticulatisporites carnosus (Knox) Neves, 1964		●	●										
Retispora staplinii (Gupta et Boozer) Ravn et Fitzgerald, 1982		●				●		●	●	●			
Retusotriletes cf. *coniferus* Kedo, 1963										∇			
Retusotriletes famenensis Naumova, 1953		∇		∇		∇							
Retusotriletes incohatus Sullivan, 1964		∇		∇									
Rotaspora ergonulii (Agrali) Sullivan et Marshall, 1966		Δ	Δ										
Rotaspora knoxi Butterworth et Williams, 1958				●		●							
Rugospora corporata Neves et Owens, 1966	●	●	●				●		●				
Rugospora minuta Neves et Ioannides, 1974		∇				∇	∇						
Rugospora polyptycha Neves et Ioannides, 1974						∇	∇		∇	∇	∇	∇	
Savitrisporites asperatus Sullivan, 1964		●				●					●		

Appendix continued

Taxa	Paproć 29						Katarzynin 2						
	2969.0–2974.0	3120.0–3125.0	3238.0–3242.0	3390.0–3397.0	3451.0–3458.0	3520.0–3522.0	2434.5 m	2466.5 m	2511.5 m	2558.5 m	2591.5 m	2637.4 m	2650.0 m
Savitrisporites nux (Butterworth et Williams) Smith et Butterworth, 1967			•				•				•		
Schulzospora camplyoptera (Waltz) Hoffmeister, Staplin et Malloy, 1955			•										
Schulzospora elongata Hoffmeister, Staplin et Malloy, 1955	•						•						
Schulzospora ocellata (Horst) Potonié et Kremp, 1955			•	•									
Schulzospora plicata Butterworth et Williams, 1958				•									
Schulzospora rara Kosanke, 1950	•												
Schulzospora sp.	•		•					•					
Secarisporites remotus Neves, 1961		•									•		
Simozonotriletes intortus (Waltz) Potonie et Kremp, 1954	•	•				•							
Spelaeotriletes arenaceous Neves et Owens, 1966	•		•										
Spelaeotriletes crustatus Higgs, 1975				∇									
Spelaeotriletes microspinosus Neves et Ioannides, 1974						∇		∇					
Stenozonotriletes circumscriptus Ishchenko, 1958						•							
Stenozonotriletes coronatus Sullivan. et Marshall, 1966		Δ	Δ	Δ		Δ			Δ		Δ		
Stenozonotriletes lycosporoides (Butterworth et Williams) Sm. et Butt., 1967		•					•		•				
Stenozonotriletes minutus Ishchenko, 1956		•											
Stenozonotriletes triangulus Neves, 1961								•		•			
Stenozonotriletes cf. *triangulus* Neves, 1961								•					
Tholisporites decorus Bharadwaj et Venkatachala, 1961	Δ												
Tholisporites sp.							•	•	•	•			
Tricidarisporites balteolus Sullivan et Marshall, 1966		Δ		Δ		Δ							
Tripartites distictus Williams 1973	Δ										Δ		
Tripartites vetustus Schemel, 1950	•	•	•										
Triquitrites comptus Williams, 1973		•	•	•									
Triquitrites marginatus Hoffmeister, Staplin et Malloy, 1955		•		•		•							
Triquitrites piramidalis (Kedo et Jushko) Stempień et Turnau, 1988			•								•		
Tumulispora malavkensis (Kedo) Turnau, 1978		∇											
Tumulispora rarituberculata (Luber) Potonie, 1966		∇					∇						
Vallatisporites microspinosus Higgs, Clayton et Keegan, 1988			∇			∇							
Vallatisporites ciliaris (Luber) Sullivan, 1964		Δ											
Vallatisporites pusillites (Kedo) Dolby et Neves, 1970				∇									
Vallatisporites vallatus Hacquebard, 1957						∇							
Vallatisporites verrucosus Hacquebard, 1957										∇			
Velamisporites caperatus (Higgs) Higgs, Clayton et Keegan, 1988									∇				
Verruciretusispora robusta Owens, 1971		∇											
Verrucosisporites baccatus Staplin, 1960		Δ	Δ				Δ				Δ		
Verrucosisporites cerosus (Hoffmeister, Staplin et Malloy) Butt. et Wil., 1958	•		•	•			•						
Verrucosisporites irregularis Phillips et Clayton, 1980										∇			
Verrucosisporites nitidus (Naumova) Playford, 1964						∇							
Verrucosisporites scurrus (Naumova) McGregor et Camfield, 1982				∇									
Waltzispora planiangulata Sullivan, 1964		Δ	Δ	Δ		Δ							
Waltzispora polita (Hoffmeister, Staplin et Malloy) Smith et Butterworth, 1967			•	•									
Waltzispora sagitata Playford, 1962				Δ		Δ							

• — taxon included among the youngest miospores, having stratigraphical value; ∇ — taxon characteristic of the Famennian and/or Tournaisian; Δ — taxon characteristic of the Viséan