Acta Palaeobot. 42(1): 51–61, 2002

Pediastrum species (Chlorophyceae) in Quaternary sediments of "Żabie Oko" peat bog in the Tatra Mts.

KONRAD WOŁOWSKI[1], ANDRZEJ OBIDOWICZ[2] and IWONA WAWRZYCKA[1]

W. Szafer Institute of Botany Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland
[1] Department of Phycology; e-mail: wolowski@ib-pan.krakow.pl; iwaw@ib-pan.krakow.pl
[2] Department of Palaeobotany; e-mail: obidowicz@ib-pan.krakow.pl

Received 18 December 2001; accepted for publication 11 March 2002

ABSTRACT. Six taxa: *Pediastrum boryanum* var. *boryanum*, var. *longicorne*, var. *brevicorne*, *P. integrum*, *P. orientale*, and *P. duplex* var. *rugulosum* were found in fossil Quaternary sediments (Late Glacial, Holocene) from the "Żabie Oko" bog in the Tatra Mts. All of them are described and original documentation is added.

KEY WORDS: *Pediastrum*, Chlorophyceae, Interglacial, Late Glacial, Holocene, Tatra Mts., Poland

INTRODUCTION

The taxonomical research of the genus *Pediastrum* in fossil sediments, e.g., lake and peat bog deposits in Poland have not been carried out. Only general information about the occurrence of genus *Pediastrum* was to be found in the papers concerning fossil flora (Krupiński 1988, 1992, 1993, 1996, 1997, Krupiński & Marks 1985, Bińka et al. 1991, Lindner et al. 1991, Latałowa 1992, Janczyk-Kopikowa 1991, Zachowicz et al. 1982). More detailed information about *P. boryanum* is given by Harmata (1995). Pidek (2000) gives information concerning several varieties of *P. boryanum*, *P. duplex*, *P. alternans*, *P. kawraiskyi*, and *P. simplex* which have been found in profile Zdany and Brus (Lublin Upland, Poland). Many data on fossil *Pediastrum* come from southern Europe, mainly from the Czech Republic: Jankovská and Komárek (1982, 1995), Pokorny and Jankovská (2000) and Russia: Jankovská and Komárek (2000), Komárek and Jankovská (2001). Very interesting data on environmental preference of fossil *Pediastrum* from southwestern Denmark were given by Nielsen and Sorensen (1992).

MATERIAL AND METODS

The samples were taken from the core of the peat-bog "Żabie Oko" located in the Valley of Rybi Potok at the "Morskie Oko" lake in the Tatra Mts. (alt. 1390 m). The material, 1 cm^3 in volume was taken at intervals of 2–10 cm by Obidowicz (1996). The 1 cm^3 sediments samples were treated by Erdtman's acetolysis. Samples with mineral content were treated with HF prior to acetolysis, and glycerin slides were made. The taxonomical research was carried out using LM Carl Zeiss Jena. In each slide the number of coenobia and their fragments was counted in six horizontal and perpendicular fields (numbers of coenobia fragments were divided in two). For each species found microphotographs and drawings were made.

TAXONOMICAL DESCRIPTIONS

The keys of Komárek and Fott (1983) and Jankovská and Komárek (1995) were used for determining of the taxa.

Pediastrum boryanum var. ***boryanum*** (Turp.) Menegh.

Pl. 1, figs 1–5

Coenobia usually circular, without holes between cells, with 16(–32) cells. Marginal cells

with two lobes ending in two narrow processi. Incision between processi V-shaped. Cell wall regularly granular. Dimensions: coenobia 84(–92) μm in diameter, marginal cells up to 10(–11) μm long, and 20(–24) μm wide, inner cells up to 10(–15) – 20(–23) μm in diameter. Recorded at 5.10–2.80 m depth.

Common in fossil sediments, occurring in eutrophic body waters (Nielsen & Sorensen 1992, Jankovská & Komárek 2000, Komárek & Jankovská 2001). Recently occurs in more or less wide range of various mesotrophic to eutrophic but not very polluted waters (Komárek & Jankovská 2001).

Pediastrum boryanum (Turp.) Menegh. var. ***longicorne*** Reinsch

Pl. 2, figs 1–6, Pl. 3, figs 1–2

Coenobia without holes between cells, with 16(–28) cells. Marginal cells with two narrow, long, and sometimes slightly curved processi. Incision between processi V-shaped. Cells wall scarcely and distinctly granular. Dimensions: coenobia 170(–196) μm, marginal cells 10(–15) μm long, and 22(–30) μm wide, inner cells up to 34–42 μm in diameter. Recorded at 4.00–1.90 m depth, particular many were found at 3.70, 3.50 and 3.30 m depth.

Very common in sediments of Late-Glacial and early Holocene, reported in all palaeoecological analyses, it follows that this taxon indicates dystrophic water biotopes (Pokorny & Jankovská 2000, Komárek & Jankovská 2001). Recently ecologically restricted (peaty waters), known from all climatic zones (Komárek & Jankovská 2001).

Pediastrum boryanum (Turp.) Menegh. var. ***brevicorne*** A. Braun

Pl. 4, figs 1–4

Coenobium circular without holes, 16-celled. Marginal and inner cells 10(–15) μm long and 20(–230 μm wide. Processi short (compare with *P. boryanum* var. *boryanum*, and *P. boryanum* var. *longicorne*. Incision between processi wide and shallow. Dimensions: cenobia ca. 76 μmin diameter. Cell wall granular. Recorded at 4.65, 420, and 3.40 m depth.

According to Nielsen (2000) variety brevicorne should be rejected and included in var. *boryanum*. It is difficult to identify in fossils material, (can be mistakenly identified as *P. boryanum* v. *boryanum* or *P. integrum*). According to Komárek and Jankowska (2001) the records from higher altitudes are apparently atypical forms of the mentioned taxa. Recently known as thermophilic, occurring in tropical countries up to warmer regions of temperature zone (Komárek & Jankowská 2001).

Pediastrum integrum Nägeli

Pl. 5, figs 1–7

Coenobia circular or irregular in outline, without holes with 8(–31) cells. Marginal cells always with no incision. On the outline marginal cells with two very short, hyaline processi. Sometimes one of them may be reduced but invisible. Cell wall regularly granular. Dimensions: coenobia up to 60(–75) μm in diameter, marginal and inner cells up to 10–13 μm diameter. Recorded at 5.10–0.9 m depth, especially at 3.00, 2.80, and 3.75–3.40 m depth.

Common, in fossil sediments reported from cold and clear waters (Jankovská & Komárek 1982, Nielsen & Sorensen 1992, Pokorny & Jankovská 2000, Komárek & Jankovská 2001). Recently reported from clearly body waters, usually from oligotrophic to dystrophic waters (Komárek & Jankovská 2001).

Pediastrum duplex Meyen var. ***rugulosum*** Raciborski

Pl. 6, figs 1–2

Coenobia very deformed but a piece of coenobium enable determination of species. Marginal cells with internal incision 8–10 μm wide, and 7–10 μm long inner cells ca. 10 μm in diameter with incision of every side. Only two fragments of coenobia found at depth 5.10 and 2.50 m.

Very common, in Late Glacial and Holocene sediments, reported from euthrophic waters (Jankovská & Komárek 1982, Nielsen & Sorensen 1992, Jankovská & Komárek 2000, Komárek & Jankovská 2001). Recently is probably more common in tropical countries (Komárek & Jankovská 2001).

Pediastrum orientale (Skuja) Jankovská & Komárek

Pl. 6, figs 3–4

Coenobia circular or irregular in outline, without holes. Marginal cells without incision

but slightly rounded with two conical lobes ending processi, which perpendicularly orientated to the plane of coenobium. Cell wall granular. Dimensions: coenobia up to 40(–70) μm, marginal and inner cells up to 11–16 μm in diameter. Recorded at 3.30–2.10 m depth.

Common in palaeobotanical samples found mainly in cold and clear water of mountainous region, but rarely reported from recent samples; (Jankovská & Komárek 1995, 2000, Komárek & Jankovská 2001). Recently known only from cold and clear-water biotopes, in very distant regions (Komárek & Jankovská 2001).

CONCLUSION

Six taxa of *Pediastrum* were recorgnized in Late Glacial-Holocene core from the "Żabie Oko" bog in the Rybi Potok Valley (Tatra Mts.). The recorded species: *P. boryanum* var. *boryanum*, *P. boryanum* var. *longicorne*, *P. integrum* and P. *orientale* had different environmental preferences. Details of temperature and other environmental changes deduced from the presence of different *Pediastrum* species can serve as additional ones to those postulated as a result of pollen – analytical investigations. However, the climatic interpretation of the occurrence of fossil *Pediastrum* is more difficult. The difficulty is that the present distribution is not necessarily determined only by the present climate. This is seen in comparison with a pollen diagram from the bog "Żabie Oko" (Obidowicz 1996).

In the deepest layers of core, from 5.10 to 4 m, numerous specimens of *Pediastrum boryanum* var. *boryanum* with, rarely, *P. integrum* were found. *P. boryanum* var. *boryanum* indicated that the water mesotrophic to eutrophic. This phase relates to the warm climate, comprising the Pre-Allerød period and the whole Allerød Interstadial. The phase I / phase II boundary visible at a depth of 4 m (Table 1)

Table 1. Occurrence of *Pediastrum* taxa in the bog "Żabie Oko"

Depth [m]	Stratigraphy	*P. boryanum* var. *boryanum*	*P. boryanum* var. *longicorne*	*P. boryanum* var. *brevicorne*	*P. orientale*	*P. integrum*	*P. duplex* var. *rugulosum*
0.90						1	
1.00	**SA**						
1.10							
1.20						1	
1.70							
1.80						3	
1.90	**SB**	2	3				
2.00			1			1	
2.10			4		2	5	
2.50			4			4	2
2.60			2			8	
2.80		2	4		1	24	
2.90		1	5			12	
3.00	**AT**	7	6		3	22	
3.20		4	8			9	
3.30		4	32		3		
3.40	**BO**	15	3	1		18	
3.50		8	18			20	
3.70	**YD**	10	19			14	
3.75		21	5			24	
4.00		1	2				
4.20		3		1			
4.30	**AL**	7				4	
4.40		5					
4.50		12				7	
4.65		3		1		7	
4.75	**pAL**	2				6	
4.80		6				4	
5.10		6				8	1

corresponds with the Allerød/Younger Dryas boundary, being placed where the vegetation changes from a wooden landscape to an open sub-arctic park landscape (Obidowicz 1996).

At the 4–2.80 m depth numerous mesotrophic to eutrophic *Pediastrum boryanum* var. *boryanum*, dystrophic var. *longicorne*, and dystrophic/oligotrophic *P. integrum* and a few specimens *P. orientale* occurred, thus this period was recognized as a transitory zone. It comprises the Younger Dryas, the older part of the Holocene without the Preboreal period absent in the profile from the "Żabie Oko" bog, as well as the Boreal and the Atlantic.

The oligotrophic taxa *Pediastrum integrum*, *P. orientale* and *P. boryanum* var. *longicorne*, occurring during the temperature optimum period have been also found at depth 2.80 to 2.10 m belonging to phase III. The phase II / phase III boundary is combine with the beginning of the Subboreal period, when a significant rise in precipitation connected with the fall in the mean temperature took place.

In the highest layer of core from 1.80 to 0.90 m only the mentioned oligotrophic to dystrophic taxon *P. integrum* was found.

The interpretation of the occurrence of the all species of *Pediastrum* is difficult. They do not reflect a change in periods of climatic amelioration. Rather they can be used to show a shift to colder or to wetter and colder conditions.

REFERENCES

BIŃKA K., CIEŚLA A., ŁĄCKA B., MADEYSKA T., MARCINIAK B., SZEROCZYŃSKA K. & WIĘCKOWSKI K. 1991. The development of Błędno lake (Central Poland) – a palaeoecological study. Studia Geol. Polon., 100: 7–85.

HARMATA K. 1995. A Late Glacial and early Holocene profile from Jasło and recapitulation of the studies on the vegetational history of the Jasło-Sanok depression in the last 13 000 years. Acta Palaeobot., 35(1): 15–45.

JANCZYK-KOPIKOWA Z. 1991. The Ferdynandów Interglacial in Poland. Kwart. Geol., 35(1): 71–80.

JANKOVSKÁ V. & KOMÁREK J. 1982. Das Vorkommen einiger Chlorokokkalalgen in böhmischen Spätglazial und Postglazial. Folia Geobot. Phytotax., 17: 165–195.

JANKOVSKÁ V. & KOMÁREK J. 1995. *Pediastrum orientale* from subfossil layers. Folia Geobot. Phytotax., 30: 319–329.

JANKOVSKÁ V. & KOMÁREK J. 2000. Indicative value of *Pediastrum* and other coccal green algae in palaeoecology. Folia Geobot., 35: 59–82.

KOMÁREK J. & FOTT B. 1983. Chlorophyceae (Grünalgen), Ordung Chlorococcales: 208–308. In: Huber-Pestalozzi G. (ed.) Das Phytoplankton des Süsswassers. 7 Teil. Die Binnengewässer Band 16.

KOMÁREK J. & JANKOVSKÁ V. 2001. Review of the green algal genus *Pediastrum*; Implication for pollen-analytical research. Bibliotheca Phycologica, 108. J. Cramer, Berlin-Stuttgart.

KRUPIŃSKI M. K. 1988. Sukcesja roślinna interglacjału mazowieckiego w Białej Podlaskiej (summary: Plant succession of the Mazovian Interglacial age at Biała Podlaska). Przegl. Geol., 11: 647–653.

KRUPIŃSKI M. K. 1992. Flora młodoplejstoceńska z Kotliny Łomżycy (The Late-Pleistocene flora the Łomżyca Basin (NE Poland). Studia Geol. Polon., 49: 61–89. (in Polish).

KRUPIŃSKI M. K. 1993. Stanowisko interglacjalnych osadów organogenicznych w Kosiorkach k. Krzywdy (Południowa Polska) (summary: Kosiorki near Krzywda sit of organogenic interglacial deposits (southern Podlasie, eastern Poland). Przegl. Geol., 41(12): 848–852.

KRUPIŃSKI M. K. 1996. Osady interglacjału mazowieckiego w Pawłowie Nowym na Podlasiu (Sediments of the Mazovian Interglacial at Pawłów Nowy (Podlasie Region, eastern Poland)). Przegl. Geol., 44(2): 168–172. (in Polish).

KRUPIŃSKI M. K. 1997. Osady interglacjalne w Pozezdrzu koło Giżycka (Interglacial sediments at Pozezdrze near Giżycko – Mazury Lake District, NE Poland). Przegl. Geol., 45(6): 622–624. (in Polish).

KRUPIŃSKI M. K. & MARKS L. 1985. Stanowisko interglacjału w Losach koło Lubawy na Pojezierzu Mazurskim – komunikat wstępny (summary: Interglacial site at Losy near Lubawa in the Mazury Lakeland). Kwart. Geol., 29(3–4): 767–780.

LATAŁOWA M. 1992. Man and vegetation in the pollen diagrams from Wolin Island (NW Poland). Acta Palaeobot., 32(1): 123–249.

LINDNER L., KRUPIŃSKI M. K., MARCINIAK B., NITYCHORUK J. & SKOMPSKI S. 1991. Plejstoceńskie osady jeziorne w stanowisku Hurd I koło Białej Podlaskiej. (summary: Pleistocene lake sediments of the site Hurd I near Biała Podlaska). Kwart. Geol., 35(3): 337–361.

NIELSEN H. 2000. Morphometric analysis of cell wall sculpture in seven infraspecific taxa of *Pediastrum boryanum* (Sphaeropleales, Chlorophyta) and its taxonomic implications. Phycologia, 39(1): 36–49.

NIELSEN H. & SORENSEN I. 1992. Taxonomy and stratigraphy of Late-Glacial *Pediastrum* taxa from Lysmosen, Denmark – a preliminary study. Rev. Palaeobot. Palynol., 74: 55–75.

OBIDOWICZ A. 1996. A Late Glacial-Holocene history of the formation of vegetation belts in the Tatra Mts. Acta Palaeobot., 36(2): 164–165.

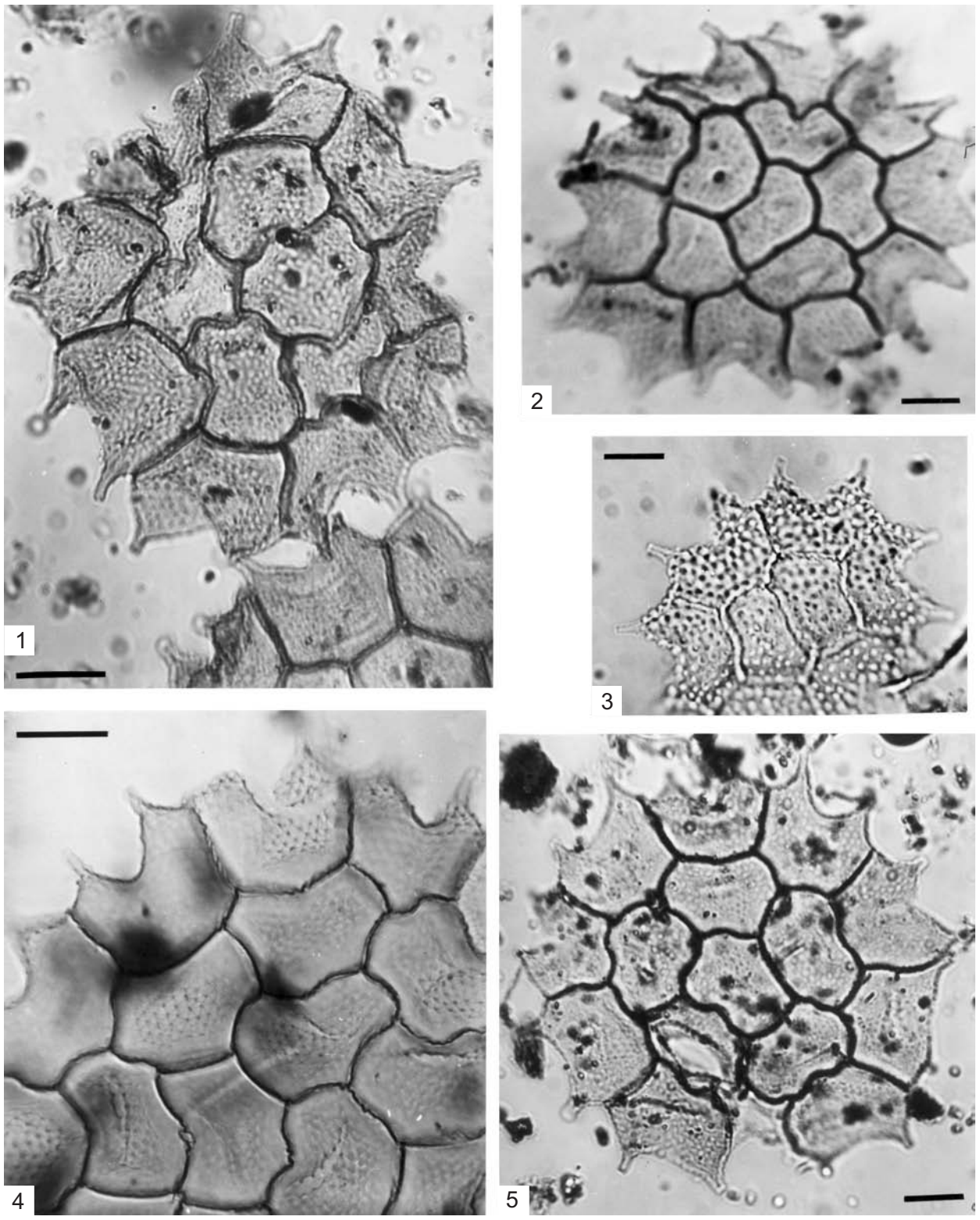
PIDEK A. I. 2000 (unpubl.). Historia roślinności pół-

nocnego przedpola Wyżyny Lubelskiej na podstawie analizy pyłkowej mezoplejstoceńskich profili ze stanowisk Zdany i Brus. Ph. D. Thesis, W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

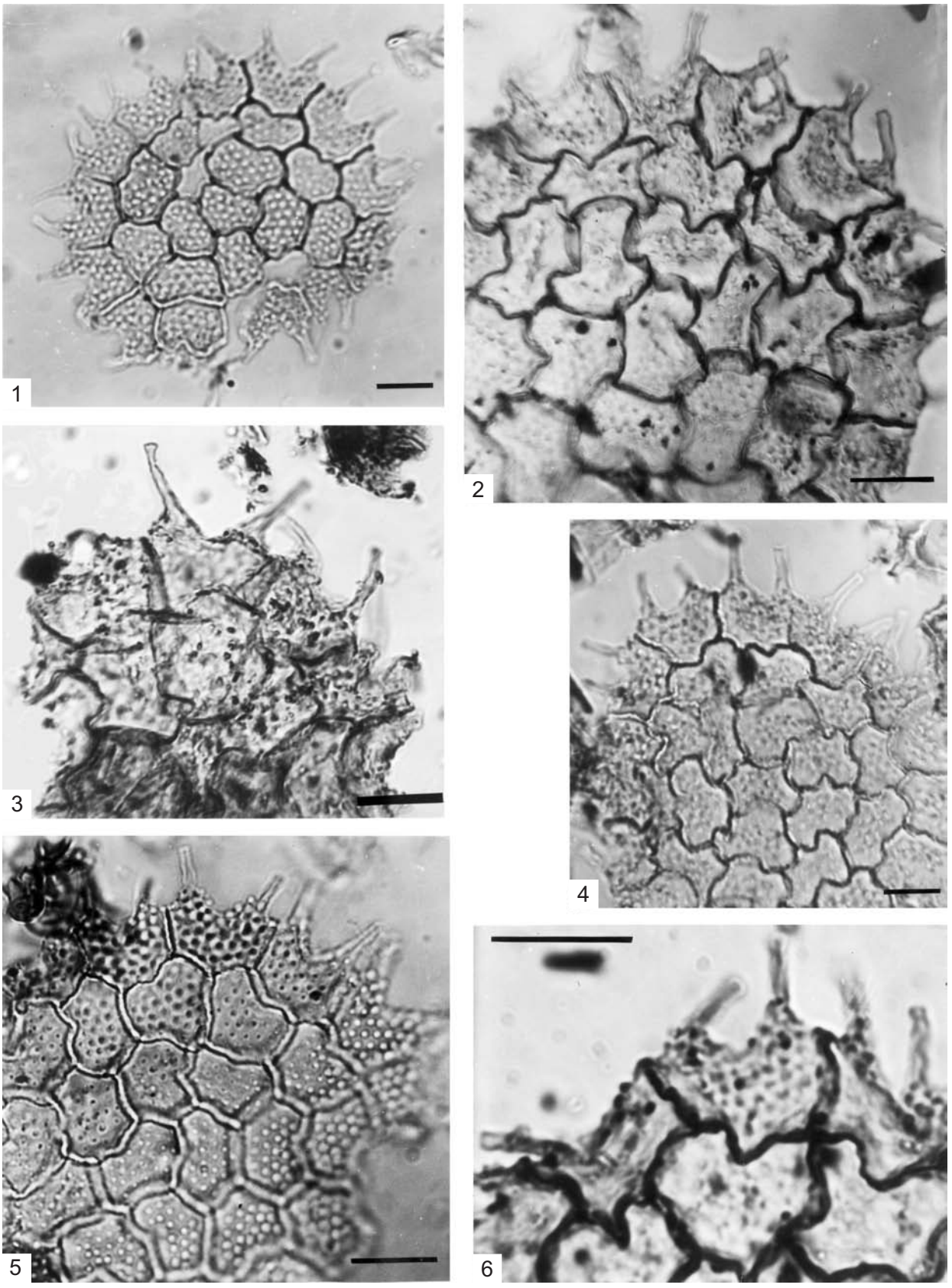
POKORNÝ P. & JANKOVSKÁ V. 2000. Long-term vegetation dynamics and the infilling process of a former lake (Švarcenberk, Czech Republic). Folia Geobot., 35: 433–457.

ZACHOWICZ J., PRZYBYŁOWKSA-LANGE W. & NAGLER J. 1982. The Late-Glacial and Holocene vegetational history of the Żuławy Region, N. Poland. A biostratigraphic study of lake Druzno sediments. Acta Palaeobot., 22(1): 141–161.

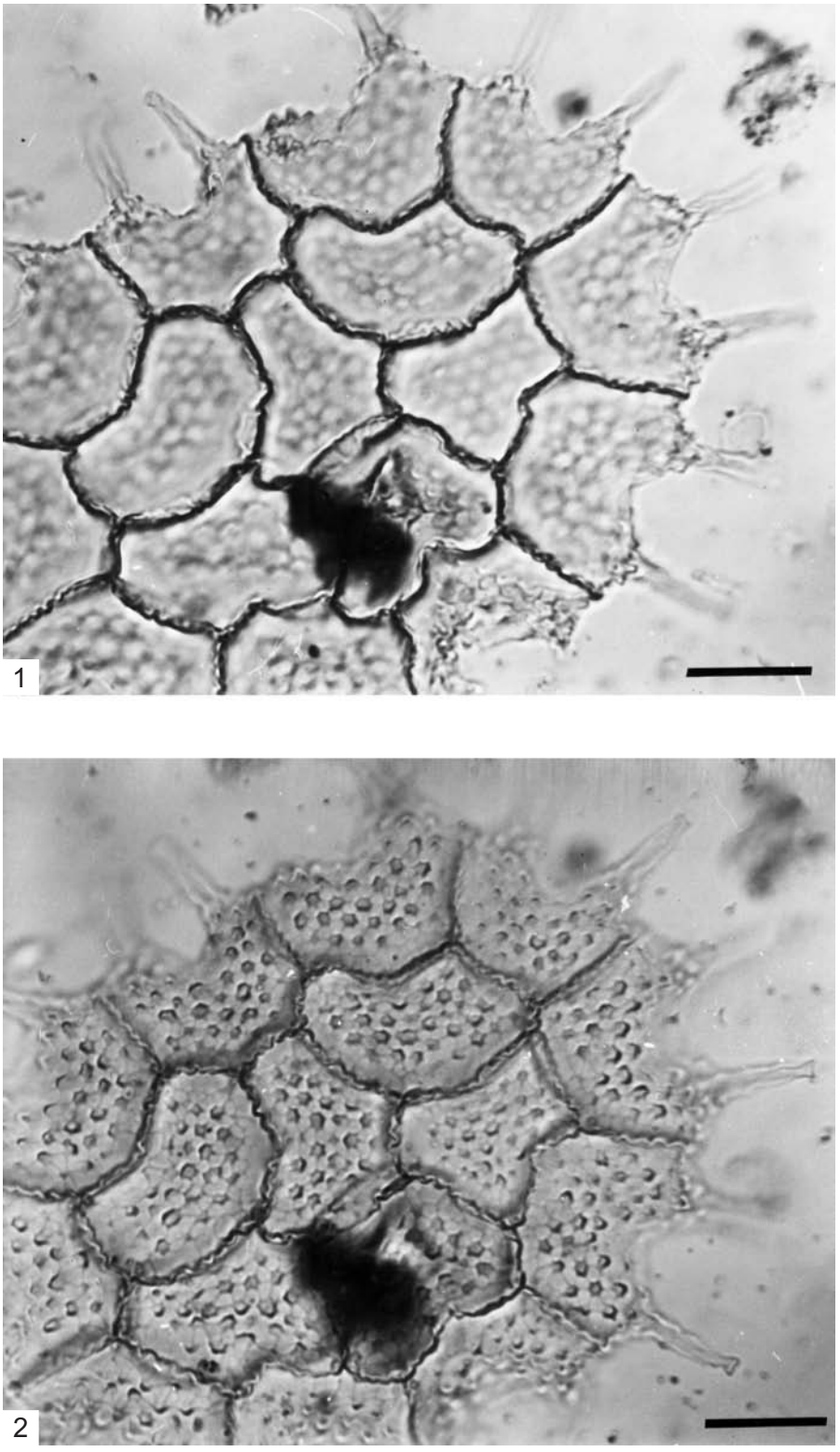
PLATES



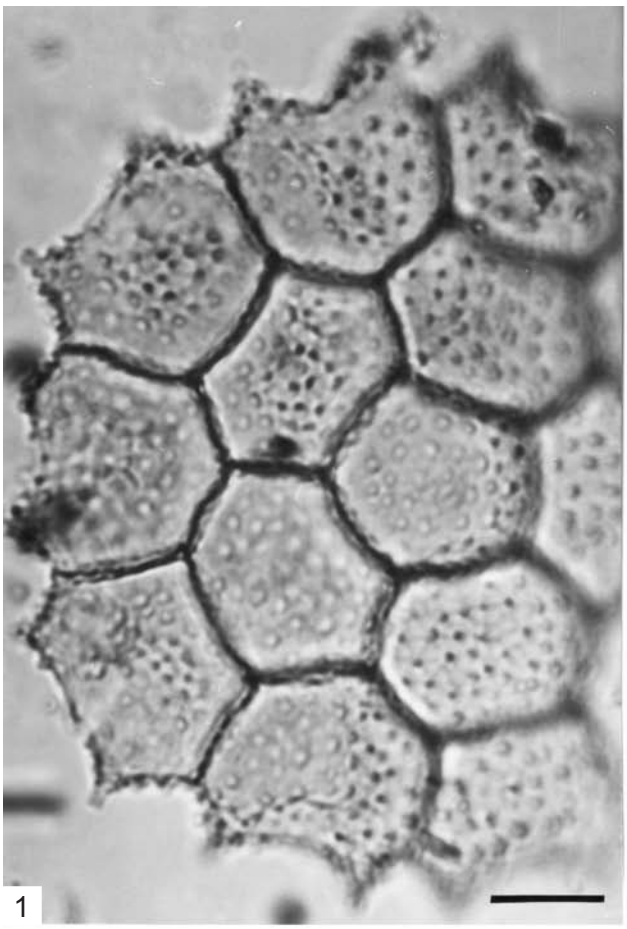
1–5. *Pediastrum boryanum* (Turp.) Menegh. var. *boryanum* (scale bar = 10 μm)

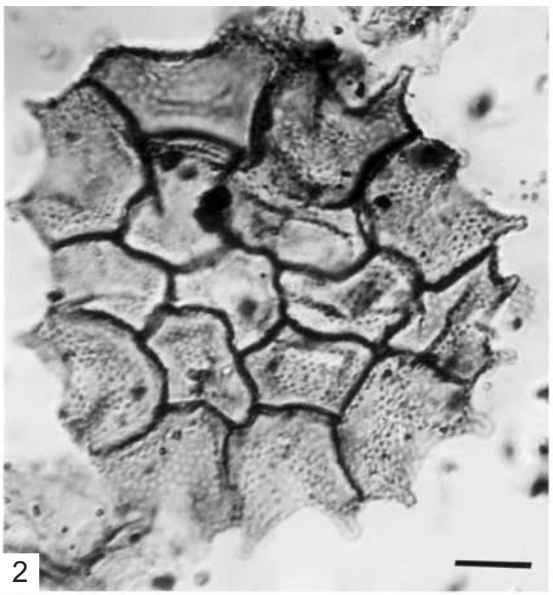


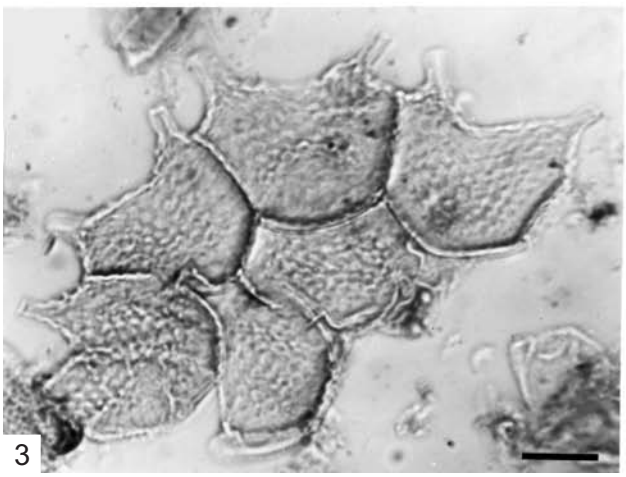
1–6. *Pediastrum boryanum* (Turp.) Menegh. var. *longicorne* Reinsch (scale bar = 10 μm)

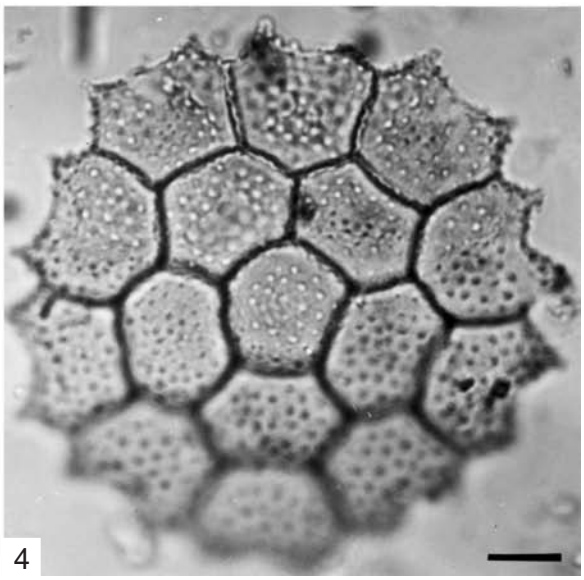


1–2. *Pediastrum boryanum* (Turp.) Menegh. var. *longicorne* Reinsch (scale bar = 10 μm)

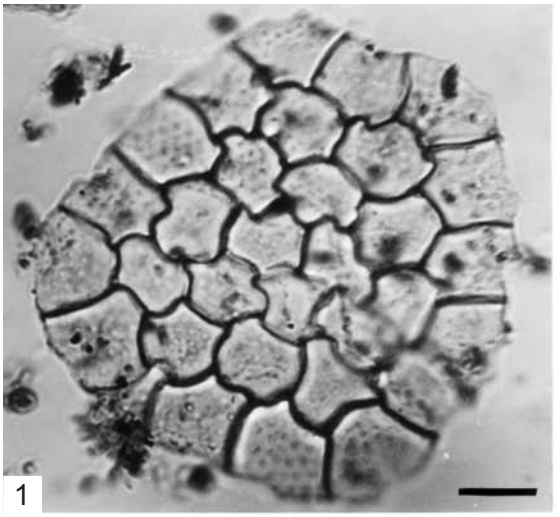


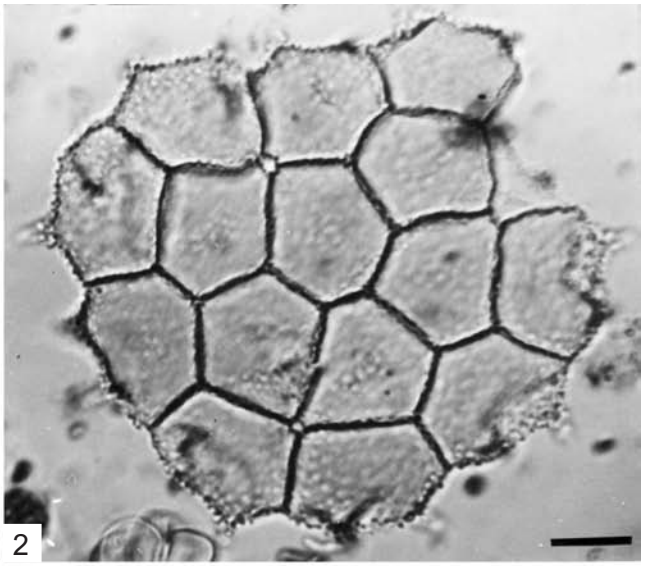


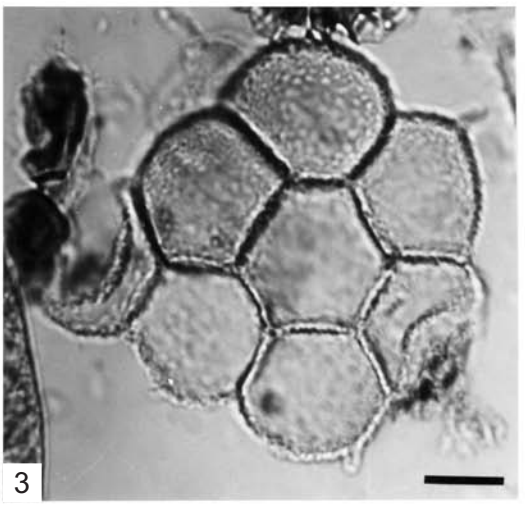


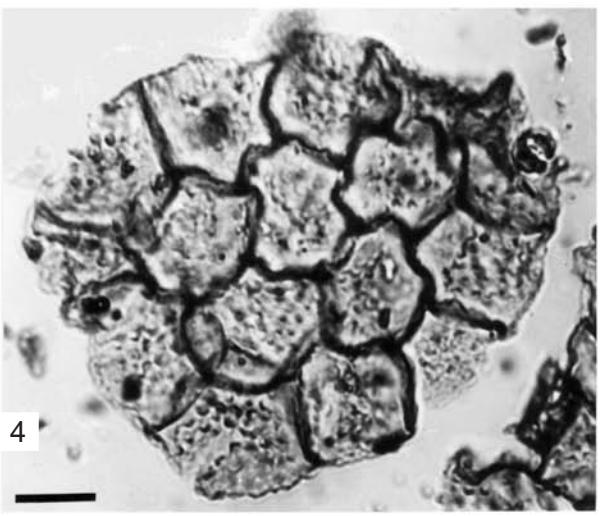


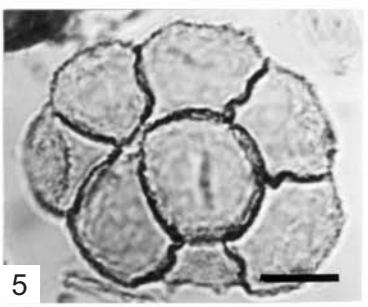
1–4. *Pediastrum. boryanum* (Turp.) Menegh. var. *brevicorne* A. Braun (scale bar = 10 μm)

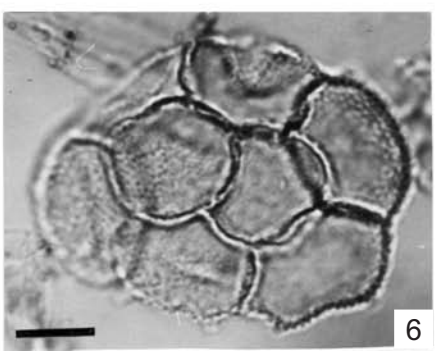

1

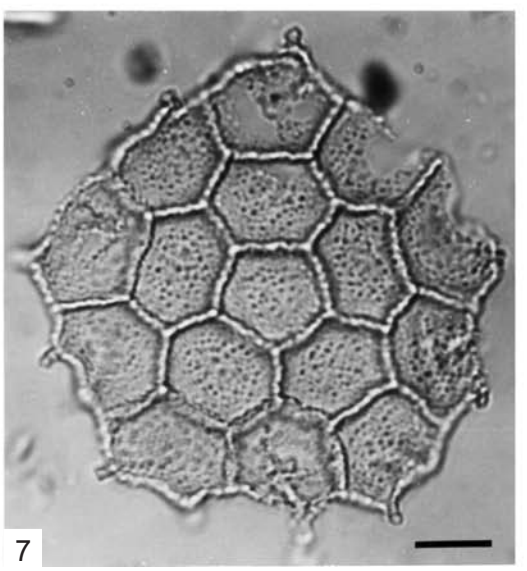

2


3

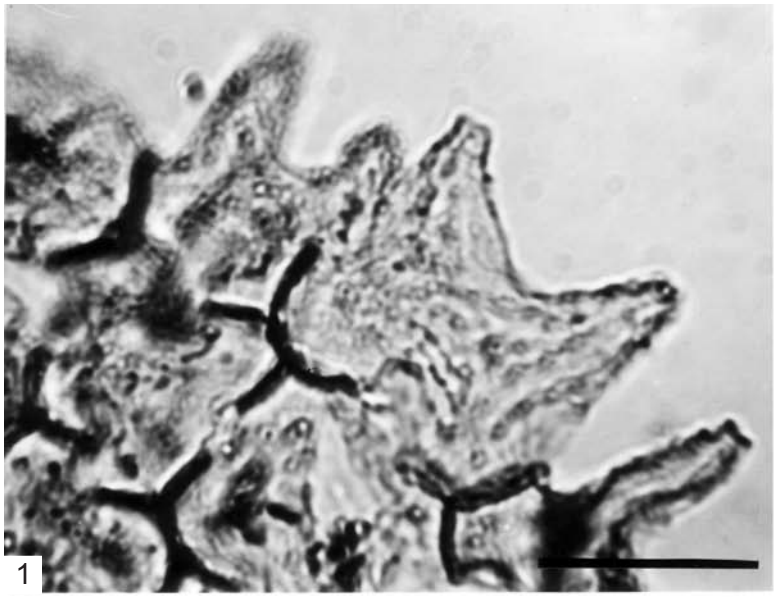

4

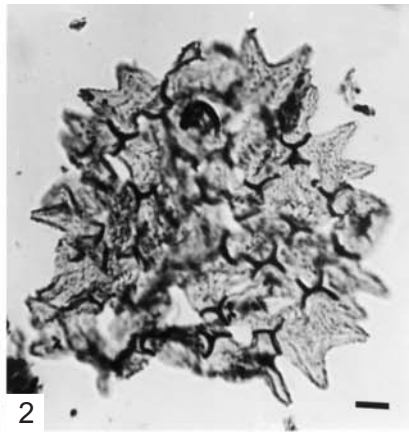

5

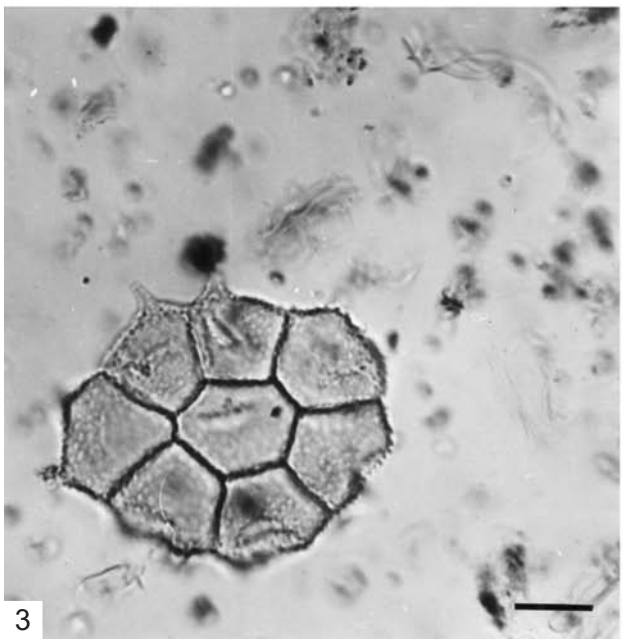

6

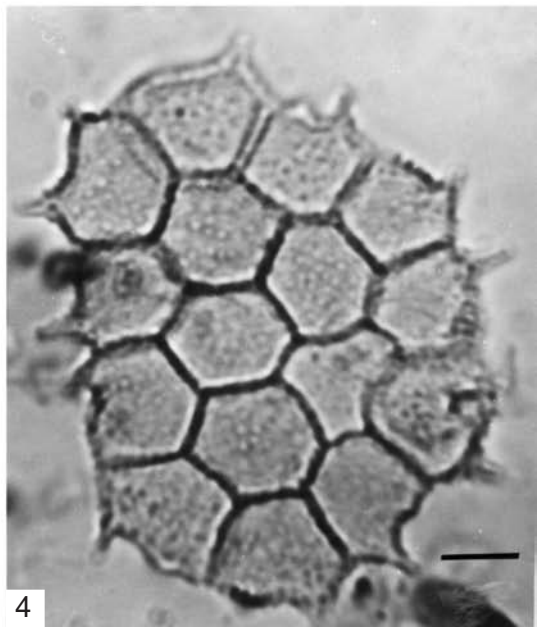

7

1–7. *Pediastrum integrum* Nägeli (scale bar = 10 μm)









1–2. *Pediastrum duplex* Meyen var. *rugulosum* Raciborski (scale 10 μm)
3–4. *Pediastrum orientale* (Skuja) Jankovská & Komárek (scale bar = 10 μm)