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SOME MONOCOT POLLEN TAXA FROM THE LOWER MIOCENE BASAL COALY DEPOSITS OF THE CZECH AND POLISH PARTS OF THE ŻYTAWA (ZITTAU) BASIN

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Abstract. LM and SEM exine microstructure data of selected monocot pollen are given. Combined LM/SEM observations of one or two sulcate and monoporate pollen with reticulate patterns or perforate tectum showed detailed differences in the arrangement of perforations, muri, and lacunae – which were then characterized in more detail. Pollen related to the monocot taxa of the families Arecaceae (Palmae), Liliaceae and *Sparganiaceae* / *Typhaceae* were assessed in relation to the modern representatives of Coryphoideae, Phoenicoideae, and Calamoideae amongst the trunk and liana palms, Sparganium, Typha, and cf. Liliaceae amongst herb plants. Chloranthaceae are mentioned from the aspect of monoaperturate pollen. In addition, all these taxa represent the earliest records and occurrences in the basin. The accompanying assemblages from the basal deposits (s.l.) are summarized in Table 1.

■ Monocots pollen, Oligocene/Miocene, brown-coal, Żytawa (Zittau) Basin, Turów/Hrádek nad Nisou, Poland, Czech Republic

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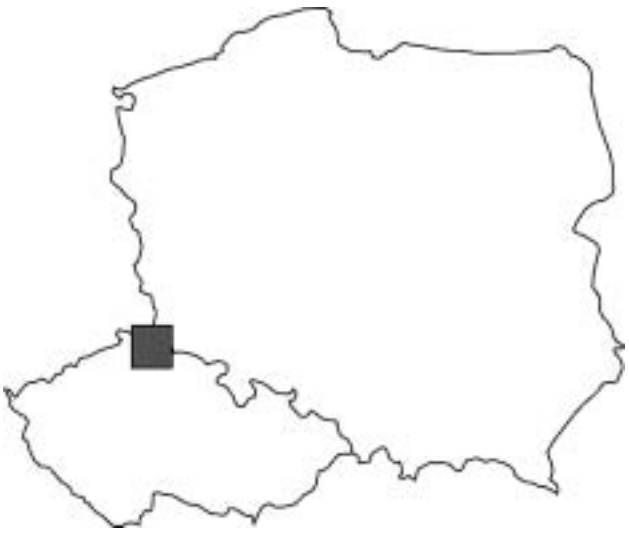
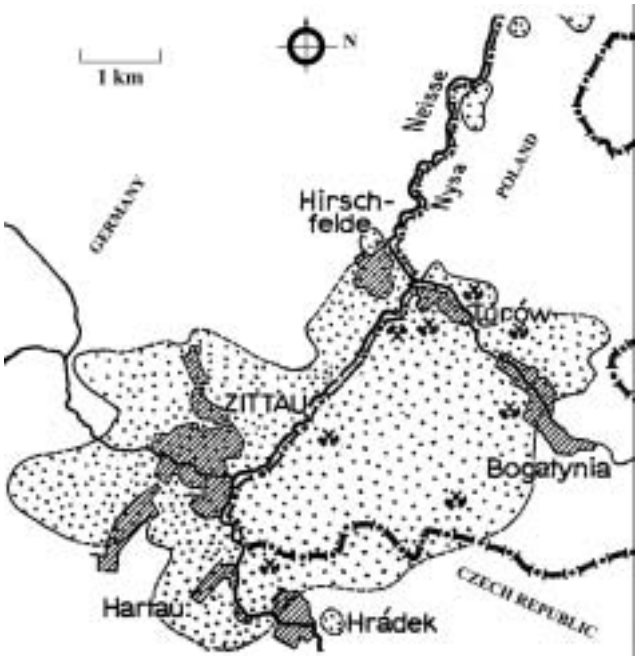
Introduction

This study focuses on the Oligocene/Miocene lignite basin at the border of Poland, Germany and Czech Republic (Text-figs 1, 2), representing a tectonic depression in the Żytawa (Zittau) Basin (geological section Text-fig. 3). The



Text-fig. 1. Geographical position of the Zittau (Żyttava) Basin at the boundary between Poland and the Czech Republic (Bohemia).



Text-fig. 2. Sketch map of the Żytawa / Zittau Basin showing the Polish (Turów) and Czech (Hrádek) parts. Bogatynia (E of Rybarzowice) and Hrádek sites refer to the areas of the deepest depressions of the eastern and southern parts of the basin.

basal part of the sedimentary fill of the basin was reached by boreholes in the Polish and Czech parts of the basin, in areas close to each other. The studied samples comprise grey clays, coaly and silty clays to clayey coal on the base of the first sedimentary cycle (Václ and Čadek 1962, Kasiński 1989, Kasiński and Ziembińska-Tworzydlo 1998).

As the earliest fossil assemblages recovered from the basal sediments contained significant monocotyledonous specimens, they were studied in detail, both under light microscope (LM) and scanning electron microscope (SEM, Oxford Camera). The pollen were compared with selected modern monocots (slide collection of the Polish Academy of Sciences, W. Szafer Institute of Botany, Kraków, living plants in the Botanical Garden Prague) and available digital pollen data.

Fossiliferous deposits were accessed only by several deep boreholes. Plant microfossils were yielded by boreholes Ry 1/77 at Rybarzowice (W of Bogatynia, Poland) and Hr 42, Hr 53 between Oldřichovice, Václavice and Hrádek in the area of Hrádek n. N. (Czech Republic). The depth of the studied deposits exceeded 220 m in both areas. The assemblages were preserved in clays and silty clays with a variable proportion of organic substances, and, in the Czech part of the basin, also in the thin clayey basal lignite seam. The basin floor is formed by crystalline rocks at Rybarzowice and by crystalline rocks and decomposed neovolcanic rock of the analcime-nephelinite basanite composition (Kavka in Václ 1967) in the Czech part of the basin. The Rybarzowice Depression and the Oldřichovice Trough (or Depression) represent the deepest parts of the Żytawa / Zittau Basin (Kasiński 2000).

Systematic part

In pollen morphological terminology we have followed Punt et al. (2007), Ferguson and Harley (1993), Harley and Baker (2001), Harley and Morley (1995), and Halbritter et al. (2006). Krutzsch's Atlas VII (1970) of monocolpate, dicolpate, and monoporate pollen was used for fossil palynotaxa and their classification, with the new data of Harley (2006) also being taken into consideration.

Arecipites Wodehouse, 1933

T y p e : *Arecipites punctatus* Wodehouse, 1933, p. 407, fig. 22.

Arecipites convexus (Thiergart, 1937) Krutzsch, 1970

Pl. 1, figs 1-7

1937 *Sabalpollenites convexus* Thiergart, p. 308, 309, pl. 24, fig. 15.
1970 *Arecipites convexus* (Thiergart, 1937) Krutzsch, p. 103, 104, pl. 21, figs 20-24.

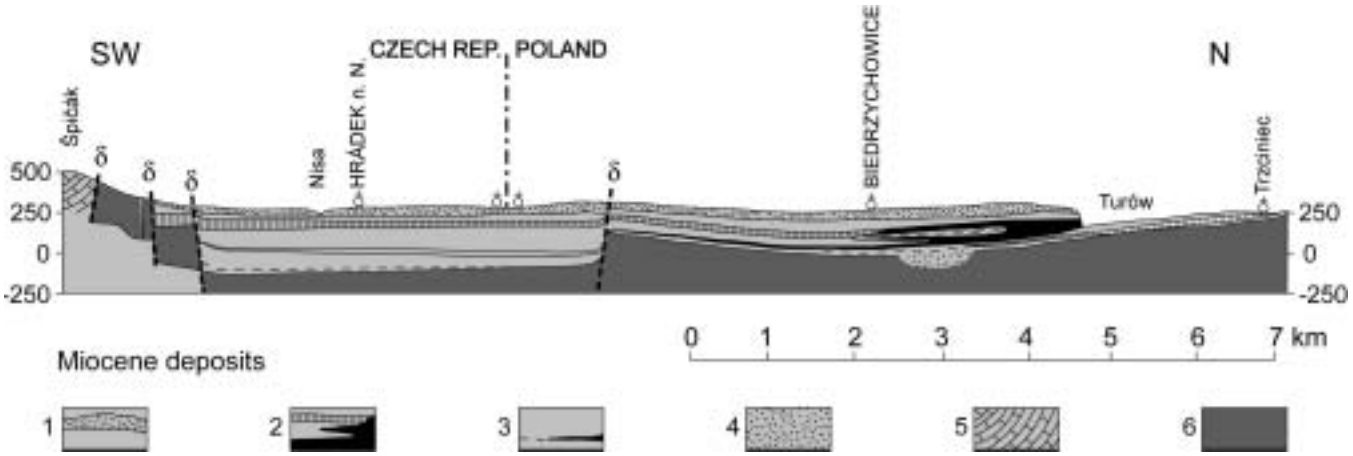
D e s c r i p t i o n : Monosulcate pollen, broadly oval, slightly asymmetrical in equatorial outline, 28-38 µm long, 22-28 µm wide at the broadest part of the grain. Sulcus reaches to the equatorial region. Exine 1.5 to 1.8 µm thick, semitectate, reticulate; reticulum differentiated, on the proximal face lumina 1.0–1.5 µm, on the distal face 0.3–0.5 µm, narrow along the sulcus. Under SEM, muri 1.0–1.5 µm wide, supported by columellae. Inside several lumina, a single free bacula was observed (Pl.1, fig. 6b). Also tiny pores were present (Pl.1, fig. 6b).

O c c u r r e n c e : Basal coal seam and lowermost clays in both parts of the basin.

F r e q u e n c y : Common to frequent in both parts of the basin.

B o t a n i c a l r e l a t i o n s h i p : Arecaceae, *Sabal* Adans. (Thiergart 1937), Arecoideae – *Chamaedorea* Willd. (Harley and Baker 2001, Thanikaimoni 1966).

R e m a r k s : Both morphospecies (*A. convexus* and the following *A. pseudoconvexus*) are linked by transitions.



Text-fig. 3. Schematic section through the Żyttawa (Zittau) Basin, on the Czech and Polish boundary; Hrádek n. Nisou and Turów parts of the basin. Explanation of the symbols. 1 – Overlying strata with the upper coal seam, 2 – middle and lower strata with the coal seam (Miocene), 3 – first sedimentary setting with basal coal seam (Miocene / Oligocene), 4 – alcalic volcanism (Tertiary), 5 – Upper Cretaceous deposits, 6 - underlying rocks of the basin. (Adapted after Václ 1967, Václ and Čadek, 1962, modified).

Arecipites pseudoconvexus KRUTZSCH, 1970

Pl. 2, figs 1-4

1970 *Arecipites pseudoconvexus* KRUTZSCH, p. 103, pl. 21, figs 1-19.

Description: Monosulcate pollen, of rather asymmetrical outline, equatorial diameter about 30 µm, tectum reticulate. Lumina predominantly circular to oval, 0.3 – 1.0 µm in diameter, micropori locally dispersed among large-sized lumina (Pl. 2, figs 2b, 4b). Lumina narrow towards sulcus. Muri 0.5–1.5 µm wide, supported by columellae (SEM illustration, Pl. 2, figs 2b, 4b, upper parts). Free bacula might be developed within lacunae (Pl. 2, fig. 4b, left corner, upper part). (Specimen in fig. 6 differs by its smaller size and rather heterobrochate reticulum; Pl.2, figs 6a, b.)

Occurrence: Basal coal seam in the Czech part and lowermost clays in both parts of the basin.

Frequency: Common in both parts of the basin, frequent in the Hrádek part (Hr 53, 238.6 m).

Botanical relationship: Arecaceae, Arecoideae.

Remarks: Harley and Baker (2001, fig. 1, p. 52) show a similar specimen, in its shape and SEM reticulate pattern, in the modern monosulcate pollen of *Chamaedorea* (*Ch. elegans* MART.), the genus of palm growing in Middle and South America.

cf. *Arecipites* sp. 1

Pl. 2, figs 5, 6

Description: **?**Monosulcate pollen, equatorial outline ellipsoidal, longer axis 23–27 µm, reticulate tectum, lumina irregularly shaped, circular to polygonal (Pl. 2, figs 6a,b); on the proximal face lumina 1.0–2.0 µm, on the distal face 0.3–0.5 µm; among lumina, also tiny micropori appear (Pl.2, fig. 6b); muri 0.5–2.0 µm wide, supported by columellae (Pl. 2, fig. 6b); somewhere inside lumina, free bacula probably present (Pl. 2, fig. 6b). (The microgranules dispersed on the surface of muri may be a secondary feature.)

Occurrence: In the Polish part of the Żytawa Basin.

Frequency: Sporadic.

Botanical relationship: Arecaceae or Araceae families may be considered as related plants (according to SEM view). Several types of Araceae (e.g. medium sized *Lasia* LOUR., 27 µm and *Anaphyllum* SCHOTT, 29–33 µm in size, Grayum 1992) display more or less comparable reticulation including free bacula inside the lacunae (e.g. *Lasia spinosa* (L.) THWAITES, *Anaphyllum wightii* SCHOTT) but show psilate exine around the aperture. Long sulcus (Pl. 2, fig. 6a) and reticulation pattern are also comparable with palm pollen (Harley and Becker 2001).

Arecipites sp. 2

Pl. 3, fig. 5

Description: Ellipsoidal, elongated pollen about 17 µm in size (long axis) with significantly long sulcus, observed only in distal view. Equatorial outline fusiform, slightly asymmetric, apex slightly pointed to rounded. Sulcus almost reaching the length of the long axis of the grain**.** Coarse reticulum with irregularly arranged lumina and smooth tall muri supported by simple columellae; upper part of the muri V shaped (a inverted V), diminishing towards the sulcus (Pl. 3, fig. 4b, lower side of the pollen, upper part).

Occurrence: Lowermost clays, so far only in the Polish part of the basin.

Frequency: One specimen found, revealed by SEM**.**

Botanical relationship: Arecaceae, *Gronophyllum* type**.**

Remarks: *Gronophylllum* pollen, *G. microcarpum* (Thanikaimoni 1966, pl. 1, figs 5, 6), *Gronophylllum* sp. (Ferguson and Harley 1993, pl. 10, figs. A, B; Harley and Baker 2001, fig. 16) were so far found to be the most similar pollen, showing a partly comparable pollen pattern. Reticulum on the fossil specimen differs by the smooth and mostly closed lumina.

Dicolpopollis PFLANZL, 1956 ex POTONIÉ, 1966

Type: *Dicolpopollis kockeli* PFLANZL, 1956, p. 241, pl. 16, figs 9-12.

Dicolpopollis kockelii PFLANZL, 1956 ex POTONIÉ, 1966

Pl. 3, figs 2,3, ?? figs 1, 4

1956 *Dicolpopollis kockeli* PFLANZL, p. 241, pl. 16, figs 9-12.
1966 *Dicolpopollis kockelii* PFLANZL; Potonié, p. 16.
1970 *Dicolpopollis kockeli* PFLANZL; Krutzsch, p.152, pl. 42, figs 1-54.

Description: Disulcate pollen, equatorial outline broadly oval to nearly circular, 20–25 µm in equatorial diameter, polar axis 20–21 µm. Probably dicolpate pollen (fig. 1, aff. fig. 2), associated with them, displaying a densely reticulate tectum, muri relatively high and wide (0.5–1.0 µm) wide, smooth and with a rather flat surface (Pl. 3, fig. 1b); lumina heterobrochate, circular to oval and even polygonal, small foveolae or micropori are also visible**;** lumina slightly larger on the proximal face (to 1.3 µm long) than along the furrow areas (to 0.5 µm long).

Occurrence: Basal coal seam in the Czech part (rarely) and lowermost clays in the Polish part of the Żytawa Basin.

Frequency: Rare to common (see Table 1).

Botanical relationship: Arecaceae, Calamoideae.

Remarks: The pollen (Pl. 3, figs 1a,b, 4 a,b) are comparable with the specimens of *Calamus* (*C. convallium* J. DRANSF. and *C. deerratus* G. MANN. et H. WENDL, figured in Harley and Baker 2001, p. 57, figs 25-28) considering the arrangement of lumina and character of muri. Under LM specimens of *Dicolpopollis kockelii* (Pl. 3, figs 2 (cf.) and 3) are comparable with the specimens figured by Krutzsch (1970, pl. 42, figs 1-54) and Konzalová (1976, pl. 19, figs 1-7). *Dicolpopollis* pl. 3, fig. 1 differs from the *kockelii* species in the SEM pattern (Zetter, written communication) and similarly the specimen on pl. 3, fig. 4.

? *Liliacidites* sp. 1

(? Liliaceae – type 1)

Pl. 4, figs 1, 2

D e s c r i p t i o n : Zonosulcate, spherical, reticulate pollen, circular in equatorial outline, equatorial diameter 17–18 µm, polar axis 16 µm. Wide-luminated reticulum, irregularly arranged, long narrow or widely polygonal lumina, bordered by slightly wavy muri with characteristic ribby structure transversally arranged (Pl.4, figs 1b, 2b), similar to "transversally segmented" muri composed of **"**discs" (Hesse and Zetter 2005)**,** or heavily compressed columellae-like elements; muri "garlandy" arranged on the exine (supporting by columellae, Pl. 4, fig. 2b, right corner, upper part). Muri ca 0.5 µm wide, outline of capita shown through the light coating (Pl. 4, figs 1b, 2b).

O c c u r r e n c e : Basal coal seam in the Czech part and lowermost clays in the Polish part of the Żytawa Basin.

F r e q u e n c y : Rare, the specimens were revealed under SEM only.

B o t a n i c a l r e l a t i o n s h i p : Not fully recognized. ?Liliaceae, ?Sparganiaceae, ?Typhaceae.

R e m a r k s : The structure of the muri is so far comparable with Liliaceae, with pollen of *Liliacites sphericus* Couper 1960, but which was later re-assigned to porate *Sparganiaceaepollis sphericus* (Couper 1960) Mildenhall in Mildenhall et Crosbie (1979) from the pollen spectra of New Zealand.

? *Liliacidites* sp. 2

(? Liliaceae – type 2)

Pl. 4, fig. 3

D e s c r i p t i o n : Zonosulcate, spherical, reticulate pollen with circular equatorial outline, 21–22 µm, in diameter; the zone or most probably colpus was not clearly observable in the specimen. Reticulum finer in contrast to the above specimens, densely arranged, lacunae obtusely polygonal or circular, 0.3 to 0.8 µm in size (under 1 µm); muri also composed of closely packed columellate elements (Pl. 4, fig. 3b).

O c c u r r e n c e : Lowermost clays in the Polish part of the Żytawa Basin.

F r e q u e n c y : Very rare, the specimens were revealed under SEM only.

B o t a n i c a l r e l a t i o n s h i p : Not fully recognized. ? Palmae, ? Liliaceae, ? angiospermous hydrophytes. Worth mentioning is the similar SEM pattern to the modern Chloranthaceae when we compared the data given in Hofmann and Zetter (2001, pl. 1, figs 10-12), and Zetter et al. (2002, pl. 3, 1-8, probably also 13-15).

Sparganiaceaepollenites sparganioides (Meyer, 1956) Krutzsch, 1970

Pl. 5, figs 1-3; aff. 4

D e s c r i p t i o n : Spherical to subspherical monoporate pollen with circular outline and densely arranged reticulate to porate tectum (semitectum). Annulate porus, annulus about 2–4 µm wide, only partly preserved, observable at higher magnification (Pl. 5, 1a). Muri psilate, 0.2–0.5 µm wide, supported by short columellae (Pl. 5, fig. 3b); small-sized predominantly circular to oval luminae and pori (Pl. 5, fig. 1b), diminishing towards center of pollen (Pl. 5, fig. 1b). On non porous area (Pl. 5, figs 3a, 3b) lumina wider and also polygonal.

O c c u r r e n c e : Lowermost clays in the Polish part of the Żytawa Basin (specimens in figs. 1-3), aff. *Sparganiaceaepollenites* sp. basal deposits in the Czech part of the Żytawa Basin (specimen in fig. 4).

F r e q u e n c y : Rare.

B o t a n i c a l r e l a t i o n s h i p : cf. Sparganiaceae, *Sparganium* L., after SEM observation (Figs 1,a,b). The specimen is similar to *Sparganium eurycarpum* Engelm. (after data in Grayum 1992); the other one (figs 3a,b) maybe the same pollen type but showing the face opposite the porus or another specimen related to *Typha latifolia* type, normally occurring in tetrads. For this pollen (fig. 4 a,b) we have not been able to recognize any other closer relationship because of the broken exine. The monolete pollen cannot be totally excluded (upper line of the split is very straight) but the SEM pattern is closer to the micrograph of the specimen in fig. 1. Therefore it was assigned to this group (aff. *Sparganiaceaepollenites* sp.).

Sparganiaceaepollenites sp.

Pl. 5, fig. 5

D e s c r i p t i o n : Monoporate pollen, oval, elliptic in outline, with distinct reticulum; luminae mostly between 6–12 µm wide, irregularly shaped, polygonal; muri distinct, 4–6 µm wide, with uneven surface, bearing low excrescenses.

O c c u r r e n c e : Basal deposits in the Czech part of the Żytawa Basin. Hr-42.

F r e q u e n c y : Rare, the specimen was revealed under SEM only.

B o t a n i c a l r e l a t i o n s h i p : At the begining of the investigation, the specimen was designated as *Monoporopollenites* sp. with some relationship to hydrophillous rim plants. For the certain assignment to the extant *Sparganium,* we are indebted to Dr. Zetter (written consultation).

Conclusions

The mosaic of monocots testifies to the different communities and environments, from water body edges to lowland communities. The correlation between the two basal levels, in the Polish and the Czech parts of the basin, show differences in frequencies and monocot taxa composition. The basal coaly deposits of Hrádek n. N display more frequently Arecaceae (Hr 42, depth 237.3 m and 238.6 m, Hr 53, depth 236 m)*,* including Calamoideae occurrence, basal clays at Rybarzowice contain a more variegated pattern of monocot pollen taxa (Ry 1/77 depth 249.0 – 249.5 m); both differences are environmentally controlled. The total pollen assemblages, dominated by upland and lowland woody dicots and their understory components, together with

Table 1. Accompanying pollen assemblages summarized from the authors' records of the borehole profiles Rybarzowice (R-1/77) and Hrádek n. Nisou (Hr 42, Hr 53).

Correlation of the Basal Coaly Clay & Seam	*Zittau Basin Polish & Czech parts*	
Pteridopsida	P	CZ
Azolla - sec. *Rhizosperma*	○	♣
Concavisporites cycloids Krutzsch	♣	○
Gleicheniaceae - *Neogenisporis neogenicus* Krutzsch	♣	○
Lycopodiaceae - *Retitriletes* sp. div. [1]	♣	○
Lygodium - *Corrugatisporites* sp. div.	●	♣
Lygodium – *Leiotriletes* sp. div.[2]	●	♣
Osmunda - *Baculatisporites* sp. div.	♣	♣
Osmunda - *Rugulatisporites quintus* Pflug et Thomson in Thomson et Pflug	●	♣
Polypodiaceae s.l. - *Laevigatosporites haardti* (Potonié et Venitz) Thomson et Pflug	●	■
Polypodiaceae s.l. - *Verrucatosporites* sp. div.	●	●
Polypodiaceae s.l. *Histiopteris* - *Verrucatosporites histiopteroides* Krutzsch	♣	♣
Polypodiaceae s.l. - *Reticuloidosporites clatriformis* (Mürriger et Pflug) Thomson et Pflug	○	♣
Pteridaceae - *Cryptogrammasporis magnoides* (Krutzsch) Skawińska	♣	○
Pteridaceae - *Polypodiaceoisporites* sp. div.	●	♣
Schizaeaceae - *Cicatricosisporites chattensis* Krutzsch	♣	○
Selaginellaceae - *Echinatisporis* sp.	○	♣
Toroisporis teupitzensis Krutzsch	♣	○
Triplanosporites sinomaxoides Krutzsch	♣	○
[1] *Corrugastisporites corruvallatus* (Krutzsch) Nagy, *C. paravallatus* (Krutzsch) Grabowska, *C. solidus* (Potonié) Thomson et Pflug [2] *Leiotriletes maxoides* Krutzsch, *Triplanosporites sinuosus* Pflug ex Thomson et Pflug		
Pinopsida		
Abietinaepollenites microalatus Potonié ex Delcourt et Sprumont	●	♣
Cathayapollis sp. div.	♣	♣?
Cedripites lusaticus Krutzsch	♣	♣
Piceapollis sp. div.	♣	♣?
Pinuspollenites labdacus (Potonié) Raatz	●	●
Podocarpidites podocarpoides (Thiergart) Krutzsch	♣	○
Sciadopityspollenites sp. div.	♣	♣
Taxodiaceae-Cupressaceae group	■	●
Tsuga - *Zonalapollenites spinosus* (Doktorowicz-Hrebnicka) Ziembińska-Tworzyd³o	♣	○
Tsuga - *Zonalapollenites verrucatus* Krutzsch	♣	○
Angiospermopsida		
Dicotyledones s.l.		
Aceraceae - *Aceripollenites striatus* (Pflug) Thiele-Pfeiffer	♣	♣
Altingiaceae - *Liquidambar* – *Periporopollenites stigmosus* (Potonié) Thomson et Pflug	●	♣
Araliaceae - *Araliaceoipollenites edmundi* (Potonié) Potonié	●	●
Araliaceae - *Araliaceoipollenites euphorii* (Potonié) Potonié	♣	♣
Asteraceae	○	♣
Aquifoliceae, *Ilex*-*Ilexpollenites iliacus* (Potonié) Thiergart, *I. margaritatus* (Potonié) Raatz	♣	♣
Betulaceae - *Alnus* - *Alnipollenites verus* (Potonié) Potonié	■	■
Betulaceae - *Carpinus* - *Carpinipites carpinoides* (Pflug) Nagy	♣	♣
aff. *Boehlensipollis hohlii* Krutzsch	♣	?
Clethraceae-Cyrillaceae - *Tricolporopollenites brühlensis* (Potonie) Thomson et Pflug	♣	♣

Clethraceae-Cyrillaceae - *Tricolporopollenites exactus/megaexactus* types	♣	♣
Cornaceae-Mastixiaceae - *Cornaceaepollis satzweyensis* (Pflug) Krutzsch	♣	♣
Ericaceae - *Ericipites ericius* (Potonié) Potonié, *E. callidus* (Potonié) Krutzsch	♣	♣
Fabaceae/Fagaceae - *Tricolporopollenites quisqualis, T. liblarensis* - Group	●	●
Fagaceae - Castaneoideae - *Tricolporopollenites oviformis* (Potonié) Thomson et Pflug	●	●
Fagaceae - Castaneoideae *Tricolporopollenites pusillus* (Potonié) Thomson & Pflug	●	♣
Fagaceae - *Fagus - Faguspollenites verus* Raatz	♣	♣
Fagaceae - *Fususpollenites fusus* (Potonié) Kedves	♣	●
Fagaceae - *Quercoidites henrici* (Potonié) Potonié, Thomson et Thiergart [1]	●	●
Fagaceae - *Quercoidites microhenrici* (Potonié) Potonié, Thomson et Thiergart	♣	♣
Fagaceae - *Tricolporopollenites pseudocingulum* (Potonié) Thomson et Pflug [1]	■	■
Fagaceae -*"Trigonobalanopsis schmidtii"* Walther et Zetter	○	♣
Loranthaceae - *Gothanipollis gothanii* Krutzsch	♣	○
Juglandaceae - *Carya - Caryapollenites simplex* (Potonié) Raatz	♣	♣
Juglandaceae - *Engelhardia - Momipites punctatus* (Potonié) Nagy	●	●
Juglandaceae - *Engelhardia. Momipites quietus* (Potonié) Nichols	♣	○
Juglandaceae - *Platycarya - Platycaryapollenites miocaenicus* Nagy, *Platycaryapoll.* sp.	♣	♣
Juglandaceae - *Pterocarya - Polyatriopollenites stellatus* (Potonié) Pflug	♣	♣
Juglandaceae -*Plicatopollis plicatus* (Potonié) Krutzsch	♣	○
Magnoliaceae - *Magnolia - Magnolipollis* sp. div.	♣	♣
Myricacea*e - Myrica - Myricipites bituitus* (Potonié) Nagy	♣	♣
Myricaceae - *Myrica - Myricipites myricoides* (Kremp) Nagy	♣	○
Myricaceae - *Myrica - Triatriopollenites rurensis* Pflug et Thomson	♣	♣
Nyssaceae - *Nyssa - Nyssapollenites kruschi* (Potonié) Nagy	♣	♣
Olacaceae - *Olaxipollis mathesii* Krutzsch	♣	○
Platanaceae - *Platanipollis ipelensis* (Pacltová) Grabowska	♣	♣
Sapotaceae - *Sapotaceoipollenites manifestus* (Potonié) Potonié, *Sapotaceoipoll* . sp. div.	♣	●
Sterculiaceae - *Reevesia - Reevesiapollis triangulus* (Mamczar) Krutzsch	♣	♣
Symplocaceae - *Symplocos - Symplocoipollenites vestibulum* (Potonié) Potonié	♣	●
Symplocaceae - *Symplocoipollenites* sp. div.	♣	●
Tiliaceae - *Tilia - Intratriporopollenites instructus* (Potonié) Thomson et Pflug	♣	♣
Tiliaceae – *Tilia - Intratriporopollenites insculptus* Mai	♣	●
Ulmaceae - *Ulmus - Ulmipollenites undulosus* Wolff	♣	♣
Vitaceae - *Tricolporopollenites marcodurensis* Thomson et Pflug	♣	♣
[1] *Quercoidites henrici* and *Tricolporopollenites pseudocingulum* are present and locally abundant in all the studied sections.		
Monocotyledones s. l.		
Arecaceae (Palmae) - *Arecipites* sp. div. [2]	♣	♣
Arecaceae - *Calamoideae - Dicolpopollis kockelii* Pflanzl	○	♣
Arecaceae - *Monocolpopollenites tranquillus* (Potonié) Thomson et Pflug	♣	♣
Cyperaceae - *Cyperaceaepollis* sp. div.	♣	♣
Liliaceae - *Liliacidites* sp. div.	●	♣
Poaceae - *Graminidites* sp. div.	♣	♣
Potamogetonaceae – *Potamogetonacidites* sp. div.	♣	♣
Sparganiaceae - *Sparganiaceaepoll. sparganioides* (Meyer) Krutzsch, *Sparganiaceaepollis* sp. div.	♣	♣
Hydrophytes - Angiospermae	○	♣
[2] *Arecipites convexus* (Thiergart) Krutzsch, *A. pseudoconvexus* Krutzsch, and other spp.		

■ abundant ♣ rare ● regularly present, present ○ absent, not recorded

monocotyledonous angiosperms, illustrate the earliest fossil records in the filling of both parts of the basin.

Palmae representatives point to a higher, subtropical temperature, dropping below zero for only a few days per year, if we consider the presence of *Trachycarpus – Chamaerops*; the occurrence of palms match well with the thermophilous ferns such as *Histiopteris* (*Verucatosporites clathriformis,* Hr 42, 237.3 m) and records of the Sapotaceae. At Hrádek n. N they are associated with Asian elements such as *Sciadopitys* and aff. *Craigia,* among the Tiliaceae (Malvaceae) at the same level.

Beside the monocots, the pollen of *Alnus*, the five-pore pollen, predominates in several horizons. Their wide spread occurrence in various quantities was recorded as a typical element for both parts of the basin. It could be derived from the alder cover of the flood plain or growths along the river banks. The assemblages of reeds and sedges occurred as a mosaic pattern in favourable places in the wide area of the early basin. Distinctive are the assemblages of coal taphocenosis; while clays display more aquatic micro- and macroplants (*Pediastrum, Botryococcus* – Hr 42, depth 237.3 m, *Azolla)*; both are controlled by the edaphic and water level conditions.

Additionally, *Platanus* records are noteworthy. In the Hrádek n. N. part of the basin it occured; its pollen in the clays directly above the basaltoid volcanic body (reached by the borehole Hr 42 at the depth of 241.5 m); *Platanus* was also recorded in the Rybarzowice section. The occurrence points to the redeposition of volcanic material in both areas of the studied sites.

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Explanation to the plates

PLATE 1

***Arecipites convexus* (Thiergart) Krutzsch**

1–3. Hrádek n. Nisou, borehole Hr 42, Late Oligocene/ Lower Miocene.
1a-c. - general appearance, three optical sections, LM × 1 000.
2 – general appearance, LM × 1 000.
3a, b. – general appearance, two optical sections, LM × 1 000.

4–7. Rybarzowice, borehole Ry 1/**77** (249.0-249.5m); Late Oligocene/Lower Miocene.
4a, b. – general appearance, two optical sections, LM × 1 000.
5a, b. – general appearance, two optical sections, LM × 1 000.
6a. – general appearance, proximal polar view; SEM × 3 000 (scale bar 10 μm),
6b. – part of sculpture, visible columellae and free bacula inside the lumina, SEM × 10 000 (scale bar 2 μm).
7. – general appearance, proximal polar view, SEM × 3 000 (scale bar 10 μm).

PLATE 2

1–4. ***Arecipites pseudoconvexus* Krutzsch,** Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene.
1a, b. – general appearance, two optical sections, LM × 1 000.
2a. – general appearance, SEM × 3 000 (scale bar 10 μm).
2**b. –** part of reticulum, visible columellae, SEM × 10 000 (scale bar 2 μm).
3a, b. – general appearance, two optical sections, LM × 1000.
4a. – general appearance, SEM × 3 000.
4b. – part of sculpture, visible columellae and free bacula inside the lumina, SEM × 10.000 (scale bar 2 μm).

5, 6. cf. ***Arecipites*** sp.1, Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene.
5a–c. – general appearance, three optical sections, LM × 1 000.
6a. – general appearance, SEM × 3 000.
6b. – part of exine, pattern of reticulate tectum, free bacula inside the lumina visible, SEM × 10 000 (scale bar 2 μm).

PLATE 3

1. ***Dicolpopollis*** sp., Hrádek n. Nisou, borehole Hr 42, Late Oligocene/Lower Miocene.
1a. – general appearance, SEM × 3 000 (scale bar 10 μm).
1**b. –** part of sculpture, SEM × 10 000 (scale bar 2 μm).

2, 3. ***Dicolpopollis kockelii* Pflanzl,** Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene, general appearance, LM × 1 000.

4. ***Dicolpopollis*** (cf.) ***kockelii* Pflanzl** - Rybarzowice, borehole Ry 1/77, Late Oligocene/ Lower Miocene, **a**

– general appearance, SEM × 3 000 (scale bar 10 μm), **b** - part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).

5. ***Arecipites*** sp. 2, Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene.
5a. – general appearance; SEM × 5 000 (scale bar 5 μm).
5**b. –** part of sculpture, pattern of reticulate tectum; SEM × 10 000 (scale bar 2 μm).

PLATE 4

1. ? ***Liliacidites*** sp. 1, Hrádek n. Nisou, borehole Hr 42, Late Oligocene/Lower Miocene.
1a. – general appearance, SEM × 4 000 (scale bar 5 μm).
1b. – part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).

2. ? ***Liliacidites*** sp. 1, Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene.
2a. – general appearance, SEM × 4 000 (scale bar 5 μm).
2b. – part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).

3. ? ***Liliacidites*** sp. 2, Rybarzowice, borehole Ry 1/77, Late Oligocene/Lower Miocene.
3a. – general appearance, SEM × 3 000 (scale bar 10 μm).
3b. – part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).

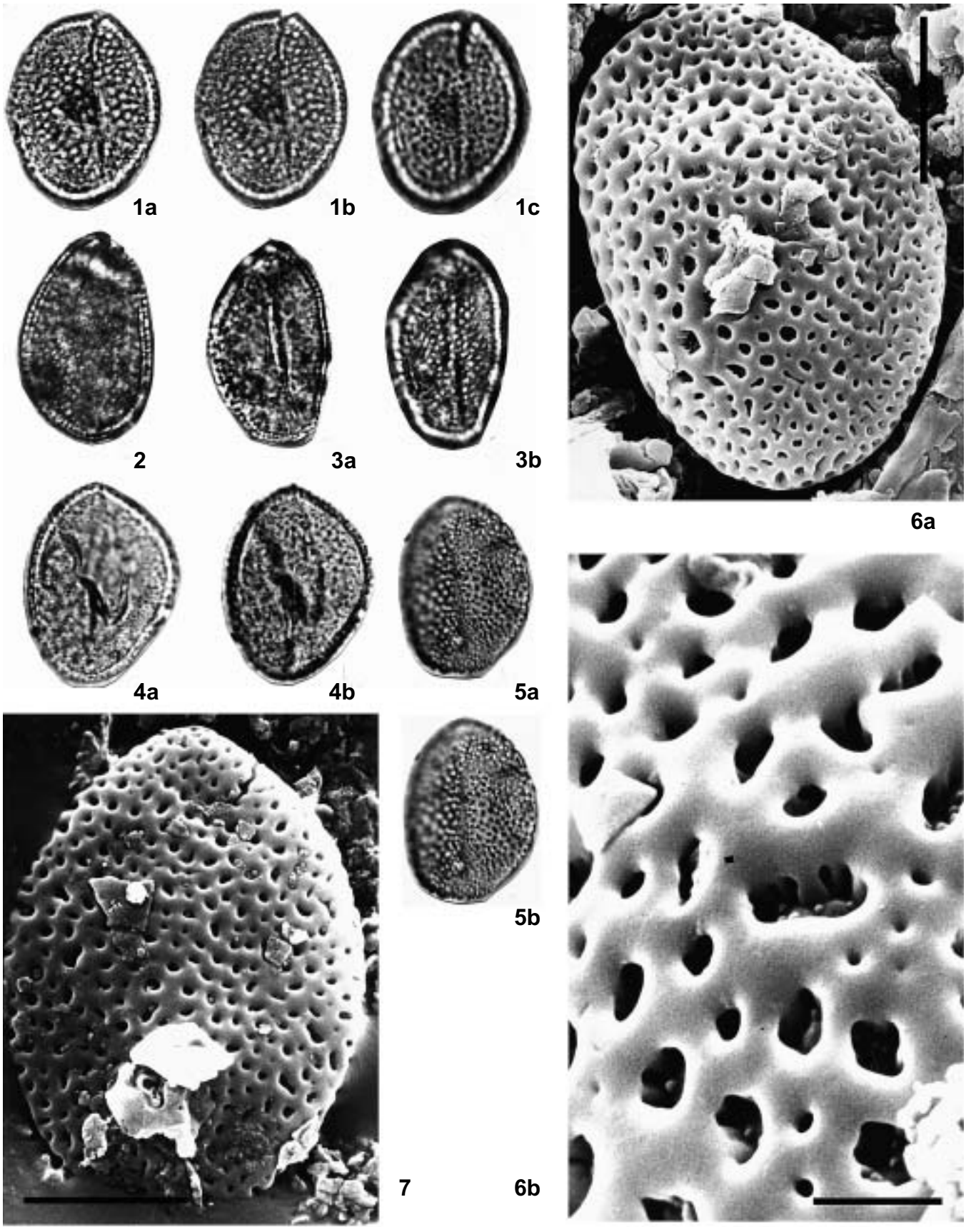
PLATE 5

1–3. ***Sparganiaceaepollenites sparganioides*** **(MEYER) KRUTZSCH,** Rybarzowice, borehole Ry 1/ 77, Upper Oligocene/Lower Miocene.
1a. – distal side**,** general appearance, SEM × 3 000 (scale bar 10 μm).
1b. – part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).
2a–c. – general appearance, LM × 1 000.
3a. – proximal side, general appearance, SEM × 3 000 (scale bar 10 μm),
3b – part of sculpture, pattern of reticulate tectum, SEM × 10 000 (scale bar 2 μm).

4. aff. ***Sparganiaceaepollenites*** sp., Hrádek n. Nisou, borehole Hr 42, Late Oligocene/Lower Miocene.
4a. – broken grain, part of exine reticulate pattern with thick muri, SEM × 3 300 (scale bar 10 μm).
4b. – exine cross-section with columellae of tectum, at higher magnification, SEM (scale bar 2.5 μm).

5. ***Sparganiaceaepollenites*** sp., Hrádek n. Nisou, borehole Hr 42, Late Oligocene/Lower Miocene. Whole grain, general appearance, reticulate tectum with irregular lumina and interrupted muri, SEM × 6 500 (scale bar 10 μm).

PLATE 1



1a

1b

3a

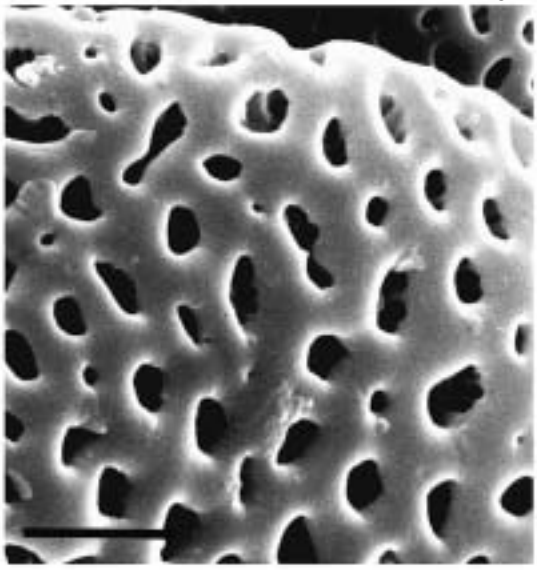
3b

5a

5b

5c

2a



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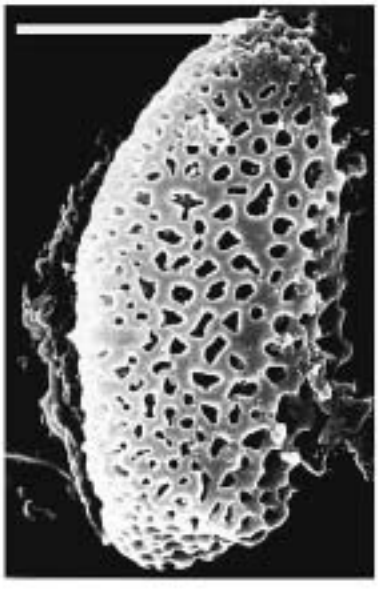

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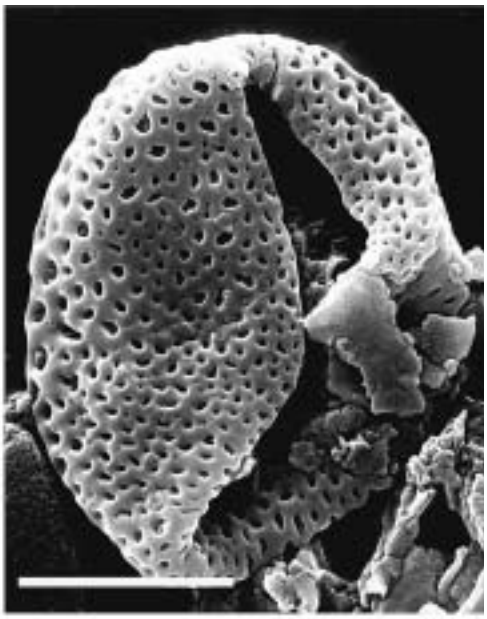

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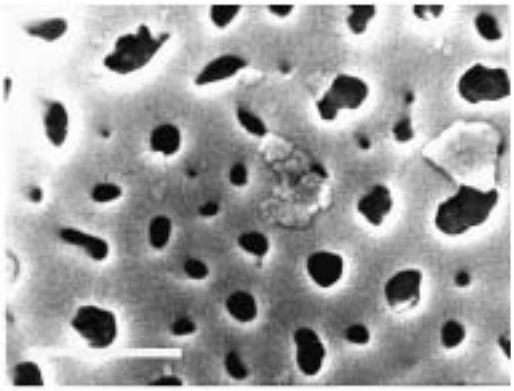

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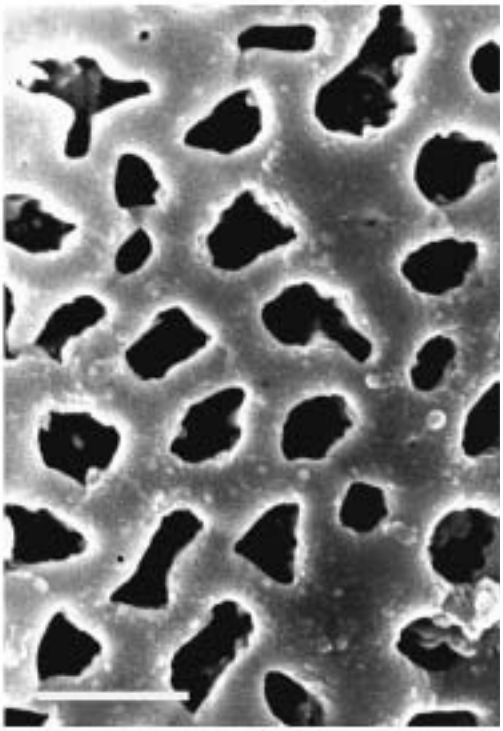
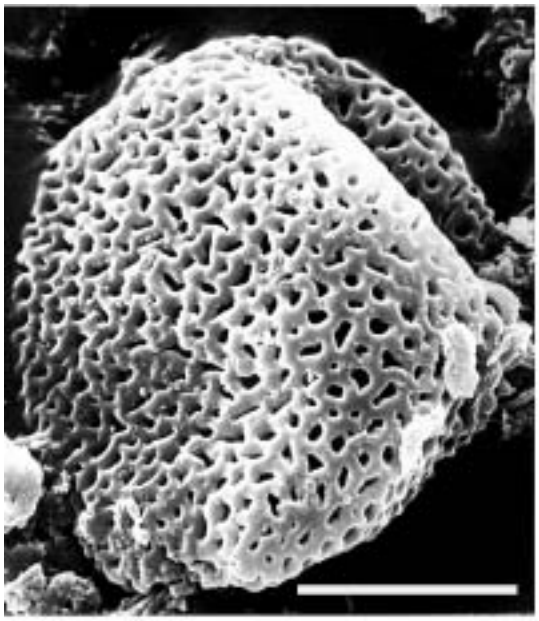


6b

PLATE 3



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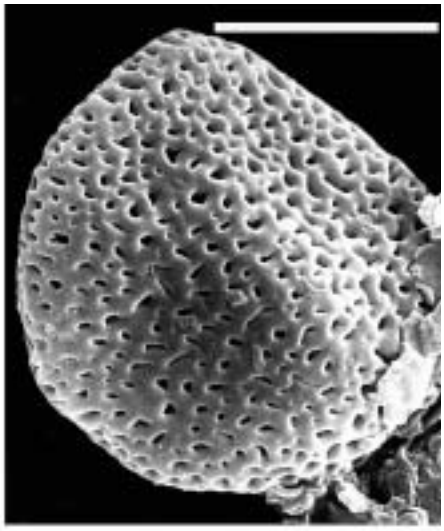
2

3



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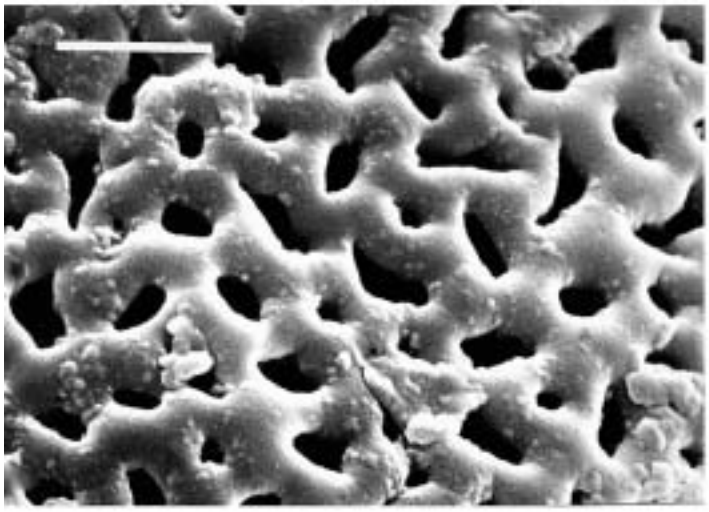

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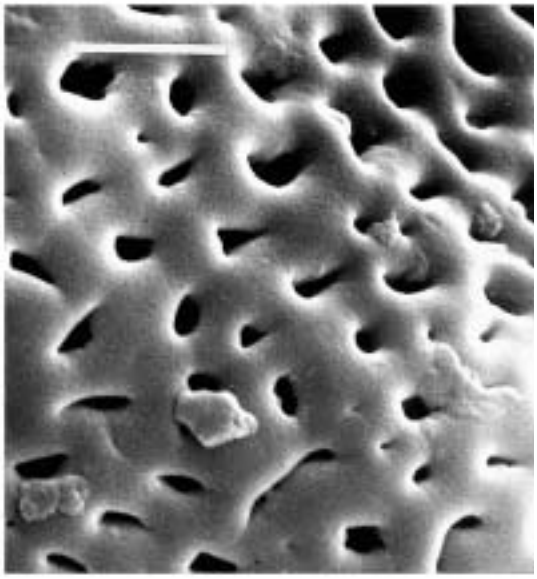

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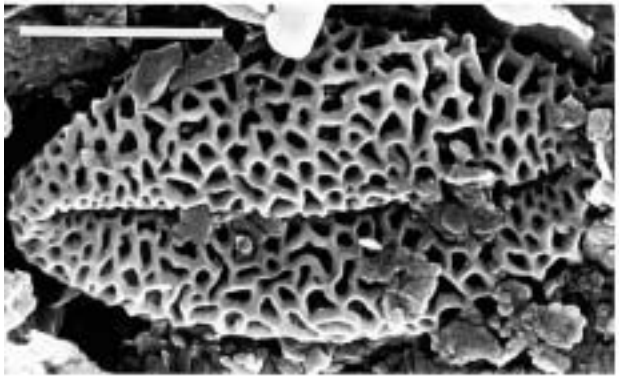

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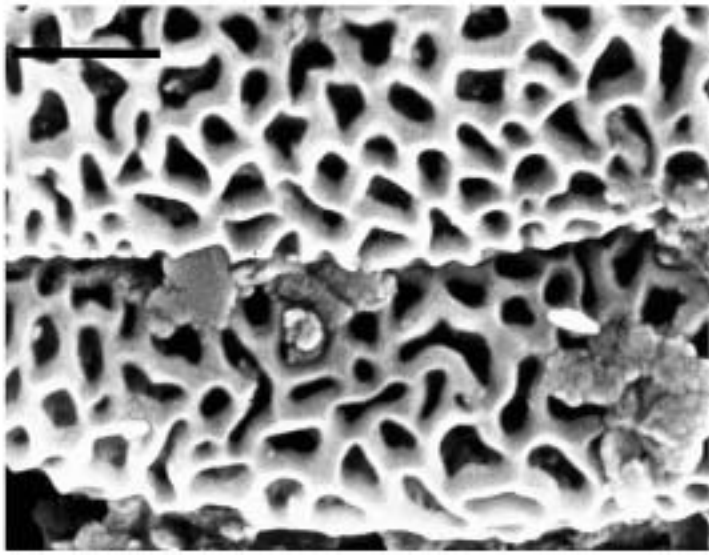

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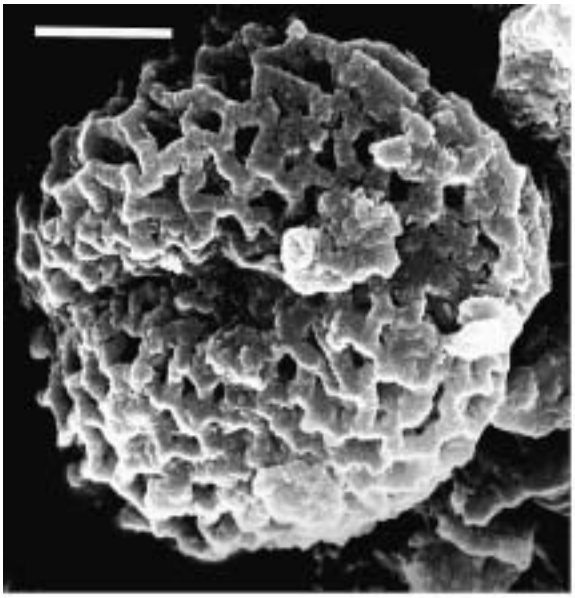

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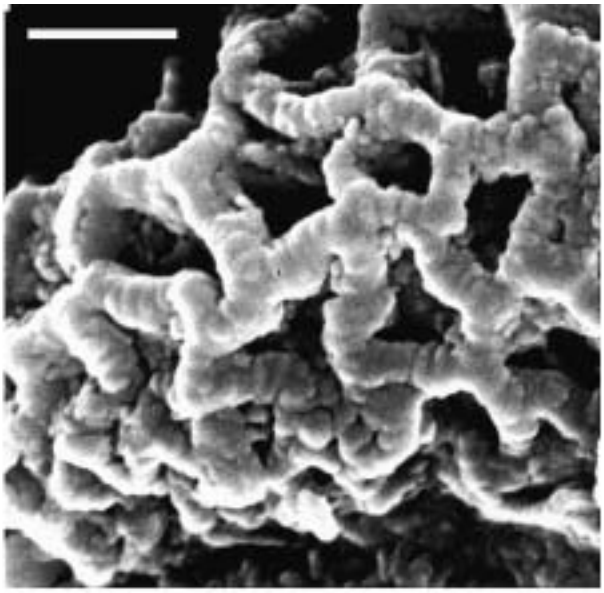

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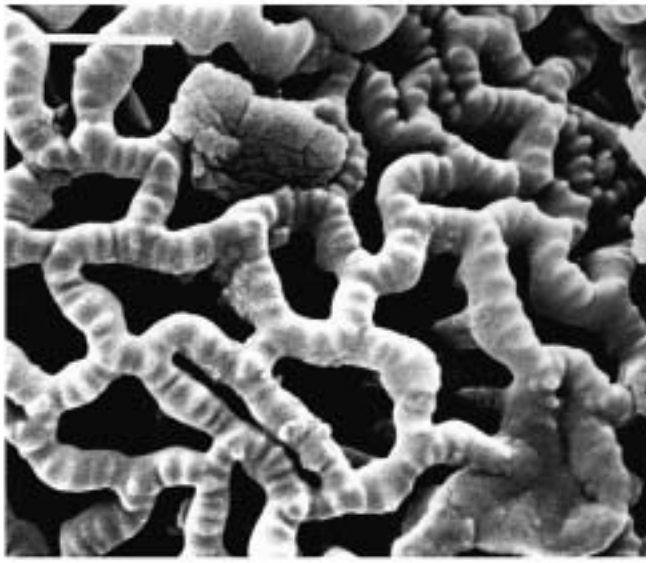

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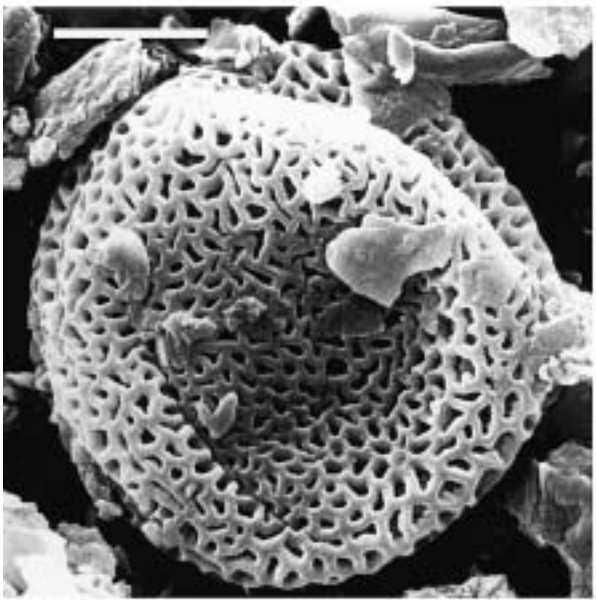

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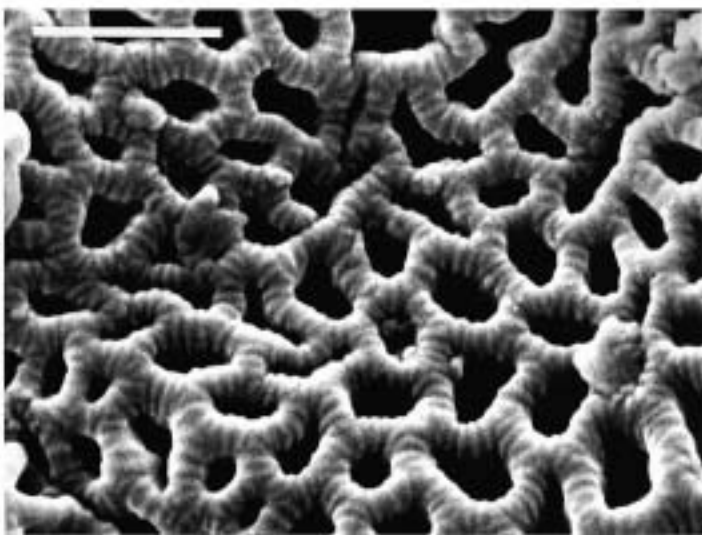
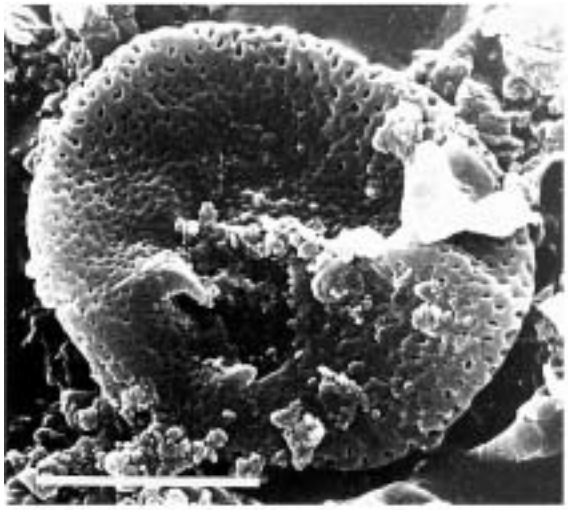


3b

PLATE 5

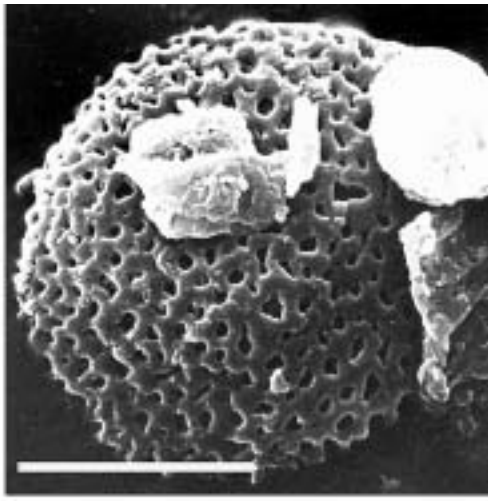


1a

2a

2b

2c



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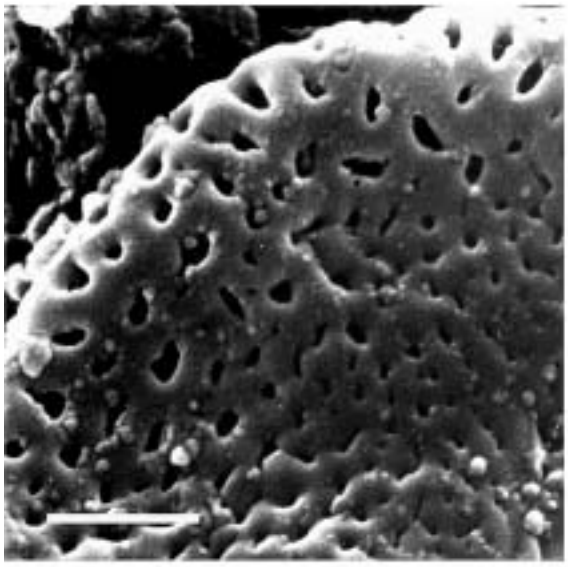

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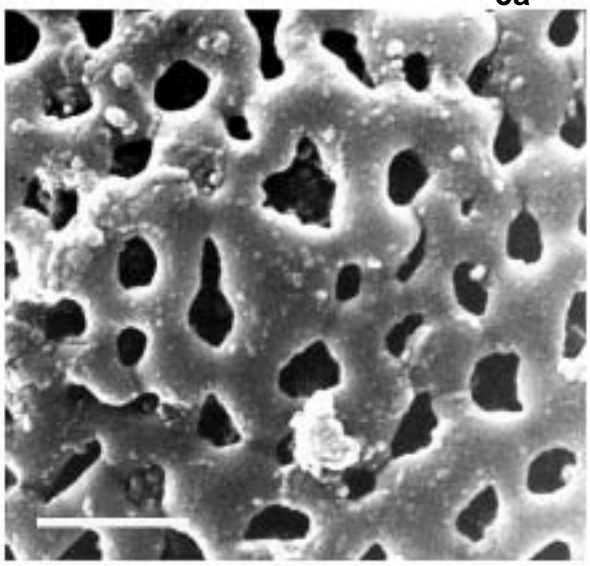

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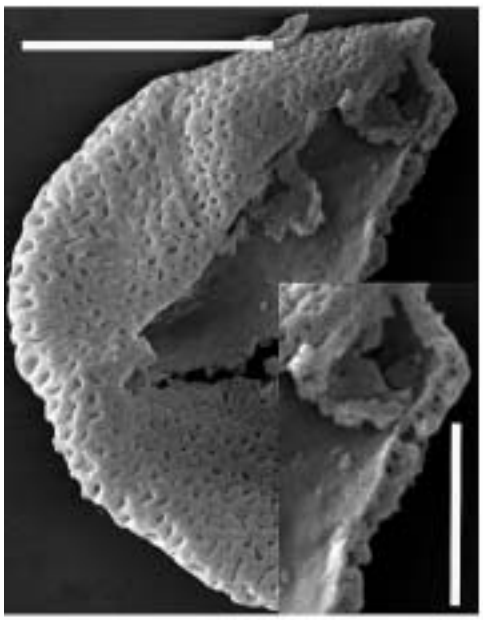

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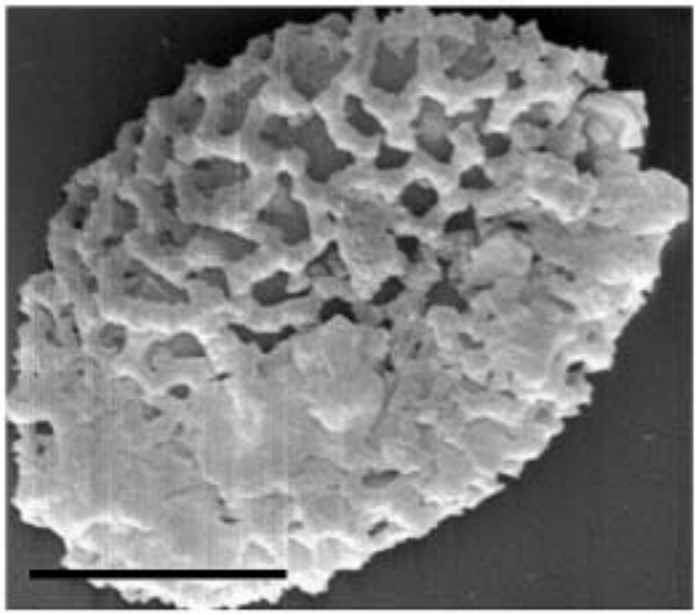
4b



5