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The Cambrian of the western part of the Pomeranian Caledonides foreland, Peribaltic Syneclise: microfloral evidence

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This paper describes the microfloral succession in Cambrian deposits in the Kościerzyna IG 1 and Gdańsk IG 1 boreholes drilled in the western part of the Peribaltic Syneclise, immediately adjoining the T-T Zone in the Pomeranian Caledonides foreland. Both these boreholes have yielded abundant acritarch assemblages that allow the partial zonation of the Lower and Middle Cambrian deposits. The Cambrian deposits of the Kościerzyna IG 1 borehole comprise the following microfloral zones: *Asteridium tornatum–Comasphaeridium velvetum*, *Skiagia ornata–Fimbriaglomerella membranacea* and *Heliosphaeridium dissimilare–Skiagia ciliosa*. The *Volkovia dentifera–Liepaina plana* Zone may also be present. The *Acadoparadoxides pinus* Zone (upper part of the *A. oelandicus* Superzone), well documented by trilobites, might correlate with the *Cristallinium cambriense–Eliasum* Superzone. This conflicts with the findings of Jankauskas and Lendzion (1992), who restricted the range of the commonly occurring *C. cambriense* (Slavikova) only to the *Paradoxides paradoxissimus* Superzone and younger deposits. The Lower Cambrian *Skiagia–Fimbriaglomerella* and (or) *Heliosphaeridium–Skiagia* Zones have been documented in the Gdańsk IG 1 borehole. As in the Kościerzyna IG 1 borehole, abundant Middle Cambrian acritarchs of the *C. cambriense–Eliasum* Superzone define the presence of rocks not older than equivalents of the *A. pinus* Zone. Palynomorphs from the Kościerzyna IG 1 borehole correspond to stage 6 of the AMOCO thermal alteration scale, i.e. to palaeotemperatures considerably exceeding 100°C. The maximum palaeotemperature of the Cambrian rocks at Gdańsk has not exceeded 100°C.

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Key words: Peribaltic Syneclise, Pomeranian Caledonides, Cambrian, biostratigraphy, acritarchs, thermal maturity.

INTRODUCTION

The western part of the Peribaltic Syneclise (Fig. 1), in particular its Cambrian deposits, is of increasing interest of geologists. Sedimentation took place adjacent to the Teisseyre-Tornquist Zone, in the foreland of the structurally contrasting, area of the Pomeranian Caledonides. The attraction of this area has lately increased owing to the discovery and exploitation of oil fields in the Cambrian deposits. Acritarch data helps resolve biostratigraphical problems, particularly in areas lacking in guide trilobites. The present investigations focussed on acritarch assemblages from the Kościerzyna IG 1 borehole with additional and preliminary studies in the Gdańsk IG 1 borehole.

STRATIGRAPHY

The Lower Cambrian succession of the Kościerzyna IG 1 and Gdańsk IG 1 boreholes are 285.5 and 173.5 m thick, respectively (Fig. 2). The Lower Cambrian rocks at Kościerzyna are represented largely by siltstones with numerous sandstone and claystone interbeds. As regards trilobite zones, the *Mobergella* Zone is the only one well documented (Lendzion, 1982). The *Holmia* Zone has been distinguished using on lithological and wireline log data. The occurrence of the *Platysolenites* Zone is also likely, while the occurrence of the *Protolenus* Zone is less probable. The Lower Cambrian siltstones grade up from the coarse-clastic Żarnowiec Series, dated at the Vendian/Cambrian transition.

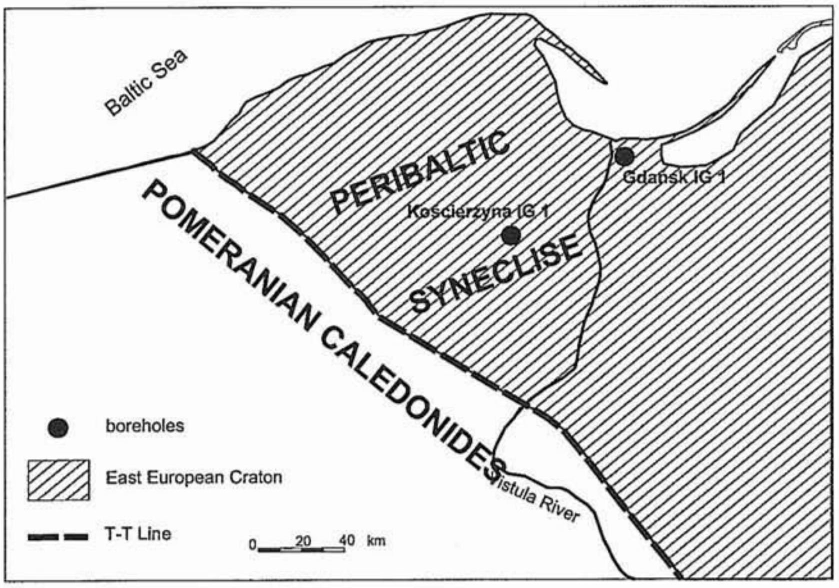


Fig. 1. Location sketch of boreholes studied

The Lower Cambrian section of the Gdańsk IG 1 borehole is also represented by siltstones and sandstones. Poorer core recovery means that both the Żarnowiec Series/*Mobergella* Zone transition deposits and the Lower/Middle Cambrian transition sediments are unavailable. No stratigraphically important macrofauna has been found in the Lower Cambrian deposits. Therefore, their stratigraphy is based only upon lithological correlation, which has allowed the inference of the *Mobergella* and *Holmia* Zones here (Lendzion, 1989).

Middle Cambrian deposits are represented in both the Kościerzyna IG 1 and Gdańsk IG 1 boreholes. They are 310.7 and 156.5 m thick, respectively (Fig. 2). The Middle Cambrian deposits are composed of claystones, siltstones and sandstones.

The top and bottom parts of the Middle Cambrian section at Kościerzyna IG 1 are dominate by sandstones. Claystones and siltstones dominate in the upper part of the *Acadoparadoxides oelandicus* Superzone and the lower part of the *Paradoxides paradoxissimus* Superzone. The Middle Cambrian deposits of this borehole are well documented palaeontologically, the *Acadoparadoxides pinus* Zone (the upper part of the *A. oelandicus* Superzone) especially so the presence of the *P. paradoxissimus* Superzone (most probably its lower part) has also been recognized (Lendzion, 1982).

Sandstones dominate the entire Middle Cambrian section from Gdańsk. Siltstones and claystones occur in considerably minor proportions. No determinate macrofauna has been found in these deposits, and the division into the three trilobite superzones of *A. oelandicus, P. paradoxissimus* and *P. forchhammeri* (Fig. 2) is based only upon a lithological and wireline log correlation with other boreholes. Individual finds of trilobites are of little biostratigraphical importance (Lendzion, 1989).

Upper Cambrian deposits are represented only by several cm-thick limestone beds (Gdańsk IG 1) and by limestones with claystone beds (Kościerzyna IG 1) (Fig. 2). Trilobites of the genus *Sphaerophtalmus*, indicating the presence of Upper Cambrian deposits, have been found only in the Gdańsk IG 1 borehole (Lendzion, 1989). Lithological criteria have been used to assume a similar age for the equivalent rocks from Kościerzyna.

AVAILABLE MATERIAL

15 core samples from the Kościerzyna IG 1 borehole and 5 samples from the Gdańsk IG 1 borehole were collected for microfloral investigations. Samples, 100–150 g in weight, were of siltstones and claystones. They were subjected to a standard palynological maceration comprising treating with strong acids, filtration and floatation. No oxidants were used during maceration in order to obtain reliable data for thermal maturity studies.

ACRITARCH PRESERVATION, ABUNDANCE AND THERMAL ALTERATION

All the samples collected from the Kościerzyna IG 1 borehole have yielded acritarchs (Fig. 2). Their frequency is moderate, locally low (most often several tens of specimens in a slide). The lowest abundance occurs in Middle Cambrian rocks, where it is many times smaller than in analogous deposits from other boreholes in the Baltic Sea area. The microflora is more poorly preserved. Burial to a depth of almost 5000 m has caused significant thermal degradation. Carbonization of palynomorph walls has made them brittle and susceptible to mechanical damage. Thin-walled and crest-ornamented specimens (*Asteridium, Heliosphaeridium, Comasphaeridium*) show particularly poor preservation. Thermal degradation has obliterated diagnostic features and strongly limited taxonomic identification. No differences in colour can be observed be-

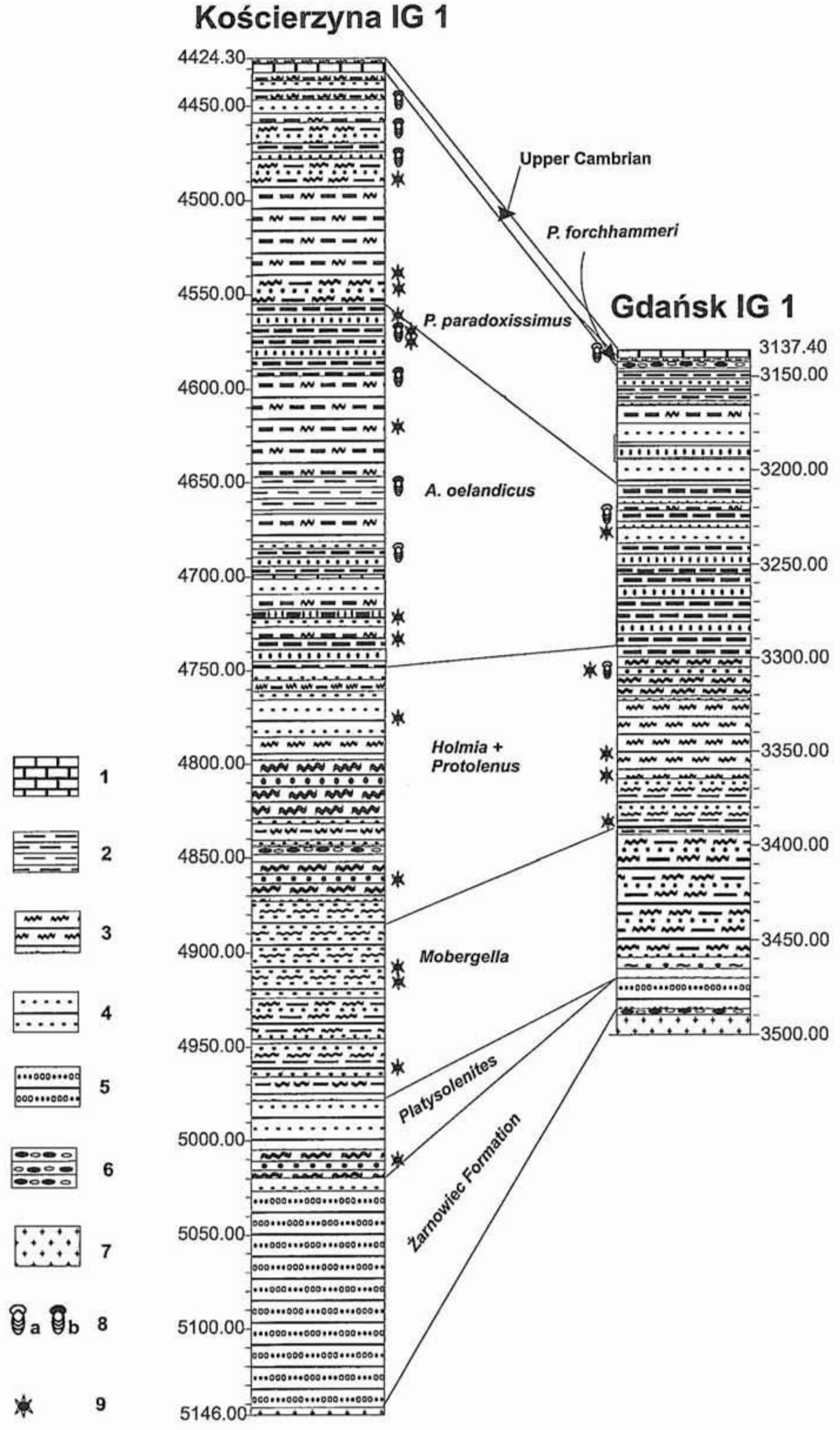


Fig. 2. Lithological logs of the boreholes

1 — limestones, 2 — claystones, 3 — siltstones, 4 — sandstones, 5 — conglomeratic sandstones, 6 — conglomerates, 7 — crystalline rocks, 8 — trilobites (a — of little stratigraphical importance, b — guide fossils), 9 — acritarchs

tween acritarchs from the lower and upper parts of the section. The colour of specimens (dark brown, occasionally black) suggests temperatures considerably exceeding 100°C (stage 6 of the AMOCO thermal alteration scale). Organic membranes are locally destroyed by the recrystallization of pyrite from inside palynomorphs.

Table 1

Occurrence of acritarch species in the Kościerzyna IG 1 and Gdańsk IG 1 boreholes

Acritarchs	Kościerzyna IG 1															Gdańsk IG 1				
	4489,00 m	4541,00 m	4545,50 m	4560,00 m	4568,00 m	4574,00 m	4620,00 m	4727,00 m	4736,00 m	4773,00 m	4864,00 m	4910,00 m	4916,00 m	4963,00 m	5012,00 m	3228,50 m	3308,50 m	3352,50 m	3362,50 m	3384,50 m
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Adara sp.				+																
Archaeodiscina umbonulata Volkova														+						
Asteridium lanatum (Volkova)											+	+	+							
Asteridium sp.	+						+		+	+	+	+	+	+						
Asteridium spinosum Volkova							+													
Asteridium tornatum (Volkova)							+				+		+							
Ceratophyton vernicosum Kirjanov															+					
Comasphaeridium cf. *mollicum* Moczydłowska									+	+										
Comasphaeridium formosum Moczydłowska												+								
?*Comasphaeridium* sp.													+							
Comasphaeridium sp.											+			+						
Comasphaeridium strigosum (Jankauskas)										+										
Cristallinium cambriense (Slavikova)	+	+	+	+	+	+	+									+				
Cristallinium sp.	+	+		+	+	+	+									+				
?*Cymatiosphaera* sp.												+		+						
Cymatiosphaera sp.										+		+								
Dictyotidium sp.	+	+	+		+		+													
Eliasum llaniscum Fombella						+														
?*Eliasum* sp.								+								+				
Eliasum sp.				+		+														
Fimbriaglomerella minuta Moczydłowska											+									
Fimbriaglomerella membranacea (Kirjanov)										+			+							
Fimbriaglomerella minuta Moczydłowska										+										
Fimbriaglomerella sp.												+								
Globosphaeridium cerinum (Volkova)										+									+	+
Granomarginata prima Naumova					+						+		+	+	+				+	
Granomarginata sp.														+			+			
Granomarginata squamacea Volkova								+				+			+	+			+	
Heliosphaeridium dissimilare (Volkova)												+								
Heliosphaeridium lanceolatum (Downie)						+														
Heliosphaeridium lubomlense (Kirjanov)							+													
?*Heliosphaeridium* sp.					+															
Heliosphaeridium sp.					+			+		+										
?*Leiofusa* sp.	+																			
Leiosphaeridia sp.					+				+	+	+		+	+	+					
?*Liepaina* sp.									+											

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Lophosphaeridium cf. *dubium* (Volkova)										+										
Lophosphaeridium dubium (Volkova)																			+	+
?*Lophosphaeridium* sp.				+	+															
Lophosphaeridium sp.				+	+	+	+		+	+	+		+	+						
Lophosphaeridium tentativum Volkova						+		+	+	+										
Lophosphaeridium truncatum Volkova									+	+							+	+		+
Micrhystridium sp.						+														
Multiplicisphaeridium sp.										+										
Multiplicisphaeridium dendroideum (Jankauskas)									+											
Pterospermella solida (Volkova)									+	+										+
Pterospermella sp.			+		+			+	+	+				+		+				
Pterospermella cf. *velata* Moczydłowska														+						
Pterospermella velata Moczydłowska														+	+					
Pterospermella vitalis Jankauskas											+									
Retisphaeridium sp.	+	+		+		+								+		+				
Skiagia cf. insigne (Fridrichsone)																	+			
Skiagia ciliosa (Volkova)									+	+								+		+
Skiagia compressa (Volkova)									+									+		+
Skiagia orbiculare (Volkova)								+	+	+										
Skiagia ornata (Volkova)									+	+										+
Skiagia sp.									+											
Skiagia div. sp.																			+	
Solisphaeridium cf. implicatum (Fridrichsone)										+										
Solisphaeridium implicatum (Fridrichsone)									+	+										
Tasmanites sp.		+			+		+						+	+		+			+	
Tasmanites tenellus Volkova											+									
Tasmanites volkovae Kirjanov									+											

Reconnaissance microfloral investigations only were performed on the Gdańsk IG 1 borehole material. No detailed palaeothermal observations were made, though Lower Cambrian acritarchs are at most orange-brown in colour (stages 5, 5+ of the AMOCO thermal alteration scale), while Middle Cambrian acritarchs are orange and yellow. This indicates temperatures below 100°C. The colour gradient between acritarchs from Lower and Middle Cambrian rocks is striking and difficult to explain solely on the basis of the burial depth. Acritarchs in this borehole are much abundant than in the Kościerzyna IG 1 borehole, in particular in the 3390.0 m sample.

The palaeothermal evidence suggests that the Kościerzyna IG 1 borehole lies within a zone of increased heat flow. Thermal alteration of the Lower Cambrian rocks is slightly greater here than in the Cambrian rocks of the Lublin slope of the East European Craton, resting at similar depths, e.g. in the Terebin IG 1 borehole (Moczydłowska, 1988*b*). Acritarchs from the West Pomeranian Caledonides also show similar or even lighter colours at depths of around 5000 m (Chojnice 5 borehole) (Szczepanik, 2000). Palaeothermal data obtained from studies of the reflectance of vitrinite-like material, conducted in the Kościerzyna IG 1 borehole (Grotek, 1999), have given

CHRONO-STRATIGRAPHY	TRILOBITE ZONATION	ACRITARCH ZONATION (MOCZYDŁOWSKA, 1991)
MIDDLE CAMBRIAN		
	A. oelandicus	
LOWER CAMBRIAN	***Protolenus***	***Volkovia dentifera Liepaina plana***
	Holmia kjerulfi	***Heliosphaeridium dissimilare - Skiagia ciliosa***
	equivalent to ***Schmidtiellus mickwitzi***	***Skiagia ornata - Fimbriaglomerella membranacea***
	Platysolenites antiquissimus	***Asteridium tornatum - Comasphaeridium velvetum***
UPPER VENDIAN	***Sabellidites - Vendotaenia***	

Fig. 3. Microfloral zonation of the Lower Cambrian after Moczydłowska (1991)

comparable results to the TAI values. Acritarchs from the Gdańsk IG 1 borehole are slightly less carbonized than suggested by the R_0 analysis.

PALYNOLOGICAL RESULTS

Acritarchs, as a group of unknown and presumably polyphyletic origin, do not possess a biological taxonomy and are classified according to an informal palaeontological taxonomy as the Group Acritarcha Evitt 1963 (Evitt, 1963). Some authors distinguish subgroups within this group, but only on the basis of morphological criteria, and such subdivisions are rarely used by palaeontologists. In practice, only genera and species are distinguishable.

63 taxa belonging to 24 genera have been identified in the material studied (of which 37 are identified to species level) (Tab. 1). The acritarch assemblages are typical of the Cambrian period, a time of low provincialism in this group.

The identifications are based mostly on literature on various areas of the East European Craton (Volkova *et al.*, 1983; Moczydłowska and Vidal, 1986, 1992; Moczydłowska, 1988*a*, 1989, 1991; Hagenfeldt, 1989; Volkova, 1990), Upper Silesia (Moczydłowska, 1998) and other areas (Downie, 1983; Vanguestaine and van Looy, 1983; Welsch, 1986).

BIOTRATIGRAPHY

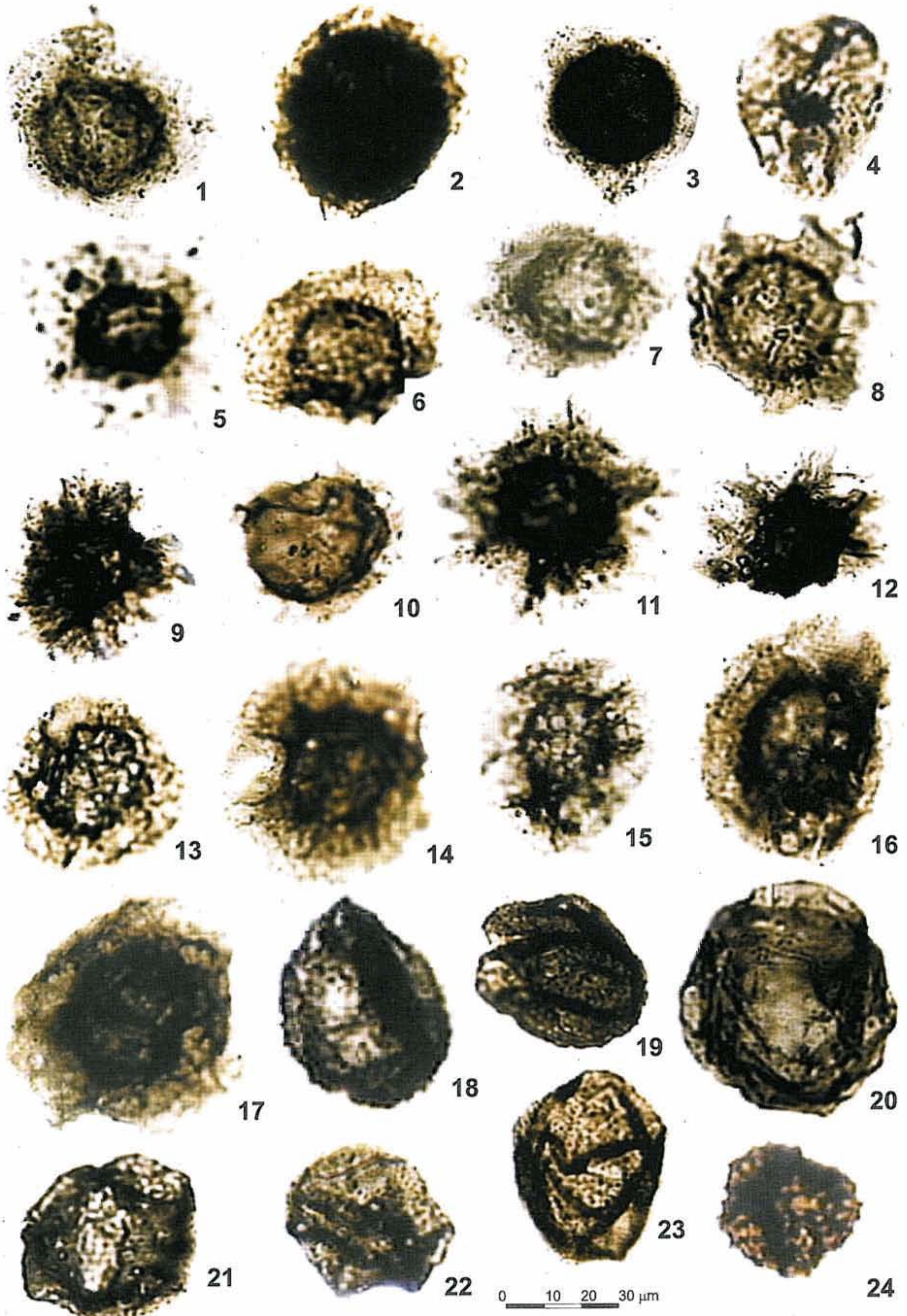
KOŚCIERZYNA IG 1

Samples from this borehole contain acritarchs documenting Lower and Middle Cambrian deposits. Microfloral assemblages from the lowermost part of the section (depth 4963.0–5012.8 m) are dominated by morphologically diverse acritarchs of the genus *Leiosphaeridia*. The genera *Tasmanites, Granomarginata, Pterospermella, Asteridium* and *Comasphaeridium* occur in considerably smaller amounts. The frequency is very variable and the assemblages are composed of several to a few hundreds of specimens in a slide. However, a huge dominance of sphaeromorphic individuals (*Leiosphaeridia*) is observed in all the samples. The taxonomic composition of these assemblages suggest a lowermost Cambrian age. The occurrence of *Pterospermella velata* (Pl. II, Fig. 5) together with abundant *Asteridium* div. sp., containing *Granomarginata prima* Naumova (Pl. II, Figs. 2, 3), *G. squamacea* Volkova and *Ceratophyton vernicosum* Kirjanov (Pl. I, Fig. 10), indicates the *Asteridium–Comasphaeridium* Zone (Moczydłowska, 1991) (Fig. 3) correlated by that author with the *Platysolenites* Zone of the Subholmia Cambrian. This zone may also be correlated with the *Granomarginata prima* Zone proposed by Jankauskas (Jankauskas and Lendzion, 1992).

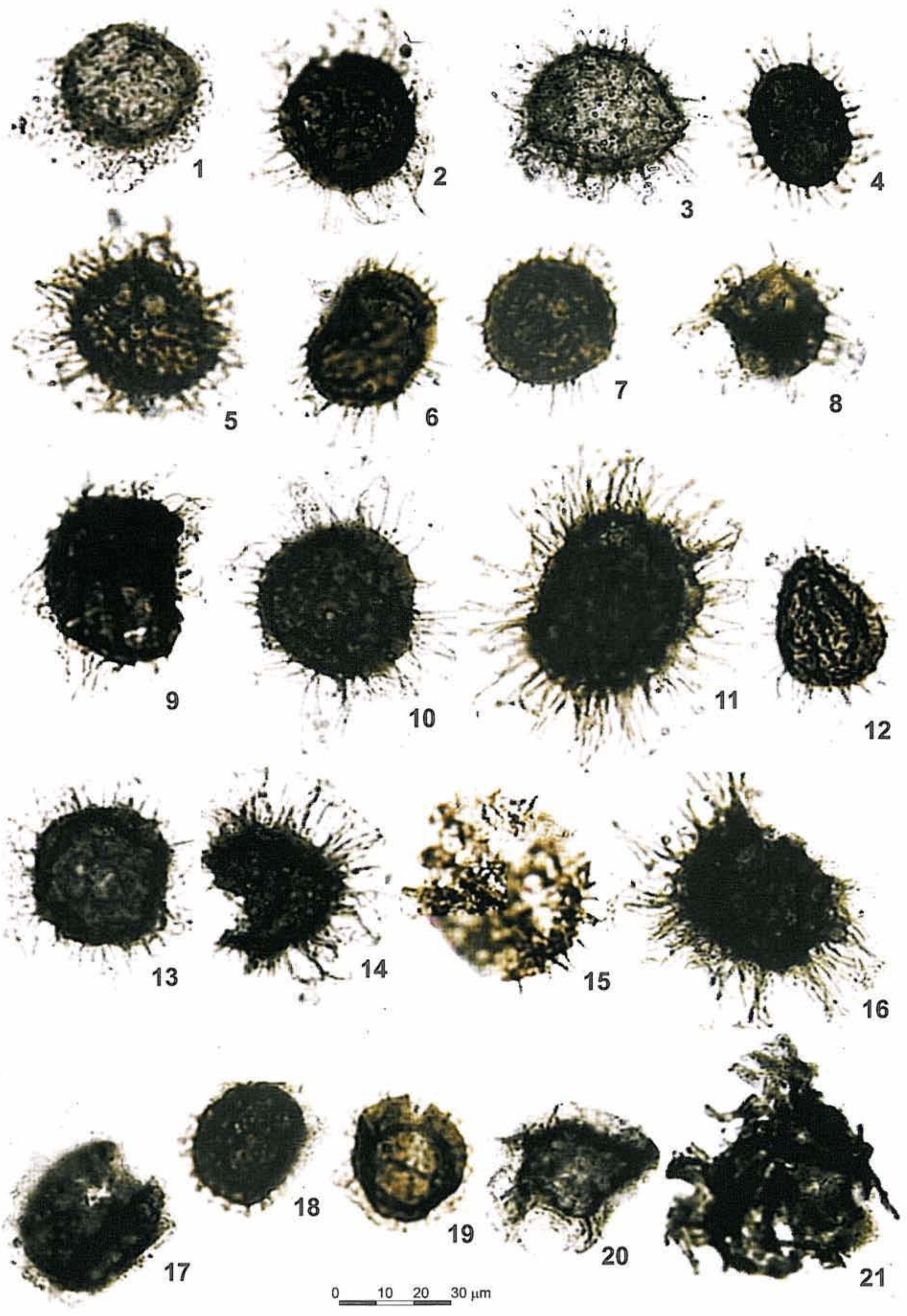
The microfloral assemblage from depths of 4864.0–4916.0 m contains numerous acritarchs from the genera *Pterospermella, Granomarginata, Asteridium, Leiosphaeridia, Lophosphaeridium, Fimbriaglomerella* and *Comasphaeridium* (Tab. 1). This assemblage differs from the previous one in considerably smaller numbers of *Leiosphaeridia* forms and much greater proportions of *Lophosphaeridium* and *Pterospermella*. Scarce specimens *Fimbriaglomerella* [*F. membranacea* (Kirjanov)] are also present. The biostratigraphical position of this microflora is not clear. The abundance of *Asteridium* and *Granomarginata* suggests the *Asteridium–Comasphaeridium* Zone (Moczydłowska, 1991) (Fig. 3), but the occurrence of *Fimbriaglomerella membranacea* Moczydłowska indicates rather the upper *Skiagia–Fimbriaglomerella* Zone (Fig. 3). However, the composition of the assemblage from Kościerzyna IG 1 significantly differs from that of the latter zone as described by Moczydłowska (1991). Firstly, no *Skiagia* forms have yet been recorded.

Another conspicuous microfloral assemblage was recorded at depths of 4727.0–4773.0 m, characterized by the presence of abundant *Skiagia, Lophosphaeridium* and *Pterospermella*. Sphaeromorphic forms are considerably less frequent here. Acritarchs are numerous and morphologicaly diverse. They may be correlated with associations assigned by Moczydłowska (1991) to the *Skiagia–Fimbriaglomerella* and *Heliosphaeridium–Skiagia* Zones (Fig. 3). There are great numbers of *Skiagia* forms [*S. ciliosa* (Volkova), *S. compressa* (Volkova), *S. orbiculare* (Volkova) and *S. ornata* (Volkova)]. The occurrence of *S. ciliosa* (Volkova) (Pl. III, Figs. 3, 12) suggests the *Heliosphaeridium–Skiagia* Zone.

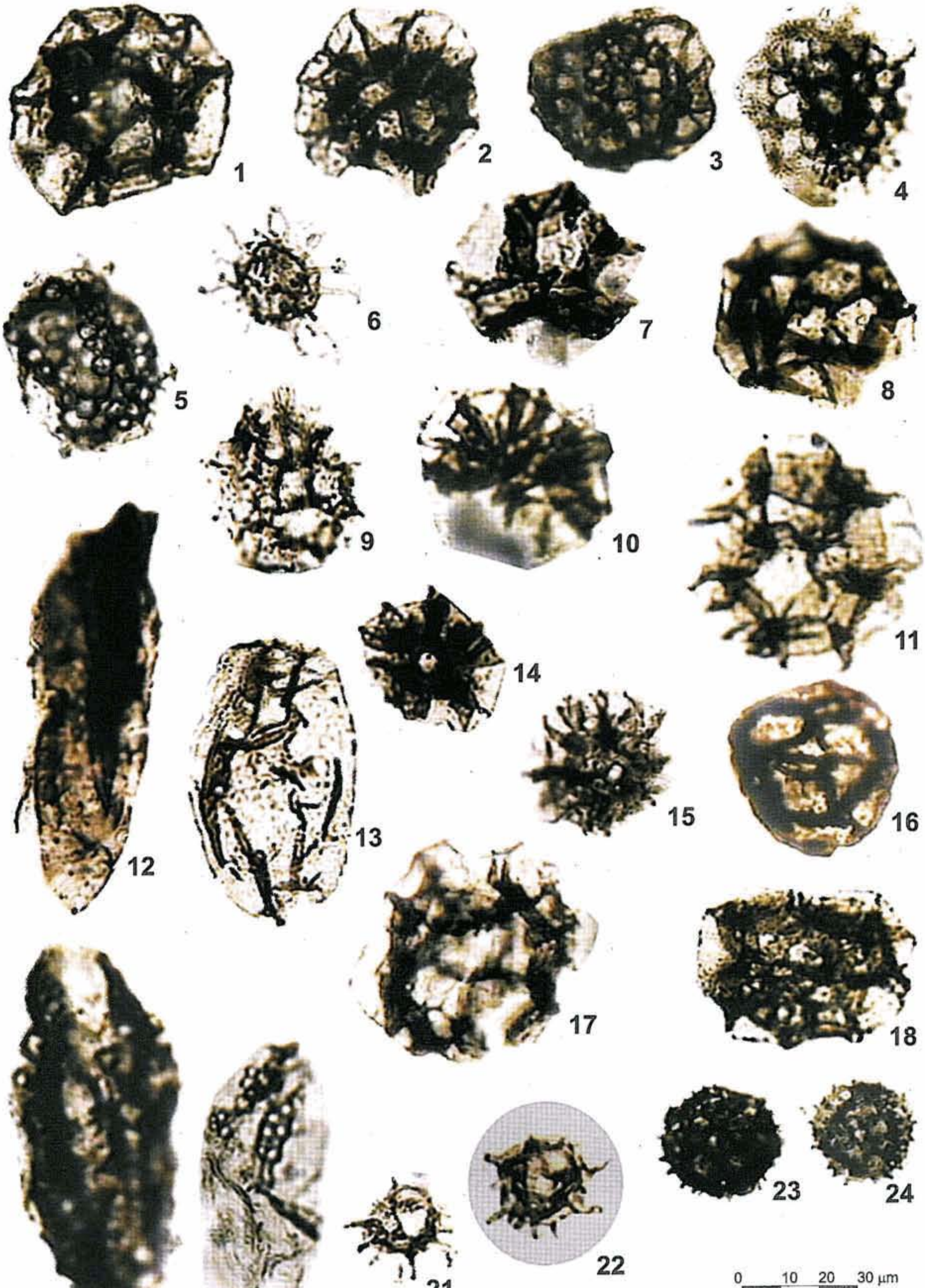
1, 4, 11. Leiosphaeridia sp., 5012.0 m. *2, 5, 6, 8, 9. Tasmanites* sp., 4916.0, 4864.0 m. *3. Tasmanites tenellus* Volkova, 4864.0 m. *7. Leiosphaeridia* sp. (colonie), 5012.0 m. *10. Ceratophyton vernicosum* Kirjanov, 5012.0. Kościerzyna IG 1 borehole



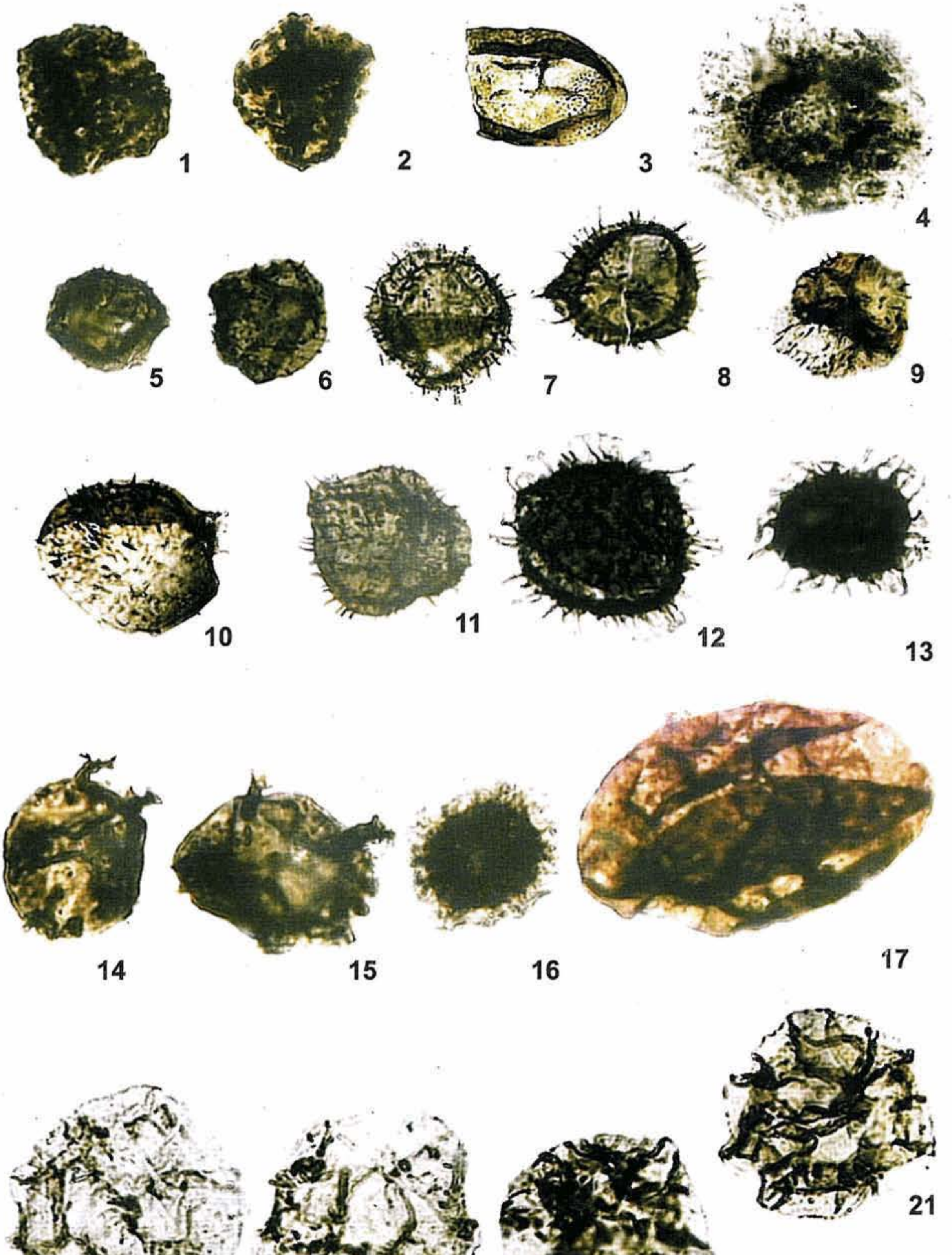
1, 6, 7, 8, 13, 16, 17. Granomarginata squamacea Volkova, 4727.0, 4910.0, 5012.0 m. *2, 3. Granomarginata prima* Naumova, 5012.0 m. *4. Archaeodiscina umbonulata* Volkova, 4963.0 m. *5. Pterospermella velata* Moczydłowska, 4963.0 m. *9, 11, 14, 15. Pterospermella solida* (Volkova), 4736.0, 4773.0 m. *10. Fimbriaglomerella* sp., 4910.0 m. *12. ?Pterospermella* sp., 4545.5 m. *18, 19, 21. Lophosphaeridium truncatum* Volkova, 4736.0 m. *20. Lophosphaeridium* sp., 4560.0 m. *22, 23. Lophosphaeridium tentativum* Volkova, 4736.0 m. *24. Lophosphaeridium* cf. *dubium* (Volkova), 4773.0 m. Kościerzyna IG 1 borehole



1, 2, 5*. Comasphaeridium* cf. *mollicum* Moczydłowska, 4736.0, 4773.0 m. ***3, 12****. Skiagia ciliosa* (Volkova), 4736.0, 4773.0 m. ***4, 6, 7, 10, 13****. Skiagia orbiculare* (Volkova), 4727.0, 4736.0, 4773.0 m. ***8, 9, 16****. Solisphaeridium implicatum* (Fridrichsone), 4773.0 m. ***11, 14****. Skiagia ornata* (Volkova), 4736.0 m. ***15****. Globosphaeridium cerinum* (Volkova), 4773.0 m. ***17, 18, 19****. Fimbriaglomerella membranacea* (Kirjanov), 4773.0 m. ***20****. ?Liepaina* sp., 4736.0 m. ***21****. Acritarcha* gen. et sp. ind., 4773.0 m. Kościerzyna IG 1 borehole



1, 2. Cristallinium cambriense (Slavikova), 4541.0 m. *3, 11, 17, 18. Retisphaeridium* sp.: *3* — 4541.0 m, *11, 17, 18* — 4574.0 m. *4, 5. Dictyotidium* sp., 4541.0 m. *6, 21, 22. Heliosphaeridium lubomlense* (Kirjanov), 4620.0 m. *7, 8, 10, 14, 15. Cristallinium* sp.: *7, 8* — 4620.0 m, *10, 14, 15* — 4574.0 m. *9. Adara* sp., 4560.0 m. *12, 19. Eliasum llaniscum* Fombella, 4574.0 m. *13, 20. Eliasum* sp., 4574.0 m. *23, 24. Heliosphaeridium lanceolatum* (Downie), 4574.0 m. Kościerzyna IG 1 borehole



1, 2. *Lophosphaeridium truncatum* Volkova, 3308.5 m. *3, 17*. *Tasmanites* sp.: *3* — 3228.5 m, *17* — 3362.5 m. *4*. *Pterospermella solida* (Volkova), 3384.5 m. *5, 6*. *Lophosphaeridium dubium* (Volkova): *5* — 3362.5 m, *6* — 3384.5 m. *7–11*. *Globosphaeridium cerinum* (Volkova), 3384.5 m. *12*. *Skiagia ciliosa* (Volkova), 3352.5 m. *13*. *Skiagia compressa* (Volkova), 3352.5 m. *14, 15*. *Skiagia* cf. *insigne* (Fridrichsone), 3308.5 m. *16*. *Granomarginata squamacea* Volkova, 3362.5 m. *18, 19*. *Retisphaeridium* sp., 3228.5 m. *20, 21*. *Cristallinium cambriense* (Slavikova), 3228.5 m. Gdańsk IG 1 borehole

The Kościerzyna section may also comprise the uppermost Lower Cambrian *Volkovia–Liepaina* Zone (Moczydłowska, 1991). Although the index taxa of *Volkovia dentifera* (Volkova) and *Liepaina plana* Jankauskas et Volkova have not been identified here, one specimen of ?*Liepaina* sp. (Pl. III, Fig. 20) found at a depth of 4736.0 m may indicate the presence of this zone.

The microflora here differs considerably from the assemblages of the upper part of the Oelandicus Cambrian (*A. pinus* Zone), well documented by trilobites. Index species of the *Volkovia–Liepaina* Zone are in general rare. Closer sampling should allow better documentation of this zone in the Kościerzyna IG 1 borehole. The data available are insufficient to assign these rocks to the Middle Cambrian. They may equally belong to the Lower Cambrian. Nevertheless, the deposits from a depth of 4736.0 m undoubtedly represent the upper part of the *A. oelandicus* Superzone.

Acritarchs from depths of 4489.0–4620.0 m (Pl. I) are represented by numerous forms of *Cristallinium,* including *Cristallinium cambriense* (Slavikova), *Eliasum, Dictyotidium, Retisphaeridium, Miltiplicisphaeridium, Leiosphaeridia, Pterospermella* and others. This microflora is typical of the Middle Cambrian (*C. cambriense–Eliasum* Superzone) (Vanguestaine and Van Looy, 1983). This assemblage differs radically from those below. The lack of *Skiagia* forms indicates that these rocks represent the uppermost part of the *A. oelandicus* Superzone or the lower part of the *P. paradoxissimus* Superzone.

GDAŃSK IG 1

Acritarchs are more abundant and better preserved here than in the Kościerzyna section. Stratigraphical studies have indicated the presence of the *Skiagia–Fimbriaglomerella* and *Heliosphaeridium–Skiagia* Zones (Fig. 3) at depths of 3297.1–3394.8 m, although it confident distinction between these cannot be made. Numerous *Globosphaeridium cerinum* (Volkova) (Pl. V, Figs. 7–11) and individual *Lophosphaeridium dubium* (Volkova) (Pl. V, Figs. 5, 6) are present. Frequent *Skagia*, including the guide species *S. ciliosa* (Volkova), indicate the presence of the *Heliosphaeridium–Skiagia* Zone. The coexistence of this taxon with *G. cerinum* may indicate the presence of the lower part of this zone, corresponding to the *Baltisphaeridium cerinum–Skiagia ciliosa* Zone proposed by Jankauskas (Jankauskas and Lendzion, 1992), i.e. to the equivalent of the *Holmia inusitata* trilobite Zone.

Neither the *Protolenus* Zone nor the lower part of the *A. oleandicus* Superzone have been identified.

The 3228.5 m sample contains a typical Middle Cambrian microfloral assemblage characterized by an abundance of *Cristallinium cambriense* (Slavikova) (Pl. V, Figs. 20, 21). This assemblage is very similar to the analogous one from the Kościerzyna IG 1 borehole. It indicates the presence of, at least, the upper part of the *A. oleandicus* Superzone (*A. pinus* Zone).

CONCLUSIONS

1. The results of investigations show the presence of both Lower Cambrian and lowermost Middle Cambrian deposits in the boreholes studied. They enabled the biostratigraphical characterization of parts of this Cambrian section, that were previously lacking in palaeontological documentation. The acritarch biostratigraphy, mostly remains in accordance with the earlier accepted stratigraphical interpretations derived from lithological and wireline log correlations.

2. The data suggest that the unfossiliferous rocks from depths of 4698.0–4748.0 m in the Kościerzyna IG 1 borehole may represent the Lower Cambrian. The upper part of *A. oelandicus* Superzone is, though, absent from this interval.

3. The rocks from a depth of 3229.0 m in the Gdańsk IG 1 borehole, which lack macrofossils, contain a typical Middle Cambrian acritarch assemblage and therefore they are not older than the *A. pinus* Zone.

4. A characteristic microflora, with abundant *Cristallinium cambriense* (Slavikova), occurs in the *Acadoparadoxides pinus* Zone. This is at variance with the zonation proposed by Jankauskas (Jankauskas and Lendzion, 1992), but in accordance with the observations made by other authors (Hagenfeldt, 1989; Moczydłowska, 1998).

5. Most of the Lower Cambrian zones in the Kościerzyna IG 1 borehole recognized: three out of four microfloral zones proposed by Moczydłowska (1991) for the Lublin slope of the East European Craton have been identified here. A continuous Lower Cambrian succession is therefore likely to be present.

6. Cambrian deposits of the Kościerzyna IG 1 borehole are characterized by a much higher degree of thermal alteration than the equivalent rocks from the Gdańsk IG 1 borehole.

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