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POLLEN ANALYSIS OF THE NEOGENE DEPOSITS FROM THE WYRZYSK REGION, NORTH-WESTERN POLAND

Analiza pyłkowa osadów neogeńskich z okolic Wyrzyska, północno-zachodnia Polska

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ABSTRACT. The palynological profiles from the geological boreholes at three localities in the Wyrzysk region in north-western Poland: Liszkowo. Kosztowo and Karolowo-Dąbki, have been investigated. They include deposits of the Lower (Rawicz Beds and Ścinawa Beds), Middle (Adamów Beds and Middle-Polish Beds) and Upper Miocene (Poznań Beds). A total of 258 taxa of sporomophs from 69 genera have been identified (Table I). The systematic part of this work gives morphological descriptions of the stratigraphically more important genera. Many of them are multispecies genera, e.g. *Sciadopityspollenites*, *Zonalapollenites* (*Tsuga* type), *Sequoiapollenites*, *Aceripollenites*, *Liquidambarpollenites*, *Liriodendroipollis* and *Arecipites* (*Palmae* type). New morphological forms have been distinguished: *Piceapollis tobolicus* f. *minor* and *major*, *Liriodendropoipollis verrucatus* f. *major*, *Carpinipites carpinoides* f. *minor* and f. *major* and *Tricolporopolleniotes marcodurensis* f. *major*. The proportions of particular taxa are presented in four pollen diagrams. The main types of plant communities have been distinguished and characterized. They are mixed deciduous-coniferous forest and marsh vegetation (swamp forest, shrubby peat-swamp, sedge-swamp and aquatics). The vegetational history of the study area covering the Miocene shows six floristic phases with a dominance of the arctotertiary element and the gradual decline of the palaeotropical element.

A correlation of the floristic phases of the Miocene from the Wyrzysk region with the coeval floras of the Polish Lowland confirms the existence of similar floristic changes throughout Poland: the type of forest, as a rule, does not change, differences take place only in the occurrence of species characteristic of particular sections of the Neogene. The dominance of the arctotertiary element indicates the existence, all through the Miocene, of a warm temperate climate with a tendency towards gradual cooling. Two warmer swings of the climate are perceptible in Phase II (Lower Miocene) and Phase VI (end of the Middle Miocene).

KEY WORDS: Tertiary, brown coal, clays, sands, palynological analysis.

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INTRODUCTION

Palynological studies of the Neogene deposits from the Wyrzysk region (Bydgoszcz and Piła Provinces) in north-western Poland were carried out at Krostkowo (Jakubowska 1956, 1957; Rejman 1955). More numerous were the studies of macroflora (Łańcucka-Środoniowa et al. 1983), of which the most complete were those dealing with the fruit-seed flora from Krostkowo (Raniecka-Bobrowska 1961) and the leaf flora from Koronowo (Menzel 1910).

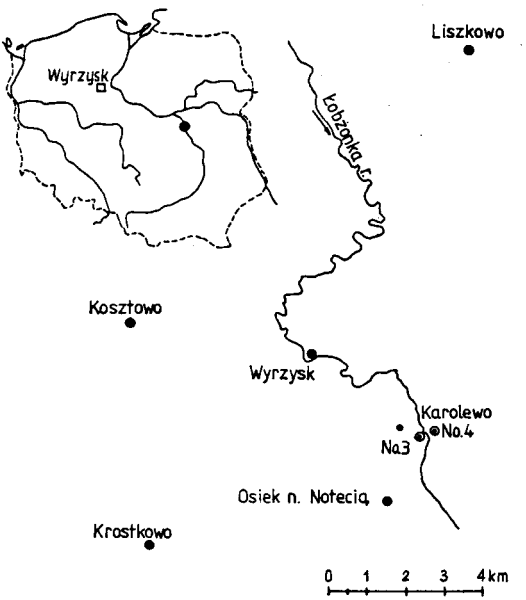

Fig. 1. A sketch of the distribution of the boreholes: Kosztowo, Liszkowo, Karolewo-Dąbki No. 3 and No. 4

Polynological investigations included three localities in the Wyrzysk region: Liszkowo, Kosztowo and Karolewo-Dąbki (Fig. 1), 7.5 to 10.5 km apart. The profiles of the boreholes at these three localities embrace the deposits of the whole Miocene, according to Ciuk's (1970) lithostratigraphical division: Rawicz, Ścinawa, Adamów, Middle-Polish Beds and a series of Poznań clays.

Piwocki (1986) numbers the Rawicz and Ścinawa Beds in the Lower Miocene; the Adamów, Middle-Polish and lower Poznań Beds in the Middle Miocene and middle and upper Poznań Beds in the Upper Miocene.

The objective of this work was a spore-pollen analysis of the above mentioned deposits, an investigation of the changes in the vegetation and climate of the study area and a comparison of the pollen flora of the Wyrzysk region with those of north-western, western, south-western and central Poland.

ABRIDGED DESCRIPTION OF GEOLOGICAL PROFILES

Karolewo-Dąbki

Two boreholes, No. 3 and 4, were located about 3 km south-east of the town of Wyrzysk, 0.5 km apart. The depth of the boreholes was 60 m.

Lithostratigraphical description*) of borehole No. 3 (Fig. 2)

0.00 – 3.60 m	Quaternary deposits
3.60 – 30.90 m	green-grey (Poznań Beds) clays
30.90 – 53.50 m	dusty clays, silts with brown-coal interbeddings (Middle-Polish Beds)
53.50 – 60.00 m	sands, coaly silts (Adamów Beds) clays

Lithostratigraphical description*) of the profile from borehole No. 4 (Fig. 2)

0.00 – 10.30 m	Quaternary deposits
10.30 – 32.45 m	green-grey (Poznań Beds)
32.45 – 50.00 m	dusty clays, coaly with brown-coal interbeddings (Middle-Polish Beds)
50.00 – 60.00 m	fine-grained sands (Adamów Beds)

Liszkowo

Borehole 55/01 was situated at Liszkowo, about 10 km north of the town of Wyrzysk, about 103 m a.s.l.; depth of borehole – 131 m.

Lithostratigraphical description*) (Fig. 2)

0.00 – 60.20 m	Quaternary deposits
60.20 – 63.00 m	light-grey clays (Poznań Beds)
63.00 – 83.00 m	grey clays and coaly clays, with small brown-coal insertions (Middle-Polish Beds)
83.00 – 93.80 m	coaly fine-grained sands (Adamów Beds)

* The lithostratigraphical descriptions of the profiles of boreholes have been made on the basis of the borehole charts prepared by Dr. Marcin Piwocki in 1970 (Archives of the Institute of Geology, Warsaw).

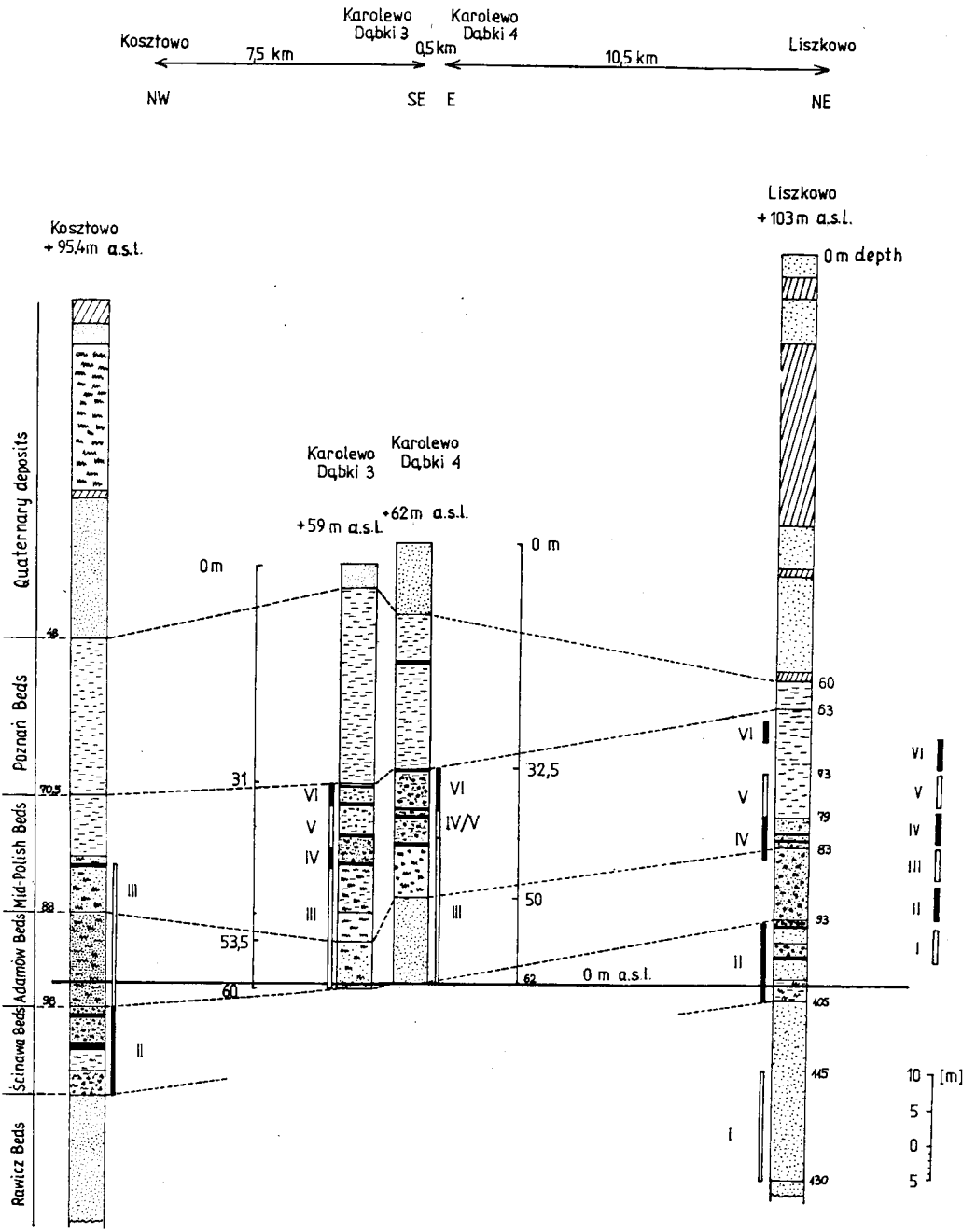

Fig. 2. Correlation of the geological profiles of the Neogenic deposits from the Wyrzysk region and the vegetational phases distinguished (expl. see Fig. 8) elaborated by M. Piwocki (1970)

93.80 – 105.00 m	sands and dusty sands, with brown-coal interbedding (Ścinawa Beds)
105.00 – 131.00 m	fine-grained sands (Rawicz Beds)

Kosztowo

Borehole 47/94a was situated at Kosztowo, about 5 km west of the town of Wyrzysk, about 95.50 m a.s.l.; borehole depth: 137 m.

Lithostratigraphical description*) (Fig. 2)

0.00 – 48.00 m	Quaternary deposits
48.0 – 70.50 m	green-grey clays (Poznań Beds)
70.50 – 88.00 m	light- grey clays with a lamina of brown-coal and silts (Middle-Polish Beds)
88.00 – 98.00 m	dusty sands (Adamów Beds)
98.00 – 109.00 m	coaly sands with two insertions of brown-coal silts (Ścinawa Beds)
109.00 – 137.00 m	fine-grained sands (Rawicz Beds)

METHOLOGICAL REMARKS

Four profiles made up of 330 samples taken from the cores at various intervals according to the sort of deposits: every 0.5–1 m from sands and gravels and at shorter intervals from 10–20 cm to 50 cm from clays, silts and brown-coal were used for palynological studies.

The samples, about 1 cm^3 in volume, were subjected several times to flotation in a heavy fluid (solution of cadium iodide, potassium iodide of a specific gravity of 2.3), next the organic matter obtained was macerated in 30% hydrogen peroxide solution, in KOH and subjected to acetolysis by Erdtman's (1943, 1960) method.

One to three microscopic preparations were made from each sample according to the amount of the pollen material. It was assumed that 100 grains of pollen and spores in 3 slides constituted the lowest frequency permitting the preparation of a pollen spectrum; below that value, the presence of sporomorphs was marked with "+" in the diagram.

Collections of contemporary pollen preparation housed in the Władysław Szafer Institute of Botany, Polish Academy of Sciences, in Cracow and the Museum of the Earth, Polish Academy of Sciences, in Warsaw were used in the determination of grains of pollen and spores. Morphological taxa were identified on the basis of works by Krutzsch (1962, 1963a, 1963b, 1967, 1970, 1971), Thomson et Pflug (1953), Nagy (1969, 1985) and others.

A total of 258 taxa have been distinguished in the study material (Tab. 1).

Tables with absolute numbers of pollen grains in particular profiles are stored in the Archives of the Museum of the Earth, Polish Academy of Sciences, Aleja Na Skarpie 27, Warsaw.

The percentage shares of particular taxa have been calculated from the total sum of pollen grains of trees, shrubs and herbaceous plants; the proportion of Pteridophyta was computed separately in relation to the total sum. The sporomorph curves are arranged in the diagrams according to plant communities from dry to wet. Herbs and sporophytes are presented separately in the diagrams.

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* The lithostratigraphical descriptions of the profiles of boreholes have been made on the basis of the borehole charts prepared by Dr. Marcin Piwocki, Państwowy Instytut Geologiczny (State Institute of Geology), Warszawa in 1970 (Archives of the Institute of Geology).

SYSTEMATIC DESCRIPTION OF SPOROMORPHS

Bryophyta
Musci
Sphagnaceae
Sphagnum L.

Spores included in the genus *Sphagnum* show great morphological diversity. Three groups have been distinguished: *Stereisporites* (*Stereisporites*), *Stereisporites* (*Distverrusporis*) and *Stereisporites* (*Distancoraesporis*) of which the group of *Stereisporites* (*Stereisporites*) spores is the most abundant.

Stereisporites Pflug 1953
Stereisporites (*Stereisporites*) *maximus* Krutzsch 1963
Pl. 1 fig. 3

1963b. *Stereisporites* (*Stereisporites*) *maximus* n. fsp.; Krutzsch, p. 52 Pl. 8, figs 8–11.

Remarks. The spores occur only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Stereisporites (*Stereisporites*) cf. *macroides* Krutzsch 1963
Pl. 1 fig. 5

1963b. *Stereisporites* (*Stereisporites*) *macroides* n. fsp.; Krutzsch p. 52 Pl. 8, figs 5–7.

Remarks. The spores differs from that described by Krutzsch (1963) in its more rounded shape. These spores were found very rarely in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Stereisporites (*Stereisporites*) *involutus minutoides* Krutzsch et Sontag 1963
Pl. 1 fig. 7

1963b. *Stereisporites* (*Stereisporites*) *involutus minutoides* n. subfsp.; Krutzsch, p. 46 Pl. 5, figs 4–7.

Remarks. The spores occur rarely in the Mid-Polish Beds (Middle Miocene) of the Kosztowo profile and in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Stereisporites (*Stereisporites*) sp. 1
Pl. 1 figs 6a, b

Remarks. In its structure the spores most resembles *Stereisporites* (*St.*) *stictus* (Wolff, 1934) Krutzsch 1959 subfsp. *stictus* Krutzsch 1963; from which it differs in larger size and thicker exine. They occur sporadically in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Stereisporites (*Stereisporites*) sp. 2
Pl. 1 fig. 8

Remarks. In the group *Stereisporites* (*Stereisporites*) described by Krutzsch (1963) there is not a form with so thick exine, psilate proximal and distal faces, and short arms of the tetrad mark. The spores were found very rarely in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles.

Stereisporites (*Stereisporites*) *intrastructuris* Krutzsch 1963

Pl. 1 fig. 1

1963b. *Stereisporites* (*Stereisporites*) *intrastructuris* n. sp.; Krutzsch, p. 94 Fig. 18, Pl. 28, figs 1–14.

Spore triangular, rounded in outline, somewhat pointed at corners and 39 µm in diameter. Arms of tetrad mark bifurcate at end, reaching nearly as far as equator. Exine 2.6 µm thick, with lightly undulate surface in places. Sculpture of distal face foveolate.
Remarks. The spores occur very rarely in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Stereisporites (*Distverrusporis*) *antiquus* Krutzsch et Sontag 1963

Pl. 1 figs 2a, b

1963b. *Stereisporites* (*Distverrusporis*) *antiquus* n. fsp.; Krutzsch p. 74, Pl. 18, figs 1–8.

Spores triangular, rounded in outline, about 34 µm in diameter. Tetrad mark short, one third of the radius. Exine 1.7 µm thick, thickened to 2 µm in corners. There is a flat verruca, about 6 µm in diameter, in the central part of the distal side.
Remarks. The spores were found sporadically in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Stereisporites (*Distancoraesporis*) *wehningensis* Krutzsch 1963

Pl. 1 figs 4a, b

1963b. *Stereisporis* (*Distancoraesporis*) *wehningensis* n. fsp.; Krutzsch, p. 58, Pl. 11, figs 1–11.

Spores triangular, rounded in outline, about 30 µm in diameter. Arms of tetrad mark somewhat raised, short, half the length of radius. Large threearmed thickening, about 16 µm in diameter, on distal side. Exine about 2 µm thick, with lightly undulate surface.
Remarks. The spores differs from that described by Krutzsch (1963) only in its lightly undulate exine surface. They occur sporadically in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Hepaticae

Anthocerotaceae

Rudolphisporis Krutzsch 1963

cf. *Rudolphisporis rudolphi* (Krutzsch 1959) Krutzsch et Pacltova 1963

Pl. 1 figs 9a, b

1935. *Anthoseros* cf. *punctatus*; Rudolph, p. 328, Pl. 5, fig. 28.
1959b. *Microreticulatisporites rudolphi* n. fsp.; Krutzsch, p. 159.
1963a. *Rudolphisporis rudolphi* (Krutzsch 1959) n. comb. (Krutzsch et Pacltova) Krutzsch; Krutzsch, p. 56, Pl. 9, figs 1–7.

Spore circular in outline, 60 µm in diameter; exine about 1.6 µm thick, on distal side covered with spines, 3 µm high and 2 µm wide at base, bluntly ended and lightly curved at end; numerous foveae about 3 µm in diameter and surrounded by thick annuli, seen among spines in exine. Proximal side devoid of spines, with arms of tetrad mark distinctly bent, extending to equator; in surface many foveae, 4–5 µm in diameter.
Remarks. The structure of the distal and proximal sides of this spore is characteristic of the fossil genus *Rudolphisporis* (Krutzsch 1963, p. 3, Fig. 1); as regards the fossil

species, the spore comes nearest in size and structure to *Rudolphisporis rudolphi*, from which it, however, differs in far shorter spines on the distal side. Only one spore was found in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Lycopodinae
Lycopodiaceae
Lycopodium L.

Two morphological groups of spores belonging to the genus *Lycopodium* have been distinguished in the material examined: *Retitriletes* and *Camarozonosporites* (Krutzsch 1963). *Lycopodium complanatum-clavatum* type is dominant in the first group, while *Lycopodium inundatum* and *L. cernuum* type prevail in the second.

Retitriletes van der Hammen ex Pierce 1961
Lycopodium complanatum L. – *Lycopodium clavatum* L. – type
Retitriletes cf. *reticuloides reticuloides* Krutzsch 1963
Pl. 2 figs 1a, b

1963a. Retitriletes reticuloides reticuloides n. fsp. et subfsp.; Krutzsch, p. 102, Pl. 32, figs 1–6.

Spores triangular, rounded in outline, 53 µm in diameter. Arms of tetrad mark distinct, reaching almost as far as equator. Exine about 1.7 µm thick. On proximal side reticulum well seen only in vicinity to equator, declining rapidly towards tetrad mark; on distal side reticulum about 4.5 µm high, with polygonal lumina, 6 to 8–9.5 µm in diameter; muri straight, with small thickenings at corners.

Remarks. Krutzsch (1963) compares *Retitriletes reticuloides reticuloides* to the recent species *Lycopodium clavatum* and *Lycopodium complanatum*. The spore now determined shows resemblance to both these species in the structure of its reticulum on the distal side, whereas it differs from them in the structure of the proximal side, where reticulum does not reach the centre of the tetrad mark as it does in the recent species. Compared with *Retitriletes reticuloides reticuloides*, the spore from Karolewo-Dąbki has a more regular reticulum on the distal side. The spores were found in one sample only in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Retitriletes cf. *pseudoclavatus* Krutzsch 1963
Pl. 2 figs 2a, b

1963a. *Retitriletes pseudoclavatus* n. fsp.; Krutzsch, p. 110, Pl. 36, figs 1–11.

Triangular spore of rounded outline, about 55 µm in diameter. Arms of tetrad mark reaching equator, somewhat undulate at centre. Exine about 1.5 µm thick; on proximal side reticulum irregular, with partly unclosed brochi, extending nearly to centre of tetrad mark. On distal side reticulum about 6 µm high, with polygonal lumina, 6–7 µm in diameter and slightly undulate muri, somewhat thickened at corners.

Remarks. In structure this spore comes nearest to the recent species *Lycopodium clavatum* from which as well as from *Retitriletes pseudoclavatus* described by Krutzsch it differs only in its larger size. The spores were found rarely in Mid-Polish Beds (Middle Miocene) of the Kosztowo profile.

Lycopodium obscurum L. – type
Retitriletes cf. *frankfurtensis* Krutzsch 1963
Pl. 2 figs 3a, b

1963a. *Retitriletes frankfurtensis* n. fsp.; Krutzsch, p. 74, Pl. 18, figs 1–14.

Triangular spores of rounded outline, 37 μm in diameter. Arms of tetrad mark distinct, reaching equator, wavy at centre. Exine about 1.3 μm thick; reticulum, on proximal side, with very thin muri and radially elongate lumina, spreading out to arms of tetrad mark; on distal side reticulum about 3.5 μm high, its lumina regularly polygonal, 6–8 μm in diameter, with straight muri; thickenings sometimes present at corners.
Remarks. On the proximal side *Lycopodium obscurum*, like some other recent species, has a reticulum of the type similar to that described above, that is, long lumina occupying nearly the whole of surface. Describing *Retitriletes frankfurtensis*, Krutzsch (1963) too compared it to *Lycopodium obscurum*, laying stress upon the similarities, above all, in the structure of the reticulum on the distal side. In Krutzsch's description the proximal side of *Retitriletes frankfurtensis* has a retipilate or micropunctate to microhamulate sculpture, which does not permit the drawing of a close analogy between these two fossil taxa; nevertheless, the above-described spore more resembles the recent species *Lycopodium obscurum* in structure than does the spore of *Retitriletes frankfurtensis* described by Krutzsch. The spores occur very rarely in Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Lycopodium L. – type 1
Retitriletes cf. *robustoides* Krutzsch 1963
Pl. 2 figs 4a, b

1963a. *Retitriletes robustoides* n. fsp.; Krutzsch, p. 64, Pl. 13, figs 1–6.

Spores triangular in outline, 44 μm in diameter. Arms of tetrad mark extending as far as equator. Exine about 1.6 μm thick. On proximal side reticulum present only along equator. On distal side reticulum, about 4 μm high, made up of polygonal lumina, 9–12 μm in diameter, muri thin with thickenings at corners.
Remarks. Krutzsch (1963) described the fossil species *Retitriletes robustoides*, which has no reticulum on the proximal side and compared it with the recent species *Lycopodium paniculatum*. The spore under description differs from *Retitriletes robustoides* in its larger and more delicate reticulum on the distal side. It most resembles the specimens illustrated by Krutzsch (1963a) in Pl. 13, figs 1–6. The spores occur sporadically Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Lycopodium L. – type 2
Retitriletes sp.
Pl. 2 fig. 5

Spore circular in outline, 37 μm in diameter. Proximal side with granulate surface and poorly seen arms of tetrad mark. On distal side reticulum up to 1 μm high, composed of polygonal lumina, about 6 μm in diameter, with thin straight muri.
Remarks. In structure this spore approaches that of the fossil species *Retitriletes rip-*

persrodaensis Krutzsch 1963 (Krutzsch 1963a, p. 78, Pl. 20, figs 7–1), from which it differs in its more granulate surface of the proximal side. One spore was found in Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Camarozonosporites Pant 1954 ex Potonié 1956
Lycopodium inundatum L. – type
Camarozonosporites(Inundatisporis) wilsnackensis Krutzsch 1963
Pl. 3 figs 1a, b

1963a. *Camarozonosporites (Inundatisporis) wilsnackensis* n. fsp.; Krutzsch, p. 132, Pl. 47, figs 3–7.

Spores of circular outline, 54–58 μm in diameter. Proximal side with tetrad mark widely ruptured, extending over two thirds of radius. Surface of inter-arm areas densely covered with round verrucae, 2–3 μm in diameter. Hamulate sculpture of distal side coarse and distinct.

Remarks. These spores are slightly bigger than the specimens of this species described by Krutzsch (1963a). The spores were found rarely in Adamów Beds (Middle Miocene) of the Kosztowo and Karolewo-Dąbki profiles.

Lycopodium cernuum L. – type
Camarozonosporites (Camarozonosporites) sp.
Pl. 2 fig. 6; Pl. 3 figs 4, 5

Spores triangular, rounded in outline, 40–43 μm in diameter. Arms of tetrad mark extending up to four fifth of radius. Exine two-layered, 3.6–4 μm, in triangle corners about 2 μm thick. Proximal side smooth, distal side with indistinct (Pl. 3, figs 3–4) or distinctly sharp microhamulate sculpture (Pl. 3, fig. 5).

Remarks. These spores resemble the recent species *Lycopodium cernuum* in structure. They are rarely encountered in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Lycopodium fokienense Ching – type
Camarozonosporites (Camarozonosporites) decorus (Wolff 1934) Krutzsch 1959
Pl. 3 figs 2–3

1934. *Sporites decorus* n. sp.; Wolff, p. 67, Pl. 5, fig. 12.
1959b. *Camerozonosporites decorus* (Wolff 1934) Krutzsch; Krutzsch, p. 187.
1963a. *Camarozonosporites (Camarozonosporites) decorus* (Wolff 1934) Krutzsch 1959; Krutzsch, p. 126, Pl. 44, figs 1–13.

Triangular spores, rouded in outline; diameter ranging from 50–53 to 63 μm, Arms of tetrad mark distinct, reaching equator. Exine two-layered, about 4 μm thick. Surface of proximal side subpsilate or with poorly seen hamulate sculpture. On distal side hamulate sculpture distinct and coarse.

Remarks. These spores differ from those of *Camarozonosporites (Camarozonosporites) decorus* distinguished by Krutzsch (1963a) only in their larger measurements. Spores of similar structure and size (53.1 × 65.5 μm) occur in the recent species *Lycopodium fokienense Ching* (Sporae pteridophytorum sinicorum, 1976, p. 40, Figs 7a, b,

Pl. 1, figs 34–37). The spores occur frequently in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki, Liszkowo and Kosztowo profiles.

Selaginellaceae
Selaginella Spring

Five morphological types of spores of *Selaginella* have been distinguished.

Echinatisporis Krutzsch 1959
Selaginella vaginata Spring – type
Echinatisporis sp. 1
Pl. 3 figs 6a, b

Microspore triangular-circular in outline, 34 µm in diameter. Arms of tetrad mark extending to equator. Exine about 1.5 µm thick. Both proximal face and distal densely covered with low conical verucae of irregular shape, about 2 µm high and 1.4–2 µm in diameter.

Remarks. The morphological type of this spore differs from the spores of *Echinatisporis* described by Krutzsch (1963). On the other hand, among the recent members of the genus *Selaginella, Selaginella vaginata* (Krutzsch 1963, Fig. 11F; Sporae pteridophytorum sinicorum, 1976, p. 45, Pl. 4, figs 23–27) is most similar to it. One microspore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Selaginella delicatula (Desv.) Alston – type
Echinatisporis sp. 2
Pl. 4 fig 7

Microspores of circular outline, about 33 µm in diameter. Arms of tetrad mark thick, about three quarters of radius in length. Exine about 1 µm thick. Proximal and distal faces covered with processes varying in shape and size: from simple bacula, 1.2–1.7 µm in diameter and 2–5 µm in height, to typical pila.

Remarks. In size and number of bacula on the surface these spores is similar to the recent species *Selaginella delicatula* (Sporae pteridophytorum sinicorum, p. 44, Fig. 8a, Pl. 4, figs 1–4). They occur only sporadically in one sample of the Karolewo-Dąbki profiles in the Mid-Polish Beds (Middle Miocene).

Selaginella Spring. – type 1
Echinatisporis sp. 3
Pl. 3 figs 7a, b

Microspore oval in outline, 37 µm in diameter. Arms of tetrad mark distinct, reaching equator. Exine 1.5 µm thick. Proximal side psilate, distal side densely covered with spines, 3.5 µm high, pointed at ends.

Remarks. This spore is similar to the recent species *Selaginella mairei* (cf. Sporae pteridophytorum sinicorum 1976, p. 46, Pl. 3, figs 1–3). One microspore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Selaginella Spring. – type 2
Echinatisporis sp. 4
Pl. 4 fig. 8

Microspores circular in outline, 28–34 μm in diameter. Arms of tetrad mark well seen, extending to equator. Exine 1.3 μm thick. Distal and proximal face covered with sparsely distributed bacula, 1–2 μm high and 1.7 μm diameter.
Remarks. Among the fossil species distinguished by Krutzsch (1963b, Fig. 11:L) there are no forms similar in structure to that described above, whereas the recent species taken into consideration by that author have morphologically similar spores, e.g. *Selaginella anceps/wallachii*-type. They were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Selaginella Spring. – type 3
Echinatisporis sp. 5
Pl. 4 fig. 6

Microspores arranged into tetrad, about 40 μm in diameter. Microspores oval in outline, measuring 20 × 27 μm. Exine about 1 μm thick. Proximal face smooth, distal covered sparsely with bottle-shaped spines, about 2.5 μm high and about 1.5 μm in diameter at base.
Remarks. The spore is similar to the recent species *Selaginella magnifica/alligans*-type, (cf. Krutzsch 1963b). One spore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Filicinae
Osmundaceae
Osmunda L.

Among the spores included in the genus *Osmunda* two groups differing in morphological structure have been distinguished: spores with a scabrate-verrucate sculpture and those with a baculate.

Baculatisporites Pflug et Thomson 1953

Spores with scabrate-verrucate sculpture:

Osmunda lancea Thunb. – type
Baculatisporites sp. 1
Pl. 4 fig. 2

Spore circular in outline, about 50 μm in diameter. Arms of tetrad mark narrow, distinct, reaching equator. Exine about 1.3 μm thick. Proximal and distal faces densely covered with flat verrucae of irreegular shape, 1.8–2 μm in diameter and about 0.6 μm in height.
Remarks. This spore from Karolewo-Dąbek with a sculpture similar to that of the fossil spacies *Baculatisporites primarius oligocenicus* (Krutzsch 1967, p. 60, Pl. 12, figs 1–6) and compared to the recent species *Osmunda bromelifolia* l.c. Fig. 2:H), how-

ever, more resembles *Osmunda lancea*. One spore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Osmunda regalis L. – type
Baculatisporites quintus, quintus Krutzsch 1967
Pl. 4 fig. 1

1967. *Baculatisporites quintus, quintus* n. subfsp.; Krutzsch, p. 48, Pl. 6, figs 1–7.

Spores subcircular in outline, about 75 μm in diameter. Arms of tetrad mark narrow, reaching equator. Exine 1.2–1.4 μm thick, densely covered with verrucae, 1.3–2.5 μm high and 1.6–2.3 μm in diameter, of irregular shape and fusing with each other.
Remarks. The sculpturing of these spores is similar to that of the recent species *Osmunda regalis* (Krutzsch, 1967, Fig. 2:A). They were found rarely in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Osmunda L – type
Baculatisporites sp. 2
Pl. 4 fig. 3

Spore subcircular in outline, 69 μm in diameter. Arms of tetrad mark distinct, narrow, extending to equator. Exine 1.3 μm thick, densely covered with verrucae, about 1.5 μm high and 1.5–1.8 μm in diameter, of irregular shape, mostly more or less conical and fusing with each other.
Remarks. In structure this spore resembles the fossil species *Baculatisporites quintus rugulatoides* Krutzsch 1967 (p. 52, Pl. 8, figs 8–11), from which it differs in its less distinct sculpture of the irregularly rugulate type. No similar spores have been found in the available comparative material of *Osmunda* species. One spore was found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Osmunda banksiaefolia (Pr.) Kuhn. – type
Baculatisporites primarius crassiprimarius Krutzsch 1967
Pl. 4 fig. 4

1967. *Baculatisporites primarius crassiprimarius* n. subfsp.; Krutzsch, p. 58, Pl. 11, figs 1–7.

Spores of circular outline, about 58 μm in diameter. Arms of tetrad mark distinct, reaching equator. Exine 1.6 μm thick, densely covered with verrucae, about 2.5 μm high and 1.4–2.8 μm in diameter, varying in shape and size, sometimes merging with each other.
Remarks. Krutzsch (1967, p. 58, Fig. 2:E) compares the species *Baculatisporites primarius crassiprimarius* to three recent species: *Osmunda interrupta*, *Osmunda javanica* and *Osmunda banksiaefolia*. The spores from Karolewo-Dąbek most resembles the spores of O. *banksiaefolia*. They were found sporadically in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Spores with bacula sculpture:

Osmunda cinnamomea L. – type
Baculatisporites primarius, primarius Krutzsch 1967
Pl. 4 fig. 5

1967. *Baculatisporites primarius, primarius* n. subfsp.; Krutzsch, p. 54, Pl. 9, figs 4–12.

Spores subcircular in outline, 45–53 μm in diameter. Arms of tetrad mark, poorly seen, extending to equator. Exine about 1.2–1.5 μm thick, rather densely covered with detached, bluntly ended bacula, 2.5–3.2 μm high and 1.5–3 μm thick.

Remarks. Krutzsch (1967) compares this fossil species to recent species *Osmunda vachelii* (Fig. 2:K). More similar seem to be the spores of *Osmunda cinnamomea*, with bluntly ended bacula varying in thickness and about 3 μm high, like those in the fossil spores. The spores were found frequently in the all profiles.

Gleicheniaceae – Cyatheaceae

The distinction between these two families and determination to generic level are difficult for lack of sufficient comparative materials. Nevertheless, it should be supposed that some spores with irregularly thick exine may have their counterparts in the family *Gleicheniaceae*, for instance, in the recent species *Hicriopteris laevissima* (Erdtman 1957, p. 63, Fig. 114), whereas the spores with more or less uniform exine all over the surface may belong to either of these families only that in the *Gleicheniaceae* spores are distinctly convex in the central part on the distal side, which is not observed in the spores of the *Cyatheaceae* (cf. Sporae pteridophytorum sinicorum, 1976, pp. 90 and 318, Pl. 15, figs 9–20; Pl. 66, figs 32–36; Pl. 68, figs 1–5, 11).

Gleicheniaceae
Neogenisporis Krutzsch 1962
Neogenisporis neogenicus Krutzsch 1962
Pl. 5 fig. 1

1962a. *Neogenisporis neogenicus* n. fsp.; Krutzsch, p. 267–268, Pl. 1, figs 1–12.

Remarks. The spores were regularly encountered in the all profiles, but in small quantities.

Neogenisporis crassicus Krutzsch 1962
Pl. 5 fig. 4

1962b. *Neogenisporis crassicus* n. fsp.; Krutzsch, p. 90, Pl. 38, figs 1–5.

Remarks. The spores occur rarely in the Adamów Beds (Middle Miocene) and in the Mid-Polish Beds (Middle Miocene) of the Kosztowo and Karolewo-Dąbki profiles.

Neogenisporis cf. *plicatoides* Krutzsch 1962
Pl. 5 fig. 2

1962b. *Neogenisporis plicatoides* n. fsp.; Krutzsch. p. 90, Pl. 38, figs 6–10.

Remarks. The spores differs from *Neogenisporis plicatoides* distinguished by Krutzsch (1962b) in its larger size, thicker exine and smaller concavity of the sides, but

it represents the same type of structure; they were found in only one sample in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Neogenisporis sp.
Pl. 5 fig. 3

Spore concave-triangular in outline with rounded corners, 48 µm in diameter. Arms of tetrad mark distinct, reaching equator. Exine smooth, two-layered, more or less uniformly thick all over spore surface, averaging 2.4 µm; surface distinctly convex on distal side.

Remarks. The spore is very similar to that of *Neogenisporis pseudoneddeni* (Krutzsch 1962b, p. 94, Pl. 40, figs 1–5), from which it differs in its stronger side concavity and smooth surface; one spore was found in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Cyatheaceae ?
Pl. 6 fig. 4

Remarks. The spores occur very rarely in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Cyatheaceae ? *Schizaeaceae* ?
Toroisporis Krutzsch 1959
cf *Toroisporis pliocenicus* Krutzsch 1962
Pl. 5 fig. 7

1962b. *Toroisporis* ? *pliocenicus* Thg. 1940 n. comb.; Krutzsch, p. 86, Pl. 36, figs 1–6.

Spore of triangular outline with rounded corners, about 75 µm in diameter. Arms of tetrad mark extend as far as equator. Exine two-layered, smooth, about 2.6 µm thick, reaching a thickness of 3.4–4 µm in corners.

Remarks. These spores are larger by about 10 µm than the spores of *Toroisporis pliocenicus* distinguished by Krutzsch. Spores of similar structure were observed in some recent species from the genera *Cyathea* and *Lygodium*. They occur very rarely in the Rawicz Beds (Lower Miocene) of the Liszkowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Schizaeaceae
Lygodium Sw. – type
Leiotriletes (Naumowa 1937) Potonié et Kremp 1954
Leiotriletes cf. *maxoides* Krutzsch 1962 ssp. *minoris* Krutzsch 1962
Pl. 5 fig. 5

1962b. *Leiotriletes maxoides* Krutzsch *minoris* n. subfsp.; Krutzsch, p. 16, Pl. 1, figs 1–6.

Remarks. The spores occur very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Leiotriletes wolffi wolffi Krutzsch 1962

Pl. 5 fig. 6

1962b. *Leiotriletes wolffi wolffi* n. fsp. et subfsp.; Krutzsch, p. 26, Pl. 6, figs 5–9.

Remarks. The spores occur rarely in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Schizaeaceae ?

Radialisporis Krutzsch 1967

Radialisporis radiatus (Krutzsch 1959) Krutzsch 1967

Pl. 6 fig. 7

1959a. *Cicatricosisporites radiatus* n. fsp.; Krutzsch, p. 126.

1967. *Radialisporis radiatus* (Krutzsch 1959) n. comb.; Krutzsch, p. 88, Pl. 26, figs 6–18.

Spore triangular, rounded in outline, 56–58 μm in diameter. Arms of tetrad mark distinct, narrow, reaching equator. Exine 4.6 μm thick, composed of thin inner layer, on which there are densely distributed ridges, about 4 μm high; at centre on distal side ridges short, 3–4 μm wide, of irregular shape, hamulate. Towards equator they are about 4 μm high, 4–18 μm long and radially arranged. On the proximal side the ridges are the same size as on the distal and run radially from the arms of the tetrad mark towards the equator.

Remarks. The spores were found rarely in the Adamów Beds (Middle Miocene) and Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Polypodiaceae

Spore of a fern from the family *Polypodiaceae* are for the most part devoid of perine.

Laevigatosporites Ibrahim 1933

Laevigatosporites nutidus (Mamczar 1960) subsp. *nutidus* Krutzsch 1967.

Pl. 6 fig. 2

1960c. *Polypodiaceae – Sporites haardti* Potonié et Venitz forma *nitida*; Mamczar, p. 23, Pl. 1, fig. 9.

1967. *Laevigatosporites nutidus* (Mamczar 1960) emend. et n. comb. subfsp. *nutidus*; Krutzsch, p. 149, Pl. 53, figs 6–7.

Remarks. The spores were very frequent in the all profiles, their maximum (60%) in the upper Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles.

Verrucatosporites Pflug et Thomson 1953

Polypodium vulgare L. – type

Verrucatosporites pseudoalienus Krutzsch 1967

Pl. 6 fig. 1

1967. *Verrucatosporites pseudoalienus* n. fsp.; Krutzsch, p. 198, Pl. 75, figs 8–13.

Spore bean-shaped in equatorial view, 75.6 μm × 53 μm in size. On proximal side single long laesura; exine about 1.2 μm thick, covered with big verrucae all over surface; verrucae about 3.5 μm high and 6–12 μm in diameter, of irregular shape, flatly rounded at top, subradially distributed.

Remarks. In its structure the spore comes nearest to *Polypodium vulgare* (cf. *Sporae Pteridophytorum Sinicorum*, 1976, Pl. 82, figs 1–3). *Verrucatosporites pseudoalienus* (Krutzsch 1967) differs from this recent species in the larger size of its verrucae, their shape and distribution being similar. Only one spore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Davalliaceae
Davallia Sm. – type
Verrucatosporites sp.
Pl. 6 fig. 3

Spore bean-shaped in equatorial view, 37 × 28 μm in size; single long laesura on proximal side. Exine about 1.5 μm thick, densely covered with flat verrucae, about 2 μm high in diameter, decreasing gradually to about 1 μm towards laesura.
Remarks. The spore shows much resemblance to the spores of the recent genus *Davallia* and to those of some members of the genus *Polypodium* (Sporae pteridophytorum sinicorum, 1976, Pl. 21–23, and Pl. 81). As regards fossil species, it comes nearest in structure to *Verrucatosporites tenelli* (Krutzsch 1967, p. 190, Pl. 71, figs 4–19). Only one spore was found in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sinopteridaceae
Cryptogramma R. Br. – type 1
Pl. 6 fig. 5

Spore triangular, rounded in outline, 46 μm in diameter. Arms of tetrad mark distinct, reaching three quarters of radius. Exine two-layered, about 2.3 μm thick; upper layer composed of round verrucae tightly clinging together. On distal side verrucae about 1.8 μm high and 5–6 μm in diameter, on proximal side smaller, about 1 μm high and 1.8–2 μm across.
Remarks. In structure this spore resembles *Cryptogramma brunnoniana* (Sporae pteridophytorum sinicorum, 1976, p. 162, Figs 50a-c). The character that the recent species and the only so far know similar fossil from *Favoisporis trifavus* (Krutzsch 1967) have in common is the difference in size of verrucae between the distal side and the proximal. Compared with the spore from Liszkowo, that of *Favoisporis trifavus* is trangular or concave-trangular in outline, it is smaller and has a more distinct sculpture, giving an impression of being of the quasi-reticulate type. The spore was found only one in the Rawicz Beds (Middle Miocene) of the Liszkowo profile.

Cryptogramma R. Br. – type 2
cf *Favoisporis trifavus* Krutzsch 1959
Pl. 6 fig. 6

1959a. *Favoisporis trifavus* n. fsp.; Krutzsch, pp. 127–128.

Triangular spore, rounded in outline, about 37 μm in diameter. Arms of tetrad mark distinct, reaching as far as three quarters of radius; exine two-layered, about 1.7 μm thick, upper layer composed of flat, densely distributed verrucae, 2.5 μm in diameter

and about 1.5 μm high, looking like a quasi-reticulum on the spore surface. This type of sculpture occurs both on distal side and on the proximal.

Remarks. In structure this spore resembles the recent genus *Cryptogramma* and the fossil species *Favoisporis trifavus*. Its size is smaller and quasi-reticulum more distinct than in the preceding form of *Cryptogramma* – type 1 (Pl. 6, fig. 5). The spore was found only one in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Dicksoniaceae? *Cyatheaceae* ?

Pl. 6 fig. 8

Spore triangular, rounded in outline, about 56 μm in diameter. Arms of tetrad mark distinct, extending for three quarters of radius. Exine about 4 μm thick reduced in corners to about 2 μm. On distal side numerous big pits, varying in shape, in exine.

Remarks. Botanically nondescript spore, resembling both the family *Dicksoniaceae* (genus *Cibotium* ?) and the family *Cyatheaceae* (genus *Amphidesmium* ?) (Erdtman 1957). One spore was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Gymnospermae
Coniferae
Pinaceae
Pinus L.

Pinus type *sylvestris* Roudolph 1935

Pityosporites Seward 1914
Pityosporites labdacus, *labdacus* Krutzsch 1971

Pl. 7 fig. 1

1931c. *Pollenites labdacus* n. sp.; Potonié, p. 3–5, Fig. 32.
1971. *Pityosporites labdacus* subsp. *labdacus*; Krutzsch p. 64–65, Pl. 7, figs 11–18.

Remarks. Pollen grains, very frequent in the profiles studied.

Pityosporites insignis (Naumowa et Bolchovitina, 1953) Krutzch 1971

Pl. 7 fig. 2

1953. *Pinus insignis* Naumowa; Bolchovitina p. 85, 175, Pl. 13, figs 1–3.
1971. *Pityosporites insignis* (Naumowa et Bolchovitina, 1953) n. comb.; Krutzsch, p. 60, Pl. 6, figs 1–4.

Remarks. Pollen grains were found rarely in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Pinus type *haploxylon* Roudolph 1935

Pityosporites microalatus (Potonie 1931) Thomson et Pflug 1953

Pl. 7 fig. 4

1931c. *Piceae-pollenites microalatus* n. sp.; Potonié, p. 5, Fig. 3.
1953. *Pityosporites microalatus* (Potonié) n. comb.; Thomson et Pflug, p. 67, Pl. 5, figs 47, 51, 57.

Remarks. Pollen grains occur regularly in all profiles.

Pityosporites alatus (Potonié 1931) Thomson et Pflug 1953

Pl. 7 fig. 3

1931c. *Piceae-pollenites alatus* n. sp.; Potonié, p. 5, Fig. 31.
1953. *Pityosporites alatus* (Potonié) n. comb.; Thomson et Pflug, p. 68, Pl. 5, fig. 63.

Remarks. Pollen grains were found frequently in all profiles, attaining their maximum (15%) in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Picea A. Dietr.

Piceapollis Krutzch 1971

Piceapollis tobolicus (Panova 1966) Krutzsch 1971

1966. *Picea tobolica* n. sp.; Panova, Tom I, p. 220, Tom III, Pl. XLIX, fig. 8.
1971. *Piceapollis tobolicus* (Panova 1966) n. comb.; Krutzsch, p. 104, Pl. 22, figs 1–6.

Distinct differences in size occurred among the pollen grains of this fossil species which allowed the distinction of two forms.

f. *minor*

Pl. 9 fig. 3

Pollen grains, 151 µm long and 82 µm high in polar view. Body ellipsoid, 113 × 82 µm, exine on body thin, up to 2.3 µm. Air-sacks semiglobular, 82 × 70 µm, with microreticulum; attachment line equal to air-sack diameter. In equatorial view the grain is 141 µm long and 88 µm high. The ellipsoid body and air-sacks form a continuous line. The thickening of exine to 3 µm is visible on the proximal side.
Remarks. Pollen grains occur rarely in all profiles.

f. *major*

Pl. 9 fig. 4

In equatorial view pollen grains 151–176 µm long and about 100 µm high. Body ellipsoid, measuring 130–161 × 63–100 µm, in continuous line with air-sacks. On the proximal side the exine forms a small crest, 2.5–3.5 µm thick. On the distal side the exine is thin, mostly cracked. The air-sacks are semiglobular, about 70 µm in diameter, with a distinct microreticulum on them. In the polar view the grain is about 150 µm long and 94 µm high. The ellipsoid body and air-sakcs form a continuous line. Exine thin, about 2 µm; semiglobular air-sacks, 94.5 µm in diameter, with microreticulum on surface.
Remarks. Krutzsch (1971) refers *Piceapollis tobolicus* to *Picea excelsa* (=*P. abies*), *P. ajanensis* and *P. jezoensis*. Pollen grains occur rarely in all profiles, attaining their maximum (4%) in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Piceapollis planoides Krutzsch 1971

Pl. 8 fig. 1

1971. *Piceapollis planoides* n. sp.; Krutzsch, pp. 110–111, Pl. 25.

In equatorial view pollen grain 119 µm long and 94 µm high; body and air-sacks in continuous line, microreticulum on air-sacks very fine. On proximal side exine with pronounced crest, about 4 µm thick. In polar view grain 128 µm long and 100 µm high. Body roundish, 88 × 78 µm in size. On proximal side exine about 3.5 µm thick. The

air-sacks are semiglobular, with a very fine microreticulum, form a continuous line with the grain body.

Remarks. Krutzsch (1971) compares this type of pollen grains to the grains of the recent species *Picea asperata* from China and *Picea schrenkiana* from Central Asia. Pollen grains occur only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Abies Mill.
Abiespollenites Thiergart 1937
Abies nordmanniana (Stev.) Spach – *Abies firma* S. et Z. – type
Abiespollenites latisaccatus (Trevisan 1967) Krutzsch 1971
Pl. 8 figs 7, 8

1967. *Pityosporites latisaccatus*, *latisaccatus* n. fsp. subf. sp.; Trevisan, p. 21, pl. XII, fig. 4, pl. XIII, fig. 1.
1971. *Abiespollenites latisaccatus* (Trevisan 1967) n. comb.; Krutzsch, p. 88, Pl. 16, figs 1–6.

In equatorial view pollen grain 121 μm long; body ellipsoid to ovally flattened, measuring 113–126 × 75 μm; exine with crest on proximal side, about 7.0 μm thick, narrowing to 6 μm in the middle and tapering towards the distal side to 1.5 μm. The air-sacks, in the shape of three quarters of a globe lie in a more or less continuous line with the body, reticulum on air-sacks medium-sized.

Remarks. According to some palinologists this morphological type resembles *Abies nordmanniana* from Caucasus (Shatilova 1974, Purtseladze 1977; and others). In Krutzsch (1971) opinion, *Abiespollenites latisaccatus* compares with the recent species *Abies firma* (Japan), whose body is however shorter and the narrowing of the crest on the proximal face not always present. A ellipsoild body with a distinct constriction on the proximal side occurs in the pollen grains of recent *Abies nordmanniana*. This fir species is therefore morphologically more similar to the fossil form presented in Pl. 8, fig. 8, and *Abies firma* to the fossil form illustrated in Pl. 8, fig. 7. And so *Abiespollenites latisaccatus* is similar in structure to both the above-mentioned recent species. Pollen grains were found very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Abies alba Mill. – type
Abiespollenites absolutus Thiergart 1937
Pl. 7 fig. 5

1937. *Abies-pollenites absolutus* n. sp. – *Abies*-Pollen.; Thiergart, p. 306, Pl. 24, fig. 9.

In equatorial view pollen grains 157–163 μm long. Body ovally-flattened, 75–94 × 107–120 μm in size. On proximal side exine with lightly undulate crest, 6.5–8.5 μm thick, thinning towards distal side to 1.5–2 μm. Air-sacks more or less globular, 69 × 75 μm in measurements, microreticulum present on sacks.

Remarks. In their morphological structure these pollen grains resemble the species *Abies alba*, which is characterized by an analogous, thick, lightly undulate crest on the body and the air-sacks of the same medium size. Krutzsch (1971) compares the fossil

species to *Abies bicolor*. Pollen grains were found rarely in the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles.

Abies Mill. – type
Abiespollenites sp.
Pl. 7 fig. 6

In equatorial view pollen grain 155 μm in length; body ellipsoid, 136 × 75 μm in size. On the proximal face the exine forms a crest, about 8.5 μm thick, which narrows to about 1.5 μm on the distal side. Air-sacks in the shape of three quarters of a globe, 98 × 50 μm in size, with a microreticulum on them.
Remarks. Morphologically this form approaches the modern species *Abies alba* and *Abies koreana*. In the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles were found only two grains of this genus.

Keteleeria Carr. – *Abies* Mill. – type
Abiespollenites maximus Krutzsch 1971
Pl. 7 fig. 7

1971. *Abiespollenites maximus* n. sp.; Krutzsch, p. 92, Pl. 18.

Pollen grains in polar view about 164 μm long; body ovate, 113 × 100 μm in size. On the proximal side the exine forms a crest, about 8 μm thick, with an undulate edge. The air-sacks, in the shape of three quarters of a globe, measure 109 μm × 75 μm, and bear a microreticulum.
Remarks. According to Krutzsch (1971), the fossil species compares with *Keteleeria* in its large measurements, while the thick crest on the body suggests its affinity to *Abies*. Pollen grains occur very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Keteleeria Carr. – type
Abiespollenites dubius (Chlonova 1960) Krutzsch 1971
Pl. 8 fig. 2

1960. *Keteleeria dubia* sp. n.; Chlonova, pp. 59–60, Pl. IX, fig. 5.
1971. *Abiespollenites dubius* (Chlonova 1960) n. comb.; Krutzsch, p. 98, Pl. 21.

Pollen grain about 164 μm long in polar view; body more or less circular in outline, 100 × 103 μm in size; exine about 3.3 μm thick. The air-sacks in the shape of three quarters of a globe, widely set on the body, are small, 79 × 50 μm in size, and bear a reticulum of lumina, 3–6 μm in diameter.
Remarks. In its structure and size this pollen grain resembles the recent genus *Keteleeria*, among others, the Chinese species *Keteleeria davidiana Beiss.*, especially in its not very thick crest on the body and air-sacks of the parvisaccate type (or smaller than the body). Pollen grains occur very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tsuga Carr.

Tsuga pollen shows very great variation. Two main groups consist of grains with spines present on the surface and those devoid of spines. The first group dominates in the Neogene.

Studies of grains of the recent species of *Tsuga* (Sivak 1973, Mczedliszwili 1983) show that only the pollen of *Tsuga canadensis* is void of spines and, in this connection, the fossil forms without spines and with a narrow collar are generally described as *Tsuga* t. *canadensis*. It is much more difficult to classify the grains of the second group, which includes sporomorphs with large or small collars and more or less densely covered with spines.

In the whole assemblage of pollen grains examined three groups have been distinguished: grains with a narrow collar and no or only a few spines, grains with a narrow collar but densely covered with spines and those with a large collar and sparsely distributed spines.

Zonalapollenites Pflug 1953

Pollen grains with a narrow collar and devoid of spines or with very sparsely distributed spines:

Tsuga canadensis (L.) Carr. – type ?
Zonalapollenites verrucatus Krutzsch 1971
Pl. 9 figs 2a, b, c

1971. *Zonalapollenites verrucatus* n. sp.; Krutzsch, p. 144, Pl. 39.

Pollen grain suboval in outline, 94 μm × 75 μm in outer dimensions, with small collar about 4 μm wide (Pl. 9; fig. 2a). Distal side densely covered with small roundish verrucae, about 1 μm in diameter (Pl. 9; fig. 2b); proximal side with big polygonal verrucae, about 3 μm in height and 3 μm in diameter, evidently hollow inside (Pl. 9; fig. 2c).

Remarks. Krutzsch (1971) gives no recent botanical analogues to this fossil species. For lack of spines it may be associated with *Tsuga canadensis* (North America). Pollen grains were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tsuga canadensis (L.) Carr. – type
Zonalapollenites maximus (Raatz 1937) Krutzsch 1971
Pl. 9 figs 1a, b, c

1937. *Tsuga-pollenites igniculus* (Potonié) f. *maximus* n. f.; Raatz, p. 15,
1971. *Zonalapollenites maximus* (Raatz 1937) n. comb.; Krutzsch, p. 138, Pl. 36,

Pollen grain oval in outline, 100 × 78 μm in outer dimensions, with collar about 7.5 μm wide (Pl. 9; fig. 1a). On distal side of grain operculum densely covered with small round verrucae, 1.5–2 μm in diameter, some of them hollow inside (Pl. 9; fig. 1b). Proximal side covered with big verrucae of irregular shape and visibly hollow, about 4 μm high and 2.5–3.5 μm in diameter (Pl. 9; fig. 1c).

Remarks. The morphological structure is similar to that of the recent species *Tsuga*

canadensis (cf. Sivak 1973, p. 411, Pl. XI and XII). Out of the fossil species distinguished by Krutzsch (1971), *Zonalapollenites maximus*, compared by him to *Tsuga canadensis*, is similar to our specimen in size and in its structure of the distal and proximal sides. Pollen grains occur rarely in all profiles.

Tsuga caroliniana Englm. – type ?
Zonalapollenites sp. 1
Pl. 10 figs 1a, b, c

Pollen grain oval in outline, 94 × 60 μm in outer dimensions; small collar, about 4.5 μm wide, with very sparsely distributed thick spines (Pl. 10; fig. 1a). On distal side operculum covered with verrucae, 2–2.5 μm in diameter, with small canaliculi inside (Pl. 10; fig. 1b) and poorly seen, small spines. On proximal side there are also verrucae, irregular in shape and visibly hollow inside, about 4 μm in diameter; thick spines perceptible in places (Pl. 10; fig. 1c).
Remarks. The general shape of the grain and its narrow collar with a small number of spines are like those in the recent North American species *Tsuga caroliniana* (cf. Sivak 1973, p. 411, Pl. XIII and XIV), but the fossil pollen grain has spines on the proximal side. Pollen grains were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Pollen grains with a narrow collar and very densely covered with spines:

Tsuga blaringhemii Floues – type ?
Zonalapollenites cf. *neogenicus* Krutzsch 1971
Pl. 10 figs 2a, b, c

1971. *Zonalapollenites neogenicus* n. sp.; Krutzsch, p. 160, Pl. 47.

Pollen grains of oval outline, 100–107 × 75–88 μm in outer dimensions, with collar, 9–12 μm wide, and densely distributed thick spines (Pl. 10; fig. 2a). No verrucae on distal side, operculum covered with layer of dense thick spines, 1.5 μm in diameter at base (Pl. 10; fig. 2b). Proximal side composed of big flat verrucae, about 2.5 μm in diameter, of which some show fine canaliculi inside; thick spines amidst verrucae (Pl. 10; figs 2c).
Remarks. In structure the pollen grains approach those of the recent species *Tsuga blaringhemii* from Japan (cf. Sivak 1973, p. 408, Pl. V and VI), but their collar is a little narrower. Out of the fossil species described by Krutzsch (1971) only *Zonalapollenites neogenicus* is similar to this recent species. Pollen grains occur rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tsuga sieboldii Carr. – type
Zonalapollenites sp. 2
Pl. 10 figs 3a, b, c, d

Pollen grain oval in outline, 100 × 94.5 μm in outer dimensions, with narrow collar, about 5 μm wide, covered densely with spines (Pl. 10; fig. 3a). No verrucae on distal side, operculum covered with tightly packed spines, whose rounded ends form almost a layer (Pl. 10; figs 3b, c). Proximal side covered with verrucae, irregular in shape, about

4 μm in diameter, hollow inside and also with a large number of spines on the surface (Pl. 10; fig. 3d).

Remarks. This pollen grain most resembles the pollen of the recent species *Tsuga sieboldii* from Japan in structure (Sivak 1973, p. 413, Pl. XXV and XXVI). Pollen grains were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Pollen grains with a large collar and covered with spines:

Tsuga diversifolia (Maxim.) Mast. – type
Zonalapollenites reuterbergensis Krutzsch 1971
Pl. 11 fig. 2a, b, c

1971. *Zonalapollenites reuterbergensis* n. sp.; Krutzsch, p. 156, Pl. 45.

Pollen grains circular or oval in outline, 98 × 85 μm in outer dimensions; collar large, 10–12 μm wide, covered with densely distributed thin spines, pointed at ends (Pl. 11; fig. 2a). On distal side, operculum with numerous twisted short spines; under layer of spines flat verrucae of irregular shapes, about 2.5 μm in diameter (Pl. 11; fig. 2b). Verrucae on proximal side much bigger, 3.5–4 μm in diameter, irregular in shape, evidently hollow inside and covered densely with short spines (Pl. 11; fig. 2c).

Remarks. The pollen grains of *Tsuga diversifolia* described by Sivak (1973) have a fairly large number of spines on the distal side, just as have the pollen grains found in the material under study. Krutzsch (1971) mentions *Tsuga diversifolioider* (major) type Rudolph as one of the synonyms of *Zonalapollenites reuterbergensis*. Pollen grains occur regularly in all profiles attaining their maximum (9.5%) at the bottom of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Zonalapollenites minimus Krutzsch 1971
Pl. 8 fig. 6

1971. *Zonalapollenites minimus* n. sp.; Krutzsch, p. 150, Pl. 42.

Pollen grain of circular outline, about 50 μm in outer diameter; collar about 9.5 μm wide, covered with thick spines. Distal side with tick, densely disposed spines, rounded at ends, about 1.5 μm in diameter at base. On proximal side flat verrucae, about 2.5 μm in diameter, with thick spines occuring sparsely among them.

Remarks. Krutzsch (1971) mentions *Tsuga diversifolioder* (*minor*) type Rudolph as one of the synonyms of *Zonalapollenites minimus* that is to say, he is of the opinion that both fossil species - *Z. reuterbergensis* and *Z. minimus* – come morphologically near to the recent species *Tsuga diversifolia*. In the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles were found only two grains of this species.

Tsuga Carr. – type
Zonalapollenites robustus Krutzsch 1971
Pl. 11 figs 1a, b, c

1971. *Zonalapollenites robustus* n. sp.; Krutzsch, p. 158, Pl. 46.

Pollen grain circular in outline, 103 μm in outer diameter, with collar about 16 μm

wide, covered with sparsely distributed, thin and small spines (Pl. 11; fig. 1a). Small verrucae on distal side, irregular in shape, 2–3 μm in diameter, with small canaliculi inside; short thin spines occasionally seen (Pl. 11; fig. 1b). Verrucae on proximal side much bigger, 4–4.5 μm in diameter, with empty chambers inside; short spines seen in places (Pl. 11; fig. 1c).

Remarks. In structure this pollen grain most resembles the recent species *Tsuga calcarea* (Sivak, 1973, p. 410, Pl. IX and X), from which it differs in the structure of verrucae on the distal and proximal sides. In the recent species the verrucae are solid inside. Pollen grains occur only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Podocarpaceae
Podocarpus L'Hérit. et Pers.
Podocarpidites Cookson 1947
Podocarpidites gigantea (Zaklinskaja 1957) Nagy 1985
Pl. 8 fig. 5

1957. *Podocarpites gigantea* sp. nov (pollen); Zaklinskaja, pp. 109–110, PL. III, figs 1–4.
1985. *Podocarpidites gigantea* (Zaklinskaja 1957) n. c.; Nagy, p. 149, Pl. LXXXII, fig. 5.

Remarks. Pollen grains were found sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Podocarpidites podocarpoides (Thiergart 1958) Krutzsch 1971
Pl. 8 fig. 3

1958. *Pityosporites podocarpoides* n. sp.; Thiergart, p. 449, Pl. 1, fig. 15.
1971. *Podocarpidites podocarpoides* (Thiergart 1958) n. comb.; Krutzsch, p. 130, Pl. 33, figs 1–11.

Remarks. Pollen grains occur frequently in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki, Liszkowo profiles and in the Ścinawa Beds (Lower Miocene) of the Kosztowo profiles.

Podocarpidites libellus (Potonié 1932) Krutzsch 1971
Pl. 8 fig. 4

1931c. *Pini* (?) – *pollenites libellus* n. sp.; Potonié, p. 5, Fig. 33.
1971. *Podocarpidites libellus* (Potonié 1931) n. c.; Krutzsch, p. 128, Pl. 32.

Remarks. Pollen grains were found only sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Taxodiaceae – Cupressaceae

Pollen grains from the families *Taxodiaceae – Cupressaceae* belong, beside those of *Pinus*, to the grains occurring most abundantly in the profiles under study.

Three genera – *Taxodium, Glyptostrobus, Cunninghamia* – and pollen grains of closely undeterminable botanic status were determined as *Inaperturopollenites*.

Inaperturopollenites Pflug et Thomson 1953
Inaperturopollenites dubius (Potonié et Venitz 1934) Thomson et Pflug 1953
Pl. 14 fig. 1

1934. *Pollenites magnus dubius* n. f.; Potonié, Venitz p. 17, Pl. 2, fig. 20, 21.
1953. *Inaperturopollenites dubius* (Potonié et Venitz 1934) n. comb.; Thomson et Pflug, p. 64, Pl. 5, fig. 11.

Pollen grains circular in outline, 25–35 μm in diameter; exine thin, 0.8–0.9 μm but never exceeding 1.0 μm in thickness, with strongly crumpled surface, bearing a very dense granulate sculpture.

Remarks. This collective includes pollen grains devoid of the papilla and with psilate exine surface, met with in the families *Cupressaceae*, *Taxodiaceae*, *Taxaceae* (among others, *Cupressus*, *Thuja*, *Libocedrus*, *Juniperus*, *Taxus*), in the diagrams defined as the group *Taxodiaceae-Cupressaceae*. Pollen grains occur frequently in all profiles.

Taxodium Rich. – type 1, sensu Oszast 1960
Inaperturopollenites concedipites (Wodehouse 1933) Krutzsch 1971
Pl. 14 figs 2, 3

1933. *Cunnighamia concedipites* sp. nov.; Wodehouse, p. 495, fig. 19.
1960. *Taxodium sp.*; Oszast,. p. 11, Pl. 3, figs 9, 12.
1971. *Inaperturopollenites concedipites* (Wodehouse, 1933) n. comb.; Krutzsch, p. 204, Pl. 65.

Pollen grains circular in outline, 35–40 μm in diameter, deep cracked; papilla poorly seen, in hollow; exine two-layered, 1–1.5 μm thick; outer layer, finely undulate, forming delicate small wrinkles on surface.

Remarks. Pollen grains were frequent in all samples but in not large quantities. Only in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles their attaining 5% in two samples.

Taxodium Rich. – type 2
Inaperturopollenites concedipites (Wodehouse 1933) Krutzsch 1971
Pl. 14 fig. 4

1933. *Cunninghamia concedipites* sp. nov.; Wodehouse, p. 495, Fig. 19.
1971. *Inaperturopollenites concedipites* (Wodehouse, 1933) n. comb.; Krutzsch, p. 204, Pl. 65.

Pollen grain circular in outline, about 37 μm in diameter. Exine two-layered, about 1 μm thick; outer layer finely undulate, numerous wrinkles seen on surface, sunken papilla at centre.

Remarks. The pollen grains are the same morphological type as the grains of *Taxodium* – type Oszast (1960). They are not cracked and for the most part polarly positioned. Pollen grains were often found in all profiles.

Taxodium Rich. – type 3
Inaperturopollenites sp.
Pl. 14 fig. 6

Pollen grain ellipsoid in outline, 25 × 40 μm in size; distinct short papilla on distal side, 2.8 μm high, with its thin top part curved in a beak-like manner. Exine two-layered, about 1 μm thick, outer layer finely undulate, granulations present on surface.

Remarks. This pollen grain. like the previous ones, belongs probably to the genus *Taxodium*. It differs from the grains of *Sequoia* mainly in its thin small papilla and in thickness of exine on the distal and proximal sides. The recent *Glyptostrobus* pollen grains are far smaller and have thicker exine (Pl. 14; figs 12, 13) than the grains of *Taxodium* (Pl. 14, figs 7–9). Two pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Glyptostrobus Endl. – type sensu Oszast 1960

Pl. 14 figs 5

1960. *Glyptostrobus* sp.; Oszast, p. 12, Pl. III, figs 13, 16.

Pollen grains ellipsoid in outline, 44–55 × 20–28 μm in dimensions, mostly with a very deep longitudinal crack; two subparallel folds along crack on either side; papilla imperceptible. Exine thin, about 1 μm in thickness, two-layered; outer layer with distinct granulations on surface.

Remarks. Pollen grains occur regularly in all studied profiles, but mostly less then 1%. Only in the Karolewo-Dąbki profiles in the Mid-Polish Beds (Middle Miocene) several times reaches 3–5%.

Cunninghamia R. et Br. – type sensu Oszast 1960
Inaperturopollenites radiatus Krutzsch 1971

Pl. 14 figs 10, 11a, b

1960. *Cunninghamia* sp.; Oszast, p. 12, Pl. III, figs 15, 17–19.
1971. *Inaperturopollenites radiatus* n. sp.; Krutzsch, p. 199, Pl. 63, figs 1–19, Pl. 12, fig. 12.

Pollen grains of circular in outline, 35–40 μm in diameter, sunken at centre, with aperature, about 2.0 μm in diameter, in depression; exine about 1.2 μm thick, two-layered. Outer exine, loosely placed on inner exine, with numerous secondary folds on surface, running mostle radially, from fairly wide aperture to equator.

Remarks. In their structure and size the pollen grains come near to *Cunninghamia*, above all, to *C. lancéolata* (*C. sinensis*) from South-Eastern China. Pollen grains occur rarly in studied profiles less then 1%, only twice attaining 2% in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Taxodiaceae

Four genera have been isolated from the pollen grains of the family *Taxodiaceae*: *Sequoia, Metasequoia, Cryptomeria* and *Sciadopitys* and included in the fossil species described by Krutzsch (1971).

Sequoia Endl. – *Cryptomeria* D. Don.

In the diagrams the pollen grains of these two groups are placed all together in one group: *Sequoia – Cryptomeria.* The thick-walled pollen grains with a straight papilla belong to *Cryptomeria*, while the thin-walled grains with a curved papilla are referred to the genus *Sequoia.*

Sequoia Endl. – type
Sequoiapollenites Thiergart 1937
Sequoiapollenites major Krutzsch 1971
Pl. 15 figs 12, 13

1971. *Sequoiapollenites major* n. sp.; Krutzsch, p. 220, Pl. 72 figs 1–4.

Pollen grains broad-oval in outline, measuring 41–45 × 37 μm with big papilla, 5.4–6 μm high and about 4.6–6 μm wide at base, curved at end. Papilla and broad arms surrounding it are smooth and built of exine, about 1 μm thick; proximal side of grain coated with loose exine; it has a coarsely granulate surface with secondary folds; exine on proximal side about 2.2 μm thick; two-layeredness of exine on papilla and so-called arms not noted.

Remarks. The general shape of the grain and the structure of its proximal side are similar to *Sequoiapollenites major* (Krutzsch 1971), from which it differs only in one-layered exine on the distal side. Only two pollen grains of this species are encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sequoiapollenites polyformosus Thiergart 1937
Pl. 15 figs 15

1937. *Sequoia – pollenites polyformosus* n. sp.; Thiergart, pp. 301, 302, Pl. 23, figs 6–11.

Pollen grains ellipsoid in outline, measuring 22–28 × 31–33 μm with short papilla curved at end, 3.5 μm high and 4.5–6 μm wide at base. Papilla and papilla-surrounding arms smooth, built of one-layered exine; proximal side with two-layered exine, about 1.5 μm thick; undulate external layer adhering to the whole of the grain either rather loosely or tightly.

Remarks. The general features of the grain structure, that is, the thin exine and not very big papilla make the basis for the classification of these grains in the collective fossil species *S. polyformosus* (Krutzsch 1971, p. 212, Pl. 68). Pollen grains frequent in all studied profiles, mostly less then 1%, maximum of frequency 5% in numerous samples in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sequoiapollenites cf. *megaligulus* Krutzsch 1971
Pl. 15 fig. 11

1971. *Sequoiapollenites megaligulus* n. sp.; Krutzsch, p. 222, Pl. 73, figs 33–35.

Pollen grains broad-oval in outline, measuring 26–28 × 30–33 μm with long, thick papilla, curved at end, 6–7 μm high and 3.5–4.5 μm wide at base. Papilla and arms surrounding-papilla smooth, built of one-layered exine, 1.4 μm thick on arms and considerably thinner on papilla. On proximal side exine 2–2.2 μm thick, with very coarsely granulated surface.

Remarks. In their structure the pollen grains resemble *Sequoiapollenites megaligulus* Krutzsch 1970 (cf. Pl. 73, figs 33–35). In Krutzsch's opinion, the exine of the distal side is, however, two-layered, which has not been noted in the pollen grains from Kosztowo and Karolewo-Dąbki. Among the recent genera from the family *Taxodiaceae* only the pollen grains of *Sequoiodendron* have such a long papilla, but it is at the same time wide at the base. Pollen grains were found only sporadically in some samples in the Ścinawa

Beds (Lower Miocene) of the Kosztowo profile and in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Cryptomeria D. Don. – type
Sequoiapollenite cf. *largus* (Kremp 1949) Manum 1962
Pl. 15 figs 9, 10

1949. cf *Cryptomeria* – *Poll. largus* n. sp.; Kremp, p. 58, Pl. V, fig. 30.
1962. *Sequoiapollenites largus* Kremp; Manum, p. 43 (after Krutzsch 1971, p. 210).
1971. *Sequoiapollenites largus* (Kremp 1949) Manum 1962; Krutzsch, p. 208, Pl. 67.

Pollen grains ellipsoid in outline, measuring 25–31 × 30–37 μm with straight papilla, 4.4–6 μm high and 3.5–4.2 μm wide at base. Exine on papilla and arms surrounding it smooth, one-layered, about 1 μm thick. On the proximal side it is two-layered, 1.4–1.8 μm thick, with both layers closely adhering to each other and the surface coarsely granulate.
Remarks. Straight papilla and thick exine are features common to this taxon and, at the same time, they are characteristic of the recent pollen grains of *Cryptomeria*. On the other hand, in the pollen grains of *Sequoia* the papilla is, for the most part, set on the arms unequal in length. Two fossil species of the genus *Sequoiapollenites* distinguished by Krutzsch (1971), namely, *S. largus* and *S. rotundus*, come near in their morphological structure to the pollen grains of the recent genus *Cryptomeria*. Of the two, the bigger papilla makes the *S. largus*-type pollen grains more similar to the recent genus *Cryptomeria*. Pollen grains occur sporadically in some samples in the Adamów Beds (Middle Miocene) and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sequoia Endl. – *Cryptomeria* D. Don. – type
Pl. 16 figs 1–2

Pollen grains ellipsoid in outline, measuring 35–40 × 37–41 μm deep ruptured, with distinct big papilla in hollow (Pl. 16; figs 1), or grains circular in outline, 37 μm in diameter, with papilla visible at centre (Pl. 16; fig. 2). Exine, 1.7–1.9 μm thick, two-layered, layers either joined closely together, with coarsely granulate surface, or not adhering to each other (Pl. 16; fig. 2).
Remarks. The thickness of exine and the similar structural type of these pollen grains suggest that they belong probably either to *Sequoia* or to *Cryptomeria*. The specimens with thick, uniform exine (Pl. 16; fig. 1) more resemble the pollen grains of *Cryptomeria* vel *Sequoia*, whereas those with a loose external layer of exine (Pl. 16; fig. 2) belong rather to *Sequoia*. In the recent material the thin, loose external layer of exine is not observed in pollen grains of *Cryptomeria* (Pl. 15; fig. 14), being sometimes present in the grains of *Sequoia* (Pl. 16; figs 3, 4). Pollen grains abundant in all profiles in most cases with pollen grains of *Sequoia* and *Cryptomeria*.

Metasequoia Miki ex Hu et Cheng – type
Sequoiapollenites cf. *sculpturius* Krutzsch 1971
Pl. 15 figs 1, 2, 3

1971. *Sequoiapollenites sculpturius* n. sp.; Krutzsch, p. 216, Pl. 70, figs 1–23,

Pollen grains broad-oval in outline, measuring 33–37 × 34–34 μm, with papilla

somewhat curved at end, 3.3–3.6 μm high and 3.5–4.5 μm wide at base. Papilla and broad arms surrounding-papilla smooth, formed from one-layered of exine about 1 μm thick; exine on proximal side two-layered, about 1.5–2 μm thick; outer layer sometimes detached from inner; it is very finely undulate and forms a microhamulate pattern on the surface.

Remarks. In structure these pollen grains approach recent *Metasequoia glyptostroboides* (Pl. 15; figs 7–8) and also the fossil species *Sequoiapollenites sculpturius* (Krutzsch 1971). They differ from *Sequoiapollenites rugulus* (Krutzsch 1971) in their more delicate sculpture on the proximal side and the psilate surface of the papilla and arms. Pollen grains occur rarely in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Metasequoia Miki ex Hu et Ching – *Sequoia* Endl. – type
Sequoiapollenites rugulus Krutzsch 1971

Pl. 15 figs 4, 5

1971. *Sequoiapollenites rugulus* n. sp.; Krutzsch, p. 90, Pl. 71, figs 1–36,

Pollen grains circular in outline, 35–40 μm in diameter, with short papilla, 3 μm high. Exine on papilla and papilla-surrounding arms one-layered, about 1 μm thick. On proximal side exine two-layered, 2 μm thick, outer layer finely undulate, with granulations seen on surface.

Remarks. These pollen grains differ from *Sequoiapollenites sculpturius* (Krutzsch 1971) in thicker and more undulate exine. Pollen grains occur rarely in the Rawicz Beds (Lower Miocene) of the Liszkowo profile and in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Sequoiapollenites cf *rugulus* Krutzsch 1971

Pl. 15 fig. 6

1971. *Sequoiapollenites rugulus* n. sp.; Krutzsch, p. 90, Pl. 71, figs 1–36,

Pollen grains circular in outline, 33–34 μm in diameter, sunken papilla, with thin acerose spinules, seen at centre. Exine two-layered, about 2 μm thick, outer layer very coarsely undulate, forming a very compact maze of short hamuli on the surface.

Remarks. These pollen grains have a coarser sculpture than have the species similar in structure described by Krutzsch (1971): *Sequoiapollenites sculpturius* and *S. rugulus*. Pollen grains occur rarely in the Adamów and the Midd-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopitys S. et Z.

Very great variation occurs in pollen grains of *Sciadopitys* (Fig. 3). Nine morphological types have been distinguished; most of them have a "*serratus*" sculpture, which means that their two-layered exine consists of a thin, homogeneous inner layer of exine and a layer of verrucae, spherical in shape, with ragged edges and verying in size, – hollow within. *Sciadopityspollenites serratus, S. quintus, S. tuberculatus*, and *S. crassus*

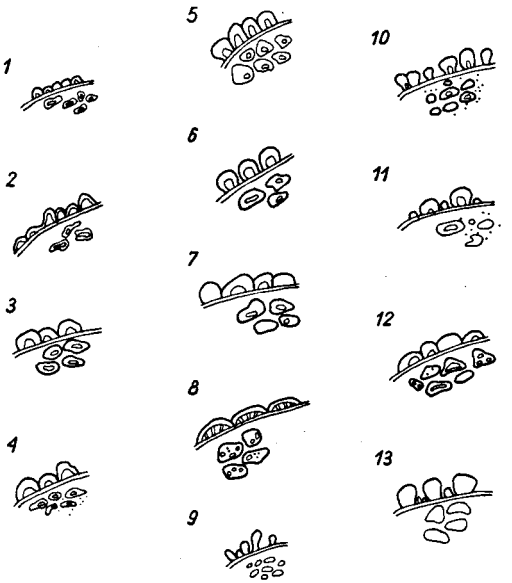

Fig. 3. Sculpture variability of the pollen grains *Sciadopityspollenites* from the Neogenic deposits of the Wyrzysk region (figs 1–13 × 1000): 1 – *Sciadopityspollenites* sp. 1 (Pl. 12, fig. 1); 2 – *S. quintus* Krutzsch 1971 (Pl. 12, fig. 2); 3 – *S. serratus* (Potonié et Venitz, 1934) Raatz 1937, (Pl. 12, figs 6a, b); 4 – *S. serratus* (Potonié et Venitz, 1934) Raatz 1937, (Pl. 12, figs 5a, b); 5 – *S. crassus* Krutzsch 1971 (Pl. 12, figs 7a, b); 6, 7 – *S. tuberculatus* (Zaklinskaja, 1957) Krutzsch 1971 (Pl. 13, fig. 1); 8 – *Sciadopityspollenites* sp. 3 (Pl. 13, fig. 4a, b); 9 – *S. verticillatiformis* (Zauer, 1960) Krutzsch 1971 (Pl. 12, fig. 9); 10 – *S. varius* Krutzsch 1971 (Pl. 13, fig. 6); 11 – *S. varius* Krutzsch 1971 (Pl. 13, fig. 7); 12 – *Sciadopityspollenites* sp. 2 (Pl. 13 fig. 3); 13 – *Sciadopityspollenites* sp. 2 (Pl. 13 fig. 2)

have such a sculpture. The other, "*verticillatiformis*" type of sculpture is present only in *Sciadopityspollenites verticillatiformis* with small pila-type verrucae, solid within, *Sciadopityspollenites varius*, with big solid verrucae, having scarcely visible spinules on the surface, and *Sciadopityspollenites* fsp. with more or less solid verrucae.

Studies of the recent pollen grains of *Sciadopitys verticillata* from natural stands in Japan and grown in Georgia (Kvavadze 1988) indicate their huge variation. The sculpture of the grains described may range from psilofoveolate, granulate to verrucate and coarsely verrucate (cf. Kvavadze 1988, Pl. XVII). Those observation suggest the presence of only one fossil species of *Sciadopitys* in the Miocene. There is need for a careful and close study of the sculpture and structure of fossil species of *Sciadopitys* and their comparison with the recent material.

Observation of pollen grains under the light microscope corroborate Krutzsch's (1971) opinion that the only now living recet species *Sciadopitys verticillata* (Pl. 13; figs 5a, b) in respect of the structure of verrucae comes nearest to the Tertiary species e.g. *Sciadopityspollenites varius* with solid verrucae. In the material examined from the region of Wyrzysk the pollen grains with more or less hollow verrucae, or with the "*serratus*" type sculpture are dominant, whereas the grains with the "*verticillatiformis*" type sculpture were very rarely encountered.

Sciadopityspollenites Raatz 1937

Pollen grains of "*serratus*" type sculpture:

Sciadopityspollenites sp. 1

Pl. 12 fig. 1

Pollen grains of circular outline, 36–39 μm in diameter, with depression present on the distal side. Exine two-layered, 1.6–2.5 μm thick; inner layer of exine very thin, less than 1 μm in thickness. Small verrucae, 1–1.5 μm high and 1.5–2.5 μm in diameter, with ragged edges and small openings, are densely distributed on the inner layer of exine.

Remarks. Only some pollen grains of this type encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopityspollenites quintus Krutzsch 1971

Pl. 12 figs 2, 3, 4

1971. *Sciadopityspollenites quintus* n. sp.; Krutzsch, p. 180, Pl. 55, figs 1–16,

Pollen grains oval in outline, measuring 43–56 × 35–44 μm, with depression on distal side. Exine two-layered 1.6–2.5 μm thick; inner layer of exine very thin, with not very densely disposed verrucae on it; verrucae varying in shape, 1–2 μm high and 2–3 μm in diameter, evidently hollow within.

Remarks. This fossil species is given by Krutzsch (1971) and Ziembińska-Tworzydło (1974) as characteristic of the warm phases of the Miocene. Pollen grains occur rarely in the Rawicz Beds (Lower Miocene) of the Liszkowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopityspollenites serratus (Potonié et Venitz, 1934) Raatz 1937

Pl. 12 figs 5a, b; 6a, b

1934. *Sporites serratus* n. sp.; Potonié et Venitz, p. 15, Pl. 1, figs 6, 7.
1937. *Sciadopitys – pollenites serratus*, Potonié et Venits; Raatz, p. 13, Pl. 1, fig. 16.

Pollen grains circular in outline, 46–54 μm in diameter, with distinct furrow-like depression on distal side. Exine two-layered, 2.6–3 μm thick; inner layer of exine thin, less than 1 μm; on it densely distributed verrucae, 2–3 μm in diameter, with ragged edges and small canaliculi inside; distinct granulations among them.

Remarks. In Krutzsch's (1971) opinion, this species is characteristic of the cool phases of the Miocene. Pollen grains occur regularly in the all profiles in quantities 2–5% attaining their maximum (10–15%) at the bottom part of the Mid-Polish Beds (Middle Miocene) in many samples.

Sciadopityspollenites tuberculatus (Zaklinskaja, 1957) Krutzsch 1971

Pl. 13 figs 1

1957. *Sciadopitys tuberculata* n. sp.; Zaklinskaja, pp. 165–166, Pl. XVI, fig. 3.
1971. *Sciadopityspollenites tuberculatus* (Zaklinskaja, 1957) n. comb.; Krutzsch, p. 182, Pl. 56, figs 1–9.

Pollen grains ellipsoid in outline, measuring 37–44 × 44–50 μm two-layered exine

about 3 μm thick; inner layer of exine very thin, less than 1 μm with a layer of tightly packed verrucae, 2.5–4 μm in diameter, on it. Verrucae very irregularly shaped, placed close to each other, sometimes fused together, hollow within. Fine acerose spinules can be seen on the surface of the verrucae.

Remarks. Pollen grains occur sporadically in some samples in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopityspollenites crassus Krutzsch 1971

Pl. 12 figs 7a, b

1971. *Sciadopityspollenites crassus* n. sp.; Krutzsch, p. 186, Pl. 58, figs 13–20,

Pollen grain of circular outline, 31.5 μm in diameter. Exine two-layered, about 3.6 μm thick, inner layer of exine thin, about 1 μm; on it tightly disposed verrucae with ragged edges, about 2.5 μm in diameter, hollow within.

Remarks. Only two pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopityspollenites sp. 3

Pl. 13 figs 4a, b

Pollen grain ellipsoid in outline, measuring 63 × 50.4 μm; exine about 2.8 μm thick; endoexine thin, less then 1 μm, with a layer of flat, big, polygonal verrucae, 4–6 μm in diameter; not very distinct rib-like structure inside verrucae.

Remarks. Only some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Pollen grains of "*verticillatiformis*" type sculpture:

Sciadopityspollenites vercticillatiformis (Zauer, 1960) Krutzsch 1971

Pl. 12 figs 8, 9

1960. *Sciadopitys verticillatiformis* sp. nov.; Zauer in Pokrowskaja, Stelmak et al., p. 410, Pl. V, fig. 6.

1971. *Sciadopityspollenites verticillatiformis* (Zauer, 1960) n. comb.; Krutzsch, p. 178, Pl. 54, figs 7–24.

Pollen grains ellipsoid in outline, measuring 50 × 44 μm. Exine about 2 μm thick; inner layer of exine thin, less than 1 μm, with densely distributed verrucae on it; verrucae solid in top part, hollow beneath, 1.8–2 μm in diameter.

Remarks. Pollen grains sporadically encountered in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sciadopityspollenites varius Krutzsch 1971

Pl. 13 figs 6, 7

1971. *Sciadopityspollenites varius* n. sp.; Krutzsch, p. 188, Pl. 59, figs 1–12,

Pollen grains ellipsoid in outline, measuring 47–57 × 44–49 μm. Exine two-layered, inner layer of exine about 1.2–1.4 μm thick, with a layer of round verrucae, 2–3 μm high and 2–3 μm in diameter; fine acerose spinules visible on some verrucae. Verrucae

solid, but sometimes may be hollow just close to the inner layer of exine; surface among verrucae strongly granulate.

Remarks. Pollen grains occur sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Sciadopityspollenites sp. 2

Pl. 13 figs 2, 3

Pollen grains ellipsoid in outline, measuring 59–63 × 50–58 μm. Exine about 4 μm thick; high bulbiform verrucae, 3–4 μm in diameter are densely distributed on the thin inner layer of exine, less than 1 μm thick; verrucae rather solid, some of them with small openings visible inside.

Remarks. Only three pollen grains of this type were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Gnetinae
Ephedraceae
Ephedra L.
Ephedripites Bolchovitina 1953
Ephedripites (*Distachyapites*) *tertiarius* Krutzsch 1970

Pl. 16 fig. 6

1970. *Ephedripites* (*Distachyapites*) *tertiarius* n. sp.; Krutzsch, pp. 156, 158, Pl. 44, figs 1–21.

Remarks. Only some pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ephedripites (*Distachyapites*) *lusaticus* Krutzsch et Sontag 1961

Pl. 16 fig. 5

1961. *Ephedripites (Distachyapites) lusaticus* n. fsp.; Krutzsch et Sontag – Krutzsch, p. 26, Pl. VI, figs 120–128.

Remarks. Pollen grains occurring sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Angiospermae
Dicotyledones
Betulaceae
Betula L.
Betulaepollenites Potonié 1934
Betulaepollenites betuloides (Pflug 1953) Nagy 1969

Pl. 16 figs 7, 8

1953. *Trivestibulopollenites betuloides* n. sp.; Pflug, in Thomson et Pflug, p. 85, Pl. 9, figs 25–34.
1969. *Betulaepollenites betuloides* (Pflug 1953) n. c.; Nagy, p. 228, Pl. III fig. 12.

Remarks. Pollen grains numerous in all profiles, maximum of frequency (30%) in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Corylus L.
Triporopollenites coryloides Pflug 1953
Pl. 16 fig. 12

1953. *Triporopollenites coryloides* n. sp.; Thomson et Pflug, p. 84, Pl. 9, figs 20–24.

Remarks. Pollen grains encountered in all profiles, in most cases less than 1%. In the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles several times come up to 5%.

Alnus B. Ehrh.
Alnipollenites Potonié 1934
Alnipollenites verus (Potonié 1931) Potonié 1934
Pl. 16 figs 9, 10, 11

1931a. *Pollenites verus* n. sp.; Potonié, p. 320, Pl. II, fig. 40.
1934. *Alnipollenites verus*, Potonié; Potonié, pp. 58–59, Pl. II figs 13, 17, 18, 25, 26.

Remarks. The big pollen grains, 31 μm in diameter, with distinct arci of sexine, approach the grains of *Alnus glutinosa*, while the small ones resemble *Alnus incana*, *A. japonica*, *A. formosana*, *A. nepalensis*. *Alnus glutinosa* type prevails in the fossil material. Pollen grains abundant in all profiles, in upper parts of the Karolewo-Dąbki and Liszkowo profiles to come up 20%–65%.

Ostrya Scop.
Ostryapollenites Thomson 1950
Ostryapollenites rhenanus (Thomson 1950) Nagy 1969
Pl. 16 figs 13–14

1950. *Ostrya*? – *poll. granifer rhenanus* n. spm.; Thomson in: Potonié, Thomson, Thiergart, p. 52, Pl. B, figs 9–10.
1969. *Ostryapollenites rhenanus* (Thomson 1950) n. c.; Nagy, pp. 226–227, Pl. III, fig. 10.

Remarks. In structure the pollen grains come near to *Ostrya carpinifolia*. They are often hard to distinguish from triporate pollen grains of *Carpinus* and for this reason are included together in one group in the diagrams. Pollen grains of the species are found sporadically in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Carpinus L.

Two morphological forms have been distinguished within the fossil species *Carpinipites carpinoides*.

Carpinipites Srivastava 1966
Carpinipites carpinoides (Pflug 1953) Nagy 1985

1953. *Polyporopollenites carpinoides* n. sp.; Pflug, in Thomson et Pflug, p. 92, Pl. 10, figs 79–84.
1969. *Carpinuspollenites carpinoides* (Pflug 1953) n. c.; Nagy, p. 226, Pl. LII, fig. 8.
1985. *Carpinipites carpinoides* (Pflug 1953) n. comb.; Nagy, pp. 197–198, Pl. CXII, figs 9–14.

f. *major*

Pl. 17 figs 4, 5

Pollen grains 4-porate, in polar view polygonal in outline, 40–50 μm in diameter; pores distributed in the corners of the quadrangle in the equatorial plane. Exine 1.6 μm thick, sexine thicker than nexine, tectate; tectum-supporting bacula well seen in sexine, tectum surface micropunctate, irregular wrinkles visible in places (rugulate).

At the pores the strongly turned-up exine forms a distinct labrum which surrounds the oval exopore. In the pore regions the nexine disappears and a wide atrium develops. Remarks. In their type of structure the pollen grains are similar to the recent grains of the European species *Carpinus betulus*. Pollen grains occurring in all profiles, in most cases less than 1%, maximum of frequency 5% in some samples in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

f. *minor*

Pl. 17 figs 1, 2, 3

Pollen grains 3–4-porate, in polar view rounded-triangular or circular in outline, 36–40 μm in diameter; pores situated in the corners of the polygon in the equatorial plane. Exine 1.4 μm thick, sexine thicker than nexine, tectate; tectum surface finely granulate, in places irregularly rugulate; tectum-supporting bacula visible. At pores, exine very delicately turned up; exopore oval, large. In the regions of the pores the nexine disappears and a poorly seen atrium is formed; it is closed by an oval endopore.
Remarks. These pollen grains are similar in structure to the grains of *Carpinus orientalis* from south-eastern Europe and Asia Minor and to *Carpinus cordata* from Japan and south-eastern Asia. Pollen grains occur in all investigated profiles, but rather less than 1%.

Fagaceae

Castanea Mill. – *Castanopsis* (D. Don) Spach.

The pollen grains of *Castanea* and *Castanopsis* have a very similar morphological structure (inter alios, Kedves 1982, Jones 1986). A comparison of pollen grains of *Castanea* (*C. vesca, C. henii, C. seguiniy*) and *Castanopsis* (*C. chrysophylla, C. nepalensis*) shows that they differ merely in their more or less psilate exine, all the other characters of the structure of grains being identical.

Two fossil subspecies, differing in size, *Tricolporopollenites cingulum ssp. pussillus* and *Tricolporopollenites cingulum ssp. oviformis* have been distinguished in the material under study. In the diagram the pollen grains of *Castanea* and *Castanopsis* are presented in one group.

Tricolporopollenites cingulum (Potonié 1931) Thomson et Pflug 1953 ssp. *pussillus* (Potonié 1934) Thomson et Pflug 1953

Pl. 18 figs 9a, b

1934. *Pollenites quisqualis pusillus* n. f.; Potonié, p. 71, Pl. 3, fig. 21.
1953. *Tricolporopollenites cingulum* (Potonié) n. comb. subsp. *pusillus* (Potonié) n. comb.; Thomson et Pflug, p. 100, Pl. 12, figs 28–41.

Remarks. Pollen grains 22.5–25 × 19–15 μm in size, occur in all profiles mostly less than 1%.

Tricolporopollenites cingulum (Potonié 1931) Thomson et Pflug 1953 ssp. *oviformis* (Potonié 1931) Thomson et Pflug 1953

Pl. 18 fig. 8

1931a. *Pollenites oviformis* n. sp.; Potonié, p. 328, Pl. 1, fig. 20.
1953. *Tricolporopollenites cingulum* (Potonié) n. comb. subsp. *oviformis* (Potonié) n. comb.; Thomson et Pflug, p. 100, Pl. 12, figs 42–49.

Remarks. Pollen grains 17.5–20 × 9–11 μm in size, were found only sporadically in all profiles.

Fagus L.

The pollen grains of the fossil species *Faguspollenites verus* have been divided into two morphological types: thick-walled with a coarsely granulate surface and thin-walled with a delicately granulate surface, occurring sporadically.

Faguspollenites Raatz 1937
Faguspollenites verus Raatz 1937

1937. *Fagus-pollenites verus* n. sp.; Raatz, p. 23, Pl. 1, fig. 17.

Faguspollenites verus Raatz 1937 – type 1

Pl. 18 fig. 10

Remarks. In structure the pollen grains resemble recent *F. sylvatica* and *F. longipetiolata*. Only some pollen grains of this species were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Faguspollenites verus Raatz 1937 – type 2

Pl. 18 figs 11a, b

Remarks. In structure the pollen grains resemble the recent species: *Fagus orientalis* from the territory of Asia Minor and the Caucasus as well as *F. ferruginea* form North America. Pollen grains occur rarely in all profiles, in most cases less than 1%, more frequently in some samples in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles (4%).

Quercus L.

Within the genus *Quercus* numerous species (*Q. robur*, *Q. libani*, *Q. ilex*, *Q. lineata*) are characterized by pollen grains with a granulate-scabrate sculpture, while the other group has pollen grains with a scabrate-verrucate sculpture, mostly with a thick tectum (among others, *Q. pontica*, *Q. serrata*, *Q. ilicifolia*) (cf. Benthem and Punt, 1984). Besides, there are no fairly distinct differences in the structure of grains between the recent species.

Much morphological variety in pollen grains of *Quercus* was observed in the fossil material under study. Two groups of grains have been distinguished: granulate-scabrate

and scabrate-verrucate, and within these groups three fossil species: *Quercoidites henrici*, *Tricolpopollenites pudicus*, *Tricolpopollenites asper* (collective species) and 4 morphological types.

Pollen grains with granulate-scabrata sculpture, exine thickness from 1 to 1.5 μm:

Quercoidites henrici (Potonié 1931) Potonié, Thomson, Thiergart 1950

Pl. 18 fig. 13

1931a. *Pollenites henrici* n. sp.; Potonié, p. 332, Pl. 2, fig. 19.
1950. *Quercoidites henrici*, Potonié; Potonié in: Potonié, Thomson, Thiergart, p. 54, Pl. B, figs 22–23.

Remarks. Pollen grains were found rarely in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolpopollenites asper Thomson et Pflug 1953

Pl. 18 fig. 14

1953. *Tricolpopollenites asper* n. sp.; Thomson et Pflug, p. 96, Pl. 11, figs 43–49.

Remarks. Pollen grains were found frequently in all profiles, particularly often in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles where attain 15%.

Tricolpopollenites pudicus (Potonié 1934) Thomson et Pflug 1953

Pl. 18 fig. 15

1934. *Pollenites confinis* f. *pudicus* n. sp.; Potonié, p. 90, Pl. 5, figs 12–13.
1953. *Tricolpopollenites pudicus* (Potonié 1934) n. comb.; Thomson et Pflug, p. 95, Pl. 11, figs 27–29.

Pollen grains tricolpate, prolate, measuring 50 × 35 μm. Colpi narrow, parallel to polar axis and going deep into polar area. Exine two-layered, 1.3 μm thick tectate. Tectum surface coarsely granulate; tectum-supporting bacula visible in lower optical section.

Remarks. Only some pollen grains of this species were found in the Rawicz Beds (Lower Miocene) of the Liszkowo prolile and the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Quercus L. – type 1

Pl. 18 fig. 12

Remarks. Pollen grains differ from the some previous fossil species belonging to *Quercus* in shape, in thine exine, in very delicate granulate surface. Pollen grains occur sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Pollen grains with scabrate-verrucate sculpture, exine thickness from 1.5 to 2 μm:

Quercus L. – type 2

Pl. 19 fig. 1

Remarks. Pollen grains differ from the some fossil species belonging to *Quercus* in

distinctly verrucate sculpture. Pollen grains occur rarely in the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles.

Quercus L. – type 3

Pl. 19 figs 3a, b; 4a, b

Pollen grains tricolpate, subprolate, heteropolar, one of polar areas pointed; grains measurements: 34–35 × 25–28 μm. Colpi drawn somewhat aside in equatorial plane and concurring at poles. Distinct loosening of exine, oriented meridionally, in equatorial region of colpi. Exine about 1.6 μm thick; sexine thicker than nexine, tectate; tectum-supporting bacula visible, its surface covered with small, flat verrucae, varying in size and shape, about 1 μm in diameter.

Remarks. The shape and sculpture of grains approach those of *Quercus pontica*, a recent species from the Caucasian region. Only some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Quercus L. – type 4

Pl. 19 fig. 2

Pollen grain tricolpate, subprolate, measuring 34 × 28 μm. Colpi subparallel to polar axis, reaching poles. Loosening of exine, oriented meridionally, occurring in equatorial region of colpi. Exine 2 μm thick, sexine thicker than nexine; tectate. Tectum surface covered with flat microverrucae, varying in size, to 1 μm in diameter.

Remarks. The structure of pollen grains and chiefly their very thick exine with a scabrate-verrucate surface resemble those traits in the recent species *Quercus serrata* from Japan, Korea and China. Some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Kosztowo profile.

Myricaceae

Myrica L.

In the deposits under study the genus *Myrica* is represented by three morphological types of pollen grains: *Myricipites rurensis*, characterized by the presence of a thick annulus around the pores, and *M. bituitus* and *M. rurobituitus*, in which the annuli are small, if present at all. In diagrams they are represented by a single *Myrica* group.

Myricipites Wodehouse 1933

Myricipites rurensis (Pflug et Thomson 1953) Nagy 1969

Pl. 17 figs 6, 7

1953. *Triatriopollenites rurensis* n. sp.; Thomson et Pflug, p. 79, Pl. 7, figs 81–109.

1969. *Myricipites rurensis* (Pflug et Thomson 1953) n. c.; Nagy, p. 245, Pl. LIII, fig. 27.

Pollen grains triporate, in polar view triangular-rounded in outline, 36–40 μm in diameter, with pores disposed regularly in equatorial plane. Exine 1.8–2 μm thick; sexine thicker than nexine, tectate; surface of tectum delicately granulate; at pores exine thicknnes to 2–4 μm, where it forms distinct annuli, surrounding the oval exopores.

Nexine declines in vicinity to the pores and a wide atrium with well-seen granulations develops.

Remarks. In structures the pollen grains come close, among others, to the recent species *Myrica nagy* (NW Himalayas) and to *Myrica salicifolia* (Ethiopia, Demot Prov.). Romanowicz (1962) compares some specimens of *Triatriopollenites rurensis*, distinguished by Thomson and Pflug (1953, Pl. 7, fig. 92), to the pollen of the North America species *Myrica carolinensis*, and others (Pl. 7, figs 84, 89 and 103) to the pollen of the Asiatic species *Myrica rubra*. Pollen grains frequently were found in all profiles.

Myricipites bituitus (Potonié 1931) Nagy 1969

Pl. 17 fig. 9

1931a. *Pollenites bituitus* n. sp.; Potonié, p. 332, Pl. II, fig. 17.
1969. *Myricipites bituitus* (Potonié 1931) n. c.; Nagy, p. 245, Pl. LV, fig. 1.

Pollen grain triporate, in polar view triangular in outline, about 26.5 μm in diameter; pores disposed regularly in equatorial plane. Exine about 1.4 μm thick; sexine thicker than nexine, slightly thickened at pores tectate. Tectum surface granulate. Exopores oval with distinct labrum, nexine declines in vicinity to the pores, giving rise to a wide atrium with granulations; endopores wide-oval.

Remarks. In structure the pollen grains are similar to the grains of the recent species *Myrica gale* (Europe, North America and North Asia). Romanowicz (1962) compares some specimens of the group *Triatriopollenites bituitus* (Thomson et Pflug 1953, Pl. 7, fig. 128) to *Myrica javanica*. Pollen grains occur rarely in all profiles.

Triatriopollenites rurobituitus Pflug 1953

Pl. 17 fig. 8

1953. *Triatriopollenites rurobituitus* n. sp.; Thomson et Pflug, p. 79, Pl. 7, figs 110–115.

Pollen grains triporate, in polar view triangular in outline, 33–36 μm in diameter; pores distributed regularly in equatorial plane. Exine about 1.6 μm thick, sexine thicker than nexine, slightly thickened at pores, tectate. Tectum surface finely granulate. Exopores wide-oval; nexine declines in vicinity to pores and a wide atrium is formed. Endopores wide-oval, with the sexine perceptibly separated from the nexine; distinct granulations present in the region of the atrium.

Remarks. In structure these pollen grains come near, among others, to the recent North America *Myrica cerifera*. Pollen grains occurring sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Juglandaceae

Egelhardtia Leschen – type

Three morphological types of grains have been distinguished, including *Momipites punctatus*, which is most frequently encountered.

Momipites Wodehouse 1933
Momipites punctatus (Potonié 1931) Nagy 1969
Pl. 18 fig. 6

1931a. *Pollenites coryphaeus punctatus* n. f.; Potonié, p. 332, Pl. II, figs 7, 11.
1969. *Momipites punctatus* (Potonié 1931) n. c.; Nagy, p. 246, Pl. LIV, figs 9–10.

Pollen grains triporate, in polar view triangular in outline, 24–31 μm in diameter; pores regularly distributed in equatorial plane, somewhat sunken. Exine 1.4 μm thick; sexine thicker than nexine, not thickened at pores, tectate. Round elements densely distributed on the surface of exine (LO-pattern). Nexine declines in vicinity to pores and a poorly seen, wide, shallow atrium is formed, the wide-oval endopores being poorly seen, too.

Remarks. According to Nagy (1985), the fossil species differs from the pollen grains of *Engelhardtia* in the presence of thick exine. The sculpture of the grains is, however, typical of *Juglandaceae* and the genus *Engelhardtia*. Pollen grains occur regularly in all profiles, mostly less than 1%, occasionally 2–3%, it reaches its maximum in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile where in many samples they attain 5%.

Momipites quietus (Potonié 1931) Nichols 1973
Pl. 18 fig. 7

1931b. *Pollenites quietus* n. sp.; Potonié, p. 556, Fig. 13.
1973. *Momipites quietus* (Potonié 1931) n. c.; Nichols, p. 107.

Pollen grains triporate, in polar view triangular in outline, 21.5 μm in diameter; pores regularly disposed in equatorial plane. Exine 1 μm thick, sexine thicker than nexine, tectate. Numerous round elements perceptible on tectum (LO-pattern). Exopores small, oval; nexine declines in vicinity to pores and a poorly seen atrium is formed.

Remarks. Only some pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Engelhardtioidites Potonié, Thomson, Thiergart 1950; ex Potonié 1960
Engalhardtioidites microcoryphaeus (Potonié 1931) Potonié 1960
Pl. 18 fig. 5

1931a. *Pollenites microcoryphaeus* n. sp.; Potonié, p. 332, Pl. II, fig. 13.
1960. *Engelhardtioidites* (al. *Pollenites*) *microcoryphaeus* (Potonié 1931), Potonié, Thomson, Thiergart 1950; in Potonié, p. 118.

Pollen grains triporate, triangular in outline in polar view, 19–22 μm in diameter; pores regularly distributed in equatorial plane, wide-oval, about 1.5 μm in diameter. A poorly seen, wide atrium develops in vicinity to pores. Exine about 0.9 μm thick, two-layered; sexine thicker than nexine, tectate with granulate surface; characteristic exine folds visible at centre.

Remarks. Only some pollen grains of this species were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Platycarya S. et Z.

Three morphological types distinguished are represented together in a single group in diagrams.

Platycaryapollis Krutzsch 1969
Platycaryapollis semicyclus Krutzsch et Vanhoorne 1977
Pl. 18 fig. 2

1977. *Platycaryapollis semicyclus* n. fsp.; Krutzsch et Vanhoorne, pp. 44, 45, Pl. 20, figs 11–16.

Pollen grains triporate, triangular in outline in polar view, 25 μm in diameter. Pores regularly distributed in corners in equatorial plane and somewhat sunken. Exopores oval, about 2.2 μm in diameter, endopores wide-oval, surrounded by a poorly seen wide atrium. Exine 1.5 μm thick, two-layered, tectate. Exine folds form a characteristic geometric pattern on the surface.

Remarks. Pollen grains occur sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Platycaryapollis sp.
Pl. 18 fig. 4

Pollen grain triporate, in polar view triangular in outline, measuring 14 × 15 μm. Pores regularly distributed in equatorial plane. Exopores very small, atria hardly visible. Exine about 1 μm thick, sexine thicker than nexine, tectate. Exine folds form a geometrical pattern, different on either side.

Remarks. The only pollen grain of this type found in the material under study comes nearest in structure to the recent Chinese species *Platycarya strobilacea*. Only two pollen grains of this species were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Platycaryapollis platycaryoides (Roche 1969) n. comb.
Pl. 18 fig. 3

1969. *Triatriopollenites platycaryoides* n. fsp.; Roche, p. 135, Fig. 6, 7

Pollen grains triporate, in polar view triangular-convex in outline, 25–30 μm in diameter. Pores regularly distributed in equatorial plane. Exine about 1.7 μm thick. Sexine much thicker than nexine, tectate. More or less distinct round elements on tectum surface (LO-pattern). Exopores round, about 2 μm in diameter; nexine declines at pores, giving rise to a poorly seen wide atrium. Thick exine folds form an indistinct geometrical pattern on the surface.

Remarks. Pollen grains occur very rarely in the Mid-Polish Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Juglans L.

Two morphological types have been distinguished: *Juglans* sp. - stephanoporate pollen grains with thick annuli round the pores (frequent in the material studied) and *Multiporopollenites maculosus* - pollen grains multiporate.

Juglans L. – type 1

Pl. 17 fig. 11

Pollen grains multiporate (about 7–10 pores), in polar view-oval in outline, 31–39 μm in diameter. Pores oval, measuring 5 × 2 μm, surrounded by a thick annulus and irregularly distributed on the grain surface. Exine 1.4 μm thick; sexine thicker than nexine, tectate. Tectum surface granulate.

Remarks. Pollen grains occur rarely in all profiles less than 1%, only in one sample in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile it reaches 8%.

Juglans L. – type 2

Multiporopollenites maculosus (Potonié 1931) Thomson et Pflug 1953

Pl. 17 fig. 12

1931d. *Pollenites maculosus* n. sp.; Potonié, p. 28, Pl. II, fig. V, 19d.
1953. *Multiporopollenites maculosus* (Potonié) n. c.; Thomson et Pflug, pp. 94–95, Pl. 10, fig. 95.

Pollen grains multiporate (about 20 pores), circular in outline, 43–50 μm in diameter. Circular pores irregularly distributed all over grain surface, about 2 μm in diameter. Exine 1.4 μm thick; sexine thicker than nexine, tectate, delicate round elements present on its surface (LO-pattern).

Remarks. Only some pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Pterocarya Kunth.

Pterocaryapollenites Raatz 1937

Pterocaryapollenites stellatus (Potonié 1931) Raatz 1937

Pl. 18 fig. 1

1931d. *Pollenites stellatus* n. sp.; Potonié, Pl. II, fig. V, 47b.
1937. *Pterocarya-pollenites stellatus* Potonié; Raatz, p. 18, Fig. 8.

Remarks. Pollen grains occur regularly in all profiles, mostly less than 1%, only in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles several times it reaches 3–8%.

Carya Nutt.

Caryapollenites Raatz 1937 emend. Krutzsch 1961

Caryapollenites simplex (Potonié 1931) Raatz 1937 ex Potonié 1960

Pl. 17 fig. 10

1931c. *Pollenites simplex* n. sp.; Potonié, p. 3, Fig. 4.
1937. *Carya pollenites simplex* Potonié; Raatz, p. 19, Pl. I, fig. 6.
1960. *Caryapollenites simplex* (Potonié 1931) Raatz 1937; in Potonié, p. 123.

Remarks. Pollen grains occur regularly in all profiles, mostly less than 1%, only in the middle parts of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles, it reaches several times 3–4%.

Salicaceae
Salix L.
Salixipollenites Srivastava 1966
Salixipollenites sp.
Pl. 19 figs 5a, b

Remarks. Pollen grains occur regularly in all profiles, mostly less than 1%.

Ulmaceae
Celtis L.

Two fossil species have been distinguished: *Celtipollenites intrastructurus* with triporate grains, of rare occurrence, and *Celtipollenites* fsp. with multiporate grains, frequent.

Celtipollenites Nagy 1969
Celtipollenites intrastructurus (Krutzsch et Vanhoorne 1977)
Thiele-Pfeiffer 1980
Pl. 19 fig. 7

1977. *Subtriporopollenites intrastructurus* n. fsp.; Krutzsch, Vanhoorne, p. 58, Pl. 23, figs 8–11, 15–19.
1980. *Celtipollenites intrastructurus* (Krutzsch et Vanhoorne 1977) n. comb.; Thiele-Pfeiffer, pp. 130–131, Pl. 8, figs 32–33, 34.

Pollen grains triporate, of circular outline in polar view, 30–40 μm in diameter. Pores circular, about 2.5 μm in diameter, with ragged edges and delicately marked annuli, not always distributed in equatorial plane. Exine, about 1.4 μm thick, tectate; its two-layered structure is poorly seen, and so are the tectum-supporting bacula. Surface of tectum granulate or delicately rugulate.
Remarks. Pollen grains occur sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Celtipollenites sp.
Pl. 19 fig. 6

Pollen grains 5–6-porate, in polar view circularly oval in outline, 44–45 μm in diameter; pores 4–5 μm in diameter, distributed inexactly in equatorial plane, with ragged edges and scarcely perceptible thickenings round the pores. Exine about 1 μm thick, sexine thicker than nexine; tectate. Surface of tectum granulate, tectum-supporting bacula densely disposed but poorly seen.
Remarks. Pollen grains occur regularly in all profiles, not exceeding 1%, only in the upper parts of the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles several times it reaches 2–8%.

Ulmus L., *Zelkova* Spach.

Two fossil genera have been distinguished in the descriptive part: *Zelkovaepollenites* (rare) and *Ulmipollenites* (very common).

Zelkovaepollenites Nagy 1969
Zelkovaepollenites potoniei Nagy 1969
Pl. 19 fig. 8

1969. *Zelkovaepollenites potoniei* n. g. n. sp.; Nagy, p. 225, Pl. LI, figs 17, 20.

Remarks. In structure the pollen grains come close to the Caucasian species *Zelkova carpinifolia*. Pollen grains occur rarely in all profiles under examination not exceeding 1%.

Ulmipollenites Wolff 1934
Ulmipollenites undulosus Wolff 1934
Pl. 19 fig. 9

1934. *Ulmi-pollenites undulosus* n. sp.; Wolff, p. 75, Pl. 5, fig. 25.
1953. *Polyporopollenites undulosus* (Wolff) n. comb.; Thomson et Pflug, p. 91, Pl. 10, figs 52–58.

Remarks. The structure of these pollen grains resembles that of the recent species, among others, *Ulmus laevis* and *U. racemosa*. Pollen grains occur regularly in all profiles, mostly attaining 1–3%, only in the upper parts of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles in some samples they attaining 5–12%.

Ulmipollenites sp.
Pl. 19 figs 10a, b

Remarks. These pollen grains are similar to the Japanese species *Ulmus parviflora*. Only some pollen grains of this type were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Eucommiaceae
Eucommia Oliv. – type, sensu Oszast 1960
Pl. 20 figs 1a, b; 2

1960. *Eucommia* aff. *ulmoides* n. spm.; Oszast, p. 22, Pl. VII, figs 17–19, 21, Pl. VIII, figs 1, 3.

Remarks. The pollen grains of this taxon break up into two morphological forms: one, measuring 27 × 36 μm, with pores weakly marked as a thinning of exine, and the other, measuring 30 × 44–45 μm, with more distinct, meridionally elongate pores. The size of pollen grains of *Eucommia ulmoides* from China is 31 × 42 μm (Erdtman 1952). Pollen grains of this species occur in some samples in the Mid-Polish Beds (Middle Miocene) of the Kosztowo and Karolewo-Dąbki profiles not exceeding 1%.

Loranthaceae
Arceuthobium Bieb.
Spinulaepollis Krutzsch 1962
Spinulaepollis arceuthobioides Krutzsch 1962
Pl. 20 figs 3a, b

1962a. *Spinulaepollis arceuthobioides* n. fsp.; Krutzsch, p. 278, Fig. 7, Pl. VI, figs 1–15.

Remarks. The pollen grains resemble recent *Arceuthobium oxycedri* in structure. Pollen grains of this species occur very rarely in the profiles under examination not exceeding 1%.

Polygonaceae
Polygonum L.
Persicarioipollis Krutzsch 1962
Persicarioipollis pliocenicus Krutzsch 1962
Pl. 20 fig. 6

1962a. *Persicarioipollis pliocenicus* n. fsp.; Krutzsch, p. 284, Pl. IX, figs 18–25.
1964. *Polygonum "persicaria"* L. – type; Stuchlik, p. 42, Pl. XIII, fig. 14.

Remarks. In structure this pollen grain approaches the recent species of *Polygonum caespitosum, P. japonicum* and *P. perfoliatum* (cf. Huang 1972). Only some pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Persicarioipollis cf *lusaticus* Krutzsch 1962
Pl. 20 fig. 7

1962a. *Persicarioipollis lusaticus* n. fsp.; Krutzsch, p. 284, Pl. IX, figs 13–17.

Remarks. The pollen grain is similar to *Polygonum lapathifolium* (cf. Huang 1972, Pl. 120; figs 15–17). Out of the fossil taxa only *P. lusaticus* Krutzsch has a reticulum of a similar type of structure (undulate, simplibaculate muri), but it differs from the grain from Karolewo-Dąbki in smaller lumina of the reticulum. Only single pollen grain of this species encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Chenopodiaceae
Chenopodipollis Krutzsch 1966
Chenopodipollis neogenicus Nagy 1969
Pl. 20 figs 12a, b

1969. *Chenopodipollenites neogenicus* n. sp.; Nagy, p. 215, Pl. L, figs 9, 10.

Remarks. Pollen grains of this species occur rarely less than 1%, only several times in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Rawicz Beds (Lower Miocene) of the Liszkowo profile attain 3–5%.

Orapollis Krutzsch 1966
Orapollis potsdamensis Krutzsch 1966
Pl. 20 fig. 4

1966. *Orapollis potsdamensis* n. fgen. et fsp. -n. c.; Krutzsch, p. 34, Pl. VII, figs 11–21.

Remarks. Pollen grains similar in structure occur in the families *Alismataceae, Chenopodiaceae* and *Caryophyllaceae* (Krutzsch 1966). Only single pollen grain of this species encountered in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Caryophyllaceae vel *Amaranthaceae* ?
Pl. 20 fig. 5

Remarks. Only some pollen grains of this type were found in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Hamamelidaceae
Liquidambar L.
Liquidambarpollenites Raatz 1937
Liquidambarpollenites styracifluaformis Nagy 1969
Pl. 20 figs 11a, b

1969. *Liquidambarpollenites styracifluaeformis* n. sp.; Nagy, p. 404, Pl. XLI, figs 13, 20.

Pollen grains multiporate, circular in outline, 36–37 μm in diameter; pores circularly oval, with ragged edges, 4.5–5 μm in diameter, covered with membrane; granulations visible on membrane surface. Exine about 1.8 μm thick, sexine thicker than nexine, semitectate, reticulate; reticulum made up of small round lumina, up to 1 μm diameter, enclosed by muri, 0.6–0.8 μm wide, built of tifgtly standing bacula, about 0.6 μm in diameter.

Remarks. Nagy (1969) compares the fossil taxon with the recent North American *Liquidambar styraciflua*. Pollen grains were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Liquidambarpollenites orientaliformis Nagy 1969
Pl. 20 fig. 8

1969. *Liquidambarpollenites orientaliformis* n. sp.; Nagy, pp. 403, 404, Pl. XLII, figs 1–2.

Pollen grains multiporate, circular in outline, 44–50 μm in diameter; pores oval, measuring 9 × 6 μm, with ragged edges, covered with membranes; granulations present on membrane surface. Exine about 1.5 μm thick, sexine thicker than nexine, semitectate, reticulate; lumina of reticulum small, round, 0.6–1 μm in diameter; muri, 0.9 μm wide, formed by one row of bacula, about 0.6 μm in diameter.

Remarks. The species comparable with *Liquidambar orientalis* from Asia Minor (Nagy 1969). Pollen grains occur rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Liquidambarpollenites stigmosus (Potonié 1931) Raatz 1937
Pl. 20 fig. 9

1931a. *Pollenites stigmosus* n. sp.; Potonié, p. 332, Pl. 2, fig. 1.
1937. *Liquidambarpollenites stigmosus* (Potonié) n. comb.; Raatz, p. 17, Fig. 26.

Pollen grains multiporate, circular in outline, 33–39 μm in diameter; pores oval, measuring 6 × 4.8 μm, with ragged, protruding edges, covered with membrane, which has a granulate surface. Exine 1.7 μm thick, sexine thicker than nexine, semitectate, reticulate. Sexine composed of densely standing bacula, which form a reticulum of very small round lumina, 0.6 μm in diameter, separate by 0.6 μm thick muri.

Remarks. In Ziembińska-Tworzydło's opinion (1974), similar pollen grains occur in recent *Liquidambar*, but also in *Altingia* and *Sycopsis*. Pollen grains rarely encountered in all profiles.

Liquidambarpollenites formosanaeformis Nagy 1969

Pl. 20 fig. 13

1969. *Liquidambar formosanaeformis* n. sp.; Nagy, pp. 404, 405, Pl. XLI, figs 9, 14.

Pollen grains multiporate, circular in outline, 39 μm in diameter; pores irregularly distributed all over grain surface, oval, relatively large, measuring 6–8 × 4.8–6 μm and covered with granulate membrane. Exine 1.6 μm thick, sexine thicker than nexine, semitectate, reticulate; built of densely disposed bacula which form a reticulum of small round lumina, about 0.6 μm in diameter, separated by muri, about 0.6 μm thick.

Remarks. This species resembles recent *Liquidambar formosana* (Nagy 1969). Only two pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Corylopsis S. et Z.

Corylopsis S. et Z. – type, sensu Oszast 1960

Pl. 20 figs 10a, b

1960. *Corylopsis* sp.; Oszast, p. 24, Pl. VIII, figs 6, 8–10.

Remarks. In structure this pollen grain comes near to recent *Corylopsis spicata*, but its shape is more elongate. Pollen grains occur rarely in all profiles in quantities less than 1%.

Magnoliaceae

Liriodendron L.

Liriodendroipollis Krutzsch 1970

Liriodendroipollis verrucatus Krutzsch 1970

Pl. 21 figs 3–4

1970a. *Liriodendroipollis verrucatus* n. sp.; Krutzsch, p. 142, Pl. 37.

Pollen grains monocolpate, elongate, oval in outline, measuring 56–73 × 37–50 μm. Exine about 1 μm thick, sexine thicker than nexine, made up of densely distributed bacula, which in the upper part form the incomplete perforate tectum; perforations, about 0.7 μm in diameter, densely distributed. Tectum surface with numerous verrucae, 2–2.5 μm in diameter and about 2 μm high, with larger verrucae occurring sparsely among them, about 5 μm in diameter and 3 μm in height.

Remarks. Fossil species similar to North America *Liriodendron tulipifera* (Krutzsch 1970c). Pollen grains occuring rarely in all profiles in quantities not exceeding 1%. Only in the Adamów Beds and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles they occur in many samples but also less than 1%.

Liriodendroipollis verrucatus Krutzsch 1970 f. *major*

Pl. 21 fig. 1

1970c. *Liriodendroipollis verrucatus* n. sp.; Krutzsch, p. 142, Pl. 37.

Pollen grains monocolpate, circularly elongate in outline, 75–88 × 63–68 μ size. Exine about 1 μm thick; sexine thicker than nexine, composed of close-set bacula, which in the upper part form the incomplete, perforate tectum; perforations numerous,

about 0.7 μm in diameter. Tectum surface covered with sparsely distributed big verrucae, about 6 μm high and 5–7 μm in diameter; smaller verrucae, about 2 μm in diameter and about 1.5 μm in height are thinly scattered among them.

Remarks. The pollen grains of the same structure as in *Liriodendroipollis verrucatus* Krutzsch, but their verrucae, thinly distributed on the surface of the grain, are much bigger. Pollen grains encountered very rarely in the Adamów and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Liriodendroipollis semiverrucatus, semiverrucatus Krutzsch 1970

Pl. 21 fig. 2

1970c. *Liriodendroipollis semiverrucatus, semiverrucatus* n. sp. et subsp.; Krutzsch, p. 138, Pl. 35, figs 1–9.

Pollen grains monocolpate, ellipsoid in outline, measuring 69–73 × 41.4–45 μm. Colpus long, on distal side. Exine about 1.6 μm thick, sexine thicker than nexine, composed of close-set bacula, which in the upper part form the incomplete tectum with densely distributed, very fine perforations, 0.6–0.8 μm in diameter. Flat verrucae, 2–3.5 μm in diameter, cover the whole of the grain surface.

Remarks. This species resembles *Liriodendron chinense* (Krutzsch 1970c). Only some pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Adamów Beds (Middle Miocene) of the Kosztowo profile.

Magnolia L.

Magnolipollis Krutzsch 1970

Magnolipollis neogenicus minor, Krutzsch 1970

Pl. 21 fig. 8

1970c. *Magnolipollis neogenicus minor* n. subsp.; Krutzsch, p. 134, Pl. 33, figs 11–17.

Pollen grain monocolpate, ellipsoid in outline, measuring 50 × 25 μm; colpus long on distal side. Exine 0.9–1.0 μm thick, tectate, tectum surface coarsely granulate; two-layered of exine poorly seen.

Remarks. Pollen grains encountered very rarely in quantities not exceeding 1% in the Rawicz Beds (Lower Miocene) of the Liszkowo profile and in the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles.

Magnolipollis cf neogenicus minor Krutzsch 1970

Pl. 21 fig. 7

1970c. *Magnolipollis neogenicus minor* n. subsp.; Krutzsch, p. 134, Pl. 33, figs 1–8, 18.

Pollen grain monocolpate, ellipsoid in outline, measuring 50 × 31 μm; colpus long on distal side. Exine 1.2 μm thick. Sexine thicker than nexine, composed of poorly seen thin bacula and fairly thick tectum; irregular granulations, with perforations among them are seen on its surface.

Remarks. Pollen grains with thick perforate tectum, coearsely granulate surface and with type of structure characteristic of pollen grains of recent *Magnolia*. Some grains of

Magnolipollis neogenicus minor (Krutzsch 1970c, Pl. 33, figs 1–8, 18) have a similar general habit, but differ in thicker exine with dense perforation on its surface. Only same pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Magnolipollis cf *magnolioides* Krutzsch 1970
Pl. 21 fig. 9

1970c. *Magnolipollis magnolioides* n. sp.; Krutzsch, p. 124, Pl. 28.

Pollen grain monocolpate, ellipsoid in outline, measuring 56 × 29 μm. Exine about 1.6 μm thick; sexine thicker than nexine, composed of close-set bacula, covered with thick tectum. Tectum surface is coarsely granulate and densely perforate.
Remarks. The type of structure is similar to that in the pollen grains of *Magnolipollis magnolioides*, except for exine, which is somewhat thicker. Pollen grains of recent *Magnolia acuminata*, with thick exine, coarsely granulate surface and numerous small perforations, are very similar. Only two pollen grains of this type encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Nymphaeaceae
Nymphaea L. – type
Pl. 22 fig. 1

Remarks. Pollen grains occurring very rarely in all profiles in quantities less than 1%.

Rosaceae
Spiraea L. – type
Pl. 22 fig. 5

Pollen grains tricolporate, circular in polar view, 21.4 μm in diameter. Colpi with ragged edges, widely cutting into apocolpium; apocolpium about 6 μm in diameter. Exine 1.2 μm thick; sexine thicker than nexine, tectate, with coarsely granulate surface.
Remarks. The morphological type characteristic among others, of *Spiraea* and *Pyracantha*. Some pollen grains of this types were found in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Rubus L. – type 1
Pl. 22 fig. 2

Pollen grain tricolporate, prolate, 45 × 28 μm in size. Colpi extending along polar axis of grain, in equatorial region undulate. Exine 1.8 μm thick; sexine thicker than nexine, semitectate. Tectum falling into striae less than 0.5 μm in thickness, subparallel or slanting to grain axis; in places poorly seen reticulum.
Remarks. The morphological type characteristic, among others, of *Rubus* and *Crataegus*. Only two pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Rubus L. – type 2

Pl. 22 figs 4a, b

Pollen grain tricolporate (?), prolate, measuring 44 × 29 μm. Colpi extending along polar axis of grain, with their edges drawn slightly apart and undulate in equatorial region; they do not reach the poles. Exine 1.6 μm thick; sexine thicker than nexine, semitectate. Tectum striated, striae subparallel to grain axis.

Remarks. The morphological type characteristic of some species of *Rubus*, especially of *Rubus xanthocarpus*. Only some pollen grains of this type were encountered in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Crataegus L. – type

Pl. 22 fig. 3

Pollen grain tricolporate, in polar view triangular-rounded in outline, 40–50 μm in diameter. Colpi with ragged edges, cutting deep into polar area, join together below the pole, forming apocolpium, which has an outline of the three-armed mark. Exine 1.7 μm thick; sexine thicker than nexine, formed by very thick tectum and tectum-supporting bacula. Tectum surface granulate and perforate.

Remarks. The morphological type characteristic of some species of *Crataegus*, among others, *Crataegus submollis*. Pollen grains occurring rarely in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile and in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Saxifragaceae

Itea L.

Iteapollis Ziembińska-Tworzydło 1974

Iteapollis angustiporatus (Schneider 1965) Ziembińska-Tworzydło 1974

Pl. 21 figs 5–6

1965. *Psilodioporites angustiporatus* n. sp.; Schneider, p. 205, Pl. I, fig. 10.

1974. *Iteapollis angustiporatus* comb. n.; Ziembińska-Tworzydło, p. 402, Pl. figs 2, 3.

Remarks. The pollen grains of *Iteapollis* are similar to recent *Itea* from the family *Saxifragaceae* (Sadowska 1973; Ziembińska-Tworzydło 1974). Pollen grains occurring rarely in the Mid-Polish Beds (Middle Miocene) in all profiles not exceeding 1%, in single sample it reaches 2% in the upper part in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Leguminosae – type

Two groups of sporomorphs have been distinguished. The first of them includes tricolpate pollen grains, with delicately marked pores or without any; their polar axis does not exceed 25 μm, surface psilate or granulate. Five morphological types have been separated here, among them two fossil species *Tricolpopollenites libranensis* Thomson (1959) Thomson et Pflug 1953 and *Tricolpopollenites quisqualis* Potonié 1934, which differ in shape, exine thickness and the presence or lack of pores.

Among the recent genera from the family *Leguminosae* mentioned in the Morpho-

logy of Pollen Chinese Plants by Fu-Hsung & Nan-Feng (1960) and Pollen Flora of Taiwan by Huang (1972) a similar structure of pollen grains characterizes, among others, such species as *Caragana arborescens*, *Cladrostis wilsonii*, *Maackia amurensis*, *Piptanthus concolor* (Fu-Hsung & Nan-Feng 1960, Pls. LVIII, LIX), *Clotolaria usaramoensis*, *C. albida* (Huang 1972, Pls. 97, 98) and *Ormosia eliptica* (collection of the Museum of the Earth).

The second group consists of tricolpate or tricolporate pollen grains, whose polar axis ranges from 30 to 50 μm, colpi have thick edges and exine is about 2 μm, with varied sculpture. Out of the recent genera of *Leguminosae*, similar species are, among others, *Desmodium elegans*, *Cassia glauca* and *Laucaena glauca* (Fu-Hsung & Nan-Feng 1960 Pl. LVII and LVIII).

Group I: polar axis of pollen grains ranging to 25 μm:

Tricolpopollenites liblarensis (Thomson 1950) Thomson et Pflug 1953

Pl. 22 figs 7, 8

1950. *Pollenites liblarensis* n. spm., Thomson in: Potonié, Thomson, Thiergart, p. 55, Pl. B, figs 26, 27.
1953. *Tricolpopollenites liblarensis* (Thomson) = *quisqualis* Potonié n. comb. subsp. *liblarensis* (Thomson) n. c.; Thomson et Pflug, pp. 96–97, Pl. 11, figs 111–132.

Remarks. Thomson and Pflug (1953) compare this fossil species to *Cupuliferae*, taking at the same time into consideration suggestions made by Thiergart and other authors on the belonging of this group of pollen grains to the family *Leguminosae*. Pollen grains occur very rarely in all profiles in quantities less then 1%, once it reaches its maximum 3% in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Tricolpopollenites quisqualis Potonié 1934

Pl. 22 figs 9a, b

1934. *Pollenites quisqualis* n. sp.; Potonié, pp. 70–71, Pl. 3, figs 13–16.

Remarks. These pollen grains are similar to the recent species *Maackia amurensis* (Fu-Hsung & Nan-Feng 1960, Pl. LIX, figs 6, 6a). Pollen grains encountered rarely in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Tricolpopollenites sp. 1

Pl. 22 figs 10a, b

Pollen grain tricolporate, prolate spheroidal, 24 × 15 μm in size. Colpi running parallel along polar axis, distinctly undulate in equatorial belt. Exine about 1.3 μm thick, two-layered tectate; its surface psilate.

Remarks. Some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 1

Pl. 22 figs 13a, b

Pollen grains tricolporate, prolate spheroidal, 16 × 13 μm in size. Colpi situated par-

allel along polar axis, pores very small, oval, in the middle of colpi. Exine two-layered, about 1 μm thick, tectate; its surface psilate.
Remarks. Pollen grain similar to the recent species *Cladrastis wilsonii* (cf. Fu-Hsung & Nan-Feng 1960, Pl. LVIII, figs 11a, 11b). Only some pollen grains of this type encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 2
Pl. 22 fig. 11

Pollen grains tricolporate, prolate-spheroidal, 21.5 × 15 μm in size. Colpi bent outwards in equatorial belt and converging at poles; pores in the middle of colpi, round, with ragged edges. Exine about 1.3 μm thick, two-layered; sexine as thick as nexine, tectate, tectum surface being psilate or delicately granulate.
Remarks. The pollen grain similar to the pollen grains of the recent species *Ormosia eliptica* from South-Eastern Asia. Only some pollen grains of this type were found in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Group II: polar axis of pollen grains ranging from 25 to 50 μm:

Tricolpopollenites sp. 2
Pl. 22 fig. 12

Pollen grains tricolpate, prolate, 31.4–34 × 17.5–20 μm in size. Colpi, with lightly undulate edges, extend parallel along the polar axis. Exine about 1.7 μm thick; sexine aqual in thickness to nexine, tectate; tectum surface psilate or delicately granulate.
Remarks. Pollen grains rarely found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 3
Pl. 22 fig. 15

Pollen grains tricolporate, prolate, 25 × 15 μm in size. Colpi converging at poles, pores small, round, in the middle of colpi. Exine 1.8 μm thick, two-layered; sexine thicker as nexine, tectate; tectum-supporting bacula visible, its surface psilate or delicately granulate.
Remarks. Pollen grains occur only sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Rawicz Beds (Lower Miocene) of the Liszkowo profile.

Tricoloporopollenites sp. 4
Pl. 22 fig. 6

Pollen grains tricolporate, prolate spheroidal, with rounded poles and measurements: 24 × 18 μm. Colpi situated parallel with polar axis, without converging at poles; pores small, round in the middle of colpi. Exine 1.2 μm thick; sexine thicker than nexine, tectate. Tectum surface psilate or delicately granulate.

Remarks. Two pollen grains of this type of morphology were found in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 5

Pl. 22 fig. 14

Pollen grain tricolporate, prolate spheroidal, with rounded poles and measurements: 41.5 × 30 μm. Colpi parallel with polar axis; pores in the middle of colpi, distinctly, meridionally elongate. Exine about 1.3 μm thick; sexine thicker than nexine, tectate. Tectum-supporting bacula distinct, its surface covered with poorly seen granulations.
Remarks. Only one pollen grain of this type was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 6

Pl. 22 fig. 16

Pollen grains tricolporate, subprolate, measurements: 50 × 44 μm. Colpi converging at poles, bent outwards in equatorial belt; indistinct pores with ragged edges in the middle of colpi. Exine about 2 μm thick, sexine thicker than nexine, tectate; tectum very thick (its thickness equals the layer of bacula and nexine). Tectum surface covered with flat verrucae.
Remarks. Pollen grains very rarely encountary in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 7

Pl. 23 figs 1a, b

Pollen grains tricolporate, prolate, with rounded poles and measurements: 41 × 28 μm. Colpi with thick edges extending parallel with polar axis, bent somewhat outwards in equatorial belt; pores, equatorially elongate, with ragged edges, in the middle of colpi. Exine about 1.8 μm thick; sexine as thick as nexine, tectate; tectum surface coarsly granulate.
Remarks. A similar morphological type of pollen grains, described as *Leguminosae* t. *Cassia*, was found in Neogenic deposits from Podhale (Oszast and Stuchlik 1977). In structure the pollen grains approach *Cassia* (cf. Huang, 1972, Pl. 87). Pollen grains very rarely encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 8

Pl. 23 fig. 2a, b, c

Pollen grains tricolporate, subprolate, measuring 45–46.5 × 34–36.5 μm. Colpi converging at poles, bent outwards in equatorial belt; meridionally elongate pores with ragged edges in the middle of colpi. Exine about 2 μm thick; sexine thicker than nexine, tectate. Tectum thick (its thickness equal to the layer of bacula and nexine), supported by densely distributed bacula.
Remarks. Pollen grains very rarely encountary in the Ścinawa Beds (Lower Miocene)

of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Tricolporopollenites sp. 9

Pl. 23 fig. 3a, b

Pollen grain tricolporate, oval in equatorial view, measuring 51.6 × 44 μm. Colpi with thick ragged edges, converging at poles and bent outwards in equatorial belt; pores, also with ragged edges in the middle of colpi. Exine about 2.4 μm thick; sexine thicker than nexine, with very thick, fragmentary tectum, propped by densely distributed bacula.

Remarks. Only two pollen grains of this type were found in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Elaeagnaceae

Hippophaë rhamnoides L. – type

Slowakipollis Krutzsch 1962

Slowakipollis cf. *neogenicus* Nagy 1969

Pl. 23 fig. 7

1969. *Slowakipollis neogenicus* n. sp.; Nagy, pp. 174–175, Pl. XLII, figs 3–4.

Pollen grains tricolporate, in polar view circular in outline, about 31.5 μm in diameter. Colpi narrow, short; apocolpium, about 8 μm in diameter, is formed. Exine about 1.8 μm thick with very thick tectum, its surface covered with sparsely scattered, flat verrucae; sexine thicker than nexine, densely distributed bacula, about 0.6 μm in diameter, visible in sexine. Pores disposed in equatorial plane of grain. The thickenings sexine which form the edges of the colpi, protrude beyond the equatorial outline. Pores oval, 4.5 μm in diameter, equatorially elongate and surrounded with strongly thickened nexine.

Remarks. In structure the grain approaches *Hippophaë rhamnoides* (cf. Stachurska et al. 1970). Out of the fossil species, *Slowakipollis neogenicus* (Nagy 1969) is most similar, whereas *S. hippophaeoides* described by Krutzsch (1962a) has a different structure. Only two pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Elaeagnus angustifolia L. – type

Slowakipollis cf. *elaeagnoides* Krutzsch 1962

Pl. 23 fig. 5

1962a. *Slowakipollis elaeagnoides* n. fsp.; Krutzsch, p. 274, Pl. IV, figs 16–23, Fig. 3b.

Pollen grains tricolporate, in polar view triangular-rounded in outline, about 37 μm in diameter. Colpi narrow, short; apocolpium, about 18 μm in diameter. Pores at corners of triangle, equatorially elongate, measuring 6 × 4.3 μm. Exine about 1.4 μm thick, sexine thicker than nexine, nexine distinctly thicked in the region of the pores. Exine lightly undulate, with psilate or granulate surface.

Remarks. The pollen grain resembles *Elaeagnus angustifolia* (cf. Stachurska et al.

1970, Pl. 163) in structure. As regards the fossil species, *Slowakipollis elaeagnoides* Krutzsch 1962a comes nearest to it, but it has distinctly triangular pollen grains, whereas the grain from Karolewo-Dąbek is triangular-rounded. Pollen grains of this type were found several times in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Elaeagnus L. – type
Pl. 23 fig. 6

Pollen grains tricolporate, in polar view triangular-rounded, 28 µm in diameter. Colpi narrow, short, apocolpium about 9 µm in diameter. Pores, 4 × 2 µm in size, equatorially elongate, placed in corners of triangle. Exine, 1.6 µm thick; sexine thicker than nexine, tectate, surface densely covered with verrucae, about 2 µm in diameter and 1.0–1.4 µm in height. In the regions of the pores the sexine is lightly turned outwards and thinner, the nexine being thicker.

Remarks. The pollen grain resembles *Elaeagnus angustifolia*, especially in pore structure and differs only in its smaller size and verrucate sculpturte. Only two pollen grains of this species were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Elaeagnus glabra Thunb. – type
Pl. 23 figs 4a, b

Pollen grains tricolporate, in polar view circular in outline, about 50 µm in diameter. Colpi narrow, short; apocolpium about 10 µm in diameter. Pores, 7.3 × 4.6 µm in size, equatorially elongate, distributed in equatorial plane of grain. Exine about 1.5 µm thick; sexine thicker than nexine with perforate tectum, composed of close-set bacula, about 0.6 µm in diameter, irregularly coalesced and forming thick ridges, 1–1.7 µm in diameter, and round or canalicular openings, about 0.7 µm in diameter.

Remarks. The structure of the pores and shape as in the pollen grains of *Elaeagnus glabra* (cf. Huang, 1972, Pl. 61, figs 11, 12), the perforate structure of the surface being different. Only single pollen grains of this type were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki proiles.

Trapaceae
Trapa L.
Sporotrapoidites Klaus 1954
Sporotrapoidites illingensis Klaus 1954
Pl. 24 figs 1a, b,

1954. *Sporotrapoidites illingensis* n. sp.; Klaus, pp. 114–131, Fig. 7, p. 122, Pl. 1, figs 1–3.

Remarks. The pollen grains are very similar to *Trapa*. According to Ziembińska-Tworzydło (1974), this fossil species is characteristic of the upper Middle-Polish Beds of South-Western Poland. Pollen grains occur only sporadically only in the upper part of the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profile.

Nyssaceae

Nyssa L.

Nyssapollenites Thiergart 1937

Nyssapollenites kruschi (Potonié 1931) Nagy 1969

1931c. *Pollenites kruschi* n. sp.; Potonié, pp. 2, 3, Fig. 11.

1953. *Tricolporopollenites kruschi* (Potonié 1931) n. comb.; Thomson et Pflug, pp. 103–104, Pl. 13.

1969. *Nyssapollenites kruschi* (Potonié 1934) ssp. *analepticus* (Potonié 1934) n. comb. and ssp. *contortus* (Thomson et Pflug 1953) n. c.; Nagy, p. 409.

Remarks. Pollen grains, very frequent in the profiles studied. Three forms have been distinguished, differing only in size.

Tricolporopollenites kruschi (Potonié 1931) subsp. *analepticus* (Potonié 1931) Thomson et Pflug 1953

Pl. 23 figs 8a, b

1953. *Tricolporopollenites kruschi* (Potonié, 1931) subsp. *analepticus* Potonié 1931) n. comb.; Thomson et Pflug, p. 103, Pl. 13, figs 14–24.

Remarks. Pollen grains 25–30 × 20–28 μm in size. Rare in the profiles examined.

Tricolopropollenites kruschi (Potonié 1931) subsp. *contortus* Thomson et Pflug 1953

Pl. 24 fig. 2

1953. *Tricoloporopollenites kruschi* (Potonié, 1931) subsp. *contortus* n. subsp.; Thomson et Pflug, p. 104, Pl. 13, figs 34–46.

Remarks. Pollen grains 31.5–41 × 25–32.5 μm in size, very frequent in the profiles studied.

Tricolporopollenites kruschi (Potonié 1931) subsp. *rodderenisis* (Thiergart) Thomson et Pflug 1953

Pl. 24 figs 4, 5

1953. *Tricolporopollenites kruschi* (Potonié, 1931) subsp. *rodderensis* Thomson et Pflug, p. 104, Pl. 13, figs 32–33.

Remarks. Pollen grains 45–63 × 39–48 μm in size, frequent in deposits studied.

Nyssapollenites pseudocruciatus (Potonié 1931) Thiergart 1937

Pl. 24 figs 3a, b

1931a. *Pollenites pseudocruciatus* n. sp.; Potonié, p. 328, Pl. I, fig. 10.

1937. *Nyssapollenites pseudocruciatus* (Potonié, 1931) n. comb.; Thiergart, pp. 322–323, Pl. 25, figs 32–34; Pl. 26, fig. 1.

Remarks. The pollen grains differ from *Nyssapollenites kruschi* (Pontié 1931) Nagy 1969 above all in their circular shape and pores with very thick edges, whereas the surface structure is nearly identical. Pollen grains occur only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Oenotheraceae
Corsinipollenites Nakoman 1965
Corsinipollenites oculusnoctis (Thiergart 1940) Nakoman 1965, ssp. *oculusnoctis* Krutzsch 1968

Pl. 26 fig. 1

1940. *Pollenites oculusnoctis* n. sp.; Thiergart, p. 47, Pl. VII, fig. 1.
1965. *Corsinipollenites oculusnoctis* (Thiergart), nov. comb.; Nakoman, p. 156, Pl. VIII, figs 1–5.
1968. *Corsinipollenites oculusnoctis* (Thiergart, 1940) Nakoman 1965, subfsp. *oculusnoctis*; Krutzsch, pp. 770, 787, Pl. I, figs 1, 2.

Remarks. Pollen grains occur only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Corsinipollenites polonicus Krutzsch 1968

Pl. 26 fig. 3

1968. *Corsinipollenites polonicus* fsp. n.; Krutzsch, p. 774, Fig. 2, Pl. I, figs 10–14.

Remarks. Krutzsch (1968) compares this fossil species described by him from Koronowo (Upper Miocene), noted also from the Upper Miocene of Rypin (Stuchlik 1964), to the recent genera *Chamaenerium*, *Lopezia* and *Epilobium*. Only one pollen grain of this species was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Corsinipollenites sp.

Pl. 26 fig. 2

Remarks. Only one pollen grain of this type was found in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Malvaceae – type

Pl. 24 figs 6a, b

Remarks. The pollen grains comes close in structure to the recent genus *Sphaeralcea* from the family *Malvaceae* (Saad 1960). It however differs from both fossil species of *Malvacearumpollis* from the Neogene of Hungary (cf. Nagy 1985). Some pollen grains of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Sterculiaceae
Reevesia Lindl.
Reevesiapollis Krutzsch 1970
Reevesiapollis triangulus (Mamczar 1960) Krutzsch 1970

Pl. 25 figs 6a, b

1960c. *Pollenites triangulus* n. spm.; Mamczar, p. 220, Pl. XIV, fig. 202.
1970a. *Reevesiapollis triangulus* (Mamczar 1960) comb. nov.; Krutzsch, pp. 374–376, Pl. V, figs 19–35; Pl. VI, figs 1–11, 19–41, Pl. VII, figs 1–44, Pl. VIII, figs 1–21.

Remarks. Pollen grains encountered rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles.

Sterculiaceae – Rutaceae
Tricolporopollenites sp. 10.
Pl. 25 figs 4a, b

Remarks. Pollen grains were found sporadically in the Adamów-Beds and the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 11
Pl. 25 figs 5a, b

Remarks. Pollen grains occurring rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tricolporopollenites sp. 12
Pl. 25 figs 3a, b

Remarks. Pollen grains of this type of structure were found rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Kosztowo profiles.

Meliaceae – type
Pl. 25 figs 7a, b, c

Pollen grains tetracolporate, prolate spheroidal, 30 × 29 μm in size. Colpi running subparallel to the polar axis of grain, strongly bent outwards in equatorial plane; pores round, about 2.7 μm in diameter. Exine about 2 μm thick, sexine thicker than nexine, tectate with delicately granulate surface.
Remarks. Pollen grains of similar structure were observed, among others, in *Cedrella glaziorii*, *Dysoxylum cochinchinense*. from the family *Meliaceae*. Pollen grains occurring sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Tiliaceae
Tilia L.
Intratriporopollenites Pflug et Thomson 1953
Tilia platyphyllos Scop. – type
Intratriporopollenites instructus (Potonié 1931) Thomson et Pflug 1953
Pl. 25 figa. 2a, b

1931b. *Tilia-pollenites instructus* n. sp.; Potonié, p. 556, Fig. 9.
1953. *Intratriporopollenites instructus* (Potonié et Venitz) n. comb.; Thomson et Pflug, p. 89, Pl. 10, figs 10–23.

Pollen grains tricolporate, in polar view circular in outline, about 50.5 μm in diameter. Colpi short (brevicolpate); pores in equatorial plane. Exine about 1.9 μm thick; sexine thicker than nexine, tectate. There is a round annulus, 6.0 μm thick, built of nexine around the pore (P. 25 fig. 2a). Tectum surface reticular-foveolate; thickset pila, fused together, with funnel-shaped concavities in the upper part, provide a picture

of "pseudoreticulum", with lumina 1.5–2 μm in diameter (Pl. 25, fig. 2b). The bases of the pila are visible in the lowest optical section.

Remarks. According to Mai (1961), in structure the fossil species approaches the fossil genus *Burretia* from the family *Tiliaceae*, whereas Thiele-Pfeiffer (1980) thinks that *Intratriporopollenites instructus* are pollen grains of *Tilia*. The pollen grains from the region of Wyrzysk are very similar to *Tilia platyphyllos*. Pollen grains occurring frequently in the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles.

Tilia tomentosa Moench – type
Intratriporopollenites sp.
Pl. 25 figs 1a, b, c

Pollen grains tricolporate, brevicolpate, in polar view circular in outline, about 50.5 μm in diameter. Pores in equatorial plane of grain. Exine about 2.3 μm thick, sexine thicker than nexine, tectate; a narrow, equatorially elongate annulus formed of nexine, about 3 μm thick, is present around the pore (Pl. 25, fig. 1a). Tectum surface foveoate. Sexine composed of thickset pila, with big heads and funnel-shaped concavities, which provide a picture of "pseudoreticulum" (Pl. 25, fig. 1b), whose lumina are 1.4–1.8 μm in diameter; only bases of the pila can be seen in the lowest optical section (Pl. 25, fig. 1c).

Remarks. In pore structure and surface sculpture the pollen grain resembles *Tilia tomentosa*. Many species of the genus *Tilia*, among others, *Tilia cordata*, *T. glabra*, *T. japonica*, *T. mongolica* and *T. maximovicziana* have a similar structure of the "pseudoreticulum", but none of them have grains with so narrow, alongate annulus round the pores. Pollen grains occurring sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Aceraceae
Acer L.

The pollen grains included in the genus *Acer* show a very large variety of morphological forms. Three groups of sporomorphs have been distinguished: the first with thin delicate striae, which are characteristic of some recent maples from Asia Minor, Northern China and North America (e.g. *Acer tataricum*, *A. truncatum*, *A. pensylvanicum*); the second group of sporomorphs with distinct long and thick striae characteristic of the Euroasian species (among others, *A. campestre*, *A. platanoides*, *A. pseudoplatanus* and *A. trautvetteri*) and the third group of sporomorphs with irregular wrinkles passing into striae (regulate-striate sculpture).

Aceripollenites Nagy 1969

Group I of sporomorphs:

Acer tataricum L. – *Acer truncatum* Bge. – type
Aceripollenites sp. 1
Pl. 26 figs 4a, b

Pollen grains tricolpate, in equatorial view oval elongate in outline, 31.5 × 22.6 μm in size. Colpi going deep into polar area; exine 1.5 μm thick, sexine nearly as thick as

nexine; semitectate, rugulate-striate. Striae very narrow, arranged mostly meridionally and seperated by thin simplibaculate, lirae, less than 0.5 μm thick; bacula poorly seen.
Remarks. Pollen grains encountered very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Aceripollenites sp. 2
Pl. 26 figs 5a, b

Pollen grains tricolpate, in equatorial view oval elongate in outline, with somewhat pointed poles, 30 × 20 μm in size. Colpi bending outwards in equatorial belt, go deep into polar area. Exine 1.5 μm thick; sexine nearly as thick as nexine; semitectate, striate. Striae arranged mostly meridionally, seperated by lirae, about 0.6 μm thick, supported by one row of well-seen bacula, about 0.5 μm in diameter.
Remarks. Pollen grains encountered very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Group II of sporomorphs:

Acer trautvetteri Medwed. – type
Aceripollenites sp. 3
Pl. 26 figs 6a, b

Pollen grains tricolpate, in equatorial view broadly oval, elongate in outline, poles widely rounded, measurements: 41.5 × 31.5 μm. Colpi running subparallel to the polar axis, weakly bending in equatorial belt and fairly wide apart in polar zone. Exine about 2 μm thick; sexine nearly thicker than nexine; semitectate, striate. Striae arranged slantingly meridionally, separated by thick lirae, about 1 μm thick; lirae supported by one row of bacula, about 0.8 μm in diameter.
Remarks. The form is similar to the pollen grains of the recent Caucasian species *Acer trautvetteri* in shape and very thick, striate sculpture. Only two pollen grains of this type of structure were found in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Acer campestre L. – type
Aceripollenites striatus (Pflug 1959) Thiele-Pfeiffer 1980
Pl. 27 figs 1a, b

1959. *Tricolpo-poll. striatus* n. sp.; Pflug, p. 155, Pl. 16, fig. 13.
1980. *Aceripollenites striatus* (Pflug 1959) n. comb.; Thiele-Pfeiffer, pp. 145–146, Pl. 11, fig. 22–25.

Pollen grains tricolpate, in equatorial view broad oval elongate in outline, poles lightly rounded. Measurements: 49 × 34 μm. Colpi going deep into polar area and lightly bending outwards in equatorial belt. Exine about 2 μm thick; sexine thicker than nexine; semitectate, striate. Striae arranged mostly slantingly meridionally, seperated by long lirae about 1 μm thick; lirae supported by one row of bacula about 0.7 μm in diameter.
Remarks. The size and shape of the pollen grain and its distinct, striate-type sculpture correspond to the traits of *Acer campestre* L. but also indicate its similarity to *A. platanoides* and *A. pseudoplatanus*. *A. campestre* has smaller sporomorphs with more delicate

striae. Some pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Acer platanoides L. – *Acer pseudoplatanus* L. – type
Aceripollenites sp. 4
Pl. 27 figs 2a, b

Pollen grains tricolpate, prolate, with lightly pointed poles. Colpi cutting deep into area; they run along the polar axis of the grain and bent outwards in the equatorial belt. Exine about 2 μm thick; sexine thicker than nexine; semitectate, striate. Striae arranged mostly slantingly meridionally, seperated by long lirae, about 1 μm thick; lirae supported by one row of bacula, about 0.8 μm in dimeter.

Remarks. The size and the structure of long, thick lirae bring these pollen grains close to *Acer platanoides* and *A. pseudoplatanus*. Pollen grains rarely encountered in the Mid-Polish Beds and Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Aceripollenites cf. *reticulatus* Nagy 1969
Pl. 26 fig. 7

1969. *Aceripollenites reticulatus* n. g. n. sp.; Nagy, p. 182, Pl. ?? XLIII ??, figs 10–11.

Pollen grains tricolpate, in polar view circular in outline, about 53 μm in diameter. Colpi wide, cutting deep into polar area, which is about 12 μm in diameter. Exine two-layered, about 2 μm thick; sexine thicker than nexine, semitectate. Tectum composed of irregular wrinkles, passing into striae, striato-reticulate in places; lirae short, arranged slantingly, not always meridionally, about 1.0 μm thick and supported by one row of bacula, about 0.8 μm in dimeter; small lumina of reticulum about 1 μm in diameter are sometimes visible between the lirae.

Remarks. In its short lirae, not always arranged meridionally, and in the presence of reticulum in places, this pollen grain differs from the taxa of the second group of sporomorphos (*Acer campestre-pseudoplatanus-platanoides*), although it much resembles them in general habit and size. It is most similar to *Aceripollenites reticulatus* described by Nagy (1969), from which it however differs in size of sporomorphs: in *Aceripollenites reticulatus* Nagy 1969 sporomorphs are 37 μm in diameter and so considerably smaller than those from the profile at Karolewo-Dąbki. Pollen grains occurring very rarely in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Group III of sporomorphs:

Aceripollenites sp. 5
Pl. 26 figs 8a, b, c

Pollen grains tricolpate, prolate; measurements: 31.5 × 17.6 μm; poles rounded, colpi parallel to polar axis of grain. Exine two-layered, about 1.5 μm thick; sexine thicker than nexine, semitectate. Tectum with irregular wrinkles passing into striae; reticulum perceptible in places. Lirae about 0.5 μm tick, short, running in various directions, sub-

parallel in places; they sometimes form a reticulum with lumina about 0.9 μm in dimeter.

Remarks. Pollen grains occurring sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Aquifoliaceae
Ilex L.
Ilexpollenites Thiergart 1937
Ilexpollenites iliacus (Potonié 1931) Thiergart 1937 f. *medius*
Thomson et Pflug 1953
Pl. 27 figs 3, 4a, b

1931b. *Pollenites iliacus* n. sp.; Potonié, p. 556, Fig. 5.
1937. *Ilex-pollenites iliacus*, Potonié; Thiergart, p. 321, Pl. 25, fig. 30.
1953. *Ilexpollenites iliacus* (Potonié) f. *medius*; Thomson et Pflug, p. 106, Pl. 14, figs 46–60.

Remarks. The pollen grains are similar to *Ilex aquifolium*, *Ilex cymosa* and *Ilex sieboldi*. Pollen grains occurring regularly in all studied profiles.

Ilexpollenites cf. *iliacus* (Potonié 1931) Thiergart 1937 f. *medius*
Thomson et Pflug 1953
Pl. 27 figs 5a, b

1953. *Tricolporopollenites iliacus* (Potonié) f. *medius*; Thomson et Pflug, p. 106, Pl. 14, figs 46–60.

Remarks. Pollen grains are similar to *Ilexpollenites iliacus* by characteristic pila, ending with distict heads. Pollen grains occurring encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ilexpollenites margaritatus (Potonié 1931) Thiergart 1937

1931a. *Pollenites margaritatus* n. sp.; Potonié, p. 332, Pl. I, figs 32–33.
1937. *Ilex-pollenites margaritatus* Potonié – Thiergart, p. 321, Pl. 25, figs 27–29.

The pollen grains are characterized by great morphological diversity. They have been devided into two forms: major and medius.

Ilexpollenites margaritatus (Potonié 1931) Thiergart 1937 f. *major*
Thomson et Pflug 1953
Pl. 27 figs 6a, b

1953. *Tricolporopollenites margaritatus* (Potonié) f. *major*; Thomson, Pflug, p. 107, Pl. 14, figs 64–66.

Remarks. The pollen grains of this taxon differ from *Ilexpollenites iliacus* in shorter, almost straight, and thinner pila. Pollen grains occurring rarely in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ilexpollenites margaritatus (Potonié 1931) Thiergart 1937 f. *medius*
Thomson et Pflug 1953
Pl. 27 figs 7a, b; 8a, b; 9a, b

1953. *Tricolporopollenites margaritatus* (Potonié) f. *medius*; Thomson, Pflug, p. 107, Pl. 14, figs 67–73.

Remarks. The pollen grains of a similar sculpture occur, among others, in *Ilex asprella*, *I. cinerea*, *I. mitis*, *I. olbera*. Pollen grains were frequently found in the Mid-Polish Beds (Middle Miocene) of the Kosztowo and Karolewo-Dąbki profiles.

Cyrillaceae – Clethraceae

Two groups of pollen grains, resembling the recent genera *Cyrilla* and *Clethra*, have been distinguished. The differences in the structure of colpi and pores, clearly seen in the polar aspect of the grain can be to a certain extent used to separate these two genera: the genus *Clethra* generally has its colpi going shallow into the polar area and covered with thin overlaps of exine. On the other hand, the colpi of the genus *Cyrilla* cut deep into the polar area, there being no distinct overlaps of exine above them and the pores. In the equatorial view the grain of *Clethra* shows a colpus with thick edges, is cut across by a narrow pore, whereas in *Cyrilla* the pores are mostly strongly bulged outwards and surrounded by the thick edge of the colpus in the equatorial belt.

Cyrillaceaepollenites (Mürriger et Pflug 1951) Potonié 1960
Cyrilla Gard – type
Cyrillaceaepollenites megaexactus (Potonié 1931) Potonié 1960
Pl. 28 figs 5, 6, 7

1931d. *Pollenites megaexactus* n. sp.; Potonié, p. 26, Pl. 1, figs V 42b.
1953. *Tricolporopollenites megaexactus* (Potonié) n. c. ssp. brühlensis (Thomson) n. c.; Thomson et Pflug; pp. 100–101, Pl. 12, figs 50–57, 74, 75
1960. *Cyrillaceaepollenites* (al. *Pollenites*) *megaexactus* (Potonié 1931) n. c.; Potonié, p. 102.

Pollen grains tricolporate, in equatorial view roundish in outline (Pl. 42, figs 12, 13); measurements: 25 × 30 μm. Colpi with thick edges, reach almost as far as poles, and bend so strongly outwarts in the equatorial belt that the exine forms distinct bulges beyond the outline in the region of the pores. Pores in the middle of colpi, oval, equatorially elongate. Exine about 2 μm thick, sexine thicker than nexine, tectate; tectum surface psilate. In polar view grains, circular in outline (Pl. 28, fig. 5), 30–33 μm in diameter. Colpi cutting in deep, up to four fifths of radius, with lightly thickened edges and weakly marked projections of exine over pores. Exine 1.5 μm thick, sexine thicker than nexine, tectate; grain surface psilate or delicately granulate.
Remarks. In structure these pollen grains approach *Cyrilla racemiflora*. Out of the fossil forms they most resemble those distinguished by Thomson and Pflug (1953, Pl. 12, figs 50–57, 74, 75). Pollen grains occurring frequently in all investigated profiles, mainly 1–3%, it reaches its maximum 15–35% in the upper part of the Ścinawa Beds (Lower Miocene) of the Liszkowo and Kosztowo profiles.

Cyrillaceaepollenites cf. *megaexactus* (Potonié, 1931) Potonié 1960
Pl. 28 fig. 11

1931d. *Pollenites megaexactus* n. sp.; Potonié, p. 26, Pl. 1, fig. V 42b.
1960. *Cyrillaceaepollenites* (al. *Pollenites*) *megaexactus* (Potonié 1931) n. c.; Potonié, p. 102.

Pollen grains tricolporate, subprolate, 29 × 22.6 μm in size, with rounded poles; colpi with thick edges, converging polarly and bent outwards in equatorial plane so that the

exine bulges characteristically in the region of the pores, which are oval, equatorially elongate. Exine 1.5 μm thick, sexine thicker than nexine, tectate; tectum-supporting bacula poorly seen in lower optical section.

Remarks. The pollen grain differs from *C. megaexactus* in shape and in smaller bulges of exine in the region of the pores. Its structure type is similar to the species *Cyrilla racemiflora*. Some pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Clethra L. – type
Cyrillaceaepollenites exactus (Potonié 1931) Potonié 1960
Pl. 28 figs 8, 9, 10

1931d. *Pollenites exactus* n. sp.; Potonié, p. 26, Pl. 1, fig. V 49b[2].
1960. *Cyrillaceaepollenites* (al. *Pollenites*) *exactus* (Potonié 1931) n. c.; Potonié, p. 102.

Pollen grains tricolporate, circular or slightly elongate in outline in equatorial view, with rounded poles; measurements: 20 × 15–20 μm. Colpi forming characteristic bulges at pores in equatorial belt. Exine about 1.3 μm thick; sexine thicker than nexine, tectate; grain surface psilate. In polar view grains circular in outline, 15–20 μm in diameter. Colpi cutting shallow into polar area, with characteristic overlabs of exine.

Remarks. The structure of the colpi and pores of these pollen grains is typical of the recent genus *Clethra*. In all the profiles these grains very often occur together with *Cyrillaceaepollenites megaexactus*.

Tricolporopollenites cf. *clethraceiformis* Nagy 1969
Pl. 28 figs 3a, b; 4a, b

1969. *Tricolporopollenites clethraceiformis* n. sp.; Nagy, pp. 210–211, Pl. XLIX, figs 7–8.

Grain tricolporate, subprolate, with rounded poles; measurements: 19–20 × 17.5–18 μm. Colpi bending strongly outwards in equatorial belt, crossed by narrow oval pores, equatorially elongate. Exine 1.5 μm thick, sexine thicker than nexine, tectate; grain surface psilate.

Remarks. The pollen grains resemble the recent species *Clethra alnifolia*; this is probably the same species as was described by Nagy (1969). Some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Clethraceae vel *Cyrillaceae*
Pl. 28 figs 12, 13

Pollen grains tricolporate, subprolate; measurements: 37 × 31.5 μm. Colpi thick-edged, bending strongly outwards in equatorial plane, pores oval, equatorially elongate. In polar view grain circular in outline, about 34 μm in diameter. Colpi narrow, cutting shallow into apocolpium, which is about 6 μm in diameter. Exine about 1.7 μm thick, projecting characteristically over pores and colpi; sexine thicker than nexine, tectate; grain surface delicately granulate.

Remarks. Pollen grains were found sporadically in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Vitaceae

In addition to the genus *Parthenocissus*, two types of pollen grains have been distinguished: grains representing the morphological type of *Cyphostemma-Cissus* and included in the fossil species *Tricolporopollenites marcodurensis* Pflug et Thomson 1953, and those of the morphological type of *Vitis*.

Vitis L. – type 1

Pl. 28 figs 14a, b

Remarks. Pollen grains similar to *Vitis simpsoni* and *Vitis cordifolia*. Pollen grains occurring sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles.

Vitis L. – type 2

Pl. 28 figs 15a, b

Remarks. Pollen grain similar in structure to *Vitis riparia*. Only two pollen grains of this type were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Parthenocissus Planch. – type
Tricolporopollenites marcodurensis Pflug et Thomson 1953

Pl. 28 figs 16a, b; Pl. 29 figs 1a, b; 2a, b

1953. *Tricolporopollenites marcodurensis* n. sp.; Thomson, Pflug, p. 103, Pl. 13, figs 5–9.

The pollen grains numbered in the fossil species *Tricolporopollenites marcodurensis* show great morphological variability; the traits they have in common are the elongate shape of grains, the thick-edged colpi with round pores and reticulate sculpture. The grains differ in reticulum; there are forms with an irregular delicate reticulum (Pl. 29, fig. 2a, b) and those with a coarse reticulum with thick straight muri and large polygonal lumina (Pl. 28, figs 16a, b; Pl. 29, figs 1a, b).

Pollen grains tricolporate, prolate; measurements: 40–50 × 19–25 μm. Colpi thick-edged, arranged meridionally, subparallel to each other, reaching poles; pores in the middle of colpi, round, about 4 μm in diameter, with costae colpi. Exine about 2 μm thick; sexine slightly thicker than nexine, semitectate, reticulate, showing two types of reticulum; grains with irregular reticulum: lumina about 1 μm in diameter, decreasing towards colpi, muri 0.9–1.0 μm thick, varying in shape, built of one row of bacula, 0.5–0.7 μm in diameter (Pl. 29, fig. 2a, b); grains with regular reticulum: lumina polygonal, 1–2 μm in diameter, muri almost straight, about 1 μm thick, built of one row of bacula, about 0.6 μm in diameter (Pl. 28, figs 16a, b; Pl. 29, figs 1a, b).

Remarks. Similar pollen grains were identified by Ziembińska-Tworzydło (cf. 1974, p. 391, Pl. 22, figs 13–18) and Thiele-Pfeiffer (cf. 1980, p. 113, Pl. 13, figs 19–26). Sporomorphs of grain structure characteristic of *Parthenocissus*, among others, *Parthenocissus henryana* (cf. Reille 1967). Pollen grains occur rarely in all studied profiles less than 1%, only several times in the upper parts of the Mid-Polish Beds (Middle Miocene) of the Liszkowo and Karolewo-Dąbki profiles they attaining 2–4%.

Tricolporopollenites marcodurensis Pflug et Thomson 1953
f. *major*

Pl. 29 figs 3a, b

1953. *Tricolporopollenites marcodurensis* n. sp.; Thomson, Pflug, p. 103, Pl. 13, figs 5–9.

Pollen grain tricolporate, prolate, measuring 67 × 38 μm. Colpi thick-edged, extending subparallel to polar axis of grain, not reaching poles; pores in the middle of colpi, round, about 6 μm in diameter, with costae colpi projecting over them. Exine 3.0 μm thick; sexine slightly thicker than nexine, semitectate, reticulate; lumina polygonal, 1.7–2 μm in diameter, muri more or less straight, 1 μm thick, composed of one row of bacula, 0.8 μm in diameter.

Remarks. Pollen grain with sculpture of *Tricolporopollenites marcodurensis* type but of much larger dimensions. Thomson and Pflug (1953) give 50 μm as the upper size limit of pollen grains of this species. *Leea manillensis* from the family *Vitaceae* (cf. Huang 1972, Pl. 164) has a very similar sculpture, that is, a reticulum with very thick muri, but the shape of grains is spherical not prolate. Some pollen grains were found in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Cyphostemma (Planch.) Alston – *Cissus* L. – type
Tricolporopollenites cf. *marcodurensis* Pflug et Thomson 1953

Pl. 29 figs 4a, b; 5a, b

1980. *Tricolporopollenites marcodurensis* Pflug et Thomson 1953; Thiele-Pfeiffer, p. 174, Pl. 13, figs 31–38.

Pollen grains tricolporate, subprolate; measuring 41.5–44 × 33–35 μm. Colpi thick-edged, arranged meridionally, subparallel to outline, ending in polar area; pores round, in the middle of colpi. Exine 1.7–2 μm thick; sexine thicker than nexine, semitectate, reticulate; lumina polygonal to round, about 1.5 μm in diameter, muri 0.7–1 μm thick, irregular in shape; bacula in muri very poorly visible.

Remarks. These pollen grains are similar to the specimens described by Thiele-Pfeiffer (cf. 1980, Pl. 13, figs 31–38), which however have considerably larger lumina of the reticulum. The similar recent species are: *Cissus repens* (cf. Huang 1972, Pl. 164) as well as *Cyphostemma curvipoda* and *Cissus pannosa* (cf. Reille 1967, Pl. IV, figs 1, 6, 7, 11). Only two pollen grains of this type of structure were found in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Araliaceae – Cornaceae

Reticulate sporomorphs prevail among *Araliaceae*, whereas the granulate to granulate-scabrate sculpture is characteristic of pollen grains of *Cornaceae*.

Araliaceae – type
Araliaceoipollenites Potonié 1951 ex Potonié 1960
Araliaceoipollenites edmundi (Potonié 1931) Potonié 1951

Pl. 30 figs 1a, b; 2a, b; 3a, b

1931d. *Pollenites edmundi* n. sp.; Potonié, p. 26, Pl. 1, fig. V53e.
1951. *Araliaceoipollenites edmundi*, Potonié; Potonié, pp. 137–138, 142.

1953. *Tricolporopollenites edmundi* (Potonié, 1931) n. comb.; Thomson et Pflug, p. 101, Pl. 12, figs 126–131.

Pollen grains tricolporate, subprolate, with rounded poles; measurements: 50–57 × 43–45 μm. Colpi, with thickened edged, especially in the regions of pores, running subparallel to the polar axis of the grain. Pores varying very much in shape and size: from large, oval, meridionally lightly elongate, 4–6 μm in diameter (Pl. 30, figs 2a, b), to wide open, about 6 μm in diameter (Pl. 30, fig. 3a, b) and narrow, slit-shaped, meridionally elongated (Pl. 30, fig. 1a, b). Exine about 2.5 μm thick; sexine thicker than nexine, semitectate, reticulate; reticulum irregular in shape: muri, 1–1.5 μm thick, propped by densely distributed bacula, about 0.5 μm in diameter, sometimes fused in groups of several; lumina small, round, 1–1.4 μm in diameter or long, narrow, slit-shaped, 0.5–0.7 μm in diameter.

Remarks. The pollen grains with a reticulum characteristic of the grains from the family *Araliaceae* are similar to Japanese *Acanthopanax sciadophylloides* and two species from South-Eastern Asia: *Panax pinnatum* and *P. pentadactylon*. The inclusion of the above-desribed species in the family *Cornaceae* (Mamczar 1962; Nagy 1969) is not correct, for the pollen grains of this family have mostly the psilate-scabrate sculpture of the exine surface. Pollen grains occurring in all profiles in quantity less than 1%, only in several times in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile they attaining 2–3%.

Araliaceoipollenites euphorii (Potonié 1931) Potonié 1951

Pl. 30 figs 6a, b

1951. *Araliaceoipollenites. euphorii*, Potonié 1931; Potonié, p. 151, Pl. XXI, figs 139, 140, 141.

Pollen grains tricolporate, prolate, with rounded poles; measurements: 36.5 × 22.5 μm. Colpi, arranged meridionally, with fairly thick edges, lightly bending outwards in equatorial belt; pores in the middle of colpi, elongated meridionally. Exine 1.5 μm thick; sexine slightly thicker than nexine, semitectate, reticulate; lumina polygonal, 1 μm in diameter, muri straight, less than 0.5 μm thick.

Remarks. These pollen grains are most similar to *Aralia*, e. g. *Aralia chinensis*. Only some pollen grains of this species were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Araliaceoipollenites sp. form B, Konzalova 1976

Pl. 29 figs 6a, b

1976. *Araliaceoipollenites* sp. form B; Konzalova, p. 38, Pl. 17, figs 1–3, 9.

Pollen grains tricolporate, prolate spheroidal to subprolate; measurements: 45.5–53 × 40.5–41.5 μm, in polar view oval in outline, 44 × 37 μm in size. Colpi thick-edged, somewhat bending outwards in equatorial plane, with pores in the middle. Pores, about 3.5 μm in diameter, oval, equatorially elongate. In polar view colpi cut deep into the polar area, which approximates 9 μm in diameter. Exine 2.5 μm thick; sexine slightly thicker than nexine, semitectate, reticulate. Reticulum muri 1.2–1.3 μm thick, supported by thickset bacula, 0.9 μm in diameter; lumina polygonal, 0.9–1.4 μm in diameter.

Remarks. Sulpture characteristic of *Araliaceae*. Out of the available comparative materials it most resembles *Aralia chinensis* var. *mandschurica*. Pollen grains occurring very rarely in the Adamów Beds and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Cornaceae – type
Cornus L. – type 1
Tricolporopollenites satzveyensis Pflug 1953.
Pl. 30 figs 4a, b

1953. *Tricolporopollenites satzveyensis* n. sp.; Pflug in Thomson et Pflug, p. 103, Pl. 13, figs 10–13.

Pollen grains tricolporate, prolate, measuring 48 × 34 μm. Colpi thick-edged, parallel to polar axis of grain, pores equatorially elongate, about 4.5 μm in diameter. Exine 1.6 μm thick, sexine thicker than nexine, semitectate, reticulate. Tectum surface distinctly granulate, supported by thickset bacula, about 0.5 μm in diameter.
Remarks. The pollen grain is similar to *Cornaceae*, especially to the genera *Cornus* and *Mastixia*. Only some pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Cornus L. – type 2
Pl. 31 fig. 2

Pollen grains tricolporate, subprolate; measurements: 35–45 × 26–35 μm. Colpi thick-edged, extending along polar axis of grain, bending slightly outwards in equatorial belt; pores in the middle of colpi, 2.5–3 μm in diameter, equatorially elongate. Exine 2.3–2.8 μm thick; sexine slightly thicker than nexine, sexine composed of densely distributed bacula 0.6–1 μm in diameter, covered with thick tectum; tectum surface with flat, fine verrucae.
Remarks. Pollen grains similar to *Cornus*, among others, to the North-American species *Cornus stricta* and Japanese *C. officinalis*. Pollen grains occurring regularly in all profiles under examination mainly less than 1%, several times in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles they attaining quantity 2–4%.

Anacardiaceae
Tricolporopollenites pseudocingulum (Potonié 1931) Thomson et Pflug 1953
Pl. 31 figs 1a, b

1931a. *Pollenites pseudocingulum* n. sp.; Potonié, p. 328, Pl. I, figs 3–4.
1953. *Tricolporopollenites pseudocingulum* (Potonié, 1931) n. comb.; Thomson et Pflug, p. 99, Pl. 12, figs 99–111.

Remarks. Fossil species referred to *Anacardiaceae* on account of its structure of colpi and pores. Pollen grains were found frequently in all studied profiles, it reaches its maximum in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile, in numerous samples attaining 3–8%.

Ericaceae
Ericipites Wodehouse 1933
Ericipites sp. 1
Pl. 31 fig. 5

Remarks. Pollen grains structure similar to that of *Erica arborea*, in which the surface of sporomorphs is also covered with flat verrucae. Pollen grains rarely encountered in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Ercipites baculatus Nagy 1969
Pl. 31 figs 3, 6

1969. *Ericipites baculatus* n. sp.; Nagy, pp. 211, 212, Pl. XLIX, figs 18–19.

Remarks. Pollen grains with a similar verrucate-scabrate sculpture and short colpi occur, among others, in *Calluna vulgaris* (cf. Sladkov 1954, p. 132, Fig. 16). Pollen grains rarely encountered in the Adamów Beds and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ericipites sp. 2
Pl. 31 fig. 8

Remarks. Pollen grains rarely encountered in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ericipites ericius (Potonié 1931) Potonié 1960
Pl. 31 fig. 4

1931a. *Pollenites ericius* n. fsp.; Potonié, Pl. 2, fig. 25.
1960. *Ericipites ericius* n. comb.; Potonié, p. 138.

Remarks. Pollen grains frequently occurring in the all studied profiles.

Rhododendron L. – type
Ericipites sp. 3
Pl. 30 figs 5a, b

Remarks. The considerable size of tetrads (above 56 μm), very thick exine and short narrow colpi make these pollen grains similar to *Rhododendron*. Pollen grains rarely encountered in all investigated profiles.

Ericipites sp. 4
Pl. 31 fig. 9

Remarks. Pollen grains in structure resemble those from the family *Pyrolaceae*. Only one pollen grain of this type of structure was found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ericipites roboreus (Potonié 1931) Krutzsch 1970
Pl. 31 fig. 10

1931a. *Pollenites roboreus* n. fsp.; Potonié, pp. 325–333, Pl. 2, fig. 20.
1970c. *Ericipites roboreus* (Potonié 1931) n. comb.; Krutzsch, p. 422.

Remarks. In the size and structure of copus these pollen grains are similar to the grains of the Mediterranean *Arbutus unedo*. Only some pollen grains of this type of structure were found in the Adamów Beds (Middle Miocene) of the Kosztowo profile.

Ericipites sp. 5

Pl. 31 fig. 7

Remarks. In size and structure this pollen grains comes close to the Chinese species *Pieris forresti*. Only two pollen grains of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Symplocaceae

Symplocos Jacq. – type 1

Porocolpopollenites Pflug 1953

Porocolpopollenites vestibulum (Potonié 1931) Thomson et Pflug 1953

Pl. 34 fig. 1

1931*a*. *Pollenites vestibulum* n. sp.; Potonié, p. 329, Pl. 2, fig. 23.

1953. *Porocolpopollenites vestibulum* n. sp.; (Pflug) -Thomson et Pflug, p. 94, Pl. 11, figs 3–23.

Remarks. In the structure of the pore and sculpture these pollen grains approach *Symplocos setchuensis* from China. Pollen grains very rarely encountered in all profiles in quantity less then 1%.

Symplocos Jacq. – type 2

Porocolpopollenites sp.

Pl. 34 fig. 2

Remarks. Only some pollen grains of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Convolvulaceae

Calystegia R. Br.

Calystegiapollis Krutzsch 1966

Calystegiapollis sarmaticus Nagy 1985

Pl. 32 figs 5a, b

1985. *Calystegiapollis sarmaticus* n. sp.; Nagy, p. 179, Pl. CIV, figs 8–10.

Pollen grains multiporate, circular in outline, about 63 μm in diameter. Pores round or oval, 7 μm in diameter, regularly distributed all over grain surface. Exine 3.7 μm thick, sexine thicker than nexine, composed of bacula, about 1 μm in diameter and irregularly fused together; in the upper part they form the tectum, about 2 μm thick. Tectum surface perforate and covered with small spines, about 1 μm high and 1.3 μm wide at base.

Remarks. In structure this pollen grain resembles the grains of the recent genus *Calystegia*. Two species of the fossil genue *Calystegiapollis* are known so far. From *Calystegiapollis thuryngiacus* Krutzsch 1966, the grains from Karolewo-Dąbki differs in its round and not droplet-shaped pores. *Calystegiapollis sarmaticus* Nagy 1985 has identical pores with the sporomorphs from Karolewo-Dąbki; this last, however, differs from

both the above-named species in small spines occurring on its surface. Only two pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Labiatae – type

Pl. 32 fig. 4

Remarks. Pollen grains tricolpate, occuring for the most part in polar view, with coarse granulate and reticulate sculpture. Pollen grains of this type of structure were found rarely in all studied profiles, mainly less 1%.

Scrophulariaceae – type

Pl. 28 figs 1, 2

Pollen grains triporate, prolate; measurements: 50–55 × 30–37 μm. In polar view subcircular in outline, about 50 μm in diameter. Colpi, running parallel with polar axis of grain, go deep into the polar area, which is 8 μm in diameter. Pores delicately merked in the middle of colpi as meridionally oriented thinnings of exine. Exine about 2 μm thick; sexine much thicker than nexine, semitectate, reticulate. Lumina round, 1.7–2 μm in diameter, muri about 1.5 μm thick, propped by thick bacula, about 0.9 μm in diameter and thinly distributed.

Remarks. Pollen grains with sculpture and structure of colpi similar to *Scrophulariaceae* (cf. Erdtman et al. 1961, Pl. 59, Figs 5–8 and 9–10; Huang 1972, Pl. 143, figs 1, 2). Pollen grains were found in some samples in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles in quantities 1–4%.

Lentibulariaceae

Utricularia L.

Utriculariaepollenites Nagy 1969

Utriculariaepollenites elegans Nagy 1969

Pl. 32 figs 6a, b

1969. *Utriculariaepollenites elegans* n. g. n. sp.; Nagy, p. 200, Pl. XLVIII, fig. 12.

Pollen grains multicolporate, in equatorial view circular in outline; measurements: 25.5 × 32.7 μm; 17 colpi running radially from polar area, without reaching poles. Polar area visible, smooth. Pores in equatorial plane and equatorially elongate, 4.5 × 6 μm in size. Exine two-layered, 1.2 μm thick, tectate. Tectum surface psilate.

Remarks. Pollen grain structure characteristic of recent genus *Utricularia*. Only some pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Liszkowo profiles.

Oleaceae

Ligustrum L. – type 1

Pl. 32 fig. 1

Remarks. Pollen grains similar in structure to recent species *Ligustrum amurense*. Some pollen grains of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Ligustrum L. – type 2

Pl. 32 figs 7a, b

Remarks. Pollen grains resembling recent genus *Ligustrum* in structure. Pollen grains very rarely encountered in the Adamów Beds and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Oleaceae – type

Pl. 32 figs 8a, b

Remarks. Pollen grains of structure were found sporadically in all profiles.

Fraxinus L. – type 1

Pl. 32 figs 2a, b

Remarks. Pollen grains resembling recent species *Fraxinus ornus* in structure. Some pollen grains were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Fraxinus L. – type 2

Pl. 32 figs 3a, b

Remarks. Pollen grains similar in structure to Chinese species *Fraxinus mariesii*. Only two pollen grains of structure were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Caprifoliaceae

Diervilla Mill.

Diervillapollenites Doktorowicz-Hrebnicka 1956

Diervillapollenites megaspinosus Doktorowicz-Hrebnicka 1956

Pl. 33 figs 1a, b

1956. *Diervilla-Pollenites megaspinosus* f. nov.; Doktorowicz-Hrebnicka, pp. 110, 161, Pl. 22, fig. 6.

Remarks. Doktorowicz-Hrebnicka (1956) compares this morphological type of grains to those of the recent species: *Diervilla sessiliflora* and *D. verosa*. Pollen grains were found several times in quantities less than 1% in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Sambucus L. – type

Pl. 32 figs 9a, b, c

Pollen grains tricolporate, prolate. Measurements 25 × 15 μm. Colpi extending parallel to polar axis of grain, pores about 3 μm in diameter, directed meridionally, weakly merked. Exine 1.4 μm thick, semitectate, reticulate; lumina polygonal, about 0.6 μm thick, propped by one row of bacula, less than 0.5 μm in diameter.

Remarks. This pollen grains is similar in structure to the recent species: *Sambucus canadensis*, *Sambucus nigra* and differs decidedly from the fossil species *Tricolporopollenites microreticulatus* Thomson et Pflug 1953, compared to *Sambucus* (Thomson & Pflug 1953). Only some pollen grains of structure were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Viburnum L. – type

Pl. 33, figs 7a, b; 8a, b

Pollen grains tricolporate, prolate-spheroidal, measuring 28 × 26.5 μm; in polar view circular in outline, 28 μm in diameter. Colpi with thick-edged, running along the polar axis fairly deep into the polar area, which is 8 μm in diameter. Submeridionally elongated pores, 2.5 μm in diameter and with ragged edges in the middle of colpi. Grains semitectate, reticulate, tending to be retipilate; lumina in the shape of irregular polygons, 1.3–1.8 μm in diameter, muri more or less straight, about 1 μm thick, supported by thick bacula standing wide apart in one row, 0.8–1 μm in diameter.

Remarks. In structure these pollen grains come near to *Viburnum*, above all, in their loose structure of the reticulum, composed of thick bacula standing wide apart. This is the type of reticulum characteristic of the pollen grains of that genus. The pollen grains from Liszkowo are similar, among others, to *Viburnum carlessii* and *V. lentago*. They have few features in common with the fossil species *Caprifolipites sambucoides* Nagy 1969 compared to *Sambucus ebulus* (Nagy 1969) or *Viburnum* (Ziembińska-Tworzydło 1974), the sporomorphs of which have a much larger and more regular reticulum on the surface. Pollen grains rarely encountered in the Ścinawa Beds (Lower Miocene) and in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Asclepiadaceae

Periplocoideae

Periploca L. – type

Manikinipollis Krutzsch 1970

Manikinipollis tetradoides Krutzsch 1970

Pl. 33 figs 2a, b

1970b. *Manikinipollis tetradoides* fsp. n.; Krutzsch, p. 410.

Irregular hexaporate pollen grains, about 25 μm in diameter, arranged in tetrads. Tetrad irregularly oval, elongate in outline, measuring 64 × 32.7 μm. Pores oval, 3 × 5 μm in size, with ragged edges. Exine 0.8 μm thick tectate, two-layeredness of exine poorly seen.

Remarks. Krutzsch (1970b) compares this morphological type of grains to the recent genus *Periploca*; the most similar is the north Chinese species *Periploca sepium* (cf. Fu-Hsung & Nan-Feng 1960, Pl. 15, Fig. 7). Some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Compositae

Artemisia L.

Artemisiaepollenites Nagy 1969

Artemisiaepollenites sellularis Nagy 1969

Pl. 33 figs 5a, b; 6a, b

1969. *Artemisiaepollenites sellularis* n. g. n. sp.; Nagy, p. 208, Pl. XLIX, figs 16–17, Pl. XLI, figs 18–19.

Remarks. The structure of grains characteristic of *Artemisia*. Pollen grains, with polar

axis 26–30 μm long and more delicate structure (Pl. 33, figs 6a, b), are similar to the recent species *Artemisia campestris* and *Artemisia canadensis*, whereas the grains whose polar axis is 30–34 μm long and which have distinct small spines on the surface (Pl. 33, figs 5a, b) resemble *Artemisia laccinata*, *A. vulgaris* and *A. maritima*. Pollen grains occurring very rarely in all investigated profiles in quantities less than 1%; in single smaple in the upper part of the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile they reaches 3%.

Tubuliflorae

Tubulifloridites (Cookson 1947) Potonié 1960
Tubulifloridites ambrosiinae Nagy 1969
Pl. 33 figs 3a, b

1969. *Tubulifloridites ambrosiinae* n. sp.; Nagy, p. 439, Pl. XLIX, figs 5–6.

Remarks. Nagy (1969) compares this morphological type of grains to the pollen grains of the recent species *Ambrosia maritima* (Erdtman 1952, p. 122, fig. 66c). Pollen grains encountered sporadically in all studied profiles.

Liguliflorae

Cichoreacidites Sah. 1967
Cichoreacidites gracilis (Nagy 1969) Nagy 1985
Pl. 33 fig. 4

1969. *Cichoriaearumpollenites gracilis* n. sp.; Nagy, p. 441, Pl. XLVIII, figs 13–14.
1985. *Cichoreacidites gracilis* Nagy (1969) n. c.; Nagy, p. 185, Pl. LVII, figs 6–8.

Remarks. The morphological type of these pollen grains is characteristic of the grains of the recent *Cichorieae* (cf. Wodehouse 1935, pp. 457–465, Pl. 11). Pollen grains occur only sporadically in all studied profiles.

Monocotyledones

Sparganiaceae – Typhaceae
Sparganiaceaepollenites Thiergart 1937
Sparganium L. – type
Sparganiaceaepollenites magnoides Krutzsch 1970
Pl. 34 figs 3a, b, c

1964. *Sparganium ramosum* Huds. – type; Stuchlik, p. 78, Pl. XXIV, figs 10–11.
1970c. *Sparganiaceaepollenites magnoides* n. sp.; Krutzsch, p. 82, Pl. 13, figs 14–23.

Remarks. In structure these pollen grains resemble the grains of the recent genus *Sparganium*, among others, *S. racemosum* (Stuchlik 1964) and *S. simplex*, above all, on account of the presence of a regular reticulum with large polygonal lumina and straight muri, in which it differs from the pollen grains included in the genus *Typha*, where the reticulum is less regular, with smaller lumina and not straight muri. Pollen grains were found rarely in all profiles.

Typha L. – type
Sparganiaceaepollenites polygonalis Thiergart 1937
Pl. 34 figs 6, 7

1937. *Sparganiaceae-pollenites polygonalis* n. sp.; Thiergart, pp. 307, 308, Pl. 24, fig. 11.
1970c. *Sparganiaceaepollenites polygonalis* Thiergart 1937; Krutzsch, p. 78, Pl. 11, figs 1–34.

Remarks. In structure the pollen grains come near to the species *Typha minima*, which also shows a reticulum with small lumina and irregular muri. Pollen grains were found frequently in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile and in the Mid-Polish Beds (Middle Miocenê) of the Karolewo-Dąbki profiles.

Sparganiaceaepollenites sparganioides (Meyer 1956) Krutzsch 1970
Pl. 34 figs 4, 5

1956. *Monoporopollenites sparganioides* n. sp.; Meyer, pp. 111, 128, Pl. 4, Fig. 28.
1964. *Typha angustifolia* L. – type; Stuchlik, p. 79, Pl. XXIV, figs 13–14.
1970c. *Sparganiaceaepollenites sparganioides* (Meyer, 1956) n. comb.; Krutzsch, p. 80, Pl. 12, figs 1–35.

Remarks. The pollen grains are similar in structure to *Typha angustifolia*. They differ from *Sparganiaceaepollenites polygonalis* Thiergart 1937 in larger dimensions, greater pore diameter and in reticulum with larger lumina. Only some pollen grains of this type species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Potamogetonaceae

Potamogeton L. – type
Pl. 34 fig. 8

Remarks. In structure the pollen grains resemble those of *Potamogeton* as well as *Juncaginaceae*. Pollen grains rarely encountered in all investigated profiles.

Cyperaceae

Cyperaceaepollis Krutzsch 1970
Cyperaceaepollis piriformis Thiele-Pfeiffer 1980
Pl. 34 figs 9, 10; Pl. 35 fig. 3

1980. *Cyperaceaepollis piriformis* n. sp.; Thiele-Pfeiffer, pp. 121–122, Pl. 7, figs 20–22.

Pollen grains heteropolar, pyriform, with proximal part ending in a droplike form (Pl. 34, figs 9, 10) or bent into an oval projection (Pl. 35, figs 3).

Distal part with flattened or broadly rounded polar area and a big apical pore in it. Smaller, delicate pores, 3–5 in number, are distributed in a row close to the distal part on the side surface of the grain. Pores delicate, with ragged and jagged edgee; distal pores about 12 μm in diameter, lateral ones about 5 μm. Measurements: polar axis length – 75.6–85 μm, longest diameter – 50–58 μm. Exine very thin, about 1 μm thick, two-layered, tectate, with finely granulated surface; often secondarily strogly folded.
Remarks. These pollen grains are similar in shape and structure to *Cyperaceaepollis*

piriformis Thiele-Pfeiffer (1980), but are larger by about 20 μm. The recent *Cyperaceae* comprise some species, e.g. *Bulboschenus maritimus* and *Heleocharis palustris*, in which the size of grains ranges from 48 to 63 μm, reaching even 80 μm. Despite the great variation of pollen in the recent species, the pyriform grains so characteristic of the fossil form, have not been observed anywhere. Thiele-Pfeiffer compares *Cyperaceaepollis piriformis* to some species of *Carex* and *Cladium*. Pollen grains of this type of structure were found only in some samples in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles in quantities ca 1%, in single samples they reaches 50%.

Cyperaceaepollis sp. 1

Pl. 35 fig. 8

Remarks. Pollen grains occurring regularly in all studied profiles in quantities less than 1% up to 5–10%.

Cyperaceaepollis sp. 2

Pl. 35 fig. 7

Remarks. In shape and structure these pollen grains resemble, among others, *Carex nigra*, *Scirpus eupalustris*, *Carex hudsonii*, which have much smaller pollen grains (mostly 37 × 28 μm), as well as *Heleocharis palustris*, with sporomorphs similar in size. Some pollen grains were found together with *Cyperaceaepollis piriformis* in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Gramineae

Graminidites Cookson 1947

Graminidites pseudogramineus Krutzsch 1970

Pl. 35 fig. 1

1970c. *Graminidites pseudogramineus* n. sp.; Krutzsch, p. 52, Pl. 1, figs 6–11.

Remarks. Pollen grains occurring regularly in all studied profiles in most cases less than 1%, only in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles (in sample 56) together with *Cyperaceaepollis piriformis*) they attaining 20%.

Graminidites cf. sp. B. Krutzsch 1970

Pl. 35 fig. 2

1964. *Gramineae* – type 2; Stuchlik, p. 77, Pl. XXIII, figs 11, 12.
1970c. *Graminidites* sp. B. (type 2, Stuchlik 1964); Krutzsch, p. 51, Pl. 1, fig. 2.

Remarks. Some pollen grains were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Palmae ? *Amarylidaceae* ? *Butomaceae* ?

The pollen grains included in this group are characterized by their prolate or subprolate shape, long colpus on the distal side and reticular sculpture different on the distal side and on the proximal. Such structural features of grains are characteristic of the

pollen of several recent families, of which *Palmae* constitute the most numerous group. Krutzsch (1970c) members this morphological type of pollen grains in the fossil genus *Arecipites*, distinguishing about 22 species in it.

Arecipites Wodehouse 1933

Arecipites cf. *pseudoconvexus* Krutzsch 1970

Pl. 35 figs 6a, b

1970c. *Arecipites pseudoconvexus* n. sp.; Krutzsch, p. 103, Pl. 21, figs 1–8.

Pollen grains monocolpate, in polar view circular-elongate in outline; measuring 44–50 × 31.5–34 μm, with narrow, deep colpus on distal side. Exine about 1.5 μm; sexine thicker than nexine, semitectate, reticulate. Lumina polygonal, 1.5–2 μm in diameter on proximal side, decreasing distinctly towards colpus to a diameter of 0.7–0.5 μm; muri 1–1.5 μm, supported by bacula, less than 0.5 μm in diameter, arranged in two or three rows.

Remarks. In shape and sculpture these pollen grains approach *Arecipites pseudoconvexus* Krutzsch (1970c), but they are larger by about 10 μm. Ziembińska-Tworzydło (1974) includes this fossil species among the *Palmae*. The shape of the fossil grains and the distinct decrease of the reticular lumina towards the colpus can be seen in recent *Trachycarpus excelsa* var. *typica*. There are, however, differences in the structure of muri, the recent species has simplibaculate muri, whereas in the fossil species they are of 2–3 rows of bacula. Pollen grains occurring sporadically in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Arecipites cf. *longicolpatus* Krutzsch 1970

Pl. 35 figs 4a, b; 5

1970c. *Arecipites longicolpatus* n. sp.; Krutzsch pp. 112, 118, Pl. 25, figs 10–13.

Pollen grains monocolpate, in polar view spindle-shaped in outline, measuring 41.5–51.5 × 21.4–26.5 μm; narrow, deep colpus on distal side. Exine about 1.5 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum small with rounded sides, 1–1.5 μm in diameter, muri 1–1.5 μm, in places even up to 2 μm thick, propped by bacula, about 0.5 μm in diameter, disposed in two or three rows. No differentiation in the structure of the reticulum between the distal and the proximal side; the reticulum has only a little smaller lumina on the distal side.

Remarks. In structure and shape these pollen grains are similar to fossil species *Arecipites longicolpatus*, from which they differ only in size, being larger by about 10 μm. Krutzsch (1970c) compares this fossil species with the recent genus *Butomus*. However, the pollen grains of this last genus are oval and have a simplibaculate muri. A similar type of reticulum structure (small lumina, thick muri multibaculate) occurs in the recent species *Sabal adamsonii*, but the shape of the recent grains is oval, not fusiform as it is in the fossil grains. Pollen grains occurring very rarely in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles and in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Arecipites butomoides, butomoides Krutzsch 1970

Pl. 36 fig. 2

1970c. *Arecipites butomoides, butomoides* n. sp. et subsp.; Krutzsch, p. 112, Pl. 24, figs 12–16.

Pollen grains monocolpate, in polar view oval in outline, measuring 26.5–33 × 19–21.5 μm, with long colpus on distal side. Exine about 1.7 μm thick; sexine thicker than nexine, semitectate, reticulate. Recticulum lumina small, polygonal, 0.8–1.3 μm in diameter, not much smaller on distal side than those on proximal: muri straight, 0.5–0.8 μm thick; bacula, which support muri, very poorly seen, if present at all.

Remarks. Krutzch (1970c) compares this fossil species to *Butomus umbellatus*. The type of sculpture is significantly very similar. Pollen grains occurring very rarely in the Adamów Beds and in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Arecipites lusaticus Krutzsch 1970

Pl. 36 figs 1a, b

1970c. *Arecipites lusaticus* n. sp.; Krutzsch, p. 102, 103, Pl. 20, figs 17–21.

Pollen grains monocolpate, in polar view ovate in outline, with narrow, deep colpus on distal side, measuring 34–36.5 × 22.5–24 μm. Exine about 1.6 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum polygonal, 1–2 μm in diameter, getting smaller towards colpus on distal side. Muri, varying in thickness, 0.7–1.8 μm, supported by bacula, less than 0.5 μm in diameter, distributed in two or three rows.

Remarks. These pollen grains come close to the recent species *Trachycarpus fortunei* in the shape and structure of reticulum (thick muri supported by 1, 2 or 3 rows of bacula, lumina differing in shape between the distal and the proximal side). Only two pollen grains of this species were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Arecipites butomoides semilaevigatus Krutzsch 1970

Pl. 36 figs 4a, b

1970c. *Arecipites butomoides semilaevigatus* n. sp. et subsp.; Krutzsch, p. 112, Pl. 24, figs 8–10.

Pollen grains monocolpate, in polar view oval in outline, measuring 37 × 24 μm. Colpus deep, on distal side. Exine about 1.5 μm thick semitectate, division into sexine and nexine poorly perceptible. Incomplete tectum composed of thickset verrucae, 0.6–1 μm in diameter; admist verrucae canalicular "reticular lumina", about 0.5 μm in diameter.

Remarks. Only two pollen grains of this spacies were found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Palmae – type 1

Pl. 37 figs 1a, b

Pollen grains monocolpate, in polar view oval in outline, measuring 39 × 26.5 μm, with distinct colpus on distal side. Exine about 1.4 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina polygonal, 1.6–2.5 μm in diameter, decreasing towards

colpus to a diameter of 1 μm. Muri straight, about 0.7 μm thick, supported by two rows of poorly seen, bacula.
Remarks. In structure of reticulum and shape this pollen grain is similar to the grains of the recent species *Chamaedorea lindeniana*. Some pollen grains of of this type were found in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Palmae – type 2
Pl. 37 figs 4a, b

Pollen grain monocolpate, in polar view elongate in outline, measuring 44 × 30 μm, with poorly seen, narrow colpus on distal side. Exine about 1.3 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina polygonal, about 2.5 μm in diameter, decreasing towards colpus. Muri straight, about 0.6 μm thick.
Remarks. Only one pollen grain of of this type of structure was found in the Ścinawa Beds (Lower Miocene) of the Kosztowo profile.

Palmae – type 3
Pl. 36 fig. 5

Pollen grains monocolpate, in polar view elongate in outline, measuring 44 × 30 μm, with poorly seen, narrow colpus on distal side. Exine about 1.2 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina polygonal, 1.5–2 μm in diameter, muri straight, 0.8 μm thick, particular bacula which support the muri invisible. On the distal side the reticulum stands out less distinctly, the lumina are somewhat smaller.
Remarks. Only some pollen grains of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Liszkowo profile.

Palmae – type 4
Pl. 36 fig. 6

Pollen grains monocolpate, in polar view elongate in outline, measuring 33 × 19 μm, with narrow poorly seen, narrow colpus on distal side. Exine about 1.2 μm thick; sexine thicker than nexine, semitectate, reticulate. Tectum built of thickset verrucae divided by narrow canaliculi. "Reticulum lumina" narrow, canalicular, about 0.7 μm wide. Muri of irregular shapes, 0.6–0.7 μm thick.
Remarks. Only two pollen grains of of this type of structure were found in the Adamów Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Palmae – type 5
Pl. 36 figs 3a, b

Pollen grains monocolpate, in polar view elongate in outline, measuring 40.5× 26.5 μm, with wide and deep colpus on distal side. Exine about 1.5 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum polygonal, varying in shape and size, 0.7–1.8 μm in diameter. Muri of irregular shapes, thin, about 1 μm wide.
Remarks. Only three pollen grains of of this type of structure were found in the Ścinawa Beds (Lower Miocene) of the Liszkowo profile.

Palmae ? – type 6

Pl. 36 figs 8, 9, 10a, b

Pollen grains monocolpate, in polar view oval to circular-oval in outline, measuring 35.5–44 × 25–31.5 μm, with wide and deep colpus on distal side. Exine about 1–1.5 μm in thickness, semitectate, reticulate. Division into sexine and nexine poorly perceptible. Reticulum not delineated distinctly, lumina polygonal, 2–2.5 μm in diameter, muri about 0.9–1.2 μm, small spines, about 0.5 μm in diameter, distributed 2–2.5 μm apart on the surface of the muri.

Remarks. The general habit of grains and the type of structure rather suggests that these forms belong to the family *Palmae*, though no identical morphological forms have been found in the comparative material of the recent taxa of palms. Some pollen grains of of this type of structure were found in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Corypha L. – type

Pl. 36 figs 7a, b

Pollen grains monocolpate, circular-elongate in outline, measuring 40 × 35 μm, with short, wide colpus on distal side. Exine about 2 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum irregularly polygonal, 1.8–2 μm in diameter; among them small round lumina, about 1 μm in diameter; muri, verying in thickness from 1 to 2.5 μm, supported by bacula, less than 0.5 μm in diameter and arranged in two or three rows.

Remarks. In shape and structure of reticulum (dupli- or triplibaculate muri) this pollen grain resembles the recent species *Corypha taliera*. from India. Only some pollen grains of of this type of structure were found in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Amaryllidaceae ? – type 3

Pl. 37 figa. 6a, b; 7

Pollen grains monocolpate, in polar view elongate to fusiform in outline, measuring 48–53 × 18–25 μm, with narrow, deep colpus on distal side. Exine about 1 μm thick, sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum polygonal, 1.8–2.5 μm sometimes about 1 μm in diameter. Muri 1–1.5 μm thick, propped by bacula, less than 0.5 μm in diameter, distributed in two or three rows. There is no differentiation of the reticulum structure between the distal side and the proximal.

Remarks. Pollen grains occurring rarely in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Amaryllidaceae – type 1

Pl. 37 figs 5a, b

Pollen grains monocolpate, in polar view elongate in outline, measuring 51 × 28 μm, with long colpus on distal side. Exine about 1.5 μm thick, sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum polygonal, 2–3.3 μm in diameter, arranged

in submeridional rows, with small lumina, 1 μm in diameteer, occuring sometimes among them. Muri, 1–1.5 μm thick, propped by two or three rows of bacula, less than 0.5 μm in diameter. Reticulum similarly structured on distal and proximal sides.
Remarks. The type of the reticulum structures may indicate a resemblance to *Amarylidaceae*; among others, *Agave americana* shows a similar sculpture. Pollen grains rarely encountered in the upper part of the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Amaryllidaceae – type 2

Pl. 37 figs 8a, b

Pollen grains monocolpate, circular in outline, about 39 μm in diameter, with colpus on distal side. Exine about 2 μm thick; sexine thicker than nexine, semitectate, reticulate. Lumina of reticulum varying in size and shape, 0.8–3.5 μm in diameter; small, round lumina occurring among large polygonal ones. Muri straight, 0.7–1 μm thick, propped by bacula, less than 0.5 μm in diameter and arranged in one or two rows.
Remarks. Pollen grains rarely encountered in the upper part of the Mid-Polish Beds (Middle Miocene) of the Liszkowo profiles.

Liliaceae – Iridaceae

Liliaceae – Iridaceae – type 1

Pl. 37 fig. 3

Remarks. Pollen grains encountered very rarely in the Adamów Beds (Middle Miocene) of the Kosztowo and Karolewo-Dąbki profiles.

Liliaceae – Iridaceae – type 2

Pl. 37 fig. 2

Remarks. Pollen grains of of this type of structure was found sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki and Kosztowo profiles.

Restionaceae

Milfordia Erdman 1960

Milfordia incerta (Thomson et Pflug 1953) Krutzsch 1961

Pl. 37 fig. 9

1953. *Inaperturopollenites incertus* n. sp.; Thomson, p. 66, Pl. 5, figs 31–35.
1961b. *Milfordia incerta* (Thomson et Pflug) n. comb.; Krutzsch, p. 325.
1970c. *Milfordia incerta* (Thomson et Pflug 1953) Krutzsch 1961; Krutzsch, pp. 72–73, Pl. 9.

Remarks. Pollen grains of this type were found only sporadically in the Mid-Polish Beds (Middle Miocene) of the Karolewo-Dąbki profiles.

Table 1. A list of taxa of sporomorphs identified from the Rawicz, Ścinawa, Adamów and Middle Polish Beds in the boreholes in the Wyrzysk region, with the corresponding recent taxa and the data concerning their occurrence (acc. to Kearney 1901; Engler 1954, 1964; Lawrence 1966; Wang 1961; Szafer et al., 1969; Krussman 1971–1978)

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Sphagnaceae						
	Sphagnum					*Sphagnum*	Peatbogs in both hemispheres. In tropics in mountains
1.	*Stereisporites* (*Stereisporites*) sp. 1			+			
2.	*Stereisporites* (*Stereisporites*) sp. 2			+			
3.	*Stereisporites* (*Stereisporites*) *maximus* Krutzsch 1963				+		
4.	*Stereisporites* (*Stereisporites*) cf. *macroides* Krutzsch 1963			+			
5.	*Stereisporites* (*Stereisporites*) *involutus minutoides* Krutzsch et Sontag 1963		+		+		
6.	*Stereisporites* (*Stereisporites*) *intrastructuris* Krutzsch 1963			+			
7.	*Stereisporites* (*Distverrusporis*) *antiquus* Krutzsch et Sontag 1963			+			
8.	*Stereisporites* (Distancoraesporis) wehningensis Krutzsch 1963			+			
	Anthocerotaceae						
9.	cf. *Rudolphisporis rudolphi* (Krutzsch, 1959) Krutzsch et Pacltova 1963	+				*Anthocerotae*	
	Lycopodiaceae						
	Lycopodium						
10.	*Retitriletes* cf. *reticuloides reticuloides* Krutzsch 1963				+	*Lycopodium complanatum*, *Lycopodium clavatum*	Herb layer in mixed mesophytic forests of temperate zone. In tropics in mountains

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
11.	*Retitriletes* cf. *pseudoclavatus* Krutzsch 1963				+	*Lycopodium clavatum*	
12.	*Retitriletes* cf. *frankfurtensis* Krutzsch 1963			+		*Lycopodium obscurum*	Herb layer in *Picea-Abies* mountain forest in north-eastern China
13.	*Retitriletes* cf. *robustoides* Krutzsch 1963			+		*Lycopodium paniculatum*?	
14.	*Retitriletes* sp.				+	*Lycopodium*	
15.	*Camarozonosporites* (*Inundatisporis*) *wilsnackenesis* Krutzsch 1963			+		*Lycopodium inundatum*	Mostly woodless areas: peatbogs, heaths, water edges in temperate zone of both hemispheres
16.	*Camarozonosporites* (*Camarozonosporites*) sp.		+			*Lycopodium cernuum*	In wet places in tropics and subtropics
17.	*Camarozonosporites* (*Camarozonosporites*) *decorus* (Wolff, 1934) Krutzsch 1959				+	*Lycopodium fokienense*	China
	Selaginellaceae						
	Selaginella						*Selaginella*, about 700 species. Herb layer in wet forests. many tropical species
18.	*Echinatisporis* sp. 1				+	*Selaginella vaginata*,	
19.	*Echinatisporis* sp. 2				+	*Selaginella delicatula*	
20.	*Echinatisporis* sp. 3				+	*Selaginella mairei*	
21.	*Echinatisporis* sp. 4				+	*Selaginella anceps/wallachii* – type	
22.	*Echinatisporis* sp. 5				+	*Selaginella magnifica/alligans* – type	
	Osmundaceae						
	Osmunda						*Osmunda* – 14 species, from wet forests of temperate zone to tropical swampy regions
23.	*Baculatisporites* sp. 1				+	*Osmunda lancea*	

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
24.	*Baculatisporites quintus quintus* Krutzsch 1967				+	*Osmunda regalis*	
25.	*Baculatisporites* sp. 2		+			*Osmunda*	
26.	*Baculatisporites primarius crassiprimarius* Krutzsch 1967			+		*Osmunda banksiaefolia*	
27.	*Baculatisporites primarius primarius* Krutzsch 1967	+	+	+	+	*Osmunda cinnamomea*	
	Gleicheniaceae - Cyatheaceae						
28.	*Neogenisporis neogenicus* Krutzsch 1962	+	+	+	+	*Gleicheniaceae*	Tropical, subtropical and temperate zones. some species xerophytic
29.	*Neogenisporis crassicus* Krutzsch 1962			+	+	*Gleicheniaceae*	
30.	*Neogenisporis* cf. *plicatoides* Krutzsch 1962			+		*Gleicheniaceae*	
31.	*Neogenisporis* sp.			+		*Gleicheniaceae*	
32.	*Cyatheaceae*?		+			*Cyatheaceae*?	*Cyatheaceae* – three genera: *Alsophila*, *Hemitelia* and *Cyathea* – (425) species) most of them arboreal. In tropics and subtropics, some in temperate zones
33.	cf. *Toroisporis pliocenius* Krutzsch 1962	+			+	*Cyatheaceae*? *Schizaeaceae*?	
	Schizaeaceae						
	Lygodium – type						
34.	*Leiotriletes* cf. *maxoides* Krutzsch 1962 ssp. *minoris* Krutzsch 1962				+	*Schizaeaceae*, *Lygodium*	*Schizaeaceae* – wide distribution in tropical zone and in southern hemisphere. *Lygodium* – about 39 species in tropics and subtropics. Lianas
35.	*Leiotriletes wolffi wolffi* Krutzsch 1962	+				*Schizaeaceae*, *Lygodium*	
36.	*Radialisporis radiatus* (Krutzsch 1959) Krutzsch 1967			+	+	*Schizaeaceae*?	

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Polypodiaceae						
37.	*Laevigatosporites nutidus* (Mamczar, 1960) subfsp. *nutidus* Krutzsch 1967	+	+	+	+	*Polypodiaceae*	Wide distribution, above all, in northern hemisphere, in temperate zone
38.	*Verrucatosporites pseudoalienus* Krutzsch 1967				+	*Polypodium vulgare*	
	Davalliaceae						
39	*Davallia* – type, *Verrucatosporites* sp.			+		*Davalliaceae*, *Davallia*	*Davallia* – about 40 species in palaeotropics and subtropics. Epiphytes
	Sinopteridaceae						
40.	*Cryptogramma* – type 1	+				*Sinopteridaceae*, *Cryptogramma*	*Cryptogramma* – 4 species in temperate zone of northern hemisphere
41.	*Cryptogramma* – type 2, cf. *Favoisporis trifaus* Krutzsch 1959				+	*Sinopteridaceae*, *Cryptogramma*	
42.	*Dicksoniaceae*?, *Cyatheaceae*?				+	*Dicksoniaceae* (*Cibotium*?) *Cyatheaceae* (*Amphidesmium*?)	*Cibotium* – 13 species. East Asia, Indomalaya, Hawaiian Is., Central America. *Amphidesmium* – 1 species, Central and South America
	Pinaceae						
	Pinus						
43.	*Pityosporites labdacus*, *labdacus* Krutzsch 1971	+	+	+	+	*Pinus* type *sylvestris*	*Pinus* – above 100 species in northern hemisphere
44.	*Pityosporites insignis* (Naumova et Bolchovitina, 1953) Krutzsch 1971	+				*Pinus* type *sylvestris*	
45.	*Pityosporites microalatus* (Potonié, 1931) Thomson et Pflug 1953	+	+	+	+	*Pinus* type *haploxylon*	
46.	*Pityosporites alatus* (Potonié, 1931) Thomson et Pflug 1953	+	+	+	+	*Pinus* type *haploxylon*	

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Picea						
47.	*Piceapollis tobolicus* (Panova, 1966) Krutzsch 1971, f. *minor*, f. *major*	+	+		+	*Picea excelsa* = *P. abies*, *Picea ajanensis*, *Picea jezoensis*	*P. abies* – North and Central Europe. *Picea jezoensis* – Japan, coniferous mountain forest up to 2500 m a.s.l., with *Tsuga diversifolia*
48.	*Piceapollis planoides* Krutzsch 1971				+	*Picea asperata*, *Picea schrenkiana*	*Picea asperata* – Western China. *Picea schrenkiana* – Central Asia, Turkestan, Tien Shan
	Abies						
49.	*Abiespollenites latisaccatus* (Trevisan, 1967) Krutzsch 1971				+	*Abies nordmanniana*, *Abies firma*	*A. nordmanniana* – common trees in coniferous forests of Caucasus Mts.. Endemic species of Colchis and northern Anatolia. *A. firma* – East-Asian areas (Japanese-Korean Province)
50.	*Abiespollenites absolutus* Thiergart 1937				+	*Abies alba*	Mountains of Central and South Europe
51.	*Abiespollenites* sp.				+	*Abies alba*, *Abies koreana*	*A. koreana* – mountains in southern part of Korea
52.	*Abiespollenites maximus* Krutzsch 1971				+	*Abies*, *Keteleeria*	*Abies* – about 40 species in northern hemisphere. *Keteleeria* – 8 species (China, Formosa)
	Kateleeria						
53.	*Abiespollenites dubius* (Chlonova, 1960) Krutzsch 1971				+	*Keteleeria davidina*	Mixed mesophytic forest and evergreen broad-leaved forest of south-eastern China
	Tsuga						
54.	*Zonalapollenites verrucatus* Krutzsch 1971				+	*Tsuga canadensis*?	Mixed deciduous forests: North America, from Hudson Bay to Carolina and Alabama
55.	*Zonalapollenites maximus* (Raatz, 1937) Krutzsch 1971	+	+	+	+	*Tsuga canadensis*	
56.	*Zonalapollenites* sp. 1				+	*Tsuga caroliniana*?	Mixed deciduous forests – eastern regions of North America (Appalachian Province) from south-western Virginia to northern Georgia

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
57.	*Zonalapollenites* cf. *neogencus* Krutzsch 1971				+	*Tsuga blaringhemii*?	Japan (central Honshu I.)
58.	*Zonalapollenites* sp. 2				+	*Tsuga sieboldii*	East-Asiatic area (Japanese-Korean Province)
59.	*Zonalapollenites reuterbengensis* Krutzsch 1971	+	+	+	+	*Tsuga diversifolia*	Japan: coniferous mountain forests up to 2500 m a.s.l.
60.	*Zonalapollenites minimus* Krutzsch 1971				+	*Tsuga diversifolia*	
61.	*Zonalapollenites robustus* Krutzsch 1971				+	*Tsuga calcarea*?	China: Yunnan
	Podocarpaceae						
	Podocarpus						
62.	*Podocarpidites gigantea* (Zaklinskaja, 1957) Nagy 1985				+	*Podocarpus*	About 100 species. Most frequently in mountain forests of warm temperate, subtropical and tropical zones, mainly in southern hemisphere. Some species in Japan, China, Malaya and Philippines
63.	*Podocarpidites podocarpoides* (Thiergart, 1958) Krutzsch 1971		+		+	*Podocarpus*	
64.	*Podocarpidites libellus* (Potonié, 1932) Krutzsch 1971		+			*Podocarpus*	
	Taxodiaceae - Cupressaceae						
65.	*Inaperutrpollenites dubius* (Potonié et Venitz, 1934) Thomson et Pflug 1953	+	+	+	+	*Taxodiaceae*, *Cupressaceae*, *Taxaceae* (e.g. *Cupressus*, *Libocedrus*, *Thuja*, Juniperus, *Taxus*)	*Taxodiaceae* – 8 genera. South-eastern North America, East Asia. *Cupressaceae* – 15 genera North America, East Asia, Mediterranean region
66.	*Taxodium* – type 1, sensu Oszast 1960. *Inaperturopollenites concedipites* (Wodehouse, 1933) Krutzsch 1971	+	+	+	+	*Taxodium distichum*	Swampy forests with *Nyssa* in North America: Province of Atlantic Lowlands (Gulf Lowland, Atlantic Lowland, northern Florida)

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
67.	*Taxodium* – type 2, *Inaperturopollenites* sp.			+		*Taxodium distichum*	
68.	*Taxodium* – type 3, *Inaperturopollenites* sp.			+		*Taxodium distichum*	
69.	*Glyptostrobus* – type, sensu Oszast 1960	+	+	+	+	*Glyptostrobus pensilis*	Evergreen broad-leaved forests and mixed mesophytic forest of south-eastern China.
70.	*Cunninghamia* type, sensu Oszast 1960. *Inaperturopollenites radiatus* Krutzsch 1971.	+	+	+	+	*Cunninghamia lanceolata*	*Cunninghamia lanceolata* – mixed mesophytic forests of East Asia, among others, with *Cryptomeria japonica*. *C. konishii* – coniferous montain forest in Formosa
	Taxodiaceae						
	Sequoia – type						Wet coniferous forests in Pacific area of south-western Oregon and north-western California (*S. sempervirесns*). Dry coniferous forests in north-western California, in Sierra Nevada Mts. at 1400–2550 m a.s.l. (*S. gigantea*)
71.	*Sequoiapollenites major* Krutzsch 1971				+	*Sequoia sempervirens*, *Sequoia gigantea*	
72.	*Sequoiapollenites polyformosus* Thiergart 1937	+	+	+	+		
73.	*Sequoiapollenites* cf. *megaligulus* Krutzsch 1971		+	+			
	Cryptomeria – type						
74.	*Sequoiapollenites* cf. *largus* (Kremp, 1949 (Manum 1962			+	+	*Cryptomeria japonica*	Mixed mesophytic forests in Japan and in south-eastern China, among others together with *Cunninghamia*
75.	*Sequoia*-Cryptomeria – type	+	+	+	+	*Sequoia*, *Cryptomeria*	
	Metasequoia – type						
76.	*Sequoiapollenites* cf. *sculpturis* Krutzsch 1971		+		+	*Metasequoia glyptostroboides*	Mixed mesophytic forests in south-eastern China
	Metasequoia-Sequoia – type						
77.	*Sequoiapollenites rugulus* Krutzsch 1971	+	+			*Metasequoia*?, *Sequoia*?	

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
78.	*Sequoiapollenites* cf. *rugulus* Krutzsch 1971			+	+	*Metasequoia*?, *Sequoia*?	
	Sciadopitys					*Sciadopitys verticillata*	Coniferous mountain forests, among others, with *Cryptomeria japonica*, up to 1000 m a.s.l. (Japan) in warm temperate zone
79.	*Sciadopityspollenites* sp. 1				+		
80.	*Sciadopityspollenites quintus* Krutzsch 1971	+			+		
81.	*Sciadopityspollenites serratus* (Potonié et Venitz, 1934) Thiergart 1937	+	+	+	+		
82.	*Sciadopityspollenites tuberculatus* (Zaklinskaja, 1957) Krutzsch 1971				+		
83.	*Sciadopityspollenites crassus* Krutzsch 1971				+		
84.	*Sciadopityspollenites varius* Krutzsch 1971		+		+		
85.	*Sciadopityspollenites* sp. 2				+		
86.	*Sciadopityspollenites* sp. 3				+		
87.	*Sciadopityspollenites verticillatiformis* (Zauer, 1960) Krutzsch 1971		+		+		
	Ephedraceae						
	Ephedra					*Ephedra*	42 species: semidesert and steppe areas in southern Europe, North Africa, Central Asia (Tibet), North and South Americas, outside tropical zone
88.	*Ephedripites* (*Distachyapites*) *tertiarius* Krutzsch 1970				+		

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
89.	*Ephedripites* (*Distachyapites*) *lusaticus* Krutzsch et Sontag 1961				+		
	Betulaceae						
	Betula						
90.	*Betulaepollenites coryloides* (Pflug, 1953) Nagy 1969	+	+	+	+	*Betula*	60 species in northern hemisphere, from warm temperate zone to arctic zone
	Corylus						
91.	*Triporopollenites coryloides* Pflug 1953	+	+	+	+	*Corylus*	15 species: Europe, North America and North Asia
	Alnus						
92.	*Alnipollenites verus* Potonié 1934	+	+	+	+	*Alnus glutinosa*	Europe as far as Caucasus Mts. and Siberia, North Africa
						Alnus incana	Europe, Caucasus Mts.
						Alnus formosana	Formosa
						Alnus japonica	Japan, Formosa, Manchuria, Korea
						Alnus nepalensis	Himalayas, China (south-westerm Yunnan up to 1200–1500 m a.s.l.)
	Ostrya						
93.	*Ostryapollenites rhenanus* (Thomson, 1950) Nagy 1969		+		+	*Ostrya carpinifolia*	*Ostrya*: 7 species in Europe, America, Asia. *O. carpinifolia* – southern Europe, Asia Minor
	Carpinus						
94.	*Carpinipites carpinoides* (Pflug, 1953) Nagy 1969						
	f. *major*	+	+	+	+	*Carpinus betulus*	Europe to Asia Minor
	f. *minor*	+	+	+	+	*Carpinus orientalis*, *Carpinus cordata*	*Carpinus orientalis* – forests in lower mountain tiers in Caucauses Mts. *Carpinus cordata* – East-Asiatic deciduous broad-leaved forest and mixed mesophytic forest in eastern China

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Fagaceae						
	Castanea, Castanopsis						
95.	*Tricolporopollenites cingulum* (Potonié, 1931) Thomson et Pflug 1953. ssp. *pussillus* (Potonié, 1934) Thomson et Pflug 1953	+	+	+	+	*Castanea, Castanopsis*	*Castanea* sp. – 12 species. Temperate zone in northern hemisphere. *Castanopsis* sp. – 120 species: evergreen trees. Subtropics and tropics of South and East Asia
96.	*Tricolporopollenites cingulum* (Potonié, 1931) Thomson et Pflug 1953					*Castanea, Castanopsis*	
	ssp. *oviformis* (Potonié, 1931) Thomson et Pflug 1953	+	+	+	+		
	Fagus						
97.	*Faguspollenites verus* Raatz 1937						
	Faguspollenites verus Raatz 1937 – type 1		+			*Fagus longipetiolata, Fagus sylvatica*	*Fagus longipetiolata* – mixed mesophytic forest and evergreen broad-leaved forest of Central and south-eastern China. *Fagus sylvatica* – Central Europe to Caucasus Mts.
	Faguspollenites verus Raatz 1937 – type 2	+	+	+	+	*Fagus orientalis, Fagus ferruginea*	*Fagus orientalis* – lower parts of Great and Little Caucasus Mts., *Fagus ferruginea* – North America
	Quercus						
	I group					I group: *Quercus robur, Q. libani, Q. ilex, Q. lineata*	*Q. robur* – Europe to North Africa, Asia Minor. *Q. libani* – Syria, Asia Minor. *Q. ilex* – evergreen trees, southern Europe
98.	*Quercoidites henrici* (Potonié, 1931) Potonié, Thomson et Pflug 1950		+	+			

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
99.	*Tricolpopollenites asper* Thomson et Pflug 1953	+	+	+	+		
100.	*Tricolpopollenites pudicus* (Potonié, 1934) Thomson et Pflug 1953	+			+		
101.	*Quercus* – type 1				+		
	II group					II group	
102.	*Quercus* – type 2				+	*Quercus ilicifolia*	Eastern region of USA, above all, in mountains
103.	*Quercus* – type 3				+	*Quercus pontica*	Caucasus Mts.
104.	*Quercus* – type 4				+	*Quercus serrata*	Mixed mesophytic forest and evergreen broad-leaved forest. Japan, Korea, China
	Myricaceae						
	Myrica						
105.	*Myricipites rurensis* (Pflug et Thomson 1953) Nagy 1969	+	+	+	+		
						Myrica salicifolia	Ethiopia – Damot province, 2400 m a.s.l.
						Myrica nagi	North-western Himalaya Mts.
			+	+		*Myrica carolinensis*	North-eastern coast of USA, in dry and sandy places
						Myrica rubra	Evergreen shrubs. Japan. Southern China. Mixed mesophytic forest and evergreen broad-leaved forest
106.	*Triatriopollenites rurobituitus* Pflug 1953)		+	+		*Myrica cerifera*	Evergreen shrubs. North America: coast from southern New Jersey to Florida and Texas
107.	*Myricipites bituitus* (Potonié, 1931) Nagy 1969	+	+	+	+	*Myrica gale*	Europe to North Asia. North America

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Juglandaceae						
	Engelhardtia						
108.	*Momipites punctatus* (Potonié, 1931) Nagy 1969	+	+	+	+	*Engelhardtia*	About 9 species in warm-temperature subtropical and tropical forests of East and South-East Asia (from Himalayas to Indo-Malasia), 2 species in cetranl America, deciduous trees
109.	*Momipites quietus* (Potonié, 1931) Nichols 1973		+				
110.	*Engelhardtioidites microcoryphaeus* (Potonié, 1931) Potonié 1960		+		+		
	Platycarya						
111.	*Platycaryapollis semicyclus* Krutzsch et Vanhoorne 1977		+			*Platycarya*	2 species, East Asia
112.	*Platycaryapollis platycaryoides* (Roche, 1969) n. comb.		+			*Platycarya*	
113.	*Platycaryapollis* sp.		+			*Platycarya stobilacea*	Mesophytic mixed forests and evergreen broad-leaved forests of south-eastern China
	Juglans						
114.	*Junglans* L. – type 1	+	+	+	+	*Juglans*	15 species. Southern Europe to East Asia, North and South America
115.	*Junglans* L. – type 2. *Multiporopollenites maculosus* (Potonié, 1931) Thomson et Pflug 1953		+			*Juglans*	
	Pterocarya						
116.	*Pterocaryapollenites stellatus* (Potonié, 1931) Raatz 1937	+	+	+	+	*Pterocarya*	10 species from Caucasus Mts. to Japan. *P. fraxinifolia* – Caucasus Mts. to northern Iran

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Carya						
117.	*Caryapollenites simplex* (Potonié, 1931) Raatz 1937 ex Potonié 1960	+	+	+	+	*Carya*	25 species in north-eastern regions of USA, 3 species in China
	Salicaceae						
	Salix						
118.	*Salixipollenites* sp.	+	+	+	+	*Salix*	About 500 species in northern hemisphere, in temperate zone. Several species in South America
	Ulmaceae						
	Celtis						
119.	*Celtipollenites intrastructurus* (Krutzsch et Vanhoore, 1977) Thiele-Pfeiffer 1980		+		+	*Celtis*	80 species, mostly in subtropical zone, the remaining ones in northern temperate zone
120.	*Celtipollenites* sp.	+	+	+	+	*Celtis*	
	Zelkova						
121.	*Zelkovaepollenites potoniei* Nagy 1969			+	+	*Zelkova carpinifolia*	*Zelkova* – 6 species in West and East Asia. *Zelkova carpinifolia* – Caucasus Mts.
	Ulmus						
122.	*Ulmipollenites undulosus* Wolff 1934	+	+	+	+		
						Ulmus laevis	*Ulmus* – 45 species. Temperate zone of northern hemisphere. *Ulmus laevis* – south-eastern Europe, the Caucasus Mts.
						Ulmus racemosa	North-eastern and central USA
123.	*Ulmipollenites* sp.				+	*Ulmus parviflora*	Japan, China, Korea
	Eucommiaceae						
124.	*Eucommia* – type, sensu Oszast 1960				+	*Eucommia ulmoides*	Mixed mesophytic forests of south-eastern China

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Loranthaceae						
	Arceuthobium						
125.	*Spinulaepollis arceuthobioides* Krutzsch 1962	+	+	+	+	*Arceuthobium oxycedri*	Parasite of coniferous trees (among others, *Juniperus*, *Picea*). Mediterranean region to eastern Himalayas
	Polygonaceae						
	Polygonum						
126.	*Persicarioipollis pliocenicus* Krutzsch 1962				+	*Polygonum caespitosum*, *P. japonicum*, *P. perfoliatum*	*Polygonum* – 300 species, mostly in temperate zone, herbaceous plants
127.	*Persicarioipollis* cf. *lusaticus* Krutzsch 1962				+	*Polygonum lapathifolium*	
	Chenopodiaceae?						
128.	*Orapollis potsdamensis* Krutzsch 1966		+			*Alismataceae*, *Chenopodiaceae*, *Caryophyllaceae*	*Alismataceae* – aquatic or swamp plants, about 14 genera. Northern hemisphere, temperate to tropical zone. *Caryophyllaceae* – about 80 genera. Above all, temperate zone of northern hemisphere, in tropics in mountains, herbaceous plants
	Chenopodiaceae						
129.	*Chenopodipollis neogenicus* Nagy 1969	+	+	+	+	*Chenopodiaceae*	*Chenopodiaceae* – 102 genera, cosmopolitan. Mostly xerophytes and halophytes, chiefly herbaceous plants, rarely shrubs
130.	*Caryophyllaceae*? *Amaranthaceae*?	+				*Caryophyllaceae*, *Amaranthaceae*	*Amaranthaceae* – 64 genera, common in tropical regions, above all, in tropical America and Africa. Some of them cosmopolitan, herbaceous plants, rarely shrubs and creepers

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Hamamelidaceae						
	Liquidambar						
131.	*Liquidambarpollenites styracifluaeformis* Nagy 1969				+	*Liquidambar styraciflua*	Eastern part of North America (Appalachian Province). Mixed forests with *Liriodendron tulipifera*, *Tsuga canadensis*, *Tsuga caroliniana*
132.	*Liquidambarpollenites orientaliformis* Nagy 1969	+			+	*Liquidambar orientalis*	Asia Minor
133.	*Liquidambarpollenites stigmosus* (Potonié, 1931) Raatz 1937		+	+	+	*Liquidambar*, *Altingia*? *Sycopsis*?	*Liquidambar* – 1 species in North America, 1 species in Asia Minor and 2 species in China. *Altingia* – evergreen trees. Indo-Malaya, China. *Sycopsis* – evergrees trees, 7 species in China, Himalayas, Philippines
134.	*Liquidambarpollenites formosanaeformis* Nagy 1969				+	*Liquidambar formosana*	Central China, Formosa
	Corylopsis						
135.	*Corylopsis* S. et Z. – type, sensu Oszast 1960		+	+	+	*Corylopsis spicata*	*Corylopsis* – about 12 species in subtropics of Asia, shrubs or small deciduous trees
	Magnoliaceae						
	Liriodendron						
136.	*Liriodendroipollis verrucatus* Krutzsch 1970		+	+	+	*Liriodendron tulipifera*	Eastern part of North America – oak-tulip-tree forests
137.	*Liriodendroipollis verrucatus* Krutzsch 1970, f. *major*			+	+	*Liriodendron tulipifera*	
138.	*Liriodendroipollis semiverrucatus semiverrucatus* Krutzsch 1970			+	+	*Liriodendron chinense*	Mixed mesophytic forests. South-eastern China, Japan
	Magnolia						
139.	*Magnolipollis neogenicus minor* Krutzsch 1970	+	+		+	*Magnolia*	*Magnolia* – about 80 species, deciduous or evergreen trees and shrubs. East Asia, North and Central America, Himalayas

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
140	*Magnolipollis* cf. *neogenicus minor* Krutzsch 1970				+	*Magnolia*	
141.	*Magnolipollis* cf. *magnolioides* Krutzsch 1970				+	*Magnolia acuminata*	Eastern regions of USA, deciduous trees up to 25 m in height
	Nympaeaceae						
142.	*Nymphaea* – type		+	+	+	*Nymphaea*	40 species, common in both hemispheres, perennial in stagnent waters, lakes
	Rosaceae						
143.	*Spiraea* – type			+		*Spiraea*	*Spiraea* – 100 species, in temperate zone: Asia, Europe, North America, Mexico. Deciduous shrubs
144.	*Rubus* – type 1		+			*Rubus*, *Crataegus*	*Rubus* – 400 species, most of them in northern hemisphere, some in Africa, Australia, New Zealand and on Pacific islands, deciduous or evergreen shrubs. *Crategus* – 200 species. North America, Asia, Europe. Deciduous trees and shrubs
145.	*Rubus* – type 2		+			*Rubus xanthocarpus*	China – Szechwan, low shrubs
146.	*Crataegus* – type		+	+		*Crataegus submollis*	North-eastern regions of North America, deciduous big shrubs or trees,
	Saxifragaceae						
	Itea						
147.	*Iteapollis angustiporatus* (Schneider, 1965) Ziembińska-Tworzydło 1974				+	*Itea chinensis*, *I. macrophylla*, *I. oldhamii*, *I. virginica*	*Itea* – evergreen or deciduous shrubs or trees. 15 species from Himalayas to Japan and western Malaysia. *I.chinensis* – evergreen forests of south-eastern China. *I. macrophylla* – evergreen rain forests of southern China. *I. virginica* – evergreen shrubs, shrubby swamps on Atlantic coast of North America

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Leguminosae						
148.	*Tricolpopollenites liblarensis* (Thomson, 1950) Thomson et Pflug 1953	+	+	+	+		*Leguminosae* – trees, shrubs or herbs, above 600 genera, 13.000 species, almost cosmopolitan. Tropics, subtropics, temperate zone
149.	*Tricolpopollenites quiqualis* Potonié 1934		+				
150.	*Tricolpopollenites* sp. 1				+		
151.	*Tricolporopollenites* sp. 1				+	*Cladrastis wilsonii*	Mixed mesophytic forest. South-eastern China. Deciduous tree
152.	*Tricolporopollenites* sp. 2		+			*Ormosia eliptica*	Evergreen broad-leaved forests of south-eastern China. Deciduous tree
153.	*Tricolporopollenites* sp. 2		+		+		
154.	*Tricolporopollenites* sp. 3	+	+				
155.	*Tricolporopollenites* sp. 4				+		
156.	*Tricolporopollenites* sp. 5				+		
157.	*Tricolporopollenites* sp. 6				+		
158.	*Tricolporopollenites* sp. 7				+	*Cassia*	About 600 species, in subtripical and tropical zones. Shrubs, trees and herbs
159.	*Tricolporopollenites* sp. 8		+		+		
160.	*Tricolporopollenites* sp. 9				+		
	Elaeagnaceae						
161.	*Slowakipollis* cf. *neogenicus* Nagy 1969				+	*Hippophaë rhamnoides*	Europe, West Asia, Caucasus – to East Asia (semidesert regions). Shrubs
162.	*Slowakipollis* cf. *elaeagnoides* Krutzsch 1962				+	*Elaeagnus angustifolia*	West and Central Asia (semidesert regions), shrubs
163.	*Elaeagnus* – type		+			*Elaeagnus angustifolia,*	
164.	*Elaeagnus glabra* – type				+	*Elaeagnus glabra*	Evergreen shrubs. Central China, Korea, Japan

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Trapaceae						
	Trapa L.						
165.	*Sporotrapoidites illingenis* Klaus 1954				+	*Trapa*	3 species. Europe, Asia, North Africa. Aquatic, herbs
	Nyssaceae						
	Nyssa						
166.	*Nyssapollenites kruschi* (Potonié, 1931)					*Nyssa*	*Nyssa* – 4 species in North America, 2 species in Asia. *N. aquatica* – south-eastern regions of USA. *N. ogeche* = *N. capilata* – USA, from Florida to eastern Georgia. *N. sylvatica* – eastern regions of USA. *N. sinensis* – central China. Except for N. sylvatica all the species occur in wet and marshy sites. Deciduous trees
a.	*Tricolporopollenites kruschi* (Potonié, 1931), subsp. *analepticus* (Potonié, 1931) Thomson et Pflug 1953	+	+	+	+		
b.	*Tricolporopollenites kruschi* (Potonié, 1931), subsp. *contortus* Thomson et Pflug 1953	+	+	+	+		
c.	*Tricolporopollenites Kruschi* (Potonié, 1931), subsp. *rodderensis* (Thiergart, 1937) Thomson et Pflug 1953	+	+	+	+		
167.	*Nyssapollenites pseudocruciatus* (Potonié, 1931) Thiergart 1937				+	*Nyssa*	

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Oenotheraceae						
168.	*Corsinipollenites oculusnoctis* (Thiergart, 1940) Nakoman 1965 ssp. *oculusnoctis* Krutzsch 1968		+		+	*Oenotheraceae*	About 20 genera in the tempretate to tropical zones. Most frequently herbs, rarely shrubs
169.	*Corsinipollenites polonicus* Krutzsch 1968				+	*Chamaenerion, Lopezia, Epilobium*	*Chamaenerion* – 4 North-American species. *Epilobium* – about 200 species, cosmopolitan, except tropics. *Lopezia* – 16 Central-American species
170.	*Corsinipollenites* sp. 1				+	*Oenotheraceae*	
	Malvaceae						
171.	*Malvaceae* – type				+	*Sphaeralcea*?	*Malvaceae* – cosmopolitan, about 85 genera. Herbs, shrubs, trees
	Sterculiaceae						
	Reevesia						
172.	*Reevesiapollis triangulus* (Mamczar, 1960) Krutzsch 1970			+	+	*Reevesia*	*Reevesia* – evergreen shrubs or trees. 15 species from Himalayas to Formosa, in evergreen broad-leaved forests and evergreen rain forests
	Sterculiaceae – Rutaceae						
173.	*Tricolporopollenites* sp. 10				+	*Sterculiaceae, Rutaceae*	*Sterculiaceae* – about 70 genera, for the most part in tropics. Trees, shrubs and herbs. *Rutaceae* – about 150 genera in moderate and warm, subtropical zones. Most abundant in South Africa, Australia. Trees and shrubs, rarely herbs
174.	*Tricolporopollenites* sp. 11				+		
175.	*Tricolporopollenites* sp. 12				+		

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Meliaceae						
176.	*Meliaceae* – type				+	*Cedrela glaziorii*? *Dysoxylum cochinchinense*?	*Cedrela* – evergreen or deciduous trees and shrubs. 18 species in tropics of America and South-East Asia to South Australia. *Dysoxylum* – 100 species. From Indo-Malaya to Polynesia
	Tiliaceae						
	Tilia						*Tilia* – 50 species in northern temperate zone
177.	*Intratriporopollenites instructus* (Potonié, 1931) Thomson et Pflug 1953				+	*Tilia platyphyllos*	Central and southern Europe
178.	*Intratriporopollenites* sp. 1				+	*Tilia tomentosa*	South-eastern Europe, Asia Minor
	Aceraceae						
	Acer						*Acer* – about 150 species, above all in temperate zone of northern hemisphere. In tropics in mountains
179.	*Aceripollenites* sp. 1				+	*Acer tataricum*, *Acer truncatum*	*Acer tataricum* – south-eastern Europe, Balkans, Hungary, Asia Minor, Elburs Mts.. *Acer truncatum* – deciduous broad-leaved forests in eastern China
180.	*Aceripollenites* sp. 2				+	*Acer tataricum*, *Acer truncatum*	
181.	*Aceripollenites* sp. 3			+		*Acer treutvetteri*	Great and Little Caucasus Mts., in subalpine zone belt
182.	*Aceripollenites striatus* (Pflug, 1959) Thiele-Pfeiffer 1980		+		+	*Acer campestre*	Europe, Asia Minor
183.	*Aceripollenites* sp. 4			+	+	*Acer platanoides*, *Acer pseudoplatanus*	*Acer platanoides* – Europe to Caucasus Mts.. *Acer pseudoplatanus* – Central Europe

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
184.	*Aceripollenites* cf. *reticulatus* Nagy 1969				+	*Acer*	
185.	*Aceripollenites* sp. 5				+	*Acer*	
	Aquifoliaceae						
	Ilex						*Ilex* – 400 species from temperate zone to tropics regions from North America to Australia
186.	*Ilexpollenites iliacus* (Potonié, 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953	+	+	+	+	*Ilex aquifolium, Ilex cymosa, Ilex sieboldii = Ilex serrata*	*I. aquifolim* – West, Central and South Europe, North Africa, Asia Minor to Iran *Ilex serrata* - Japan
187.	*Ilexpollenites* cf. *iliacus* (Potonié, 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953				+		
188.	*Ilexpollenites margaritatus* (Potonié, 1931), f. *major* Thomson et Pflug 1953		+	+			
189.	*Ilexpollenites margaritatus* (Potonié, 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953				+	*Ilex asprella, Ilex cinerea, Ilex mitis, Ilex olbera*	
	Cyrillaceae – Clethraceae						
	Cyrilla						*Cyrilla* – one-species genus, deciduous shrub
190.	*Cyrillaceaepollenites megaexactus* (Potonié, 1931) Potonié 1960	+	+	+	+	*Cyrilla racemiflora*	Shrubby bogs from south-eastern North America to West Indies
191.	*Cyrillaceaepollenites* cf. *megaexactus* (Potonié, 1931) Potonié 1960		+			*Cyrilla racemiflora*	
192.	*Cyrillaceaepollenites exactus* (Potonié, 1931) Potonié 1960	+	+	+	+	*Clethra*	*Clethra* – about 30 species, evergreen and deciduous trees in tropics and subtropics
193.	*Tricolporopollenites* cf. *clethraeceiformis* Nagy 1969				+	*Clethra alnifolia*	*C. alnifolia* – shrubs up to 3 m in height. Eastern regions of North America. In peat-bogs and wet forests

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
194.	*Clethraceae? Cyrillaceae?*		+			*Clethraceae? Cyrillaceae?*	
	Vitaceae						
	Vitis						*Vitis* – about 70 species in northern warme temperate zone
195.	*Vitis* – type 1				+	*Vitis simpsoni, Vitis cordifolia*	
196.	*Vitis* – type 2				+	*Vitis riparia*	Central and eastern North America
	Parthenocissus – type						*Parthenocissus* – about 15 species. North America to Mexico and Eastern Asia to South-Eastern Asia
197.	*Tricolporopollenites marcodurensis* Pflug et Thomson 1953		+	+	+	*Parthenocissus, Parthenocissus henryana?*	*P. henryana* – Central China
198.	*Tricolporopollenites marcodurensis* Pflug et Thomson 1953 f. *major*				+	*Parthenocissus, Leea manillensis?*	
	Cyphostemma-Cissus – type						*Cissus* – about 350 species in tropics and subtropics
199.	*Tricolporopollenites* cf. *marcodurensis* Pflug et Thomson 1953				+	*Cissus repens, Cissus pannosa, Cyphostemma curvipoda*	
	Araliaceae – Cornaceae						
	Araliaceae – type						*Araliaceae* – herbs, shrubs, trees, sometimes lianous about 65 genera more than 800 species, primaryly tropical. The 2 great centers of distribution – Indo-Malayas region and tropical America

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
200.	*Araliaceoipollenites edmundi* (Potonié, 1931) Potonié 1951		+	+	+	*Acanthopanax sciadophylloides*, *Panax pinnatum*, *Panax pentadactylon*	*Acanthopanax* – 50 species in East Asia to Himalayas. *A. sciadophylloides* – shrubs in mountainous regions of Japan. *Panax* – 6 species in North America and East Asia, shrubs in mixed mesophytic forests
201.	*Araliaceoipollenites euphorii* (Potonié, 1931) Potonié 1951		+			*Aralia chinensis*	Mixed mesophytic forests in south-eastern China (from Manchuria to Szechwan). *Aralia* – 35 species in warm temperate zone
202.	*Araliaceoipollenites* sp. form B, Konzalova 1976			+	+	*Aralia chinensis* var. *mandczurica*	Eastern Siberia, Manchuria, Japan
	Cornaceae – type						Trees, shrubs – about 10 genera, 90 species. Most species in warm-temperate regions of North America and Asia, others in tropics and subtropics
203.	*Tricolporopollenites satzveyensis* Pflug 1953 (*Cornus* – type 1)				+	*Cornus* or *Mastixia*	*Cornus* – about 40 species, warm-temperate zone of northern hemisphere. Chiefly an Asiatic and American genus. *Mastixia* – 25 species, Indo-Malaya
204.	*Cornus* – type 2	+	+	+	+	*Conrus stricta*, *Conrus officinalis*	*Conrus stricta* – North America. *Conrus officinalis* – Japan
	Anacardiaceae						
205.	*Tricolporopollenites pseudocingulum* (Potonié, 1931) Thomson et Pflug 1953	+	+	+	+	*Anacardiaceae*	79 genera in tropics and subtropics
	Ericaceae						
206.	*Ericipites* sp. 1		+			*Erica arborea*	South Europe, North Africa, Caucasus Mts.
207.	*Ericipites baculatus* Nagy 1969			+	+	*Calluna vulgaris*	Heaths and peatbogs of Europe and coast of North America
208.	*Ericipites* sp. 2				+		
209.	*Ericipites ericius* (Potonié, 1931) Potonié 1960	+	+	+	+		

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
210.	*Ericipites* sp. 3	+	+	+	+	*Rhododendron*	*Rhododendron* – about 500–600 species, mainly in East Asia: from southern China to Himalayas and Japan, many species also in North America, 4 in Central and South Europe, 5 in Caucasus Mts., 250 species in Malayan Archipelago and several in arctic regions
211.	*Ericipites* sp. 4				+	*Pyrolaceae*	*Pyrolaceae* – 16 genera in coniferous and mixed coniferous-deciduous forests of northern hemisphere. Occurring not numerously in high tropical mountains and in arctic tundra. Herbs
212.	*Ericipites roboreus* Potonié, 1931) Krutzsch 1970			+		*Arbutus unedo*	Evergreen tree characteristic of Mediterranean maquia
213.	*Ericipites* sp. 5				+	*Pieris formosana* var. *forrestii* = *Pieris forrestii*	*Pieris* – 10 species in North America, East Asia, Himalayas. Evergreen shrubs. *P. forrestii* – western China, Yunnan, Upper Burma
	Symplocaceae						
	Symplocos – type 1						*Symplocos* – 300 species in tropics and subtropics. Evergreen or deciduous trees and shrubs
214.	*Porocolpopollenites vestibulum* (Potonié, 1931) Thomson et Pflug 1953 – *Symplocos* – type 1		+		+	*Symplocos setchuensis*	China (Tsekiang)
215.	*Symplocos* – type 2				+	*Symplocos*	

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
	Convolvulaceae						
216.	*Calystegiapollis sarmaticus* Nagy 1985				+	*Calystegia sepium*	*Calystegia* – mostly in East Asia, 25 species. *C. sepium* – wide distribution in temperate zone of northern hemisphere, herbs, creepers, wet forests
	Labiatae						
217.	*Labiatae* – type	+	+	+	+	*Labiatae*	*Labiatae* – about 200 genera, widespread in both hemispheres, herbs or shrubs, rarely trees
	Scrophulariaceae						
218.	*Scrophulariaceae* – type				+	*Scrophulariaceae*	*Scrophulariaceae* – mostly herbs, shrubs, rarely lianas. About 200 genera from tropics to arctic regions
	Lentibulariaceae						
219.	*Utriculariaepollenites elegans* Nagy 1969			+	+	*Utricularia*	*Utricularia* – 250 species, from tropics to temperate zone. Epigean and aquatic herbs
	Oleaceae						Tress, shrubs, sometimes lianous, 22 genera, from warm-teperate to tropic regions, notably Asia and East Indies
220.	*Ligustrum* – type 1				+	*Ligustrum amurensis*	North China
221.	*Ligustrum* – type 2			+	+	*Ligustrum*	*Ligustrum* – 50 species, mostly in East Asia, from China and Japan to Malayan Archipelago. One species in Europe to North Africa
222.	*Oleaceae* – type	+	+	+	+		
223.	*Fraxinus* – type 1		+		+	*Fraxinus ornus*	*Fraxinus* – 65 species in northern hemisphere. *Fraxinus ornus* – South Europe, Asia Minor

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
224.	*Fraxinus* – type 2				+	*Fraxinus mariesii*	China. Mixed mesophytic forests
	Caprifoliaceae						
225.	*Diervillapollenites megaspinosus* Doktorowicz-Hrebnicka 1956				+	*Diervilla sessilliflora*, *Diervilla verosa*	*Diervilla* – 3 species in North America
226.	*Sambucus* – type			+		*Sambucus canadensis*, *Sambucus nigra*	*Sambucus* – 40 species in temperate and subtropical zones in northern hemisphere. *S. canadensis* – North America. *S. nigra* – Europe, Asia Minor, Caucasus Mts.
227.	*Viburnum* – type		+		+	*Viburnum carlessi*, *Viburnum lentago*	*Viburnum* – 200 species in moderate and subtropical zones in northern hemisphere, especially in Asia and North America. *V. carlessi* – Korea. *V. lentago* – North America
	Asclepiadaceae						
	Periplocoideae						
228.	*Manikinipollis tetradoides* Krutzsch 1970				+	*Periploca sepium*	*Periploca* – creepers (shrubs), evergreen or deciduous. 10 species in South Europe, Asia, subtropical and tropical Africa. *P. sepium* – deciduous broad-leaved forests in eastern China.
	Compositae						
	Artemisia						
229.	*Artemisiaepollenites sellularis* Nagy 1969	+	+	+	+	*Artemisia campestris*, *A. canadensis*, *A. laccinata*, *A. vulgaris*, *A. maritima*	*Artemisia* – about 250 species, mostly in northern hemisphere. Mainly steppe plans, sometimes ruderal, alpine. Herbs or shrubs
230.	*Tubulifloridites ambrosiinae* Nagy 1969	+	+	+	+	*Ambrosia maritima*	*Ambrosia* – 25 species, most in America, 2 Mediterranean species

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
231.	*Cichoreacidites gracilis* (Nagy, 1969) Nagy 1985	+	+	+	+	*Cichorieae*	*Cichorieae* – about 65 genera in northern hemisphere, mostly herbaceous plants
	Sparganiaceae – Typhaceae						
	Sparganium – type						*Sparganium* – 20 species, temperate zone to subarctic. 2 species in Malaysia and South Australia. Herbs
232.	*Sparganiaceaepollenites magnoides* Krutzsch 1970		+	+	+	*Sparganium racemosum*, *S. simplex*	*Sparganium racemosum* – edges of waters. *S. simplex* – edges of waters, peatbogs
	Typha – type						*Typha* – 15 species, wide distribution in temperate zone of northern hemisphere and in tropical zone, herbs
233.	*Sparganiaceaepollenites sparganioides* (Meyer, 1956) Krutzsch 1970				+	*Typha angustifolia*	Edges of waters
234.	*Sparganiaceaepollenites polygonalis* Thiergart 1937		+		+	*Typha minima*	Edges of waters
	Potamogetonaceae						
235.	*Potamogeton* – type	+	+	+	+	*Potamogeton*, *Juncaginaceae*?	*Potamogeton* – about 90 species cosmopolitan genus, stagnant waters. Herbs. *Juncaginaceae* – about 18 genera mostly in southern hemisphere. Herbs
	Cyperaceae						
236.	*Cyperaceaepollis piriformis* Thiele-Pfeiffer 1980				+	*Bulboschenus maritimus*?=*Scirpus maritimus*, *Heleocharis palustris*?=*Scirpus eupalustris*, *Carex*, *Cladium*	*Scirpus* – about 250 species, cosmopolitan genus, herbs. Edges of waters. *Cerex* – about 1100 species, cosmopolitan genus, herbs. *Cladium* – 48 species, mostly in troppics and subtropics. *C. mariscus* – Europe. In marshes and and peatbogs, herbs
237.	*Cyperaceaepollis* sp. 1	+	+	+	+	*Carex*	

Table 1. Continued

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
238.	*Cyperaceaepollis* sp. 2				+	*Scirpus eupalustris*, *Carex*, *C. nigra*, *C. hudsonii*	
	Gramineae						
239.	*Graminidites pseudogramineus* Krutzsch 1970	+	+	+	+	*Gramineae*	About 700 genera, cosmopolitan distribution
240.	*Graminidites* cf. sp. B, Krutzsch 1970				+	*Gramineae*	
	Palmae? **Amarylidaceae**? **Butomaceae**?						
241.	*Arecipites* cf. *pseudoconvexus* Krutzsch 1970				+	*Trachycarpus excelsa* var. *typica*	*Trachycarpus* – 8 species, from the western Himalaya Mts. to China and Japan
242.	*Arecipites* cf. *longicolpatus* Krutzsch 1970		+		+	*Sabal adamsonii*	*Sabal* – 25 species in tropical America: from southern regions of USA to Venezuela and Lesser Antilles
243.	*Arecipites butomoides*, *butomoides* Krutzsch 1970			+	+	*Butomus umbellatus*	Aquatic, herbaceous plant, wide distribution in temperate zone of Europe and Asia
244.	*Arecipites butomoides semilaevigatus* Krutzsch 1970		+				
245.	*Arecipites lusaticus* Krutzsch 1970				+	*Trachycarpus fortunei*	Upper Burma, China, Japan
246.	*Palmae* – type 1				+	*Chamaedorea lindeniana*	South America
247.	*Palmae* – type 2		+			*Palmae*	*Palmae* – about 236 genera, 3400 species in tropics and subtropics and in southern Europe
248.	*Palmae* – type 3				+	*Palmae*	
249.	*Palmae* – type 4			+		*Palmae*	
250.	*Palmae* – type 5		+			*Palmae*	
251.	*Palmae*? – type 6				+	*Palmae*?	

No.	Occurrence in deposits / Name of fossil taxon	Rawicz Beds	Ścinawa Beds	Adamów Beds	Mid-Polish Beds	Name of recent taxon	Occurrence
252.	*Corypha* – type				+	*Corypha taliera*	*Corypha* – 8 species in tropical Asia. *Corypha taliera* – India
253.	*Amarylidaceae* – type 1				+	*Amarylidaceae, Agave americana*?	65 genera, 860 species, in tropics and subtropics
254.	*Amarylidaceae* – type 2				+	*Amarylidaceae*	
255.	*Amarylidaceae*? – type 3				+	*Amaryllidaceae*? *Liliaceae*?	
	Liliaceae - Iridaceae						
256.	*Liliaceae-Iridaceae*, type 1			+		*Liliaceae-Iridaceae*	*Liliaceae* – 3500 genera in tropics to temperate zone, also in arctic and antarctic zones. *Iridaceae* – 75 genera, 1500 species in tropics and subtropics to temperate zone
257.	*Liliaceae-Iridaceae*, type 2				+	*Liliaceae-Iridaceae*	
	Restionaceae						
258.	*Milfordia incerta* (Thomson et Pflug, 1953) Krutzsch 1961				+	*Restionaceae*	*Restionaceae* – 25–30 genera, about 400 species, nearly all of them in southern hemisphere, in tropics, in marshy regions. Herbs.

GENERAL CHARACTERISTICS OF VEGETATION

A palynological study of four profiles examined from the Wyrzysk region allowed a reconstruction of the vegetational succession in that area during the Miocene, taking into consideration facially varying communities. In all the diagrams the sporomorph curves have been arranged according to a scheme under which plants are grouped successively as they occur in dry, wet, swampy and aquatic environments (cf. Jux 1968).

Two basic groups have been distinguished: one of them comprises mixed deciduous-coniferous forests on dry and moderately wet substrata, the other consists of swamp forests, peat-swamp communities and reed swamp and aquatic plants. It should be kept in mind that this division is schematic, for many pollen grains have been identified only to generic level, while particular species might represent different environments.

The studies on the vegetational succession in the Neogene carried out so far show that the changes in the forest vegetation towards the domination of warm or subtropical floristic elements are of broader significance; they evidence climatic fluctuations in the study area, while the swamp and aquatic flora reflects mainly local changes. In this connection, in the four pollen diagrams from the Wyrzysk region observations were made as to the variability of forest and swamp vegetation.

The following communities have been distinguished: communities of mixed deciduous-coniferous forest, riparian forest, swamp forest, peat-swamp and reed and aquatic plants.

Mixed deciduous-coniferous forests (Mixed mesophytic forest)

The pollen diagrams for the region of Wyrzysk record the presence of deciduous-coniferous forests with the dominance of deciduous and a small proportion of evergreen plants.

In rather high-lying, moderately moist places, there grew mixed deciduous-coniferous forests, in which, in addition to various species of *Pinus*, coniferous trees were represented by dominant *Sciadopitys*, *Sequoia*, *Tsuga* and, in smaller numbers, *Picea*, *Abies*, *Cryptomeria*, *Cunninghamia*, *Podocarpus*, *Metasequoia* and *Keteleeria*. They were accompanied by deciduous trees, above all, *Corylus*, *Carpinus*, *Acer*, *Tilia*, *Fagus*, *Zelkova*, *Juglans*, *Quercus*, *Carya*, *Liriodendron*, *Castanea*, *Platycarya* and *Eucommia*. These trees have been included in the warm-temperature arctotertiary geoflora prevailing in the northern hemisphere from the Cretaceous period throughout the Neogene (Mai 1981). At present their recent members occur mostly in the temperate and warm-temperate zones of the northern hemisphere. The other group of trees consists of the genera associated mainly with the subtropical and, more rarely, tropical zones of the northern hemisphere. In the pollen spectra from the Wyrzysk region there are about 15 such genera of trees and shrubs, e.g. *Engelhardtia*, *Reevesia*, *Corylopsis*, *Ilex*, *Magnolia*, *Itea* and some members of the families *Sterculiaceae-Rutaceae*, *Symplocaceae*, *Palmae*, *Amaryllidaceae*, *Araliaceae-Cornaceae*, *Anacardiaceae* and *Leguminosae*. Most of

the plants named above are a residue of the palaeotropical geoflora, dominant in Europe in the Paleogene (Mai 1981). Two arboreal genera *Reevesia* and *Engelhardtia* may be included among the warmest elements of the palaeotropical geoflora present in the pollen spectra from the Wyrzysk area. Nowadays these genera are characteristic of the zone of evergreen broad-leaved forests of East and South-East Asia. *Reevesia* is besides the only genus found in the profiles studied that is a fundamental component of the rain forests of East Asia (Wang, 1961).

The developmental dynamics of the arctotertiary flora of those times in the study area is evidenced by the below-given examples of multispecific genera occurring in the forest communities of that period. From among the coniferous trees of the mixed deciduous-coniferous forests of the Miocene, *Sequoia*, *Tsuga* and *Sciadopitys* were the main genera that exhibited clear dynamics of development; their pollen grains occurred frequently and in large numbers, showing a distinct morphological variation. The pollen grains of *Sequoia* have been counted in four fossil species. Today two species (*Sequoia sempervirens* and *Sequoia gigantea*) make up *Sequoia* forests in North America. *Tsuga*, too, was a common tree in Miocene forests. Its pollen grains represent probably eigth fossil species, whose presumable present-day members grow in mixed deciduous-coniferous and coniferous forests in North America (*Tsuga canadensis* and *T. caroliniana*) and in East Asia (*T. diversifolia*, *T. sieboldii*, *T. blaringhemii* and *T. calcarea*). The pollen grains of *Sciadopitys* are also numerous and represent nine fossil species. At the present time only the species *Sciadopitys verticillata* grows in mixed deciduous- coniferous forests in low-lying places in the mountains and in the lowlands of southern Japan.

Abies, *Picea* and *Keteleeria* were further genera of coniferous trees which were present in Miocene forests. Two fossil species of *Picea* have been isolated and compared to the species now growing in the coniferous mountains forests of North and Central Europe (*Picea abies*) and to the East-Asiatic species (*Picea jezoensis*, *Picea asperata* and *Picea schrenkiana*). Four fossil species of *Abies* have been compared to the species growing in the mountain forests of Central Europe (*Abies alba*), the Caucasus Mts. (*Abies nordmanniana*) and in East Asia (*Abies firma* and *A. koreana*). The *Keteleeria* fossil pollen has been divid between two species; now this genus grows only in the mixed mesophytic or evergreen forests of East Asia. Apart from the above-mentioned coniferous trees, such genera as *Cryptomeria*, *Cunninghamia* and *Metasequoia* also played a certain role in the Miocene forest communities. Their modern home are mixed mesophytic and evergreen forests in East Asia, more strictly, in Japan, southern Korea and central and southern China (Wang 1961). Besides the conifers a large group of genera of arctotertiary deciduous trees grew in Miocene forests. These are: *Betula*, *Corylus*, *Carpinus*, *Tilia*, *Acer*, *Fagus*, *Castanea*, *Carya*, *Juglans*, *Quercus* and *Liriodendron*. As in the conifers, the multispecific genera prevailed also among the deciduous trees.

The genus *Carpinus* was represented by two fossil species, compared to the European species *Carpinus betulus* and to East-Asiatic *C. cordata* and *C. orientalis*. This last species occurs in lower positions in the Caucasus Mts. Two fossil species of *Liriodendron* have been compared to *Liriodendron tulipifera* growing now in oak-tuliptree forests in the eastern part of North America (Kearney 1901) and to *L. chinense* from

mixed mesophytic forests in central and southern China (Wang, 1961). The genus *Quercus*, whose pollen grains show enormous morphological variability, must have formed a high proportion in Miocene forest communities. Out of the eigth morphological types distinguished, several undoubtedly represent separate fossil species. Among the recent species to which they are compared, the following deserve more attention: *Quercus ilex*, which goes to the making of evergreen hard-leaved thickets in the Mediterranean region, *Quercus pontica*, common in the Caucasus Mts., the Caucasus Mts., *Querqus serrata* from East Asia and *Q. robur*, common in Europe, North Africa and Asia Minor (Krüssmann 1978). Such trees as *Fagus*, *Tilia* and *Acer*, whose pollen grains also show distinct intrageneric morphological variation, should be mentioned in this discussion of the multispecific arctotertiary genera of the Miocene forest communities.

The pollen grains of *Acer* have been divided into seven morphological types compared, among others, to the recent Eurasian species *Acer campestre*, *A. platanoides*, *A. pseudoplatanus* or Asiatic *A. trautvetterii* – the main component of parkland vegetation in the Caucasus, *Acer tataricum* – common in southern Europe and Asia Minor and *Acer truncatum* – now growing in the deciduous forests of north-eastern China. The genus *Fagus* is probably represented by two fossil species, comparable to recent beeches in the mixed deciduous- coniferous forests of Europe (*Fagus sylvatica*), mauntain forests of the Caucasus (*F. orientalis*) and mixed mesophytic or evergreen forests in South-eastern China (*F. longipetiolata*) (Krussmann 1978; Wang 1961).

The evergreen shrub layer in Miocene forests was composed of *Palmae*, *Symplocos*, *Ilex*, *Magnolia*, *Rhododendron*, etc.

As regards sporophytes, the palaeotropical element consisted probably of certain species of *Lycopodium* (*Lycopodium cernuum* and *Lycopodium fokienense*) and *Selaginella*, ferns from the families *Gleicheniaceae*, *Cyatheaceae* and *Schizaeaeceae*, and some species of *Osmunda*.

Riparian forests

Towards the end of the Middle Miocene the genera typical of riparian forests, such as *Celtis*, *Pterocarya*, *Quercus*, *Ulmus* and *Alnus* predominated in the mixed deciduous-coniferous forests of the Wyrzysk region, whereas *Fraxinus*, *Liqiudambar* and *Salix* were also present. They were accompanied by the creepers *Parthenocissus*, *Vitis*, *Cissus* and *Calysteqia*. There were two morphological types of the pollen grains of *Ulmus*, which can possibly be compared to the recent American (*Ulmus racemosa*), Caucasian (*U. laevis*) or East-Asiatic (*U. parviflora*) species. The pollen grains of *Liquidambar* are characterized by great morphological variation. Four fossil species has been distinguished and compared to the recent species from North America (*Liquidambar styraciflua*), Asia Minor (*L. orientalis*) and central China and Formosa (*L. formosana*). *Fraxinus* also occurred in the Miocene riparian communities. Two morphological forms of pollen grains were found, comparable to *Fraxinus ornus* and *F. mairesii*.

Swamp forest

The swamp forest grows on a very wet substratum, where the water table spreads above the ground for the nearly whole vegetative period. The pollen spectra of the profiles from the Wyrzysk region show the presence of two types of such forests: a typical Neogenic swamp *Taxodiaceae-Cupressaceae* forest with *Taxodium*, *Nyssa*, *Glyptostrobus* etc. in the Lower and Middle Miocene and a swamp forest with dominant *Alnus* and *Nyssa* in the upper strata of the Middle Miocene, just under the Poznań Beds. That change may have been caused by a cooling of the climate or only a change in the edaphic conditions. The swamp forest, owing to the strictly defined environmental conditions in which it grew was floristically not very diversified, which is distinctly visible in the pollen spectra of the profiles from the Wyrzysk region. The maximum occurrence of *Alnus-Nyssa-Taxodiaceae-Cupressaceae* was accompanied by *Polypodiaceae*, *Osmundaceae*, *Cyperaceae*, *Gramineae* and *Typha*; from among shrubs, not numerous *Salix*, *Betula* and some species of *Palmae*. *Alnus* must have been an important component of those swamp forests, with its proportion reaching 65% in some sections of the profile. The diversity and abundance of the pollen grains of *Nyssa* also indicate a great role of this tree in swamp forests and perhaps in a wet mixed deciduous-coniferous forest (Fig. 4).

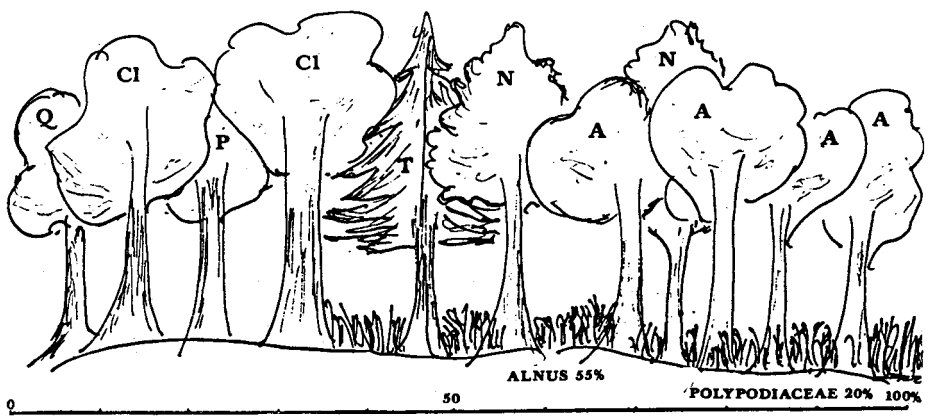

Fig. 4. Recontraction of the swamp forest (Wyrzysk region, Middle Miocene Mid-Polish Beds, Karolewo-Dąbki profile 3, sample No. 76); A – *Alnus*; *Cl* – *Celtis*; E – *Engelhardtia*; L – *Leguminosae*; *N* – *Nyssa*; P – *Pterocarya*; Q – *Quercus*; R – *Rhus*; T – *Taxodium*; U – *Ulmus*

Peat-swamp and aquatic communities

Peat-swamp and aquatic plants accompanied other plant communities in the Wyrzysk region all through the Miocene. Pollen grains of plants characteristic of shrubby and sedge swamps and aquatic communities have been determined in the pollen spectra of all the profiles. The shrubby peat-swamps were formed by two plant groups: *Cyrillaceae-Clethraceae* and *Myricaceae*, accompanied by *Salix*, *Betula* and abundant *Erica-*

ceae. The dominance of shrubby peat-swamp was observed in the Middle Miocene, more exactly in the upper Ścinawa Beds (Fig. 5). The plants which went to the making of shrubby peat-swamp are, above all, *Myrica*, *Cyrilla* and *Clethra*. Three fossil species have been isolated from the genus *Myrica* and compared to a species from southern China and Japan (*Myrica rubra*) and to two species from the Atlantic coast of North America (*M. cerifera* and *M. carolinensis*). The *Cyrillaceae-Clethraceae* group includes three fossil genera, comparable to the recent species *Cyrilla racemiflora* and *Clethra alnifolia* shrubs growing in marshy regions of the Atlantic coast of North America.

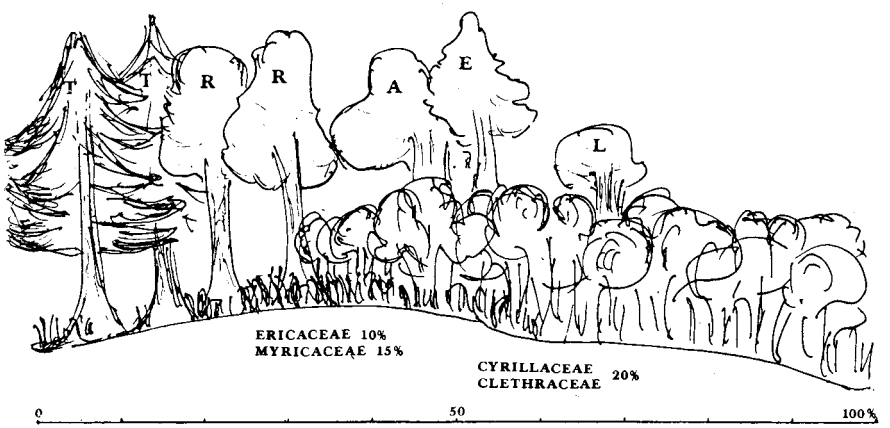

Fig. 5. Reconstruction of the shrubby peat-swamp (Wyrzysk region, Lower Miocene, Ścinawa Beds, Liszkowo profile, sample No. 43, expl. see Fig. 4)

In the upper layers of the Middle Miocene (Middle-Polish Beds), the presence of sedge swamp was distinctly visible. The pollen grains of *Cyperaceae* reached 50% in the spectrum. The pollen grains of the fossil species *Cyperaceaepollis piriformis* prevailed among them and were compared to *Cladium*, some species of *Carex* and *Scirpus maritimus*. They were accompanied by large amounts (up to 20%) of *Gramineae* pollen. As for trees, *Alnus*, *Ulmus* and *Salix* occurred in low proportions. *Sphagnun*, *Gleicheniaceae*, *L. inundatum* and *Lycopodium cernuum* were also present (Fig. 6).

The water-edge and aquatic communities were composed of plants from the families *Liliaceae-Iridaceae*, *Typha*, *Sparganium*, *Potamogeton* and *Utricularia*. At present they are for the most part cosmopolitan genera. Only the presence of *Gleicheniaceae* and *Lycopodium cernuum* gives these communities a subtropical aspect.

An analysis of the Miocene communities from the Wyrzysk region in north- western Poland and their comparison with the recent flora confirm the fact that the present refugia of Tertiary vegetation occur chiefly in the warm temperate zone of the northern hemisphare, in which the infiltration of floristic subtropical elements takes place. These are areas of eastern Asia, the Atlantic parts of North America and in Europe – the Balcan-Black Sea area (Kornaś 1986). The floristic composition of the above-discussed

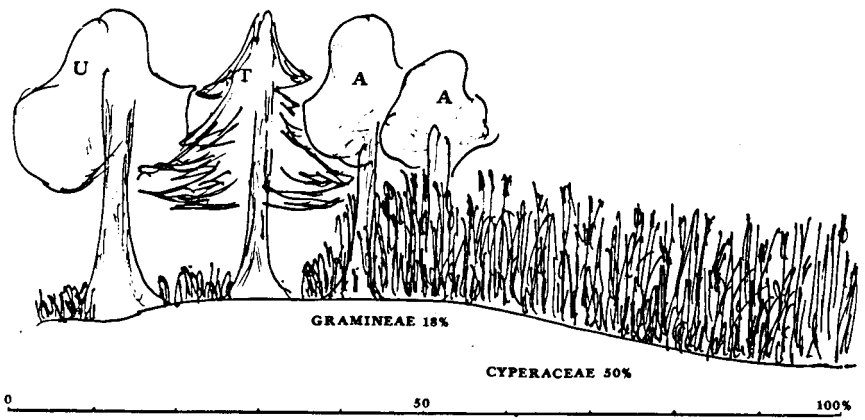

Fig. 6. Reconstruction of the sedge swamp (Wyrzysk region, Middle Miocene Mid-Polish Beds, Karolewo-Dąbki profile 3, sample No. 56, expl. see Fig. 4)

Miocene forest communities from north-western Poland indicates the dominance of a warm- temperate arctotertiary flora with elements of the palaeotropical flora.

DEVELOPMENT PHASES OF THE PLANT COVER IN THE MIOCENE

The palynological studies of four profiles in the Wyrzysk region in north-western Poland show the cyclic nature of floristic and climatic changes in this area; these were fluctuations in the warm-temperate climate towards a cooling or a warming. That is reflected by the changes in the plant cover of the Wyrzysk region, in which the arctotertiary vegetation with varying proportions of palaeotropical taxa dominate, as a rule, all through the Miocene. An increase in their proportion in the forest communities evidence warmer fluctuations in the warm-temperate climate.

Six floristic phases of the vegetation of mixed deciduous-coniferous forest have been distinguished. Changes in the swamp and aquatic vegetation are included in particular phases of the mixed forest.

PHASE I. MIXED MESOPHYTIC FOREST

This phase covers the sandy deposits of the Lower Miocene (Rawicz Beds) at a depth of 115–131 m in the Liszkowo profile (Fig. 7)*. The arctotertiary element overlying the palaeotropical element predominated in the mixed deciduous-coniferous forest. As regards coniferous trees, apart from *Pinus* there were *Sciadopitys*, *Picea*, *Abies* and *Tsyga*, and the deciduous trees comprised *Quercus*, *Carya*, *Platycarya* and *Celtis*. The palaeo-

* Fig. 7 under the cover

Mixed mesophytic forest | Swamp forest and shrubby peat-swamp | Reed and aquatic plants | Other herbs | Pteridophyta

Pinus silvestris | Pinus haploxylon | Picea | Abies | Sequoia-Cryptomeria | Tsuga | Podocarpus | Cunninghamia | Sciadopitys | Corylus | Carpinus | Acer | Tilia | Juglans | Carya | Castanea-Castanopsis | Ilex | Fagus | Ulmus - Zelkova | Quercus | Celtis | Pterocarya | Fraxinus | Liquidambar | Oleaceae | Viburnum | Vitis | Parthenocissus | Rosaceae | Leguminosae | Tricolpop. tiliarensis | Liriodendron | Magnolia | Corylopsis | Ilex | Platycarya | Engelhardtia | Tricolporopollenites pseudocingulum | Sterculiaceae-Rutaceae | Araliaceae-Cornaceae | Araliaceae pol. edmundi | Reevesia | Arcenthobium | Symplocaceae | Amaroliaceae | Areciptes

Taxodiaceae - Cupressaceae | Taxodium | Glyptostrobus | Nyssa | Alnus | Betula | Salix | Myrica | Cyrillaceae - Clethraceae | Ericaceae

Gramineae | Cyperaceae | Typha | Sparganium | Trapa | Potamogeton | Utricularia

Chenopodiaceae | Caryophyllaceae | Oenotheraceae | Labiatae | Compositae | Artemisia

Polypodiaceae | Osmundaceae | Gleichenaceae | Lycopodium | Sphagnum

Marine plankton | Fresh-water plankton

Age | Lithostratigraphy | Depth in meters | Litology | No. sample

Middle Miocene — Mid-Polish Beds

Adamów Beds

Sciawa Beds

Lower Miocene — Rawicz Beds

63 — 64,50 — 70 — 71,30 — 72,80 — 74 — 76 — 76,50 — 77,50 — 78 — 79 — 83 — 85,80 — 87,80 — 90,80 — 93,80 — 0,30 — 0,40 — 99,10 — 100,30 — 101,50 — 104 — 105 — 115 — 121 — 123 — 131

Phase VI - Riparian forest: Celtis - Ulmus - Quercus - Pterocarya climatic warming

Phase V - Riparian forest: Ulmus - Quercus maximum climatic cooling

Phase IV - Mixed mesophytic forest: Sequoia - Sciadopitys - Carpinus - Tilia - Carya further climatic cooling

Phase II - Mixed mesophytic forest: Engelhardtia - Tricolporopollenites pseudocingulum maximum climatic warming

Phase I - Mixed mesophytic forest climatic cooling

Fig. 7. Pollen diagram of the profile Liszkowo (expl. see Fig. 8)

A. Kohlman - Adamska
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tropical element was represented by *Engelhardtia*, plants of the *Araliaceae-Cornaceae* group, *Anacardiaceae* (*Tricolporollenites pseudocingulum*) and *Leguminosae*.

Swamp forest and peat-swamps

There occurred *Taxodium* swamp forests with an addition of *Alnus*, *Nyssa* and the ferns *Polypodiaceae* and *Osmunda*. Peat-swamp thickets of the *Cyrillaceae-Clethraceae-Myricaceae* type were also present and were accompanied by *Betula*, *Salix*, *Ericaceae* and the ferns of the family *Gleicheniaceae*.

The climate of this phase was damp and relatively cool.

PHASE II. MIXED MESOPHYTIC FOREST: *ENGELHARDTIA-TRICOL-POROPOLLENITES PSEUDOCINGULUM*

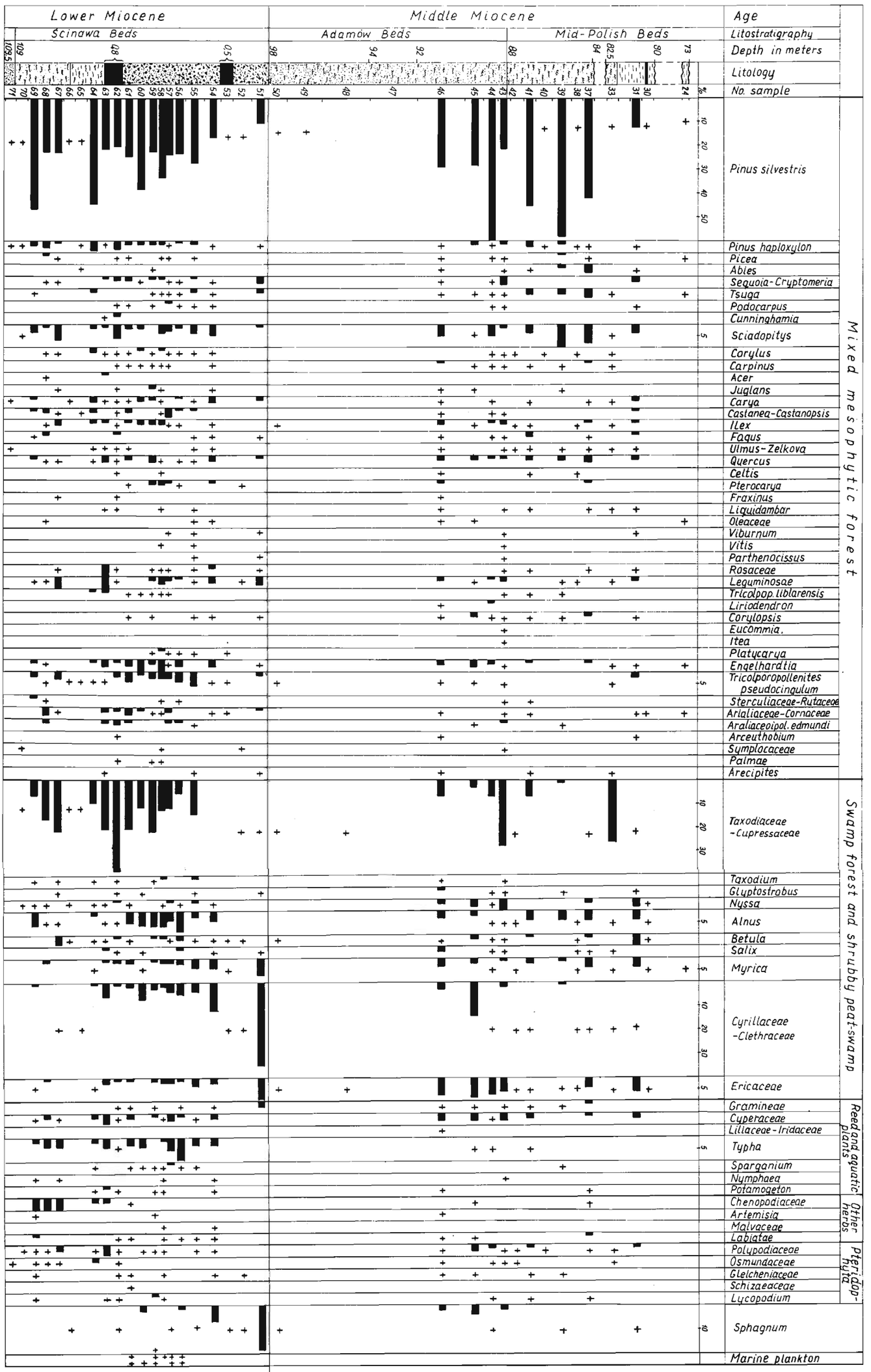
Phase II embraces the deposits of the Lower Miocene, clayey sandy with small layers of brown-coal, 0.8–0.5 m thick. They are the so-called Ścinawa Beds, occurring in the profile at Kosztowo, at a depth of 98–109 m (Fig. 8) and in the Liszkowo profile at a depth of 94–105 m (Fig. 7). The mixed deciduous- coniferous forest is characterized by a high proportion of the palaeotropical element with dominant *Engelhardtia* and *Tricolporopollenites pseudocingulum* (*Anacardiaceae*), which were accompanied by *Araliaceaepollenites edmundi* (*Araliaceae*), *Symplocos*, *Leguminosae*, *Tricolpopollenites liblarensis* (*Leguminoseae*), *Corylopsis* and Ilex. The arctotertiary floristic element is represented by *Platycarya*, *Carya*, *Castanea*, *Quercus* and *Pterocarya*. Regarding coniferous trees, besides *Pinus*, *Sciadopitys* occurred in a distinct proportion; *Sequoia* and *Tsuga* were present as admixtures.

Swamp forest and peat-swamps

In the lower Ścinawa Beds the presence of swamp forests with a dominance of *Taxodiaceae-Cupressaceae* was strongly marked. They were accompanied by *Alnus*, *Nyssa*, *Betula*; from the sedge and reed swamp vegetation by *Typha* and *Cyperaceae*, and by numerous ferns: *Osmunda* and *Gleichenieaceae*. In the upper Ścinawa Beds the *Taxodium-Nyssa* swamp forest was replaced by shrubby peat- swamps of the *Cyrillaceae-Clethracea-Myricaceae* type with some proportions of *Ericaceae*, *Gramineae* and *Sphagnum*.

This is the only Miocene phase in which the palaeotropical and arctotertiary elements remained in balance – that was the maximum warming of the climate. Starting from that moment onwards the climate was becoming cooler; however, there were stil some warmer oscillations.

Fig. 8. Pollen diagram of the profile Kasztowo. Explanation: 1 – clays; 2 – clays with fragments of brown-coal; 3 – dusty, coaly clays; 4 – sandy silts; 5 – silts; 6 – clayey silts; 7 – coaly silts; 8 – finr-grained sands; 9 – dusty sands; 10 – dusty, coaly sands; 11 – brown-coal; 12 – boulder-clay


Lower Miocene
Middle Miocene
Age
Scinawa Beds
Adamów Beds
Mid-Polish Beds
Litostratigraphy
Depth in meters
Litology
No. sample
%
Pinus silvestris
Pinus haploxylon
Picea
Abies
Sequoia-Cryptomeria
Tsuga
Podocarpus
Cunninghamia
Sciadopitys
Corylus
Carpinus
Acer
Juglans
Carya
Castanea-Castanopsis
Ilex
Fagus
Ulmus-Zelkova
Quercus
Celtis
Pterocarya
Fraxinus
Liquidambar
Oleaceae
Viburnum
Vitis
Parthenocissus
Rosaceae
Leguminosae
Tricolpop. liblarensis
Liriodendron
Corylopsis
Eucommia.
Itea
Platycarya
Engelhardtia
Tricolporopollenites pseudocingulum
Sterculiaceae-Rutaceae
Arialiaceae-Cornaceae
Araliaceoipol. edmundi
Arceuthobium
Symplocaceae
Palmae
Arecipites
Taxodiaceae -Cupressaceae
Taxodium
Gluptostrobus
Nyssa
Alnus
Betula
Salix
Myrica
Cyrillaceae -Clethraceae
Ericaceae
Gramineae
Cyperaceae
Liliaceae-Iridaceae
Typha
Sparganium
Nymphaea
Potamogeton
Chenopodiaceae
Artemisia
Malvaceae
Labiatae
Polypodiaceae
Osmundaceae
Gleicheniaceae
Schizaeaceae
Lycopodium
Sphagnum
Marine plankton
Mixed mesophytic forest
Swamp forest and shrubby peat-swamp
Reed and aquatic plants
Other herbs
Pteridophyta
1
2
3
4
5
6
7
8
9
10
11
12
Phase II - Mixed mesophytic forest: Engelhardtia-Tricolporopollenites pseudocingulum maximum climatic warming
Phase III - Mixed mesophytic forest: Sciadopitys-Sequoia-Tsuga-Quercus-Liquidambar-Engelhardtia small climatic cooling

PHASE III. MIXED MESOPHYTIC FOREST:
SCIADOPITYS-SEQUOIA-TSUGA
QUERCUS-LIQUIDAMBAR ENGELHARDTIA

Phase III comprises the sandy-clayey deposits of the Middle Miocene, with thin layers of brown-coal 0.2–0.5 m in thickness. They are the so-called Adamów and lower Middle-Polish Beds and occur in the profiles of borehole 3 at a depth of 43.5–60 m and borehole 4 at a depth of 44.5–60 m at Karolewo-Dąbki (Figs. 9, 10) and in the profile from Kosztowo at a depth of 80–91 m (Fig. 8).

The mixed deciduous-coniferous forest was characterized by a high proportion of coniferous trees, which were distinctly dominated by *Sciadopitys*. The proportions of *Tsuga* and *Sequoia* were also high and these trees were accompanied by *Picea* and *Abies*, and in some sections of the profiles also by *Cunninghamia* and *Podocarpus*. The deciduous trees were represented by *Carpinus*, *Corylus*, *Carya* and *Fagus*, most numerously however by *Quercus* and notably by *Liquidambar* – present in almost every sample. This phase was best seen in the profiles from boreholes 3 and 4 at Karolewo-Dąbki. The proportion of the palaetropical element was still distinct; it was made up of the pollen grains of *Engelhardtia*, *Tricolporopollenites pseudocingulum*, *Symplocos*, *Leguminosae*, *Palmae* and *Araliaceaepolloenites edmundi*.

Swamp forest and peat-swamps.

The *Taxodium-Nyssa* swamp forest was dominant and the *Cyrillaceae-Clethraceae-Myricaceae*-type peat-swamps were retreating. The shrubs of *Myrcia*, *Betula* and *Salix* were accompanied by large numbers of *Ericaceae*.

The climate of this phase must have been damp and, compared with that of the previous phase, decidedly coolar.

PHASE IV. MIXED MESOPHYTIC FOREST:
TSUGA-SEQUOIA CARPINUS-TILIA CARYA

Phase IV includes the clayey-coaly deposits of the Middle Miocene, where the brown-coal layers measure about 0.5 m in thickness; they are the so-called upper Middle-Polish Beds, occurring at a depth of 39.5–43.5 m in the profile of borehole 3 at Karolewo-Dąbki (Fig. 9) and at a depth of 79–86 m in the profile from Liszkowo (Fig. 7).

The mixed deciduous-coniferous forest present in this phase had a lower proportion of *Sciadopitys* than in the previous phase; thier coniferous trees were, besides, *Tsuga*, *Sequoia Abies* and *Picea*. Among the deciduous trees, as in the previous phase, the arctotertiary element was dominant but composed of different genera of trees, namely, of *Carpinus*, *Tilia*, *Carya*, *Corylus*, *Fagus*, *Ulmus* and *Pterocarya*; at the beginning of the phase also *Liquidambar*. The palaeotropical element was represented by *Leguminosae*, *Reevesia*, *Engelhardtia*, *Tricolporopollenites pseudocingulum*, *Araliaceae-Cornaceae* and *Palmae*.

Swamp forest and peat-swamps.

The *Taxodium-Nyssa* forests were replaced by the *Nyssa-Alnus* swamp forest with the presence of the shrubs: *Myrcia*, *Salix*, *Betula* and *Ericaceae*.

The climate was somewhat cooler than in the previous phase.

PHASE V. RIPARIAN FOREST: *ULMUS-QUERCUS*

Phase V includes the clayey-coaly deposits of the Middle Miocene (upper Middle-Polish Beds), occurring at a depth of 37–41.5 m in the profile of borehole 4 and at 34–39.5 m in borehole 3 at Karolewo-Dąbki (Fig. 9, 10). This phase is characterized by the dominance of riparian forest with prevailing *Ulmus*, *Quercus* and *Alnus* accompanied by *Celtis* and *Pterocarya*. The mixed desiduous-coniferous forests, growing on a dryer substratum, did not play a major role. *Engelhardtia*, *Leguminosae*, *Tricolporopollenites pseudocingulum*, *Palmae* and rather numerous *Sterculiaceae-Rutaceae* constituted the admixture of the palaeotropical element in the forest communities. Only *Pinus* and *Sciadopitys* represented the coniferous trees, the proportion of *Pinus* decreasing perceptibly in the forest communities in relation to the preceding phases.

Swamp forest and peat-swamps

Swamp forest with dominant *Alnus* and its other important component, *Nyssa*, grew in areas characterized by high dampness of the substratum and high ground water level. The trees were accompanied by such shrubs as *Salix*, *Myrcia*, *Betula* and *Ericaceae*. As regards sporophytes, *Polypodiaceae* occurred in abundance. The distinct presence of sedge peat-swamps dominated by *Cyperaceae* (about 50%) in Phase V is recorded in the profile from Karolewo-Dąbki 3 (Fig. 6). They were accompanied by *Gramineae* and, out of trees, only by *Alnus* and *Ulmus*. Pine appeared only in vestigial quantities. This peat-swamp was also recorded in the profile from Karolewo-Dąbki 4. The greatest climatic cooling fell in this phase, as evidenced by the small proportion of trees numbered in the palaeotropical element in the forest communities.

PHASE VI. RIPARIAN FOREST: *CELTIS-ULMUS-QUERCUS-PTEROCARYA*

Phase VI covers the clayey-coaly deposits of the Middle Miocene (upper Middle-Polish Beds), occurring in the profile from Karolewo-Dąbki (boreholes 3 and 4) at a depth of 31–36.5 m (Figs. 9, 10) and in the profile from Liszkowo at 63–66.5 m Fig. 7). This phase is characterized by the dominance of riparian forest with *Celtis*, *Quercus*, *Ulmus* and *Pterocarya*, shrubs – *Beutal* and *Salix* – and creepers (*Parthenocissus*). In the mixed deciduous-coniferous forests of drier habitats of this phase *Sciadopitys*, *Acer* and *Ilex* grew in fairly great abundance. Other genera of trees and shrubs were rarer.

The abudant admixture of the palaeotropical element (*Engelhardtia*, *Reevesia*, *Itea*,

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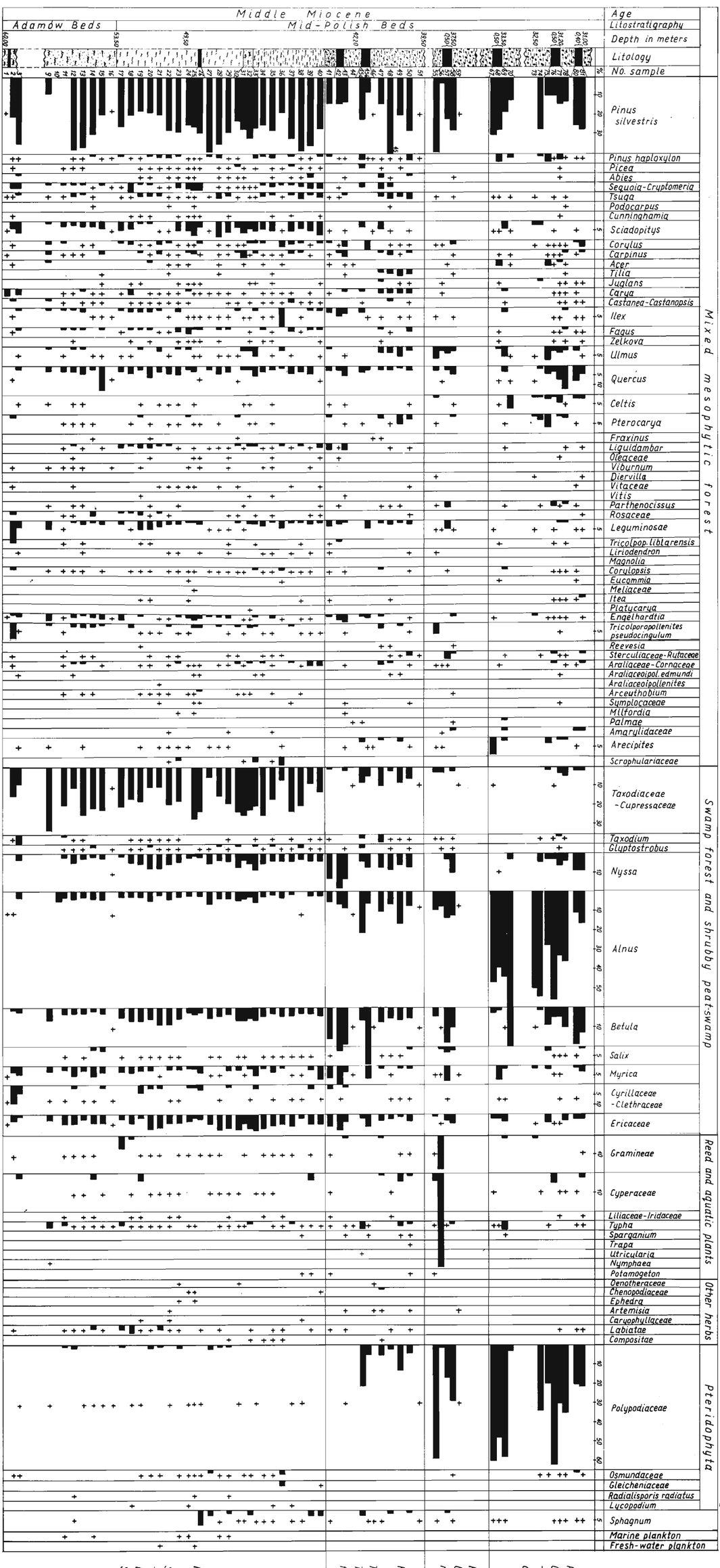
Fig. 9. Pollen diagram of the profile Karolewo-Dąbki, borehole No. 3 (expl. see Fig. 8)


Middle Miocene
Adamów Beds
Mid-Polish Beds
Age
Lithostratigraphy
Depth in meters
Litology
No. sample
Pinus silvestris
Pinus haploxylon
Picea
Abies
Sequoia-Cryptomeria
Tsuga
Podocarpus
Cunninghamia
Sciadopitys
Corylus
Carpinus
Acer
Tilia
Juglans
Carya
Castanea-Castanopsis
Ilex
Fagus
Zelkova
Ulmus
Quercus
Celtis
Pterocarya
Fraxinus
Liquidambar
Oleaceae
Viburnum
Diervilla
Vitaceae
Vitis
Parthenocissus
Rosaceae
Leguminosae
Tricolpop.liblarensis
Liriodendron
Magnolia
Corylopsis
Eucommia
Meliaceae
Itea
Platycarya
Engelhardtia
Tricolporopollenites pseudocingulum
Reevesia
Sterculiaceae-Rutaceae
Araliaceae-Cornaceae
Araliaceoipol.edmundi
Araliaceoipollenites
Arceuthobium
Symplocaceae
Milfordia
Palmae
Amaryllidaceae
Arecipites
Scrophulariaceae
Taxodiaceae -Cupressaceae
Taxodium
Gluptostrobus
Nyssa
Alnus
Betula
Salix
Myrica
Cyrillaceae -Clethraceae
Ericaceae
Gramineae
Cyperaceae
Liliaceae-Iridaceae
Typha
Sparganium
Trapa
Utricularia
Nymphaea
Potamogeton
Oenotheraceae
Chenopodiaceae
Ephedra
Artemisia
Caryophyllaceae
Labiatae
Compositae
Polypodiaceae
Osmundaceae
Gleicheniaceae
Radialisporis radiatus
Lycopodium
Sphagnum
Marine plankton
Fresh-water plankton
Mixed mesophytic forest
Swamp forest and shrubby peat-swamp
Reed and aquatic plants
Other herbs
Pteridophyta
Phase III - Mixed mesophytic forest: Sciadopitys-Sequoia-Tsuga-Quercus-Liquidambar-Engelhardtia Small climatic cooling
Phase IV - Mixed mesophytic forest: Tsuga-Sequoia-Carpinus-Tilia-Carya further climatic cooling
Phase V - Riparian forest: Ulmus-Quercus maximum climatic cooling
Phase VI - Riparian forest: Celtis-Ulmus-Quercus--Pterocarya climatic warming

Corylopsis, Araliaceae-Cornaceae and *Palmae*) provides the ground for the statement that in this very last phase of the Middle Miocene there was a well-marked climatic warming.

Swamp forest and peat-swamps.

Swamp forests, resembling those of the previous phase, consisted mainly of *Nyssa* and *Alnus*. *Betula*, *Salix* and *Myrcia* grew in the shrub layer, while numerous ferns from the family *Polypodiaceae* and few peat-swamp plants (*Sphagnum*, *Typha* and *Cyperaceae*) grew in the understorey.

CORRELATION OF THE POLLEN PROFILES FROM THE WYRZYSK REGION AND OTHER REGIONS OF THE POLISH LOWLAND

The first cumulative palynostratigraphical study of the Oligo-Miocene deposits in the Polish Lowland was carried out by Raniecka-Bobrowska (1970), who distinguished 10 pollen phases characteristic of particular lithological levels.

In 1981 Ziembińska-Tworzydło and Ważyńska compiled a new cumulative pollen diagram for Oligo-Miocene terrestrial deposits, using the study results from the area of the Fore-Sudetic Monocline and Wielkopolska. The authors established 14 pollen phases and indicator genera characteristic of particular phases.

Lower Miocene (The Rawicz Beds)

Three pollen phases were distinguished in the cumulative diagram from western Poland (Ziembińska-Tworzydło & Ważyńska 1981): the lower phase – *Alnipollenites verus* – cool climate, the middle phase – *Monocolpopollenites parareolatus* – a warm climate swing, and the upper one – *Ulmaceae* recurrence of the cooler climate.

In the pollen diagram being analysed from the Wyrzysk region some communities, very similar floristically to the Miocene forests of western Poland, with the dominant genera *Quercus*, *Carya*, *Pterocarya* and *Celtis*, appeared in the Rawicz Beds. They were accompanied by *Taxodium* swamp forests with *Alnus* and *Nyssa*. On the other hand, there was no pollen of the palm *Monocolpopollenites parareolatus*, which may have been due to the fact that the profiles under study lay further towards the north or that it did not happen on the spectra from the same layers, or of the same lithostratigraphy. In that part of the diagram only several samples were palynologically well documented.

Lower Miocene (The Ścinawa Beds).

The cumulative pollen diagram from western Poland (Ziembińska-Tworzydło & Ważyńska 1981) contains three pollen phases within the range of the Ścinawa Beds: *Quercoidites henrici* – warm climatic swing, *Tricolpopollenites liblarensis* – climatic cooling, and *Cyrillaceaepollenites exactus* – recurrence of climatic warming. Only one floristic phase (Phase II) was distinguished in the pollen diagrams from the Wyrzysk

region: deciduous-coniferous forest with dominant *Engelhardtia* and *Tricolpopollenites pseudocingulum* – maximum warming of the climate.

In comparison with the cumulative diagram (Ziembińska-Tworzydło & Ważyńska 1981) as well as with the diagrams from Legnica and Nowe Czaple (Sadowska 1977) in south-western Poland, there are no grounds for the distinction of the *Tricolpopollenites liblarensis* and *Quercoidites henrici* phases in the pollen spectra from the Wyrzysk profiles. *Quercus* does not play such a significant role among the trees, a considerable decrease being observed in the occurrence of *Quercoidites henrici*; a low frequency of the pollen grains of *Tricolporopollenites liblarensis* was also noted.

The next phase – *Cyrillaceaepollenites exactus* (Ziembińska-Tworzydło & Ważyńska 1981), closing the sedimentation of the Ścinawa Beds, is distinct in the diagrams from Kosztowo and Liszkowo. In both these diagrams *Cyrillaceae-Clethraceae* reach values from 20 to 35%. The *Cyrillaceae* facies within the Second Lusitian Seam brown-coal series II (i.e. in the Ścinawa Beds acc. to Ciuk's lithostratigraphy from 1970) had already been given by Bobrowska (1970) from the Krostkowo region near Wyrzysk and from Trzcianka near Piła. The *Cyrillaceae* phase was, besides, observed in the Neogenic deposits from Nakło (Ważyńska 1974; 1977), where in the upper Ścinawa Beds the pollen grains of *Cyrillaceae* attained a maximu occurrence up to 30%.

Therefore, the shrubby peat-swamps with dominant *Cyrillaceae-Clethraceae* occupied extensive areas of the Polish Lowland, mainly in western and north- western Poland towards the end of the Lower Miocene. It is striking that at that time *Cyrillaceae-Clethraceae* were not dominant in the pollen diagrams from the Second Lusatian Seam in south-western Poland (Legnica, Zielona Góra, Nowe Czaple – Sadowska 1977).

Pollen grains of the plants characteristic of deciduous-coniferous forests with prevailing *Engelhardtia* and *Tricolporopollenites pseudocingulum* are noted in addition to the shrubby peat-swamp of the *Cyrillaceae-Clethraceae* type in the Ścinawa Beds from the Wyrzysk region. The maximum occurrence of these two fossil forms in revealed not only by the pollen profiles from the nearest sites at Nakło (Ważyńska 1974; 1977) and in western Poland (Ślepuchowo, Mosina and Gołębin Stary – Ziembińska-Tworzydło, 1974) as well as the cumulative diagram for western Poland (Ziembińska-Tworzydło & Ważyńska 1981), but also by the profiles from the south-western of the country (Legnica, Zielona Góra and Nowe Czaple – Sadowska, 1977). Nonetheless, the differences in forest communities between these three areas under comparison are distinct. And so, the pollen spectra from the western and south-western regions show the presence of the palaeotropical element which is more significant in both qualitative and quantitative respects. Besides *Engelhardtia* and *Tricolporopollenites pseudocingulum*, they contain pollen grains of *Quercoidites henrici*, *Symplocaceae*, *Sapotaceae*, *Araliaceae-Cornaceae*, *Araliaceoipollenites edmundi*, *Palmae* and *Iteapollis*.

In the Neogenic deposits from the Wyrzysk region no Pawłowice Beds, closing the

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Fig. 10. Pollen diagram of the profile Karolewo-Dąbki, borehole No. 4 (expl. see Fig. 8)

sedimentation of the Lower Miocene (Phase – *Tsuga–Ericaceae* in the cumulative diagram by Ziembińska-Tworzydło & Ważyńska 1981), were encountered.

Middle Miocene (Adamów and Middle-Polish Beds)

In the cumulative diagram from the area of western Poland (Ziembińska-Tworzydło & Ważyńska 1981) two pollen phases were distinguished in the Adamów Beds: *Iteapollis angustiporatus* – climatic warming and *Celtipollenites verus* – cooling, and three pollen phases in the Middle-Polish Beds: *Sequoia-Nyssa-Quercus-* warming, *Azolla-Trapa* – cooling of the climate and the last phase *Tricolporopollenites pseudocingulum* – warming again.

The pollen spectra from the Adamów Beds at Wyrzysk and at Nakło (Wyżyńska 1974; 1977) did not show the presence of *Itea* pollen, while *Celtis* pollen occurred rarely and in quantities below 1%. At the same time no distinct floristic changes were observed and in this connection the possible swings of the climate within the Adamów Beds would have been difficult to see. For this reason only one phase was distinguished, Phase III, of mixed deciduous-coniferous forests with the dominance of *Sciadopitys*, *Sequoia*, *Tsuga*, *Quercus*, *Liquidambar* and *Engelhardtia*. A similar mixed forest but of a somewhat different composition (*Tsuga*, *Sequoia*, *Carpinus*, *Tilia* and *Carya*) grew also in Phase IV, whereas the next two phases, V and VI, concluding the sedimentation of the Middle-Polish Beds in the diagrams from Wyrzysk, were characterized by the presence of riparian and swamp forests.

The decline of mixed deciduous-coniferous forest in favour of riparian and swamp forests is perceptible in many pollen profiles of the Polish Lowland, namely, those from Legnica and Nowe Czaple in south-western Poland (Sadowska 1977), in the cumulative diagram from western Poland (Ziembińska-Tworzydło & Ważyńska 1981) and in the diagrams from central and north- western Poland: Rogóźno (Mamczar, 1961), Konin (Mamczar 1960b) and Nakło (Ważyńska 1974; 1977). The lower Middle-Polish layers in all these diagrams show the presence of pollen grains characteristic of mixed deciduous-coniferous forest with the prevailing arctotertiary element (e.g. *Quercus*, *Fagus*, *Castanea*, *Acer*, *Sequoia* and *Tsuga*) and a fairly large admixture of the palaeotropical element (*Engelhardtia*, *Tricolporopollenites pseudocingulum*, *Araliaceae-Cornaceae*, *Itea*, *Reevesia* and *Symplocaceae*). The *Taxodium-Nyssa* swamp forests were present everywhere. That correasponds with Phases III and IV distiguished in the diagrams from the Wyrzysk region. The only difference is the fairly large number of pollen grains of *Sciadopitys* (up to 15%) noted in the diagrams from the region of Wyrzysk and observed also over a small section of the profile from Konin (Mamczar, 1960b).

The upper Middle-Polish Beds, right under the Poznań Beds, in western and south-western Poland provide pollen spectra in which pollen grains charcteristic of riparian and swamp forests are dominant. In south-western Poland the riparian forests (Legnica – Sadowska, 1977) were of the *Quercus-Celtis-Ulmus- -Liqiudambar* type and swamp forests were composed of trees of the genera *Alnus*, *Nyssa* and *Taxodium*.

In western Poland (Gierlachowo, Oczkowice, Gołębin Stary - Ziembińska-Tworzydło 1974) there were similar *Celtis-Pterocarya-Quercus-Liqiudambar* riparian forests and

Alnus-Nyssa-Taxodium swamp forests. That type of forests is also characteristic of the last phase, Phase XIII, in the cumulative diagram from western Poland (Ziembińska-Tworzydło & Ważyńska 1981), comparable with Phases V and VI in the diagrams from Wyrzysk.

At that time the *Taxodium-Nyssa* swamp forests grew in Central Poland, while the trees characteristic of riparian forest were rare (Rogóżno – Mamczar 1961; Doktorowicz-Hrebnicka, 1964; Rypin – Stuchlik 1964). The Poznań Beds overlying the Middle-Polish deposits in the Wyrzysk region did not show the occurrence of pollen grains.

As will be seen from the foregoing survey a certain floristic differentiation can be observed in the Miocene in the territory of Poland. The flora of western and south-western Poland was richer in the palaeotropical element, even though here too as in north-western and central Poland, the arctotertiary element was dominant. The tendency for the flora to become poorer in the paleotropical element increases towards the east. The pollen diagrams of the same age from Belarus (Rylova 1980) are nearly entirely devoid of pollen grains of such plants as *Reevesia*, *Itea*, *Symplocaceae* and *Araliaceae-Cornaceae*. *Engelhardtia* occurs in small quantities and so do the pollen grains of *Taxodiaceae-Cupresaceae* and *Nyssa*. The trees and shrubs of the genera *Betula*, *Alnus*, *Carpinus* and *Quercus* dominated, the pollen grains of *Gramineae* and herbaceous plants appear in large quantities.

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STRESZCZENIE

Opracowano palinologicznie trzy stanowiska z północno-zachodniej Polski z rejonu Wyrzyska: Liszkowo, Kosztowo i Koralewo-Dąbki (Fig. 1).

Profile wierceń z tych stanowisk obejmują osady całego miocenu począwszy od miocenu dolnego, reprezentowanego przez warstwy rawickie i ścinawskie poprzez miocen środkowy: warstwy adamowskie, środkowopolskie oraz miocen górny: warstwy poznańskie. Miąższość opracowanych osadów w poszczególnych profilach wahała się od 60–135 m. Wystąpiły w nich niezbut grube od 20 cm do 50 cm warstwy węgla brunatnego zaliczane do serii pokładów ścinawskich i środkowopolskich (Piwocki 1986) (Fig. 2).

Celem opracowania było prześledzenie zmian roślinności i zmian klimatycznych badanego obszaru podczas miocenu oraz porównanie pyłkowej flory z okolic Wyrzyska z sąsiednimi pyłkowymi negeńskimi florami Polski Niżowej.

Część systematyczna pracy zawiera opisy morfologiczne 258 wyróżnionych kopalnych taksonów z

uwzględnieniem synonimiki i analogii do taksonów współczesnych (Tab. 1). Druga część pracy to zestawienia tabelaryczne bezwzględnych ilości oznaczonych sporomorf, osobne dla poszczególnych profili oraz cztery diagramy obrazujące procentowy udział poszczególnych taksonów.

W diagramach zgrupowane zostały taksony występujące w podobnych warunkach ekologicznych tzn. od środowisk najsuchszych do najwilgotniejszych czyli obrazujące różne typy zbiorowisk roślinnych: las mieszany i las bagienny, torfowiska krzewiaste, zbiorowiska szuwarowe i roślin wodnych.

Przedstawione zostały zmiany florystyczne lasu mieszanego jako zbiorowiska nadrzędnego w stosunku do pozostałych zbiorowisk, którym towarzyszą zmiany roślinności bagiennej czyli lokalnej.

Las mieszany o okresie miocenu na badanym obszarze był to las z przewagą roślinności okresowo zrzucającej liście i z niewielkim udziałem roślinności zimozielonej, w którym z drzew iglastych oprócz *Pinus* dominowały *Sciadopitys*, *Sequoia*, *Tsuga*, w mniejszej ilości występowały *Picea*, *Abies*, *Cryptomeria*, *Cunninghamia*, *Podocarpus*, *Metasequoia*, *Keteleeria*. Towarzyszyły im drzewa liściaste okresowo zrzucające liście a przede wszystkim: *Corylus*, *Carpinus*, *Acer*, *Tilia*, *Fagus*, *Zelkova*, *Quercus*, *Carya*, *Liriodendron*, *Castanea*, *Eucommia* – rodzaje zaliczane do arktyczno-trzeciorzędowej flory, której współcześni przedstawiciele występują na obszarze holarktycznym, w strefie klimatu umiarkowanego i umiarkowanie ciepłego.

Mniejszy udział miały drzewa i krzewy takie jak: *Magnolia*, *Ilex*, *Corylopsis*, *Itea*, *Platycarya*, *Engelhardtia*, *Reevesia* oraz przedstawiciele z rodzin: *Sterculuaceae-Rutaceae*, *Symplocaceae*, *Palmae*, *Amaryllidaceae*, *Araliaceae-Cornaceae*, *Anacardiaceae*, *Leguminosae*, w większości zaliczanych do paleotropikalnej flory, której współcześni przedstawiciele występują obecnie w strefie klimatu subtropikalnego i tropikalnego.

W lasach tych dominował element florystyczny arktyczno-trzeciorzędowy nie tylko ilością występujących rodzjów, ale również bogactwem gatunków w obrębie poszczególnych rodzajów, m.in. rodzaj *Tsuga* zawiera 8 gatunków kopalnych, *Sequoia* – *6 gatunków kopalnych, Sciadopitys* – 9 gatunków kopalnych, *Liriodendron* – 2 gatunki kopalne, 7 gatunków *Acer*, 4 gatunki *Liquidambar*.

Zmiany lasu mieszanego podczas trwania miocenu na badanym obszarze obrazuje 6 Faz florystycznych, w czasie trwania których przeważały drzewa i krzewy okresowo gubiące liście zaliczane do ciepło-umiarkowanego, arktyczno- trzeciorzędowego elementu florystycznego. Jednocześnie stopniowo malała obecność roślin zawsze zielonych zalicznych do paleotropikalnego elementu florystycznego.

Faza I – wyróżniona została w warstwach rawickich (miocen dolny) w profilu Liszkowo. Las mieszany wykazuje zdecydowaną przewagę elementów arktyczno-trzeciorzędowych nad paleotropikalnymi. Roślinność bagienną tworzyły cypryśnikowe lasy bagienne z udziałem *Alnus* i *Nyssa*. Brak jest roślin wyraźnie dominujących w zbiorowiskach leśnych (Fig. 7).

W osadach miocenu dolnego dolnego w warstwach ścinawskich profilu Liszkowo i Kosztowo wyróżniona została Faza II (Fig. 7, 8). Spektra pyłkowe tej Fazy są charakterystyczne dla lasu liściasto-iglastego z dominacją *Engelhardtia* i *Tricolporopollenites pseudocingulum* gatunku kopalnego, zaliczanego do rodziny *Anacardiaceae*. Towarzyszą im: *Araliaceaepollenites edmundi* (*Araliaceae*), *Platycarya*, *Symplocos*, *Corylopsis*, *Ilex*, czyli w tej Fazie lasu mieszanego zaznacza się wyraźny udział elementu paleotropikalnego. Arktyczno- trzeciorzędowy element florystyczny jest równie liczne reprezentowany. Są to przede wszystkim rodzaje *Carya*, *Castanea*, *Quercus*, *Pterocarya*. Z drzew iglastych wyraźny udział oprócz *Pinus* ma *Sciadopitys*; *Sequoia* i *Tsuga* występują w ilości niewiele powyżej 1%. Jest to jedyna Faza w czasie trwania miocenu na badanym obszarze, kiedy element florystyczny paleotropikalny pozostaje w równowadze z elementem arktyczno-trzeciorzędowym. Od tego momentu widoczne jest stale postępujące ochłodzenie klimatyczne z cieplejszymi oscylacjami podczas jego trwania.

Fazę II – las liściasto-iglasty z dominacją *Engelhardtia* i *Tricolporopollenites pseudocingulum*, można korelować ze spektrami pyłkowymi II serii łużyckiej i równoważnymi jej profilami z Polski południowo-zachodniej i Polski zachodniej, opisanymi przez różnych autorów (m.in. Sadowska, 1977; Ziembińska, 1974; Ziembińska, Ważyńska, 1981). Podczas istnienia Fazy II można wyróżnić dwa typy roślinności bagiennej: w warstwach ścinawskich dolnych wystąpiły spektra pyłkowe chara-

kterystyczne dla lasów bagiennych typu *Taxodiaceae-Cupressaceae* z *Taxodium*, towarzyszą im *Alnus* i *Nyssa*, a w górnych warstwach ścinawskich las bagienny *Taxodium-Nyssa* traci na znaczeniu i występują spektra pyłkowe charakterystyczne dla torfowisk krzewiastych typu *Cyrillaceae-Clethra-ceae-Myriaceae* z dużą ilością *Ericaceae*, *Gramineae* i *Sphagnuum* (Fig. 5).

Bobrowska (1970) podaje również z obszaru Krostkowa koło Wyrzyska i Trzcianki koło Piły fację *Cyrillaceae* w obrębie II łużyckiej serii węglowej. Dominacja *Cyrillaceae* jest też widoczna w warstwach ścinawskich górnych z Nakła (Ważyńska 1974, 1977).

Następne dwie Fazy – III i IV – wyróżnione w diagramach z Wyrzyska w warstwach adamskich i środkowopolskich, to las mieszany, w którym powoli maleje udział elementu paleotropikalnego i drzew szpilkowych (Fig. 9, 10).

Las Fazy III charackteryzuje się jeszcze wyraźnym występowaniem drzew iglastych m.in. takich jak: *Tsuga*, *Sequoia*, dominuje *Sciadopitys*, co wyróżnia tę Fazę od innych.

Wsród drzew liściastych element arktyczno-trzeciorzędowy reprezentowany jest przez wiele rodzajów drzew i krzewów jak: *Carpinus*, *Corylus*, *Carya*, *Liquidambar*. Udział elementu paleotropikalnego jest też wyraźny. Występują: *Engelhardtia*, *Tricolporopollenites pseudocingulum*, *Symplocos*, *Palmae*, *Araliaceaepollenites edmundi*, ale charakter lasu tej Fazie nadają drzewa iglaste.

Las Fazy IV, to las, w którym drzewa liściaste i iglaste pozostają w równowadze, stąd w nazwie Fazy podkreślone jest dominowanie drzew iglastych (*Tsuga*, *Sequoia*) i liściastych (*Carpinus*, *Tilia*, *Carya*).

Dwie ostatnie Fazy – V i VI, kończące sedymentację warstw środkowopolskich w diagramach z Wyrzysk przedstawiają dominację lasu łęgowego. W Fazie V jest to las łęgowy *Ulmus-Quercus*, z niewielkim udziałem drzew iglastych i elementów paleotropilanych, a w Fazie VI – las łęgowy *Celtis-Quercus-Pterocarya*; z pnączy występuje *Parthenocissus*, jak również dość obfita domieszka roślinności paleotropikalnej (*Engelhardtia*, *Reevesia*, *Itea*, *Corylopsis* i *Araliaceae-Cornaceae*). Stwarza to podstawę do stwierdzenia, że w ostatniej Fazie florystycznej miocenu środkowego nastąpiło wyraźne ocieplenie klimatyczne.

Podczas trwania wyżej wymienionych czterech Faz lasu mieszanego (Fazy III, IV, V i VI) roślinność bagienna uległa zmianie dwukrotnie. Dla Fazy III czyli dla lasu iglasto-liściastego z przewagą *Sciadopitys* charakterystyczny jest las bagienny *Taxodium-Nyssa*, który w młodszych odcinkach miocenu traci znaczenie na korzyść lasu bagiennego *Nyssa-Alnus* (Fig. 4). Jest to las, ktory dominuje już do końca czyli przez czas trwania Fazy IV, V i VI. Tylko raz, w czasie trwania Fazy V w spektrach pyłkowych z górnych warstw miocenu środkowego (warstwy środkowopolskie) wystąpiła dominacja torfowiska turzycowego. Ziarna pyłku *Cyperaceae* w tym spektrum osiągnęły wartość do 50%. Przeważały wśród nich ziarna zaliczane do gatunku kopalnego *Cyperaceaepollis piriformis* porównywanego z *Cladium*, niektórymi gatunkami *Carex*, *Scirpus maritimus*. Towarzyszyły im w dużej ilości do 20% *Graminaeae*. Z drzew tylko niewielki udział miały: *Alnus*, *Ulmus*, *Salix*. Towarzyszyły im rowniez rośliny zarodnikowe: *Sphagnum*, *Gleicheniaceae*, *Lycopodium inundatum* i *Lycopodium cernuum* (Fig. 6).

Roślinność przybrzeżną i wodną reprezentują oprócz *Cyperaceae* i *Gramineae* również *Liliaceae-Iridaceae*, *Typha*, *Sparganium*, *Potamogeton*, *Utricularia*. Są to w większości rodzaje kosmopolityczne, jedynie obecność *Gleicheniaceae* i *Lycopodium cernuum* świadczy o ciepło-umiarkowanym charakterze tej flory. Jest to typ roślinności ściśle związany z wyżej omówionymi zbiorowiskami roślinnymi tzn. z lasem bagiennym i torfowiskiem krzewiastym.

Zmienność zbiorowisk leśnych w obrębie warstw środkowopolskich (zanik lasu mieszanego na korzyść lasów łęgowych) występująca w wyżej omówionych profilach pyłkowych z okolic Wyrzyska widoczna jest w wielu florach pyłkowych Polski Niżowej, m.in. Polski południowo-zachodniej (Legnica, Nowe Czaple – Sadowska 1977), w diagramie zbiorczym z Polski zachodniej (Ziembińska & Warzyńska 1981) oraz w diagramach z Polski środkowej i północno-zachodniej: Rogóźno (Mamczar 1961; Doktorowicz-Hrebnicka 1964), Konin (Mamczar 1960) i Nakło (Ważyńska 1974, 1977). Dolne warstwy środkowopolskie wykazują w tych wszystkich diagramach obecność ziarn pyłku, charakterystycznych dla lasów mieszanych z panującym elementem arktyczno-trzeciorzędowym (m.in. *Quercus*, *Fagus*, *Castanea*, *Acer*, *Sequoia*, *Tsuga*) i dość dużą domieszką elementu paleotropi-

kalnego (*Engelhardtia*, *Tricolporopollenites pseudocingulum*, *Araliaceae- Cornaceae*, *Itea*, *Reevesia*, *Symplocaceae*). Wszędzie towarzyszyły tym lasom lasy bagienne *Taxodium-Nyssa*. Odpowiada to Fazie III i IV, wyróżnionych w diagramach z okolic Wyrzyska. Jedyną różnicę stanowi dość duża ilość ziarn pyłku *Sciadopitys* (do 15%), notowana w diagramach z okolic Wyrzyska, obserwowana również na niewielkim odcinku w profilu z Konina (Mamczar 1960).

Górne warstwy środkowopolskie, tuż pod iłami poźnańskimi z obszaru Polski zachowdniej i południowo-zachodniej, charakteryzują spektra pyłkowe z dominacją ziarn pyłku charakterystycznych dla lasów łęgowych i bagiennych. Lasy łęgowe w południowo-zachodniej Polsce (Legnica; Sadowska 1977), były typu *Quercus-Celtis-Ulmus-Liquidambar*, a towarzyszyły im lasy bagienne *Alnus-Nyssa-Taxodium*.

W Polsce zachodniej rosły lasy łęgowe *Celtis-Pterocarya-Quercus -Liquidambar oraz lasy bagienne Almus-Nyssa-Taxodium* (Gierlachowo, Oczkowice, Gołebin Stary – Ziembińska-Tworzydło 1974). Ten typ lasów charakteryzuje również ostatnią Fazę XIII w diagramie zbiorczym z zachodniej Polski (Ziembińska-Tworzydło & Ważyńska 1981), którą można porównać z V i VI Fazą wyróżnioną w diagramach z Wyrzyska.

W Polsce centralnej w tym czasie, występowały lasy bagienne *Taxodium- Nyssa*, a drzewa charakterystyczne dla lasów łęgowych bardzo rzadko (Rogóżno – Mamczar 1961; Doktorowicz-Hrebnicka 1964; Rypin – Stuchlik 1964).

Warstwy poznańskie przykrywające osady środkowopolskie w okolicach Wyrzyska nie wykazały obecności ziarn pyłku.

Podsumowując wyniki badań należy podkreślić, że:

– Obserwuje się powolne ubożenie flory w rośliny zaliczne do elementu paleotropikalnego w ujęciu stratygraficznym (flory starszych odcinków miocenu bogatsze są w element paleotropikalny, młodsze – uboższe), co świadczy o stałym ochładzaniu klimatu ciepło-umiarkowanego w czasie trwania miocenu.

– Dominuje we florze element arktyczno-trzeciorzędowy. Większość drzew zaliczona do tego elementu miała w diagramach wyraźny procentowy udział oraz wiele z nich wykazało dużą zmienność morfologiczną ziarn pyłku. Dało to możliwość wyodrębnienia form morfologicznych lub gatunków kopalnych, których współcześni przedstawiciele rosną obecnie w zbiorowiskach leśnych Ameryki Północnej i Azji Wschodniej lub tylko w jednym z tych obszarów.

Największe podobieństwo do mioceńskich zbiorowisk leśnych wykazują mieszane mezofilne lasy południowo-wschodnich Chin. Są to lasy o dużej dominacji flory umiarkowanej przy równoczesnym współudziale drzew zaliczanych do ciepło-umiarkowanego elementu florystycznego jak: *Eucommia*, *Liriodendron*, *Nyssa*, *Liquidambar*. *Platycarya* oraz drzew charakterystycznych dla wiecznie zielonych szerokolistnych lasów: m.in. *Castanea*, *Castanopsis*, *Pasania*, *Michelina*, *Quercus*. Drzewom liściastym towarzyszą w dużej ilości *Conifeae*, wchodące w skład elementu ciepło-umiarkowanego lub subtropikalnego. Są to przede wszystkim: *Cunninghamia*, *Cryptomeria*, *Metasequoia*, *Keteleeria*, *Glyptostrobus*, *Taiwania*; brak jedynie *Sciadopitys*, który rośnie tylko w lasach Japonii (Wang 1961).

Drugim obszarem podobnym do mioceńskich lasów mieszanych są zbiorowiska leśne Ameryki Północnej: lasy sekwojowe w Kalifornii i Oregonie, lasy mieszane we wschodniej części Ameryki Północnej (m.in. z *Liquidambar styracifua*, *Liriodendron tulipifera* i różnymi gatunkami *Carya*) oraz w prowincji nizin nadatlantyckich lasy bagienne typu *Nyssa biflora-Taxodium distichum* i torfowiska krzewiaste z dominacją *Ericaceae*, *Clethra alnifolia*, *Itea virginica*, *Ilex glabra*, *Aralia viscosa*, *Cyrilla racemiflora* (Kearney 1991).

PLATES

Plate 1

× 1000

1. *Stereisporites* (*Structisporis*) *intrastructuris* Krutzsch 1963 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

2a, b. *Stereisporites* (*Distverrusporis*) *antiquus* Krutzsch et Sontag 1963 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

3. *Stereisporites* (*Stereisporites*) *maximus* Krutzsch 1963 (*Sphagnum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29

4a, b. *Stereisporites* (*Distancoraesporis*) *wehningensis* Krutzsch 1963 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

5. *Stereisporites* (*Stereisporites*) cf. *macroides* Krutzsch 1963 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

6a, b. *Stereisporites* (*Stereisporites*) sp. 1 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

7. *Stereisporites* (*Stereisporites*) *involutus minutoides* Krutzsch et Sontag 1963 (*Sphagnum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 48.5–49.0 m, sample No. 27

8. *Stereisporites* (*Stereisporites*) sp. 2 (*Sphagnum* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

9a, b. cf. *Rhudolphisporis rudolphi* (Krutzsch 1959) Krutzsch et Pacltova 1963 (*Anthocerotaceae*)
Lower Miocene (Rawicz Beds), Liszkowo, depth 127.0–129.0 m, sample No. 64

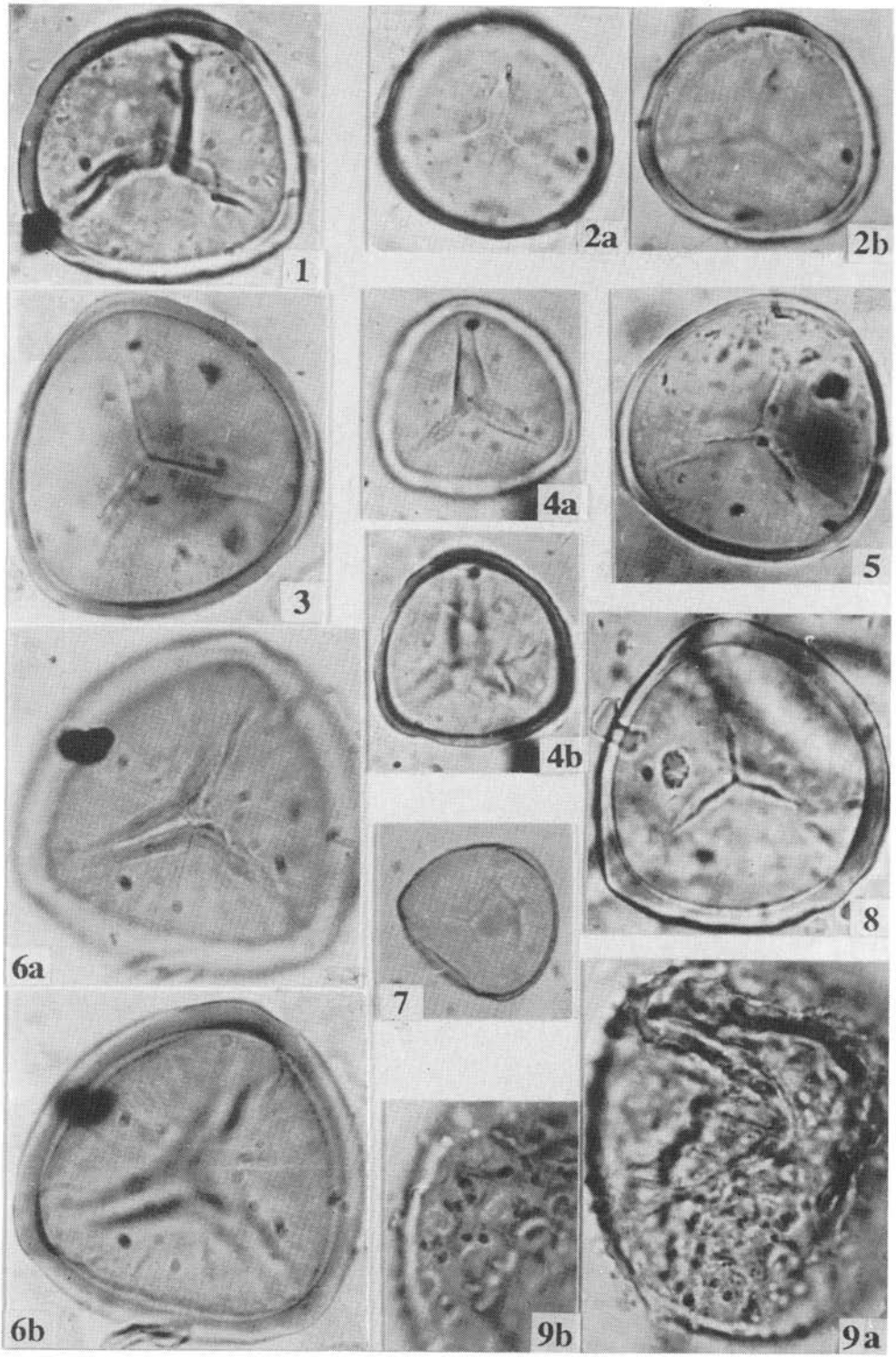

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Plate 2

× 1000

1a, b. *Retitriletes* cf. *reticuloides reticuloides* Krutzsch 1963 (*Lycopodium complanatum* L. – *Lycopodium clavatum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 37.1–37.2 m, sample No. 61

2a, b. *Retitriletes* cf. *pseudoclavatus* Krutzsch 1963 (*Lycopodium clavatum* L. – type)
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 86.5–87.0 m, sample No. 41

3a, b. *Retitriletes* cf. *frankfurtensis* Krutzsch 1963 (*Lycopodium obscurum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 52.0–52.5 m, sample No. 18

4a, b. *Retitriletes* cf. *robustoides* Krutzsch 1963 (*Lycopodium* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

5. *Retitriletes* sp. (*Lycopodium* L. – type 2)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.7–82.1 m, sample No. 29

6. *Camarozonosporites* (*Camarozonosporites*) sp. (*Lycopydium cernuum* L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

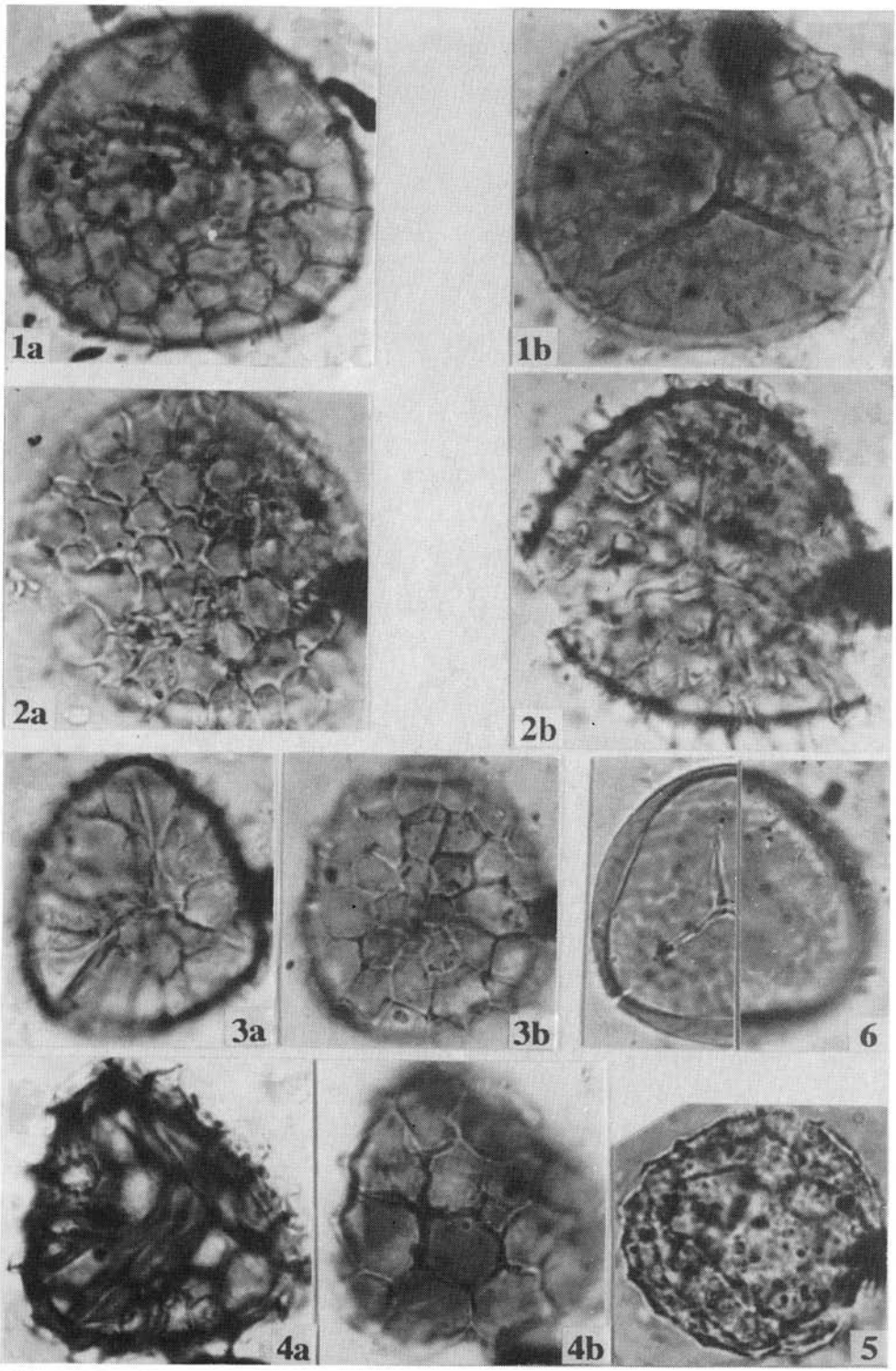

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Plate 3

× 1000

1a, b. *Camarozonosporites* (*Inundatisporis*) *wilsnackensis* Krutzsch 1963 (*Lycopodium inundatum* L. – type)
Middle Miocene (Adamów Beds), Kosztowo, depth 88.0–88.7 m, sample No. 44

2. *Camarozonosporites* (*Camarozonosporites*) *decorus* (Wolff 1934) Krutzsch 1959 (*Lycopodium fokienense* Ching – type)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 94.4–95.0 m, sample No. 39

3. *Camarozonosporites* (*Camarozonosporites*) *decorus* (Wolff 1934) Krutzsch 1959 (*Lycopodium fokienense* Ching. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

4. *Camarozonosporites* (*Camarozonosporites*) sp. (*Lycopodium cernuum* L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

5. *Camarozonosporites* (*Camarozonosporites*) sp. (*Lycopodium cernuum* L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

6a, b. *Echinatisporis* sp. 1 (*Selaginella vaginata* Spring – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 45.5–46.0 m, sample No. 36

7a, b. *Echinatisporis* sp. 3 (*Selaginella* Spring – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 40.0–40.5 m, sample No. 71

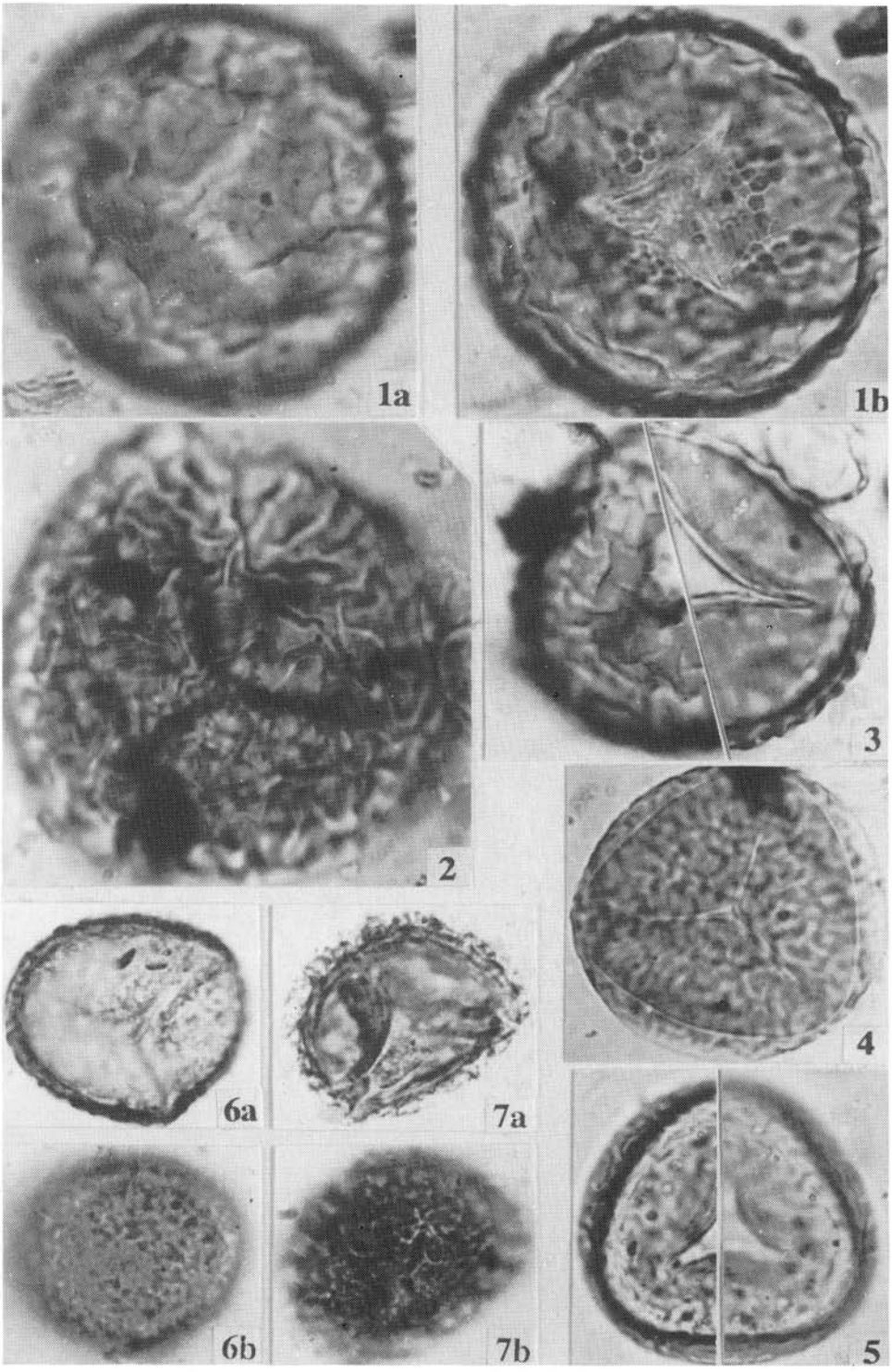

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Plate 4

× 1000

1. *Baculatisporites quintus, quintus* Krutzsch 1967 (*Osmunda regalis* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 48.0–48.5 m, sample No. 28
2. *Baculatisporites* sp. 1 (*Osmunda lancea* Thunb. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29
3. *Baculatisporites* sp. 2 (*Osmunda* L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 107.5–108.0 m, sample No. 68
4. *Baculatisporites primarius crassiprimarius* Krutzsch 1967 (*Osmunda banksiaefolia* (Pr.) Kuhn. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.5–59.8 m, sample No. 3
5. *Baculatisporites primarius, primarius* Krutzsch 1967 (*Osmunda cinamomea* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 54.5–55.0 m, sample No. 13
6. *Echinatisporis* sp. 5 (*Selaginella* Spring – type 3)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.6–42.8 m, sample No. 43
7. *Echinatisporis* sp. 2 (*Selaginella delicatula* (Desv.) Alston – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 45.5–46.0 m, sample No. 36
8. *Echinatisporis* sp. 4 (*Selaginella* Spring – type 2)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 45.5–46.0 m, sample No. 36

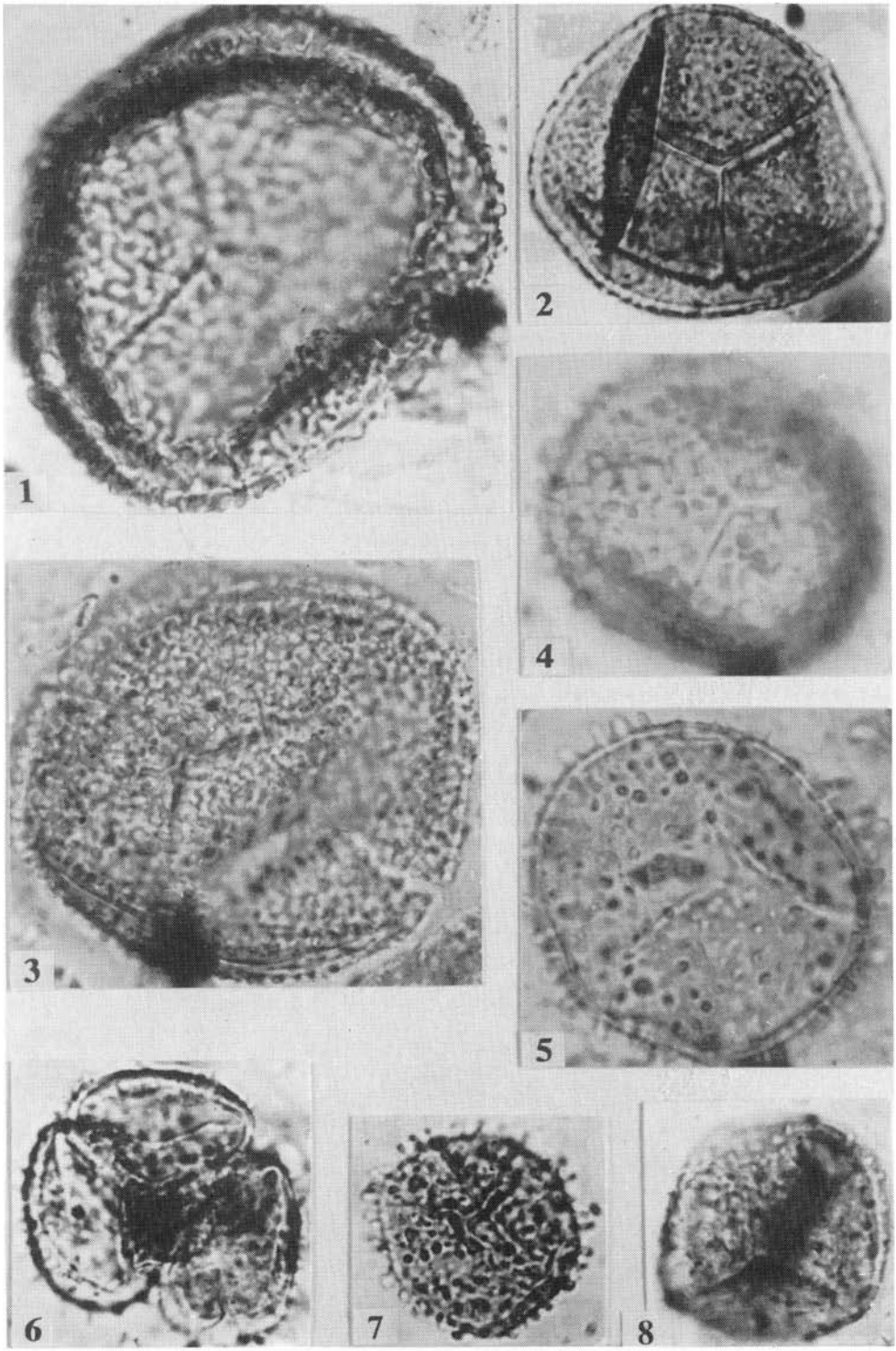

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Plate 5

× 1000

1. *Neogenisporis neogenicus* Krutzsch 1962 (*Gleicheniaceae*)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25
2. *Neogenisporis* cf. *plicatoides* Krutzsch 1962 (*Gleicheniaceae*)
   Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11
3. *Neogenisporis* sp. (*Gleicheniaceae*)
   Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.7–82.1 m, sample No. 29
4. *Neogenisporis crassicus* Krutzsch 1962 (*Gleicheniaceae*)
   Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11
5. *Leiotriletes* cf. *maxoides* Krutzsch 1962 ssp. *minoris* (*Lygodium* Sw. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.6–42.8 m, sample No.43
6. *Leiotriletes wolffi wolffi* Krutzsch 1962 (*Lygodium* Sw. – type)
   Lower Miocene (Ścinawa Beds), Liszkowo, depth 103.0–105.0 m, sample No. 52
7. cf. *Toroisporis pliocenicus* Krutzsch 1962 (*Cyatheaceae*? *Schizaeaceae*?)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.5–47.0 m, sample No. 34

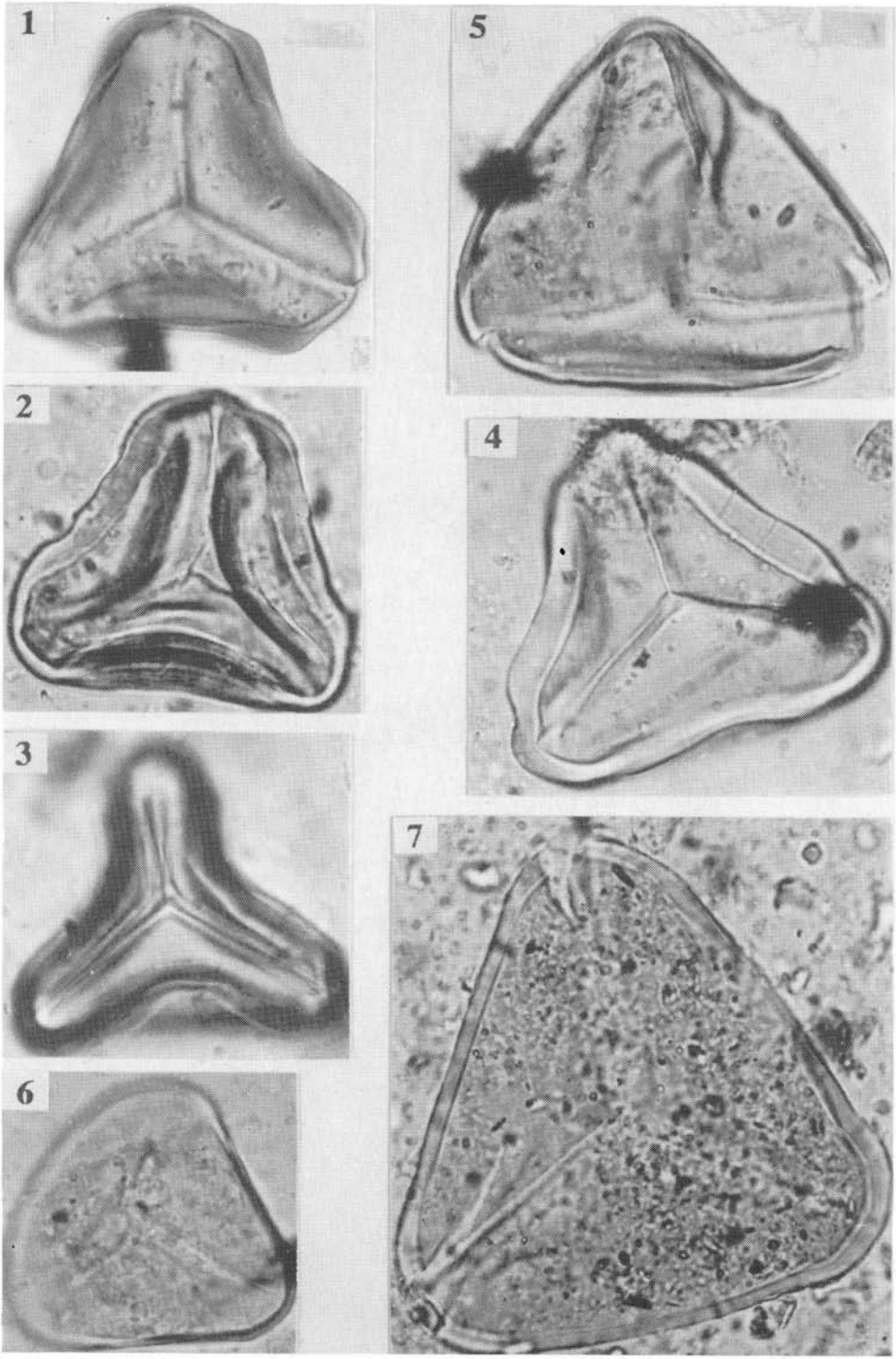

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Plate 6

× 1000

1. *Verrucatosporites pseudoalienus* Krutzsch 1967 (*Polypodium vulgare* L. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25
2. *Laevigatosporites nutidus* (Mamczar 1960) subfsp. *nutidus* Krutzsch 1967 (*Polypodiaceae*)
   Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 53.5–54.0 m, sample No. 15
3. *Verrucatosporites* sp. (*Davallia* Sm. – type)
   Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.9–60.0 m, sample No. 1
4. *Cyatheaceae*?
   Lower Miocene (Rawicz Beds), Liszkowo, depth 117.0–119.0 m, sample No. 59
5. *Cryptogramma* R. Br. – type 1
   Lower Miocene (Rawicz Beds), Liszkowo, depth 125.0–127.0 m, sample No. 63
6. cf. *Favoisporis trifavus* Krutzsch 1959 (*Cryptogramma* R. Br. – type 2)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29
7. *Radialisporis radiatus* (Krutzsch 1959) Krutzsch 1967 (*Schizaeaceae*?)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29
8. *Dicksoniaceae*? *Cyatheaceae*?
   Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

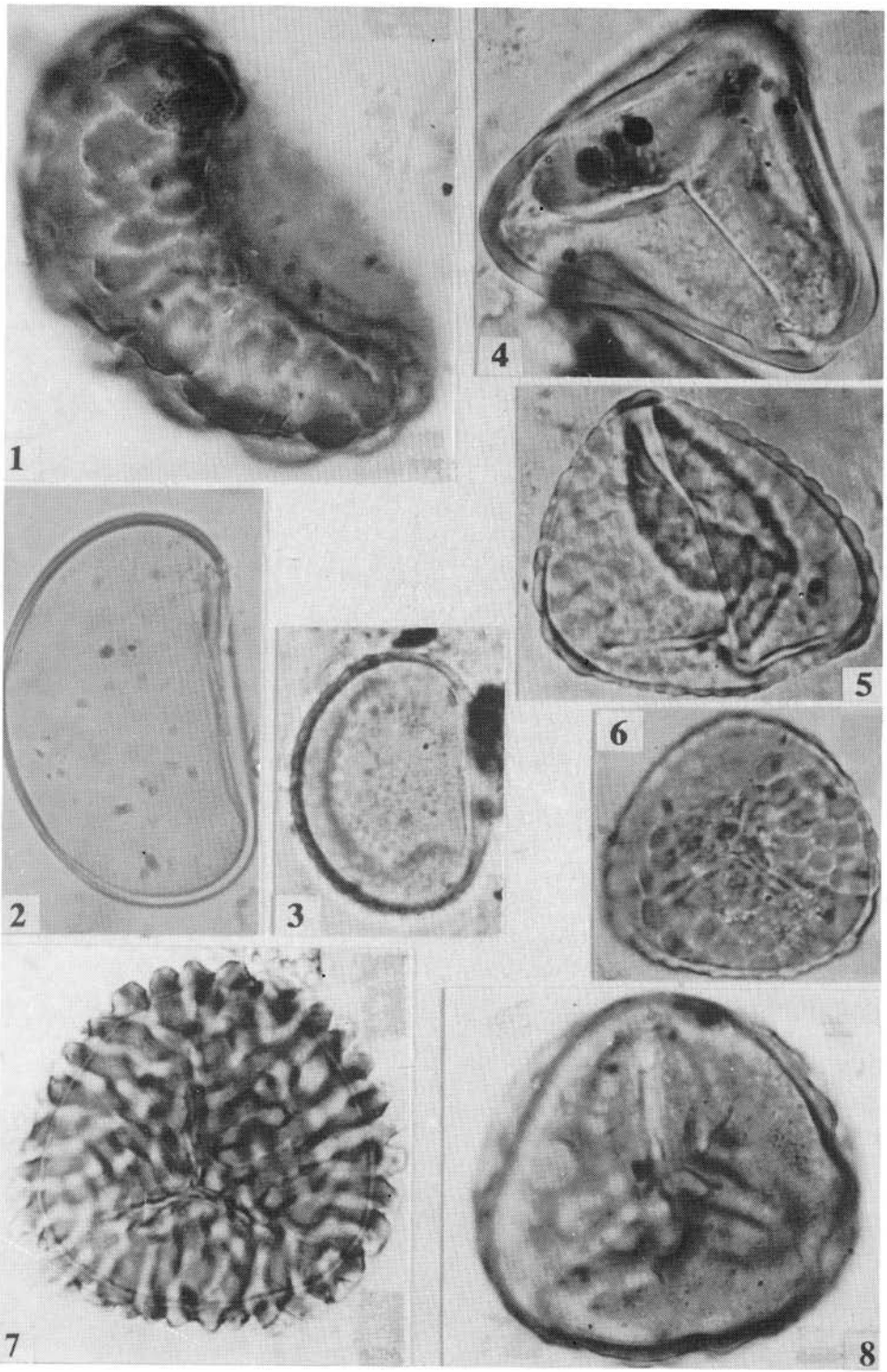

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Plate 7

× 500

1. *Pityosporites labdacus, labdacus* Krutzsch 1971 (*Pinus* type *sylvestris* Roudolph 1935)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35;
2. *Pityosporites insignis* (Naumova et Bolchovitina 1953) Krutzsch 1971 (*Pinus* type *sylvestris* Roudolph 1935)
   Lower Miocene (Rawicz Beds), Liszkowo, depth 117.0–119.0 m, sample No. 59;
3. *Pityosporites alatus* (Potonié 1931) Thomson et Pflug 1953 (*Pinus* type *haploxylon* Roudolph 1935)
   Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–105.0 m, sample No. 62;
4. *Pityosporites microalatus* (Potonié 1931) Thomson et Pflug 1953 (*Pinus* type *haploxylon* Roudolph 1935)
   Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.7–103.0 m, sample No. 58;
5. *Abiespollenites absolutus* Thiergart 1937 (*Abies alba* Mill. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.0–44.5 m, sample No. 39
6. *Abiespollenites* sp. (*Abies* Mill. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.5–45.0 m, sample No. 38
7. *Abiespollenites maximus* Krutzsch 1971 (*Abies* Mill. – *Keteleeria* Carr. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.4–47.7 m, sample No. 30;

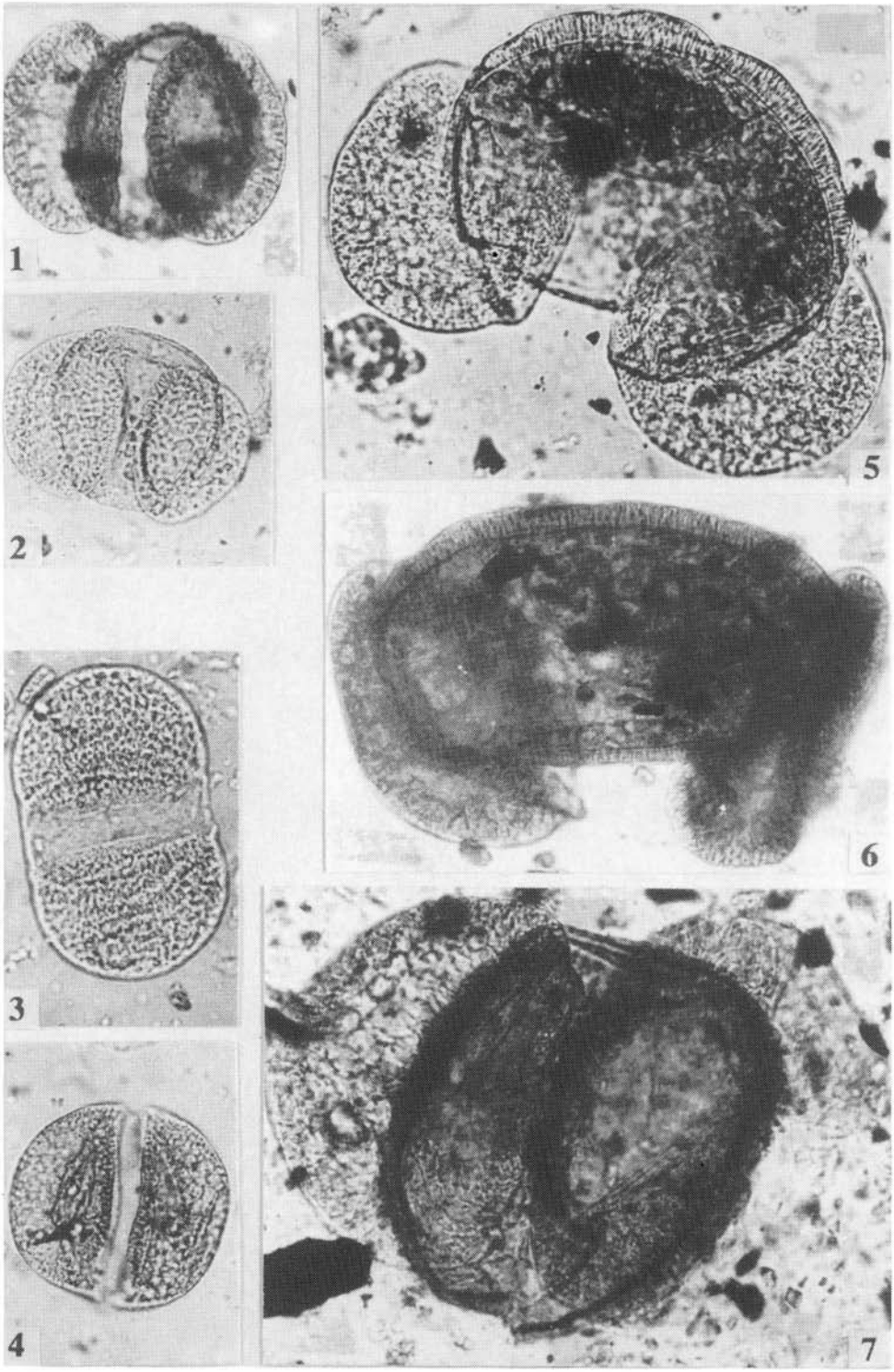

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Plate 8

1. *Piceapollis planoides* Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.4–47.7 m, sample No. 30; × 500

2. *Abiespollenites dubius* (Chlonova 1960) Krutzsch 1971 (*Keteleeria Carr.* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25; × 500

3. *Podocarpidites podocarpoides* (Thiergart 1958) Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56; × 1000

4. *Podocarpidites libellus* (Potonié 1932) Krutzsch 1971
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62; × 1000

5. *Podocarpidites gigantea* Zaklinskaja 1957
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22; × 1000

6. *Zonalapollenites minimus* Krutzsch 1971 (*Tsuga diversifolia* (Maxim.) Mast. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.5–51.0 m, sample No. 21; × 500

7. *Abiespollenites latisaccatus* (Trevisan 1967) Krutzsch 1971 (*Abies nordmanniana* (Stev.) Spach. – *Abies firma* S. et Z. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23; × 500

8. *Abiespollenites latisaccatus* (Trevisan 1967) Krutzsch 1971 (*Abies nordmanniana* (Stev.) Spach. – *Abies firma* S. et Z. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.5–42.0 m, sample No. 47; × 500

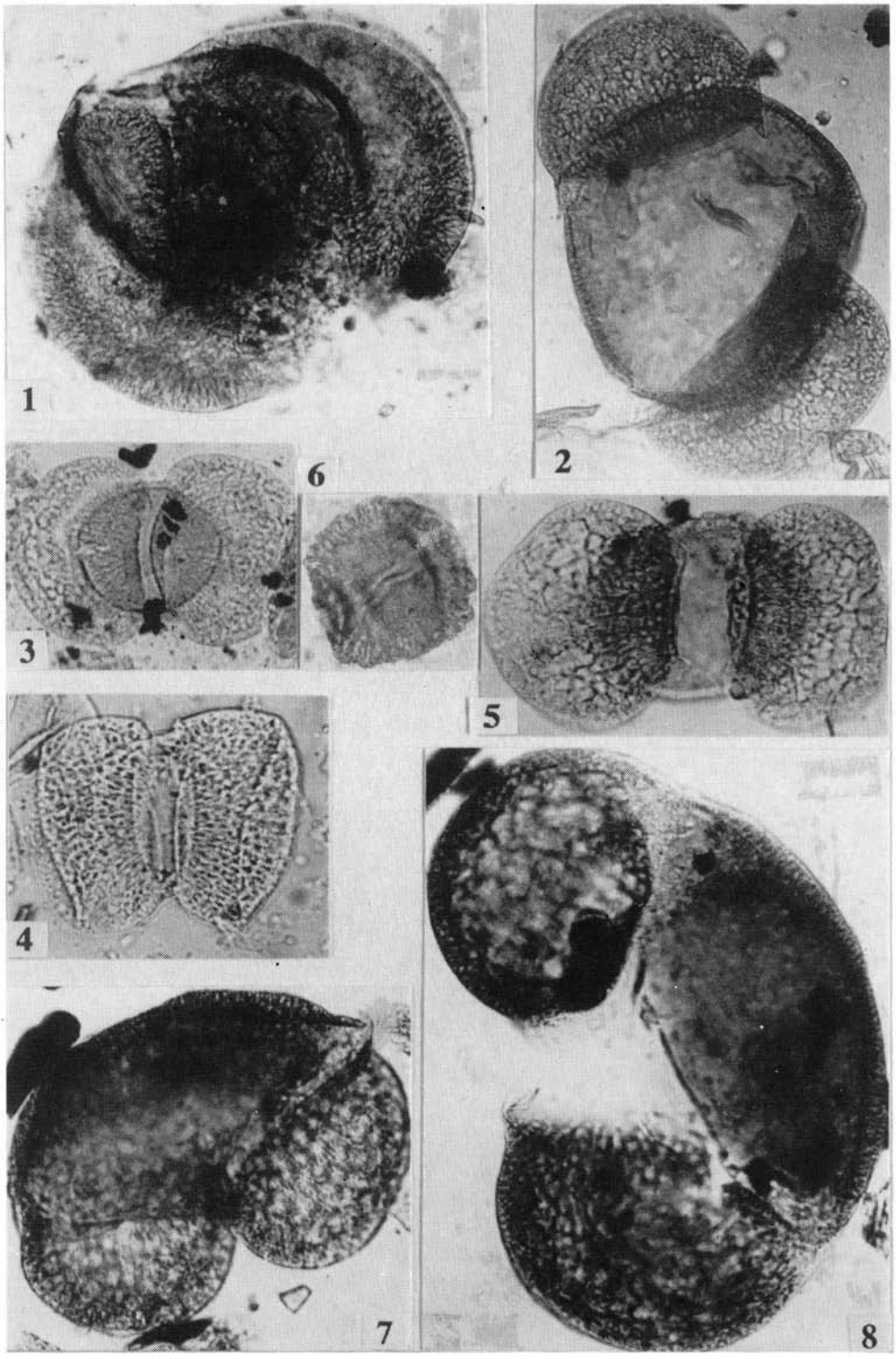

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Plate 9

1. *Zonalapollenites maximus* (Raatz 1937) Krutzsch 1971 (*Tsuga canadensis* (L.) *Carr.* – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35
   a – proximal side; × 1000
   b – distal side; × 1000
   c – general view; × 500
2. *Zonalapollenites verrucatus* Krutzsch 1971 (*Tsuga canadensis* (L.) Carr.? – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.5–44.0 m, sample No. 40
   a – proximal side; × 1000
   b – distal side; × 1000
   c – general view; × 500
3. *Piceapollis tobolicus* (Panova 1966) Krutzsch 1971, f. *minor*
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35, × 500
4. *Piceapollis tobolicus* (Panova 1966) Krutzsch 1971 f. *major*
   Lower Miocene (Rawicz Beds), Liszkowo, depth 117.0–119.0 m, sample No. 59, × 500

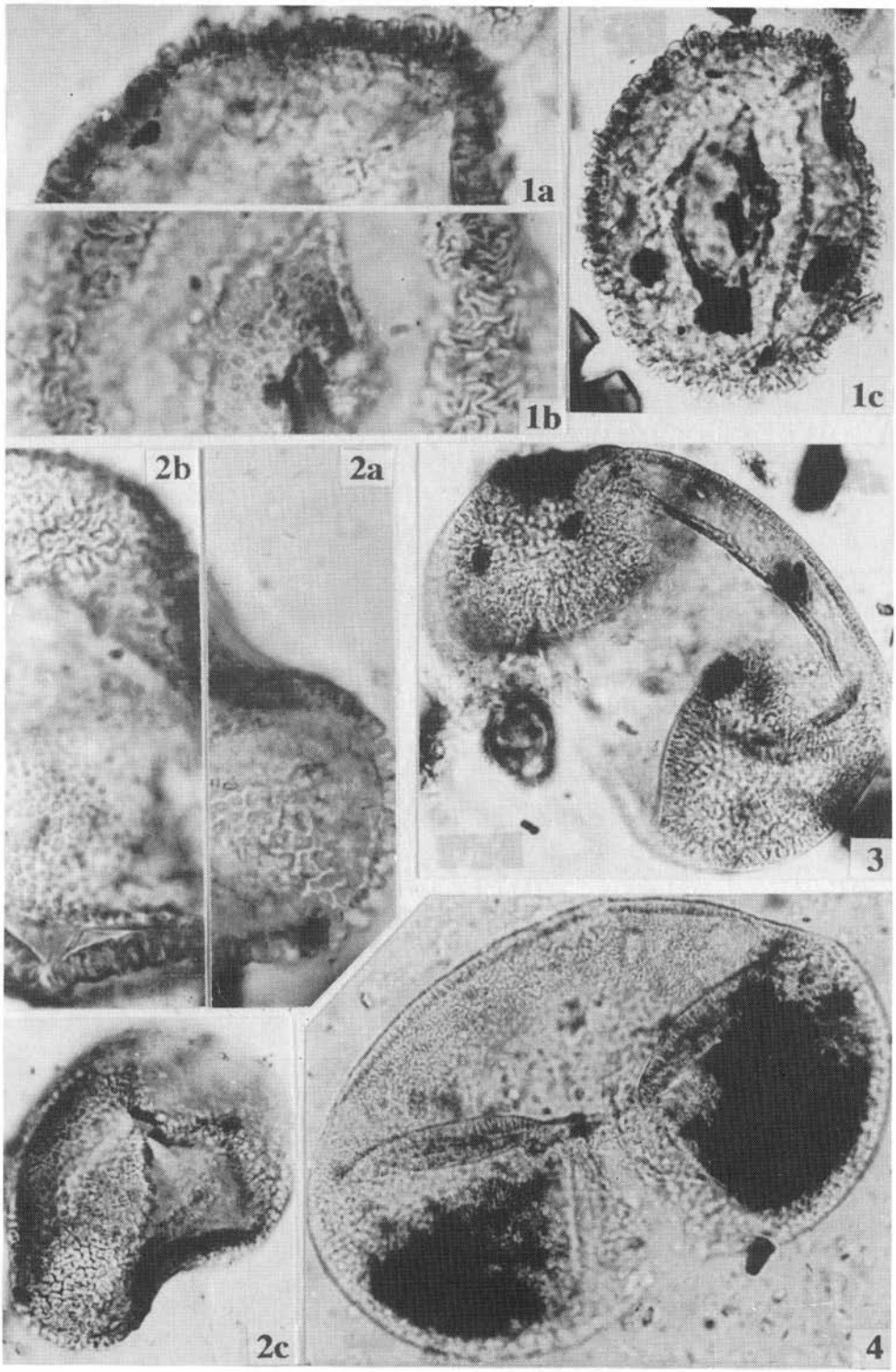

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Plate 10

1. *Zonalapollenites* sp. 1 (*Tsuga caroliniana* Englm. – type ?)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.8–43.0 m, sample No. 42
   a – general view; × 500
   b – distal side; × 1000
   c – proximal side; × 1000

2. *Zonalapollenites* cf. *neogenicus* Krutzsch 1971 (*Tsuga blaringhemii* Flous – type ?)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35
   a – general view; × 500
   b – distal side; × 1000
   c – proximal side; × 1000

3. *Zonalapollenites* sp. 2 (*Tsuga sieboldii Carr.* – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35
   a – general view; × 500
   b, c – distal side; × 1000
   d – proximal side; × 1000

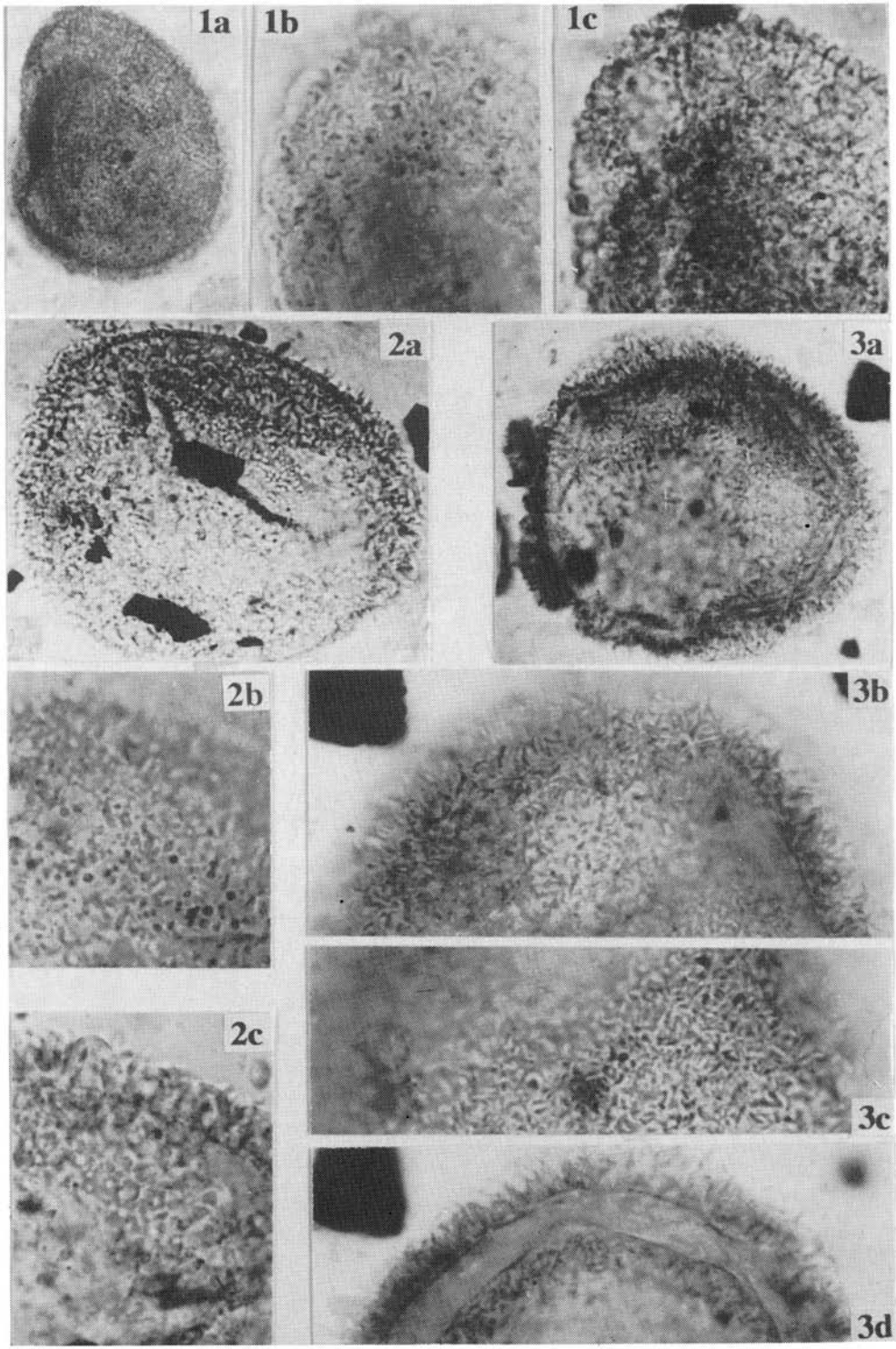

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Plate 11

1. *Zonalapollenites robustus* Krutzsch 1971 (*Tsuga* Carr. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22
   a – general view; × 500
   b – distal side; × 1000
   c – proximal side; × 1000

2. *Zonalapollenites reutenbergensis* Krutzsch 1971 (*Tsuga diversifolia* (Maxim.) Mast. – type)
   Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35
   a – general view; × 500
   b – distal side; × 1000
   c – proximal side; × 1000

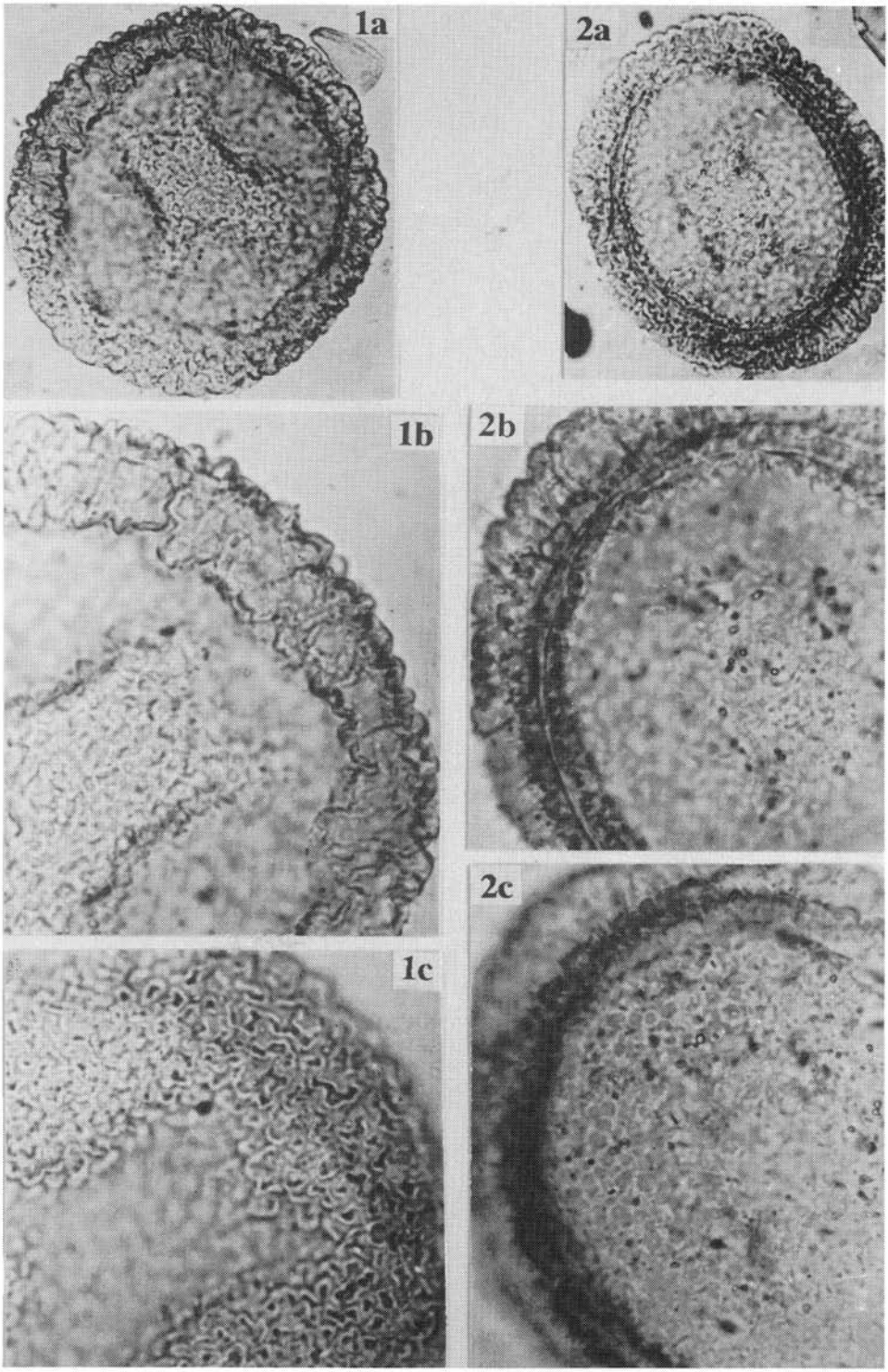
1a
2a
1b
2b
1c
2c

Plate 12

× 1000

1. *Sciadopityspollenites* sp. 1
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29

2. *Sciadopityspollenites quintus* Krutzsch 1971
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 54.5–55.0 m, sample No. 13

3. *Sciadopityspollenites quintus* Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.5–44.0 m, sample No. 40

4. *Sciadopityspollenites quintus* Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

5a, b. *Sciadopityspollenites serratus* (Potonié et Venitz, 1934) Thiergart 1937
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.2–47.3 m, sample No. 32

6a, b. *Sciadopityspollenites serratus* (Potonié et Venitz, 1934) Thiergart 1937
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

7a, b. *Sciadopityspollenites crassus* Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.5–44.0 m, sample No. 40

8. *Sciadopityspollenites verticillatiformis* (Zauer 1960) Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.5–51.0 m, sample No. 21

9. *Sciadopityspollenites verticillatiformis* (Zauer 1960) Krutzsch 1971
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

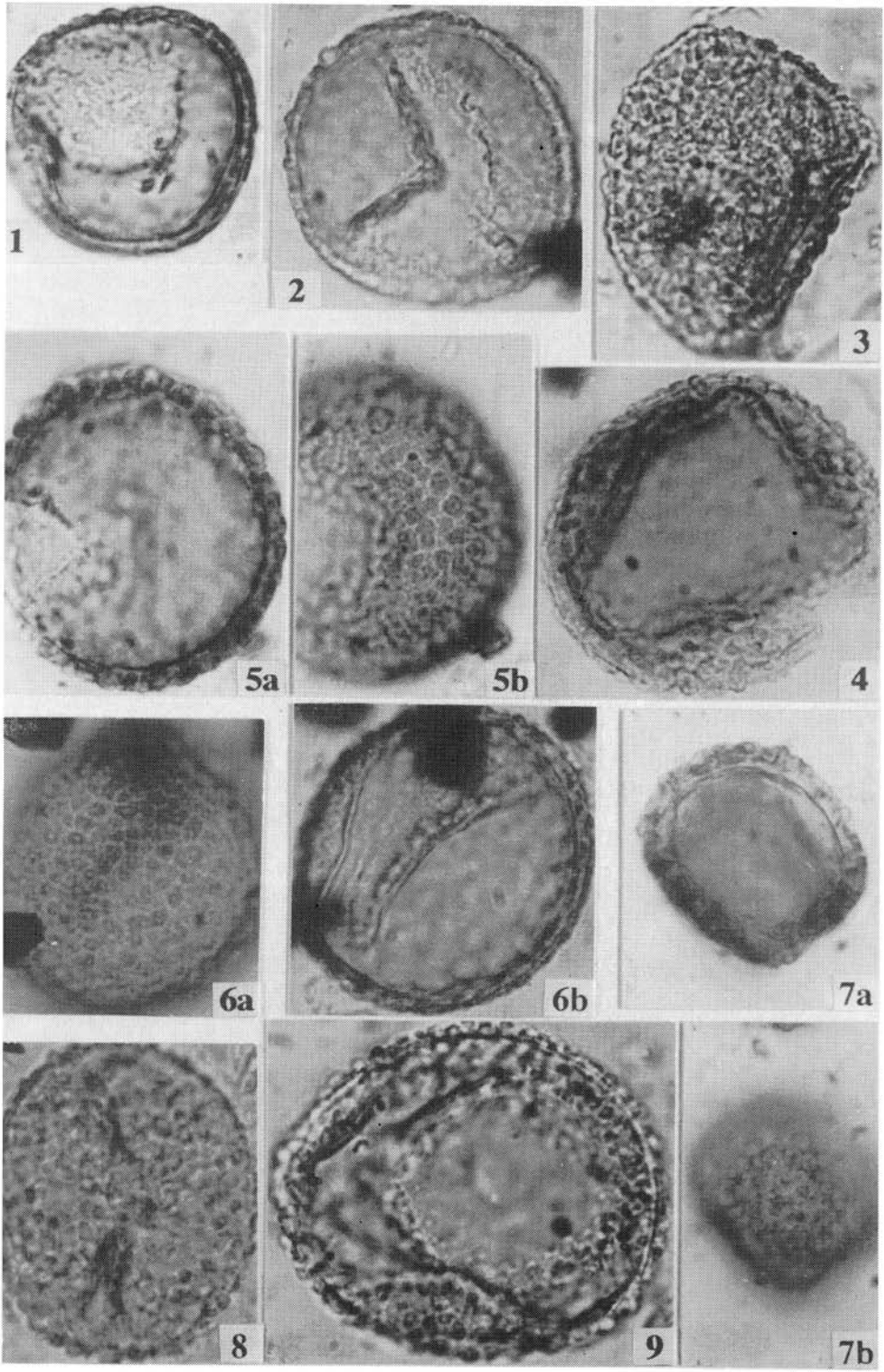

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Plate 13

× 1000

1. *Sciadopityspollenites tuberculatus* (Zaklinskaja 1957) Krutzsch1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

2. *Sciadopityspollenites* sp. 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

3. *Sciadopityspollenites* sp. 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

4a, b. *Sciadopityspollenites* sp. 3
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

5a, b. *Sciadopitys verticillata* S. et Z.
Recent pollen grain, Japan (Kyoto), Coll. Museum of the Earth, No. 432

6. *Sciadopityspollenites varius* Krutzsch 1971
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 37.7–38.0 m, sample No. 58

7. *Sciadopityspollenites varius* Krutzsch 1971
Lower Miocene (Ścinawa Beds), Liszkowo, depth 103.0–105.0 m, sample No. 52

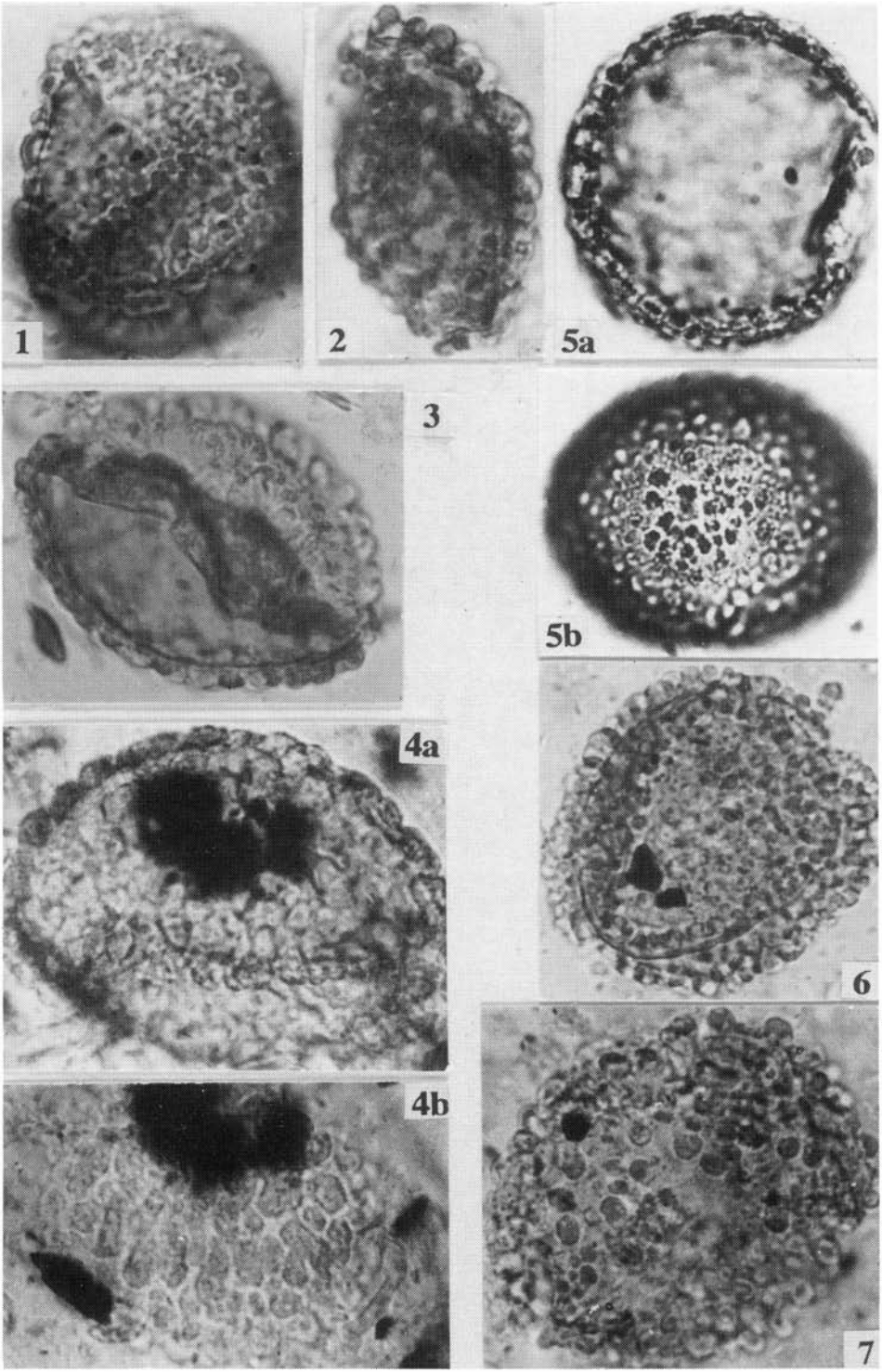

1
2
5a
3
5b
4a
6
4b
7

Plate 14

× 1000

1. *Inaperturopollenites dubius* (Potonié et Venitz 1934) Thomson et Pflug 1953 (*Taxodiaceae – Cupressaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

2. *Inaperturopollenites concedipites* (Wodehouse 1933) Krutzsch 1971 (*Taxodium* Rich. – type sensu Oszast 1960)
Lower Miocene (Rawicz Beds), Liszkowo, depth 117.0–119.0 m, sample No. 59

3. *Inaperturopollenites concedipites* (Wodehouse 1933) Krutzsch 1971 (*Taxodium* Rich. – type sensu Oszast 1960)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.3–47.4 m, sample No. 31

4. *Inaperturopollenites concedipites* (Wodehouse 1933) Krutzsch 1971 (*Taxodium* Rich. – type sensu Oszast 1960)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

5. *Glyptostrobus* Endl. – type, sensu Oszast 1960
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.5–51.0 m, sample No. 22

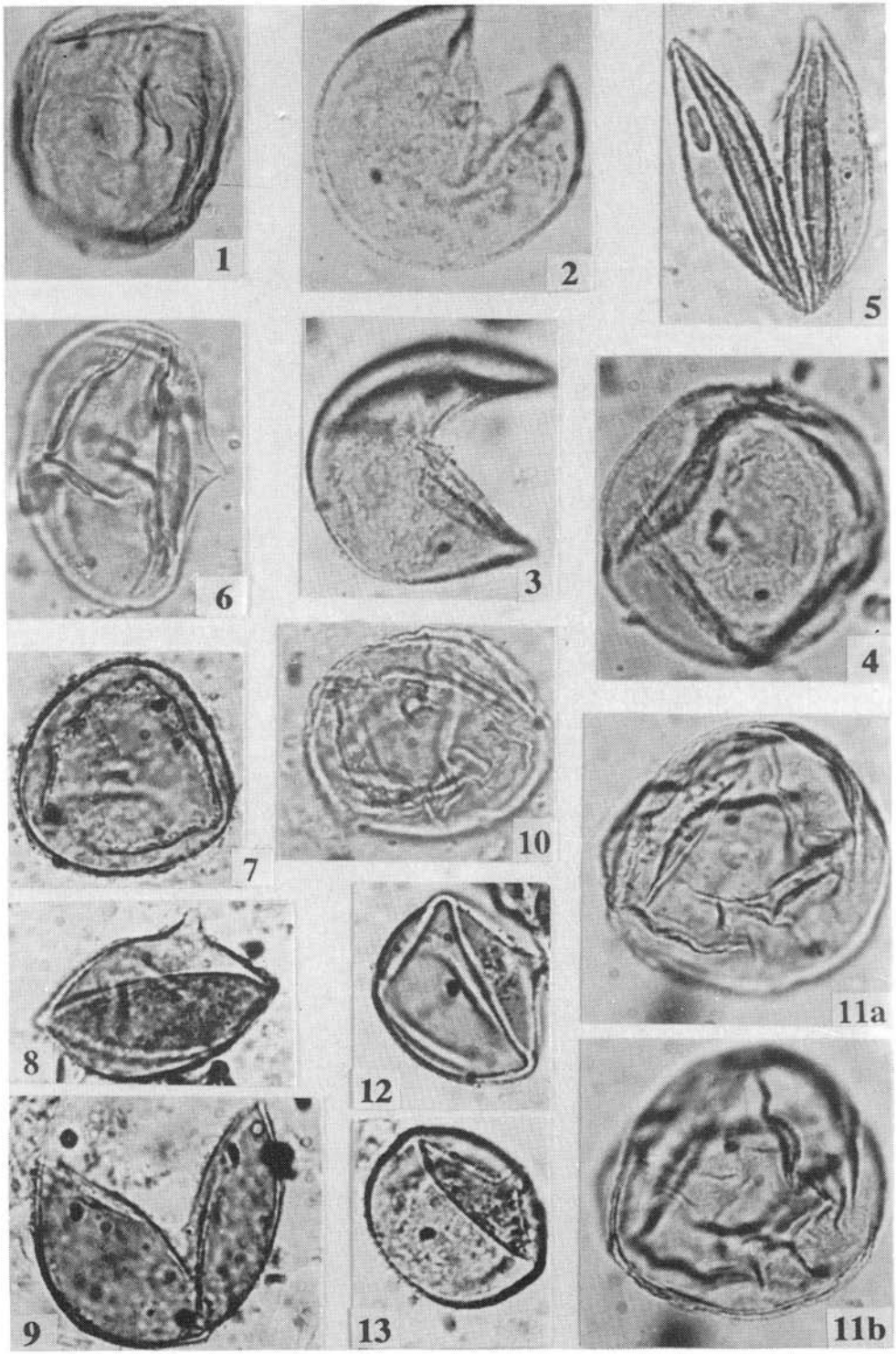
6. *Inaperturopollenites* sp. (Taxodium Rich. – type 3)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

7–9. *Taxodium distichum* Rich.
Recent pollen grains. Kew Botanical Gardens, London. Coll. Museum of the Earth, No. 100

10. *Inaperturopollenites radiatus* Krutzsch 1971 (*Cunninghamia* R. et Br. – type, sensu Oszast 1960)
Middle Miocene (Adamów Beds), Kosztowo,, depth 87.7–88.0 m, sample No. 43

11a, b. *Inaperturopollenites radiatus* Krutzsch 1971 (*Cunninghamia* R. et Br. – type, sensu Oszast 1960)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

12, 13. *Glyptostrobus pensilis* K. Koch.
Recent pollen grains. Taiwan, Coll. Museum of the Earth, No. 204


1
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11a
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11b

Plate 15

× 1000

1. *Sequoiapollenites* cf. *sculpturius* Krutzsch 1971 (*Metasequoia glyptostroboides*, Miki ex Hu et Cheng L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

2. *Sequoiapollenites* cf. *sculpturius* Krutzsch 1971 (*Metasequoia glyptostroboides*, Miki ex Hu et Cheng L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

3. *Sequoiapollenites* cf. *sculpturius* Krutzsch 1971 (*Metasequoia glyptostroboides,* Miki ex Hu et Cheng L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

4. *Sequoiapollenites rugulus* Krutzsch 1971 (*Metasequoia*, Miki ex Hu et Cheng – *Sequoia* Endl. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–104.5 m, sample No. 62

5. *Sequoiapollenites rugulus* Krutzsch 1971 (*Metasequoia* Miki ex Hu et Cheng – *Sequoia* Endl. – type)
Lower Miocene (Rawicz Beds), Liszkowo, depth 125.0–127.0 m, sample No. 63

6. *Sequoiapollenites* cf. *rugulus* Krutzsch 1971 (*Metasequoia* Miki ex Hu et Cheng – *Sequoia* Endl. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.8–59.9 m, sample No. 2

7–8. *Metasequoia glyptostroboides*, Miki ex Hu et Cheng
Recent pollen grains. China (Setschuan), Coll. Museum of the Earth, No. 707

9. *Sequoiapollenites* cf. *largus* (Kremp 1949) Manum 1962 (*Cryptomeria* D. Don. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.8–59.9 m, sample No. 2

10. *Sequoiapollenites* cf. *largus* (Kremp 1949) Manum 1962 (*Cryptomeria* D. Don. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

11. *Sequoiapollenites* cf. *megaligulus* Krutzsch 1971 (*Sequoia* Endl. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

12, 13. *Sequoiapollenites major* Krutzsch 1971 (*Sequoia* Endl. – type),
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 43.0–43.5 m, sample No. 77

14. *Cryptomeria japonica* D. Don.
Recent pollen grain. North China, Coll. Museum of the Earth, No. 1630

15. *Sequoiapollenites polyformosus* Thiergart 1937 (*Sequoia* Endl. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.8–59.9 m, sample No. 2

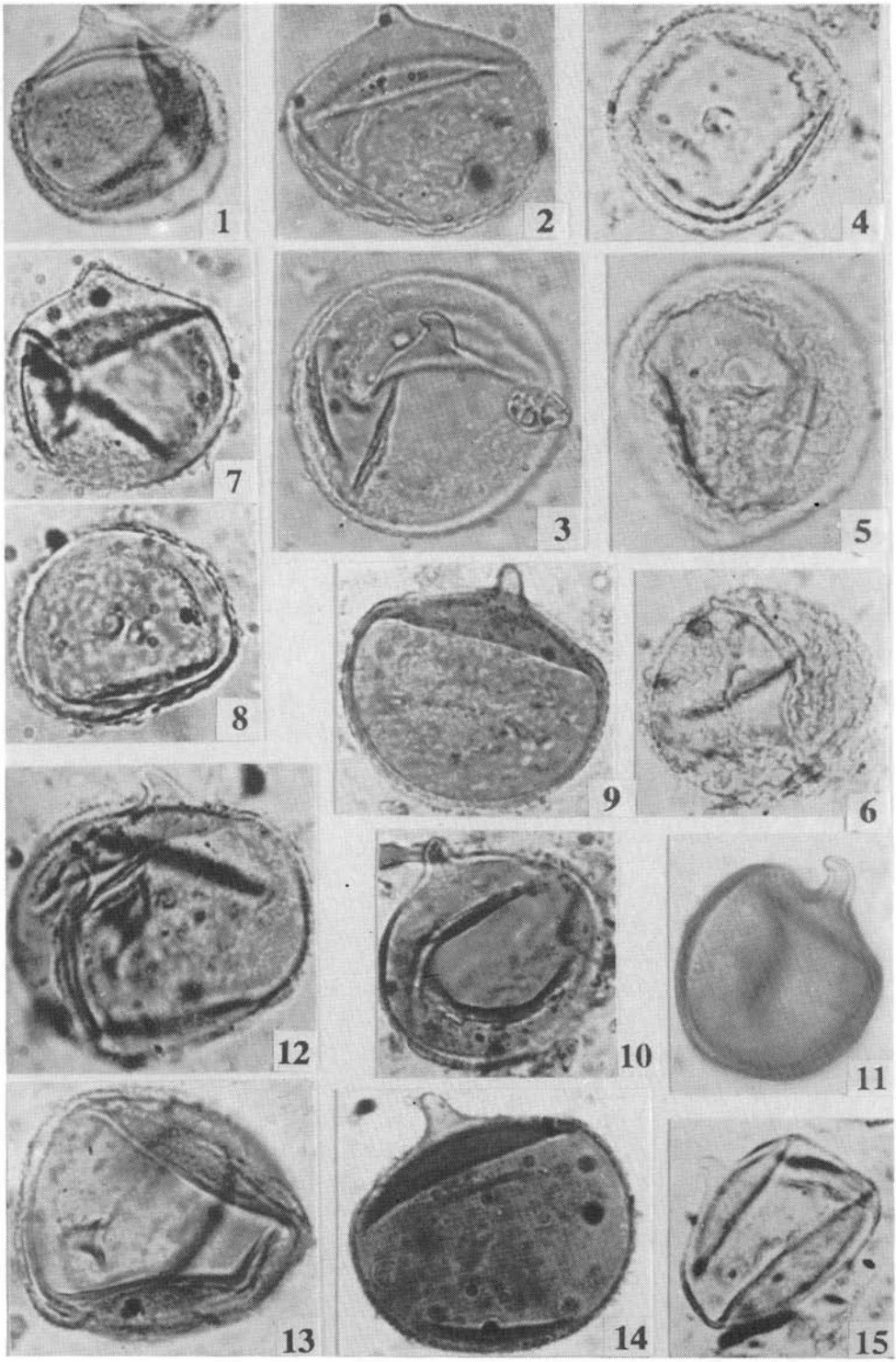

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Plate 16

× 1000

1. *Sequoia* Endl. – *Cryptomeria* D. Don. – type
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

2. *Sequoia* Endl. – *Cryptomeria* D. Don. – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 52.0–52.5 m, sample No. 18

3, 4. *Sequoia sempervirens* Endl.
Recent pollen grains. Kew Botanical Gardens, London. Coll. Museum of the Earth, No. 87

5. *Ephedripites* (*Distachyapites*) *lusaticus* Krutzsch et Sontag 1961
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25

6. *Ephedripites* (*Distachyapites*) *tertiarius* Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

7. *Betulapollenites betuloides* (Pflug 1953) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

8. *Betulapollenites betuloides* (Pflug 1953) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

9. *Alnipollenites verus* (Potonié 1931) Potonié 1934
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

10, 11. *Alnipollenites verus* (Potonié 1931) Potonié 1934
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

12. *Triporopollenites coryloides* Pflug 1953
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.5–41.0 m, sample No. 49

13. *Ostryapollenites rhenanus* (Thomson 1950) Nagy 1969
Lower Miocene (Ścinawa Beds), Kosztowo, depth 108.0–108.5 m, sample No. 69

14. *Ostryapollenites rhenanus* (Thomson 1950) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25

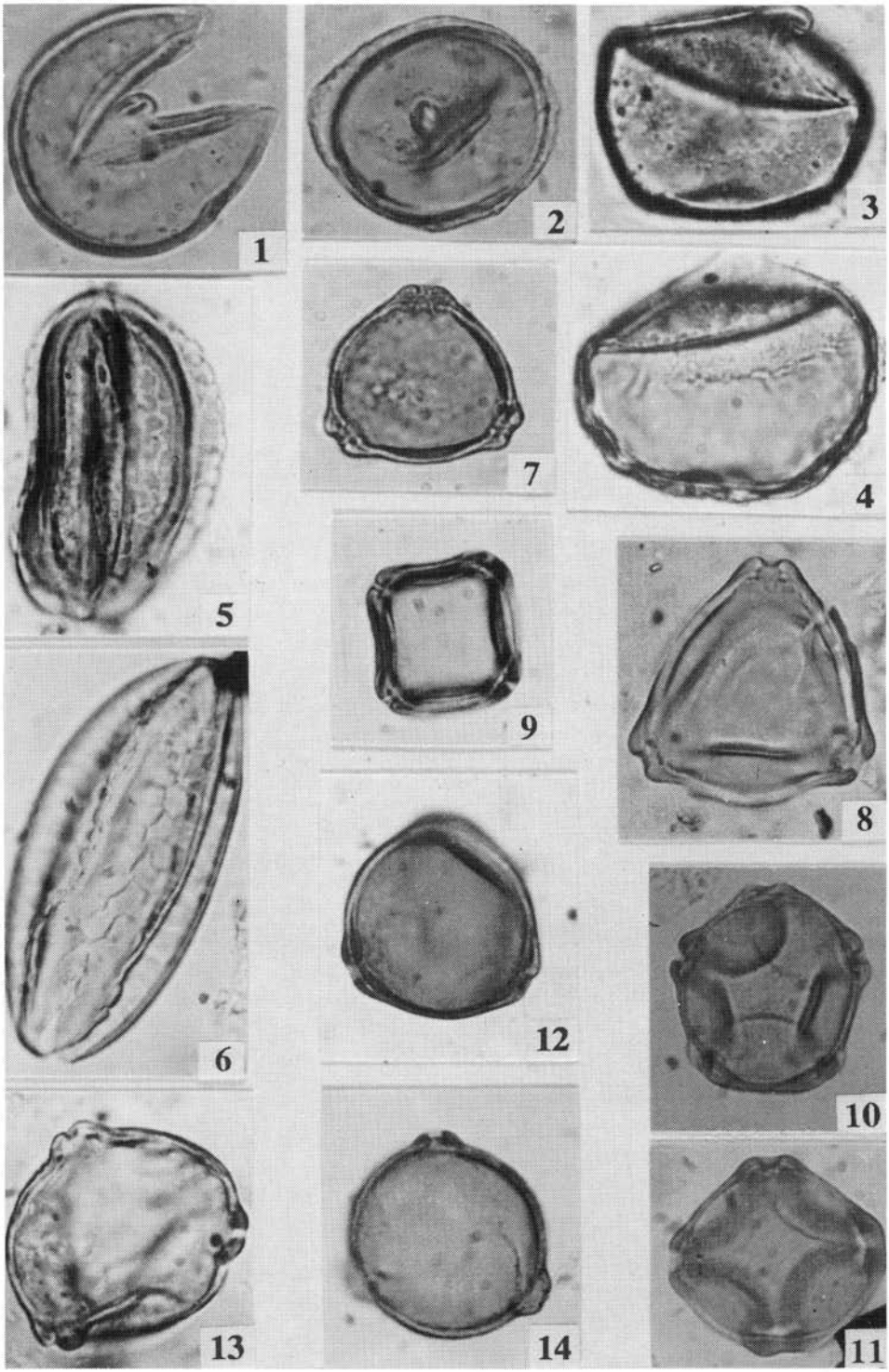

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Plate 17

× 1000

1. *Carpinipites carpinoides* (Pflug 1953) Nagy 1969, f. *minor*
Middle Miocene (Adamów Beds), Kosztowo, depth 87.7–88.0 m, sample No. 43

2. *Carpinipites carpinoides* (Pflug 1953) Nagy 1969, f. *minor*
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11

3. *Carpinipites carpinoides* (Pflug 1953) Nagy 1969, f. *minor*
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 84.0–84.5 m, sample No. 37

4. *Carpinipites carpinoides* (Pflug 1953) Nagy 1969, f. *major*
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

5. *Carpinipites carpinoides* (Pflug 1953) Nagy 1969, f. *major*
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 79.7–80.4 m, sample No. 25

6. *Myricipites rurensis* (Pflug et Thomson 1953) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.4–47.5 m, sample No. 30

7. *Myricipites rurensis* (Pflug et Thomson 1953) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.3–47.4 m, sample No. 31

8. *Myricipites rurobituitus* Pflug 1953
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11

9. *Myricipites bituitus* (Potonié 1931) Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

10. *Caryapollenites simplex* (Potonié 1931) Raatz 1937 ex Potonié 1960
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.5–41.0 m, sample No. 49

11. *Juglans* L. – type 1
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

12. *Multiporopollenites maculosus* (Potonié 1931) Thomson et Pflug 1953 (*Juglans* L. – type 2)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

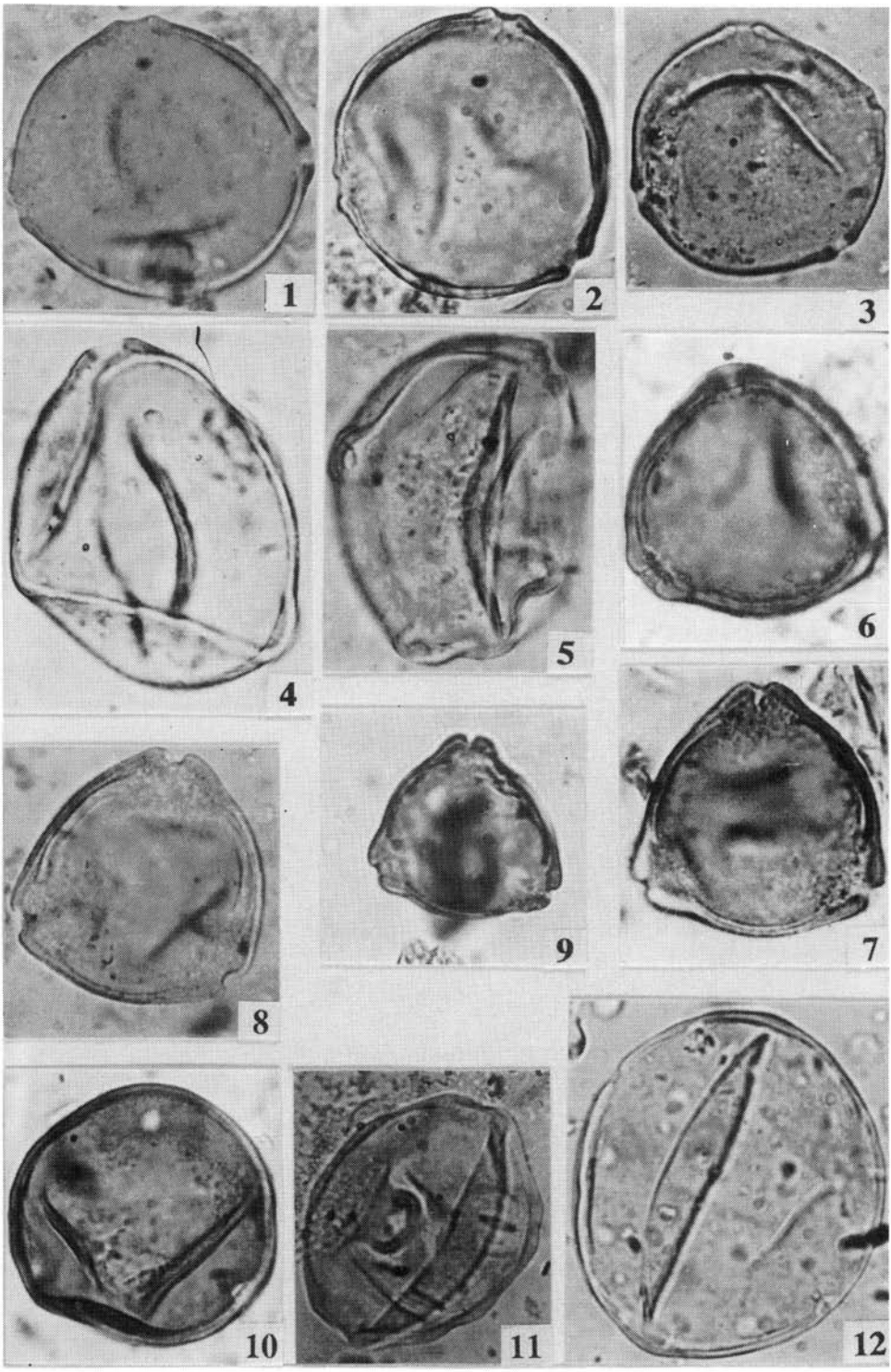

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Plate 18

× 1000

1. *Pterocaryapollenites stellatus* (Potonié 1931) Raatz 1937
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

2. *Platycaryapollis semicyclus* Krutzsch et Vanhoorne 1977
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.3–102.7 m, sample No. 57

3. *Platycaryapollis platycaryoides* (Roche 1969) n. comb.
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.3–102.7 m, sample No. 57

4. *Platycaryapollis* sp.
Lower Miocene (Ścinawa Beds), Kosztowo, depth 101.8–102.3 m, sample No. 56

5. *Engelhardtioidites microcoryphaeus* (Potonié 1931) Potonié 1960
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.7–103.0 m, sample No. 58

6. *Momipites punctatus* (Potonié 1931) Nagy 1969 (*Engelhardtia* Leschen. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

7. *Momipites quietus* (Potonié 1931) Nichols 1973 (*Engelhardtia* Leschen. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

8. *Tricolporopollenites cingulum* (Potonié 1931) Thomson et Pflug 1953 ssp. *oviformis* (Potonié 1931) Thomson et Pflug 1953 (*Castanea* Mill. – *Castanopis* (D. Don.) Spach. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

9a, b. *Tricolporopollenites cingulum* (Potonié 1931) Thomson et Pflug 1953
ssp. *pussillus* (Potonié 1934) Thomson et Pflug 1953 (*Castanea* Mill. – *Castanopis* (D. Don.) Spach. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

10. *Faguspollenites verus* Raatz 1937 – type 1
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

11a, b. *Faguspollenites verus* Raatz 1937 – type 2
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11

12. *Quercus* L. – type 1
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

13. *Tricolpopollenites henrici* (Potonié 1931) Potonié, Thomson, Thiergart 1950 (*Quercus* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 34.5–35.0 m, sample No. 54

14. *Tricolpopollenites asper* Thomson et Pflug 1953 (*Quercus* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

15. *Tricolpopollenites pudicus* (Potonié 1934) Thomson et Pflug 1953
(*Quercus* L. – type) Lower Miocene (Rawicz Beds), Liszkowo, depth 115.0–117.0 m, sample No. 58

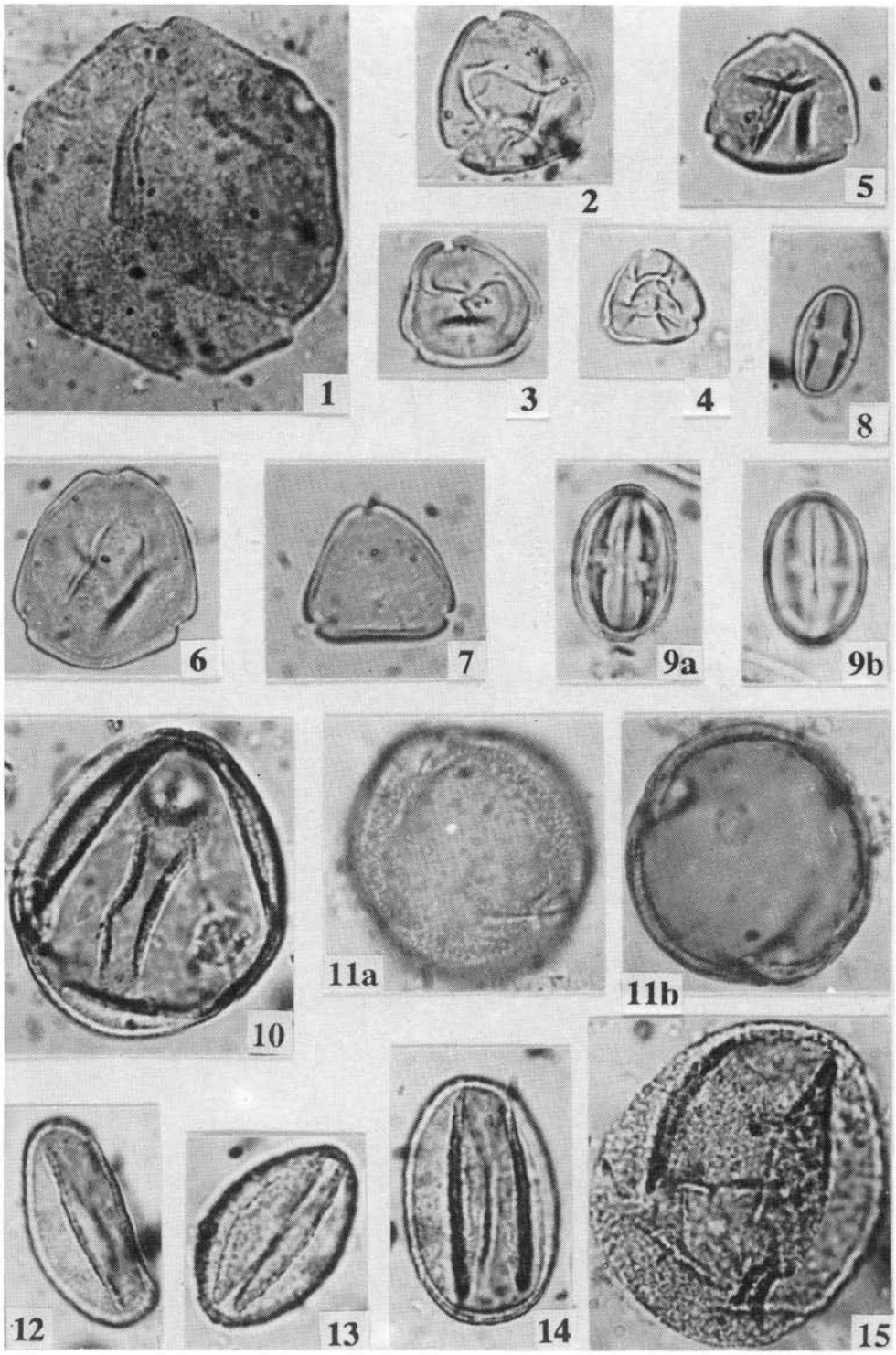
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Plate 19

× 1000

1. *Quercus* L. – type 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

2. *Quercus* L. – type 4
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 84.0–84.5 m, sample No. 37

3a, b. *Quercus* L. – type 3
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.1–49.2 m, sample No. 25

4a, b. *Quercus* L. – type 5
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 48.5–49.0 m, sample No. 27

5a, b. *Salixipollenites* sp.
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.0–81.5 m, sample No. 27

6. *Celtipollenites* sp.
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 72.8–73.0 m, sample No. 14

7. *Celtipollenites intrastructurus* (Krutzsch et Vanhoorne 1977) Thiele – Pfeiffer 1980
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

8. *Zelkovaepollenites potoniei* Nagy 1969
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.6–64.8 m, sample No. 6

9. *Ulmipollenites undulosus* Wolff 1934
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 76.6–77.0 m, sample No. 19

10a, b. *Ulmipollenites* sp.
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

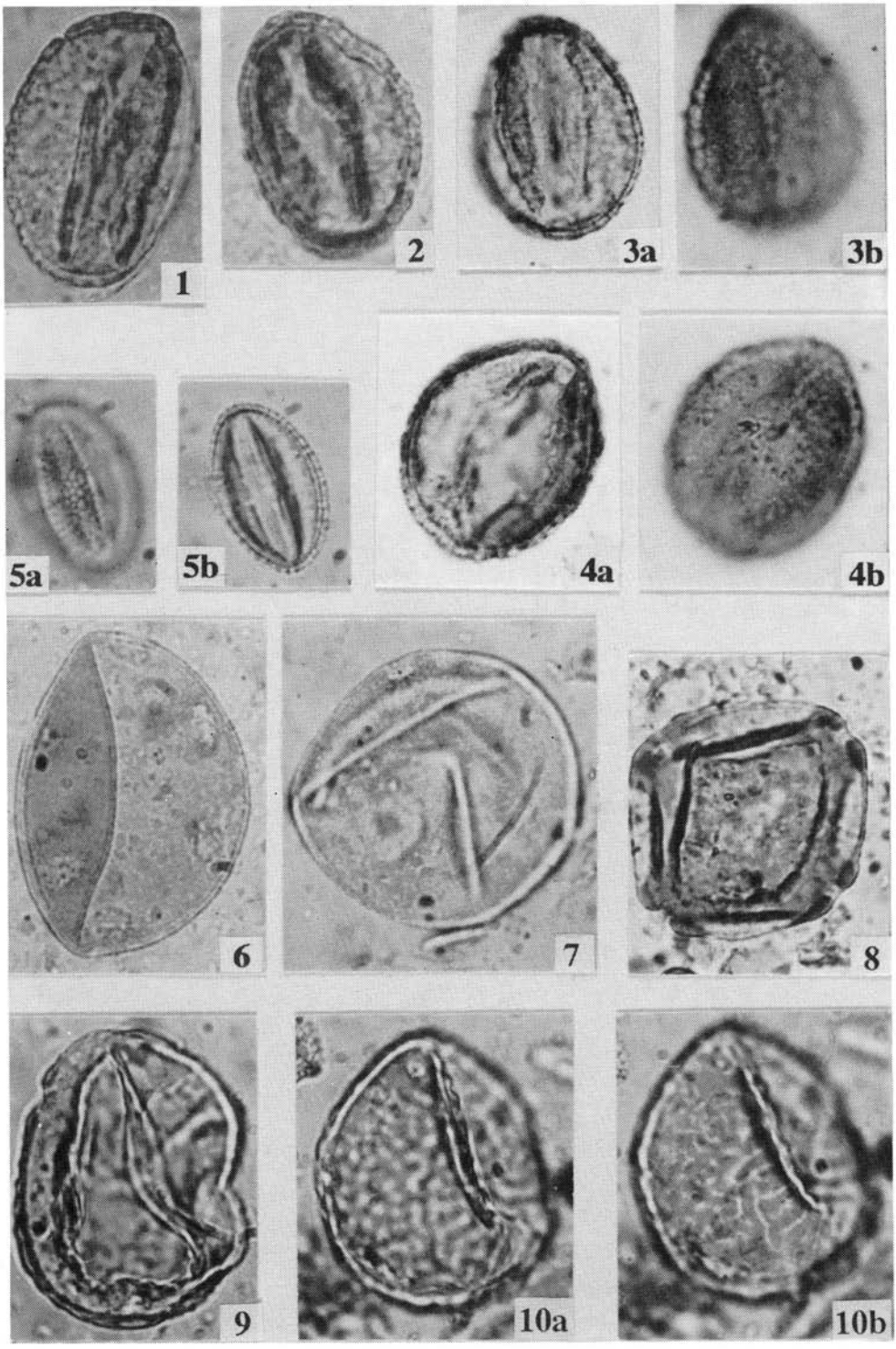

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Plate 20

× 1000

1a, b. *Eucommia Oliv.* – type. sensu Oszast 1960
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 45.5–46.0 m, sample No. 36

2. *Eucommia Oliv.* – type. sensu Oszast 1960
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 33.8–33.9 m, sample No. 68

3a, b. *Spinulaepollis arceuthobioides* Krutzsch 1962 (*Arceuthobium* Bieb. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

4. *Orapollis potsdamensis* Krutzsch 1966 (Alismataceae? Chenopodiaceae? Caryophyllaceae?)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 98.2–98.6 m, sample No. 43

5. *Caryophyllaceae? Amaranthaceae?*
Lower Miocene (Rawicz Beds), Liszkowo, depth 127.0–129.0 m, sample No. 64

6. *Persicariopollis pliocenicus* Krutzsch 1962 (*Polygonum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

7. *Persicariopollis* cf. *lusaticus* Krutzsch 1962 (*Polygonum* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

8. *Liquidambarpollenites orientaliformis* Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.5–51.0 m, sample No. 21

9. *Liquidambarpollenites stigmosus* (Potonié 1931) Raatz 1937
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11

10a, b. *Corylopsis* S. et Z. – type sensu Oszast 1960
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 95.0–96.5 m, sample No. 40

11a, b. *Liquidambarpollenites styracifluaformis* Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

12a, b. *Chenopodipollis neogenicus* Nagy 1969 (*Chenopodiaceae*)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 97.0–98.3 m, sample No. 50

13. *Liquidambarpollenites formosanaeformis* Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

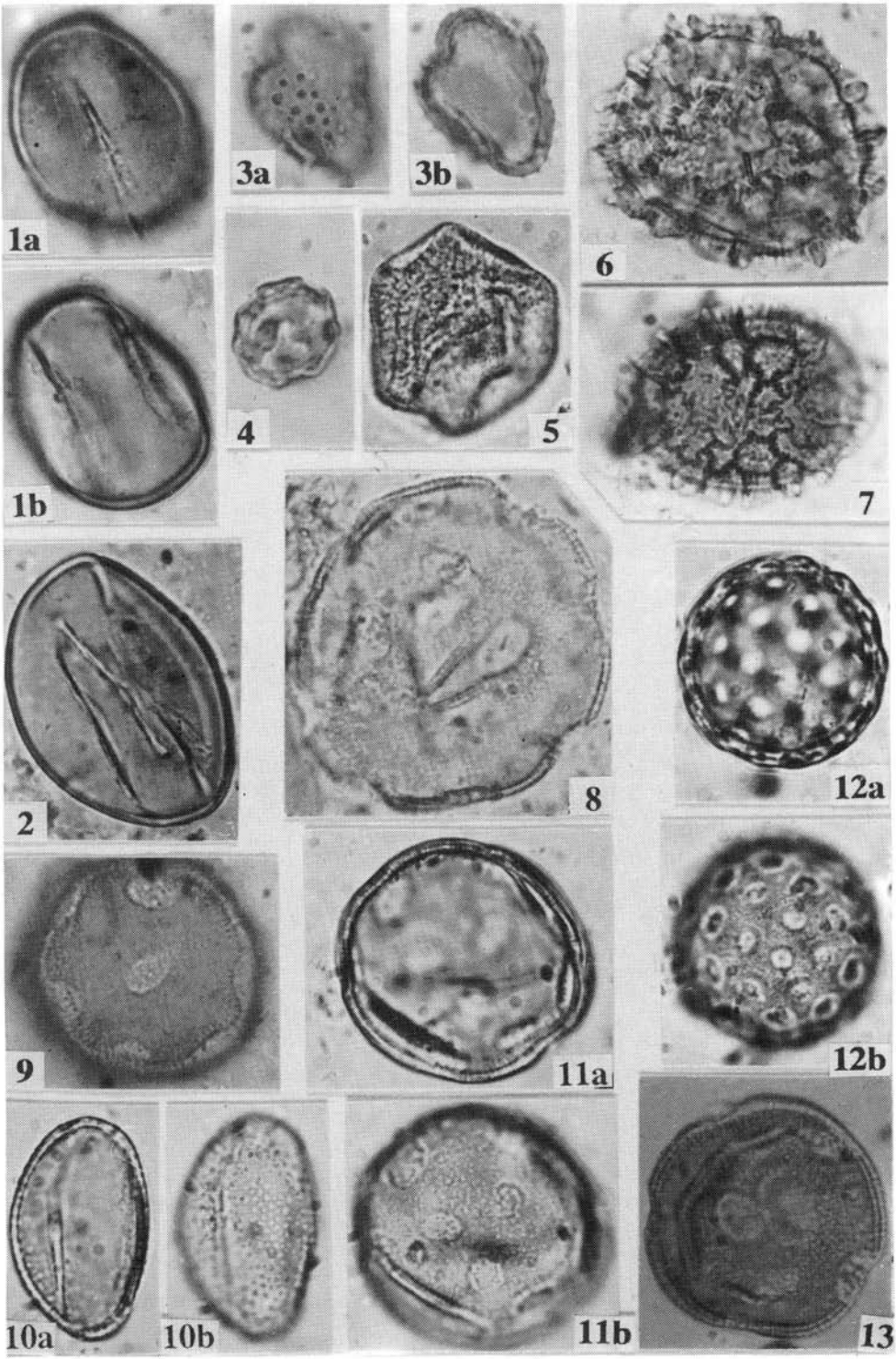

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Plate 21

× 1000

1. *Liriodendroipollis verrucatus* Krutzsch 1970 – f. *major*
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.5–59.8 m, sample No. 3

2. *Liriodendroipollis semiverrucatus semiverrucatus* Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 38.2–38.3 m, sample No. 67

3, 4. *Liriodendroipollis verrucatus* Krutzsch 1970
Middle Miocene (Adamów Beds), Kosztowo, depth 88.0–88.7 m, sample No. 44

5. *Iteapollis angustiporatus* (Schneider 1965) Ziembińska-Tworzydło 1974
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.5–45.0 m, sample No. 38

6. *Iteapollis angustiporatus* (Schneider 1965) Ziembińska-Tworzydło 1974
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

7. *Magnolipollis* cf. *neogenicus minor* Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.2–42.5 m, sample No. 45b

8. *Magnolipollis neogenicus minor* Krutzsch 1970
Lower Miocene (Ścinawa Beds), Kosztowo, depth 99.8–100.3 m, sample No. 53

9. *Magnolipollis* cf. *magnolioides* Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

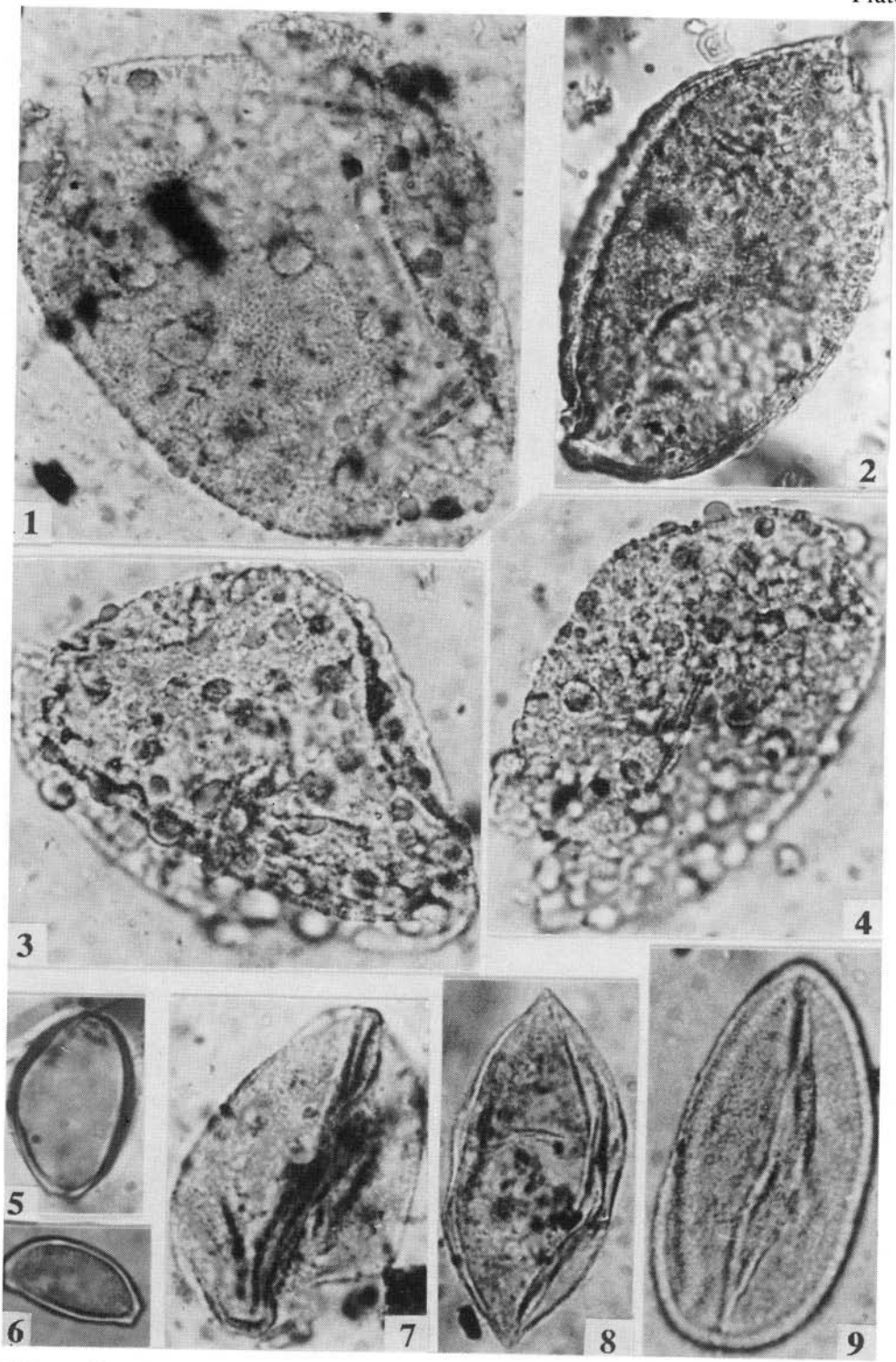

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Plate 22

× 1000

1. *Nymphaea* L. – type
Lower Miocene (Ścinawa Beds), Kosztowo, depth 107.0–107.5 m, sample No. 67

2. *Rubus* L. – type 1
Lower Miocene (Ścinawa Beds), Kosztowo, depth 105.0–105.5 m, sample No. 63

3. *Crataegus* L. – type
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 54.0–54.5 m, sample No. 14

4a, b. *Rubus* L. – type 2
Lower Miocene (Ścinawa Beds), Kosztowo, depth 105.0–105.5 m, sample No. 63

5. *Spiraea* L. – type
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 54.0–54.5 m, sample No. 14

6. *Tricolporopollenites* sp. 4 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

7. *Tricolpopollenites liblarensis* (Thomson 1950) Thomson et Pflug 1953 (*Leguminosae* – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

8. *Tricolpopollenites liblarensis* (Thomson 1950) Thomson et Pflug 1953 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.0–64.6 m, sample No. 5

9a, b. *Tricolpopollenites quisqualis* Potonié 1934 (*Leguminosae* – type),
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.0–104.5 m, sample No. 61

10a, b. *Tricolpopollenites* sp. 1 (*Leguminosae* – type),
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

11. *Tricolporopollenites* sp. 2 (*Leguminosae* – type)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 103.0–105.0 m, sample No. 52

12. *Tricolpopollenites* sp. 2 (*Leguminosae* – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.7–103.0 m, sample No. 58

13a, b. *Tricolporopollenites* sp. 1 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

14. *Tricolporopollenites* sp. 5 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.0–44.5 m, sample No. 39

15. *Tricolporopollenites* sp. 3 (*Leguminosae* – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 100.3–101.0 m, sample No. 54

16. *Tricolporopollenites* sp. 6 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 44.0–44.5 m, sample No. 80

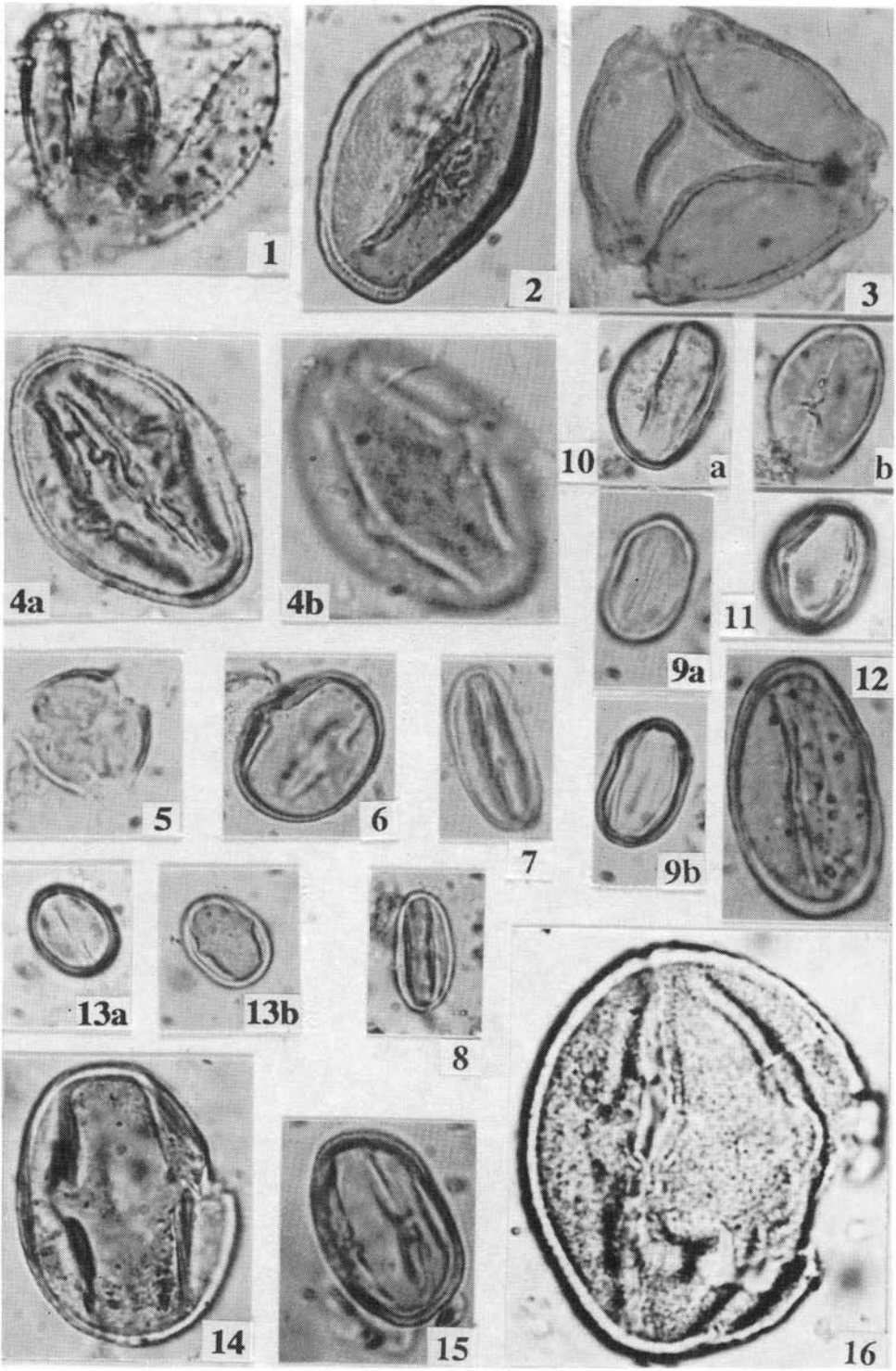

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Plate 23

× 1000

1a, b. *Tricolporopollenites* sp. 7 (*Cassia* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

2a, b, c. *Tricolporopollenites* sp. 8 (*Leguminosae* – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 103.0–103.5 m, sample No. 59

3a, b. *Tricolporopollenites* sp. 9 (*Leguminosae* – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 79.7–80.4 m, sample No. 25

4a, b. *Elaeagnus glabra* Thunb. – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

5. *Slowakipollis* cf. *elaeagnoides* Krutzsch 1962 (*Elaeagnus angustifolia* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.2–42.6 m, sample No. 44

6. *Elaeagnus* L. – type
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.7–103.0 m, sample No. 58

7. *Slowakipollis* cf. *neogenicus* Nagy 1969 (*Hippophae rhamnoides* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.0–44.5 m, sample No. 39

8a, b. *Nyssapollenites kruschi* (Potonié 1931) Nagy 1969 *Tricolporopollenites kruschi* (Potonié 1931) subsp. *analepticus* (Potonié 1931) Thomson et Pflug 1953 (*Nyssa* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 32.75–32.85 m, sample No. 49

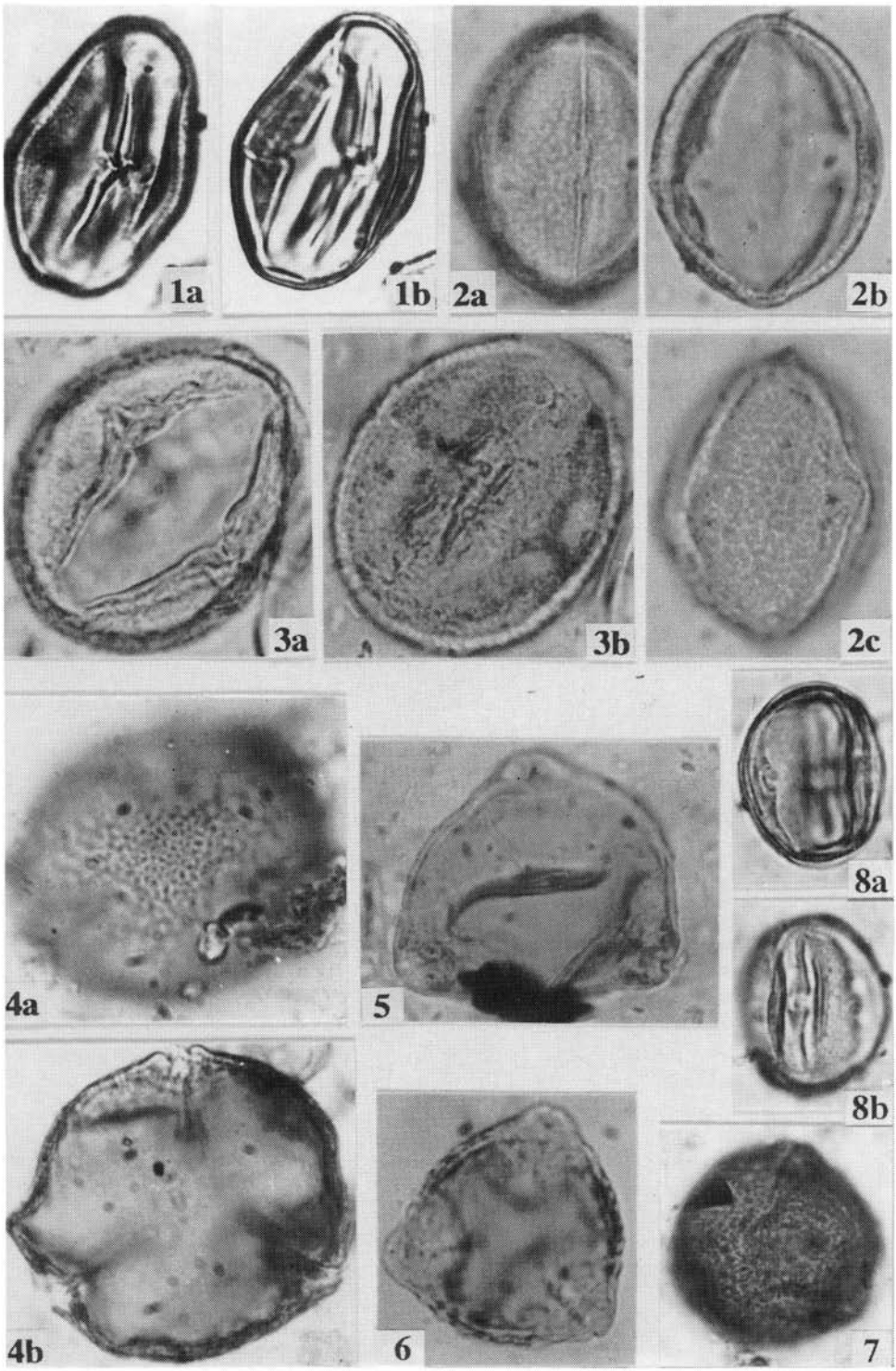
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Plate 24

× 1000

1a, b. *Sporotrapoidites ilingensis* Klaus 1954 (*Trapa* L. – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 79.7–80.4 m, sample No. 25

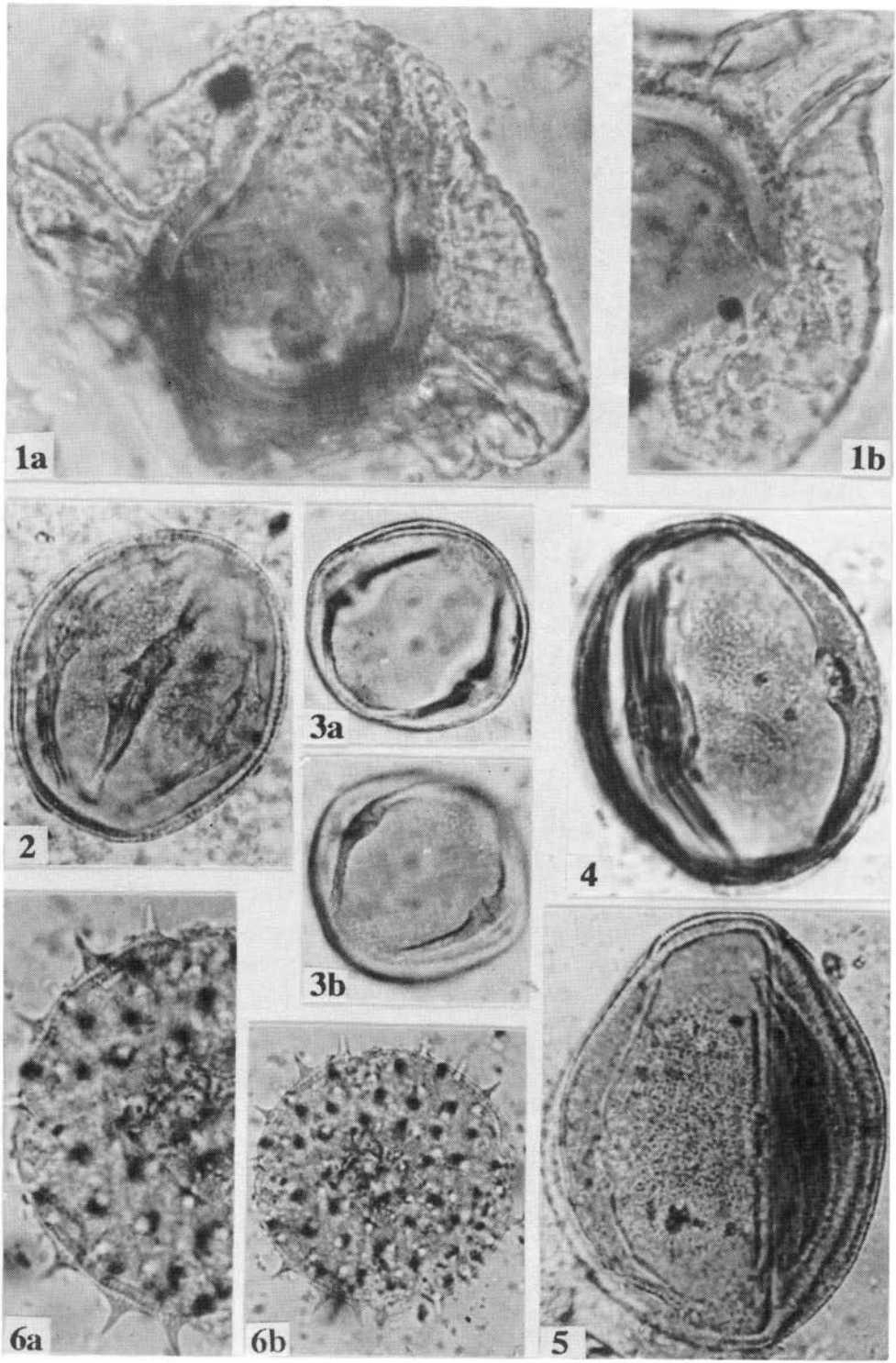
2. *Nyssapollenites kruschi* (Potonié 1931) Nagy 1969 *Tricolporopollenites kruschi* (Potonié 1931) subsp. *contortus* Thomson et Pflug 1953 (*Nyssa* L. – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.6–64.8 m, sample No. 6

3a, b. *Nyssapollenites pseudocruciatus* (Potonié 1931) Thiergart 1937 (*Nyssa* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.0–44.5 m, sample No. 39

4. *Nyssapollenites kruschi* (Potonié 1931) Nagy 1969 *Tricolporopollenites kruschi* (Potonié 1931) subsp. *rodderensis (Thiergart) Thomson et Pflug 1953 (Nyssa* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 32.75–32.85 m, sample No. 49

5. *Nyssapollenites kruschi* (Potonié 1931) Nagy 1969 *Tricolporopollenites kruschi* (Potonié 1931) subsp. *rodderensis* (Thiergart) Thomson et Pflug 1953 (*Nyssa* L. – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.6–64.8 m, sample No. 6

6a, b. *Malvaceae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56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3a
3b
4
6a
6b
5

Plate 25

× 1000

1a, b, c. *Intratriporopollenites* sp. (*Tilia tomentosa* Moench. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

2a, b. *Intratriporopollenites instructus* (Potonié 1931) Thomson et Pflug 1953 (*Tilia platyphyllos* Scop. – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.6–64.8 m, sample No. 6

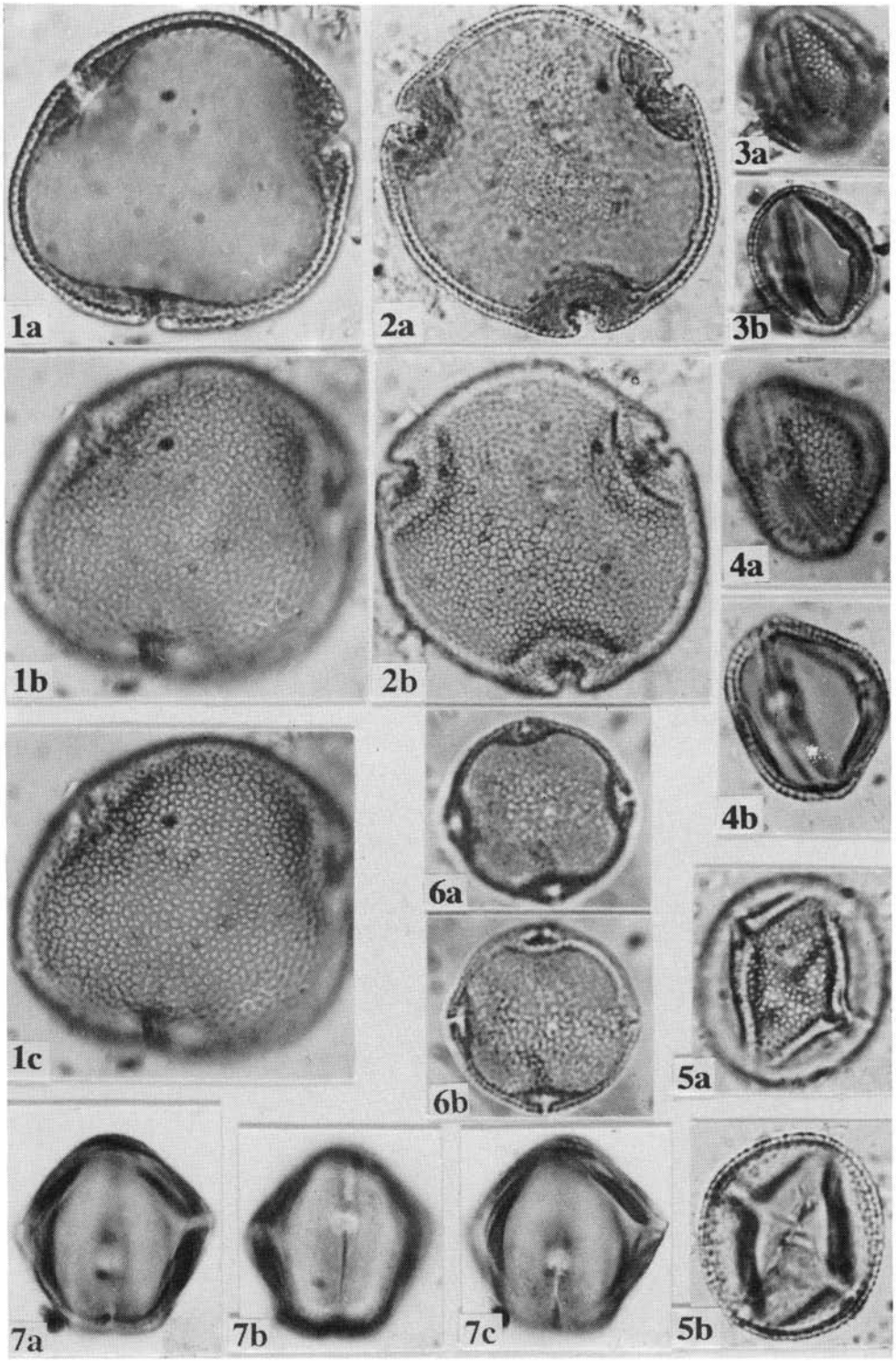
3a, b. *Tricolporopollenites* sp. 13 (*Sterculiaceae-Rutaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.4–47.5 m, sample No. 30

4a, b. *Tricolporopollenites* sp. 10 (*Sterculiaceae-Rutaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

5a, b. *Tricolporopollenites* sp. 11 (*Sterculiaceae-Rutaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 45.5–46.0 m, sample No. 83

6a, b. *Reevesiapollis triangulus* (Mamczar 1960) Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 40.0–40.5 m, sample No. 71

7a, b, c. *Meliaceae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23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7a
7b
7c
5b

Plate 26

× 1000

1. *Corsinipollenites oculusnoctis* (Thiergart 1940) Nakoman 1965 ssp. *oculusnoctis* Krutzsch 1968 (*Oenotheraceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

2. *Corsinipollenites* sp. (*Oenotheraceae*)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 64.0–64.6 m, sample No. 5

3. *Corsinipollenites polonicus* Krutzsch 1968 (*Oenotheraceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 42.0–42.3 m, sample No. 75

4a, b. *Aceripollenites* sp. 1 (*Acer tataricum* L. – *Acer truncatum* Bge. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.2–31.3 m, sample No. 78

5a, b. *Aceripollenites* sp. 2 (*Acer tataricum* L. – *Acer truncatum* Bge. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.2–42.5 m, sample No. 45b

6a, b. *Aceripollenites* sp. 3 (*Acer trautvetteri* Medwed. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.8–59.9 m, sample No. 2

7. *Aceripollenites* cf. *reticulatus* Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

8a, b, c. *Aceripollenites* sp. 5
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

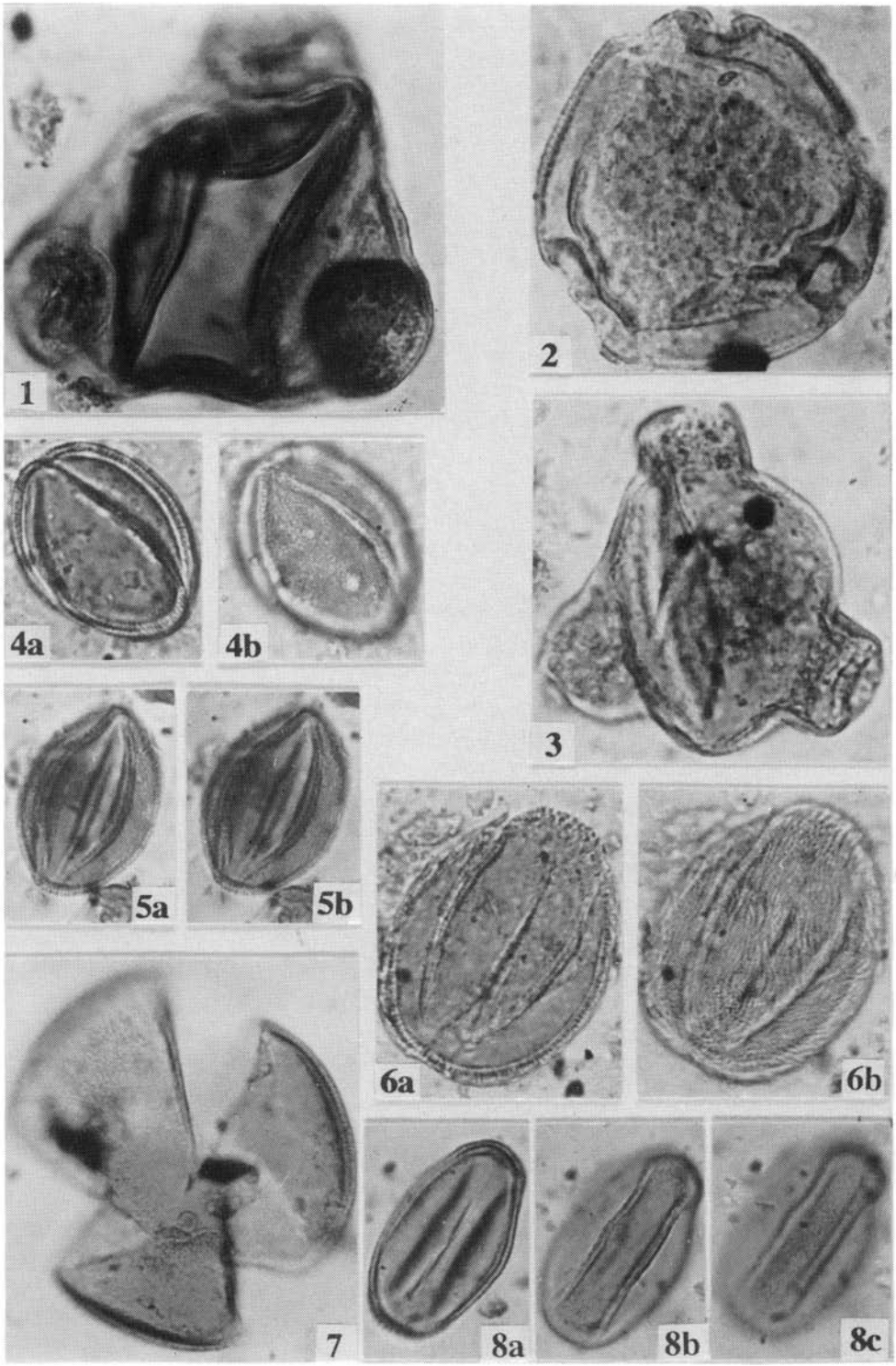

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Plate 27

× 1000

1a, b. *Aceripollenites striatus* (Pflug 1959) Thiele-Pfeiffer 1980 (*Acer campestre* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.3–47.4 m, sample No. 31

2a, b. *Aceripollenites* sp. 4 (*Acer platanoides* L. – *Acer pseudoplatanus* L. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 56.5–57.0 m, sample No. 9

3. *Ilexpollenites iliacus* (Potonié 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 44.0–44.5 m, sample No. 39

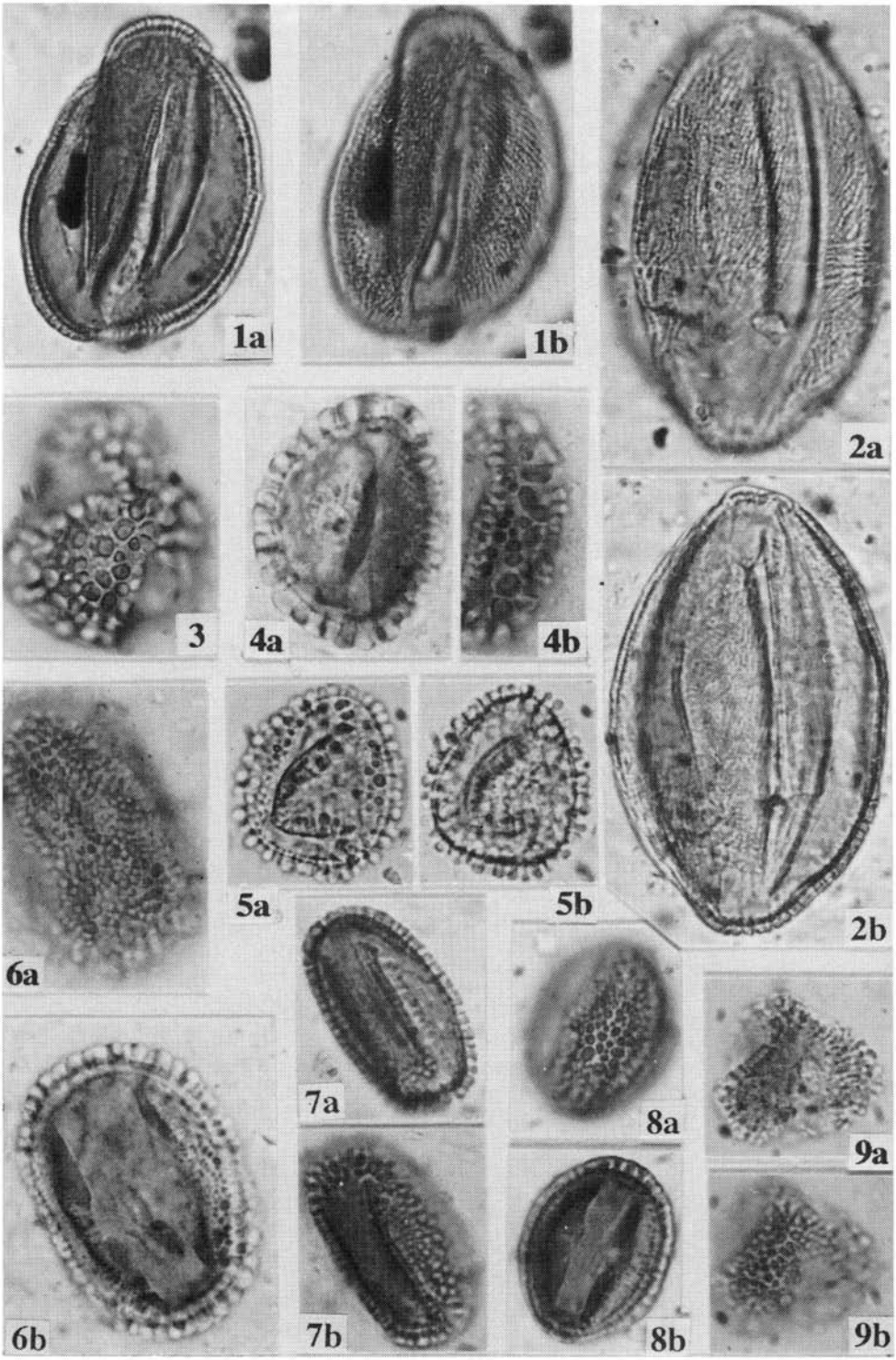
4a, b. *Ilexpollenites iliacus* (Potonié 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.5–59.8 m, sample No. 3

5a, b. *Ilexpollenites* cf. *iliacus* (Potonié 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41

6a, b. *Ilexpollenites margaritatus* (Potonié 1931) Thiergart 1937, f. *major* Thomson et Pflug 1953
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 59.5–59.8 m, sample No. 3

7a, b. *Ilexpollenites margaritatus* (Potonié 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

8a, b & 9a, b. *Ilexpollenites margaritatus* (Potonié 1931) Thiergart 1937, f. *medius* Thomson et Pflug 1953
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.0–43.5 m, sample No. 41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8b
9b

Plate 28

× 1000

1. *Scrophulariaceae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

2. *Scrophulariaceae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.5–47.0 m, sample No. 34

3a, b. *Tricolporopollenites* cf. *clethraceiformis* Nagy 1969 (*Clethra* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

4a, b. *Tricolporopollenites* cf. *clethraceiformis* Nagy 1969 (*Clethra* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

5. *Cyrillaceaepollenites megaexactus* (Potonié 1931) Potonié 1960 (*Cyrilla* Gard. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 44.0–44.5 m, sample No. 80

6. *Cyrillaceaepollenites megaexactus* (Potonié 1931) Potonié 1960 (*Cyrilla* Gard. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.2–49.5 m, sample No. 24

7. *Cyrillaceaepollenites megaexactus* (Potonié 1931) Potonié 1960 (*Cyrilla* Gard. – type)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 98.2–98.6 m, sample No. 43

8. *Cyrillaceaepollenites exactus* (Potonié 1931) Potonié 1960 (*Clethra* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.7–43.0 m, sample No. 77

9. *Cyrillaceaepollenites exactus* (Potonié 1931) Potonié 1960 (*Clethra* L. – type)
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 80.4–81.0 m, sample No. 31

10. *Cyrillaceaepollenites exactus* (Potonié 1931) Potonié 1960 (*Clethra* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 44.0–44.5 m, sample No. 80

11. *Cyrillaceaepollenites* cf. *megaexactus* (Potonié, 1931) Potonié 1960 (*Cyrilla* Gard. – type)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 97.8–98.2 m, sample No. 42

12. *Clethraceae*? *Cyrillaceae*?
Lower Miocene (Ścinawa Beds), Kosztowo, depth 100.3–101.0 m, sample No. 54

13. *Clethraceae*? *Cyrillaceae*?
Lower Miocene (Ścinawa Beds), Kosztowo, depth 98.3–99.0 m, sample No. 51

14a, b. *Vitis* L. – type 1
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.5–81.7 m, sample No. 28

15a, b. *Vitis* L. – type 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 51.5–52.0 m, sample No. 19

16a, b. *Tricolporopollenites marcodurensis* Pflug et Thomson 1953 (*Parthenocissus* Planch. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 101.0–101.8 m, sample No. 55

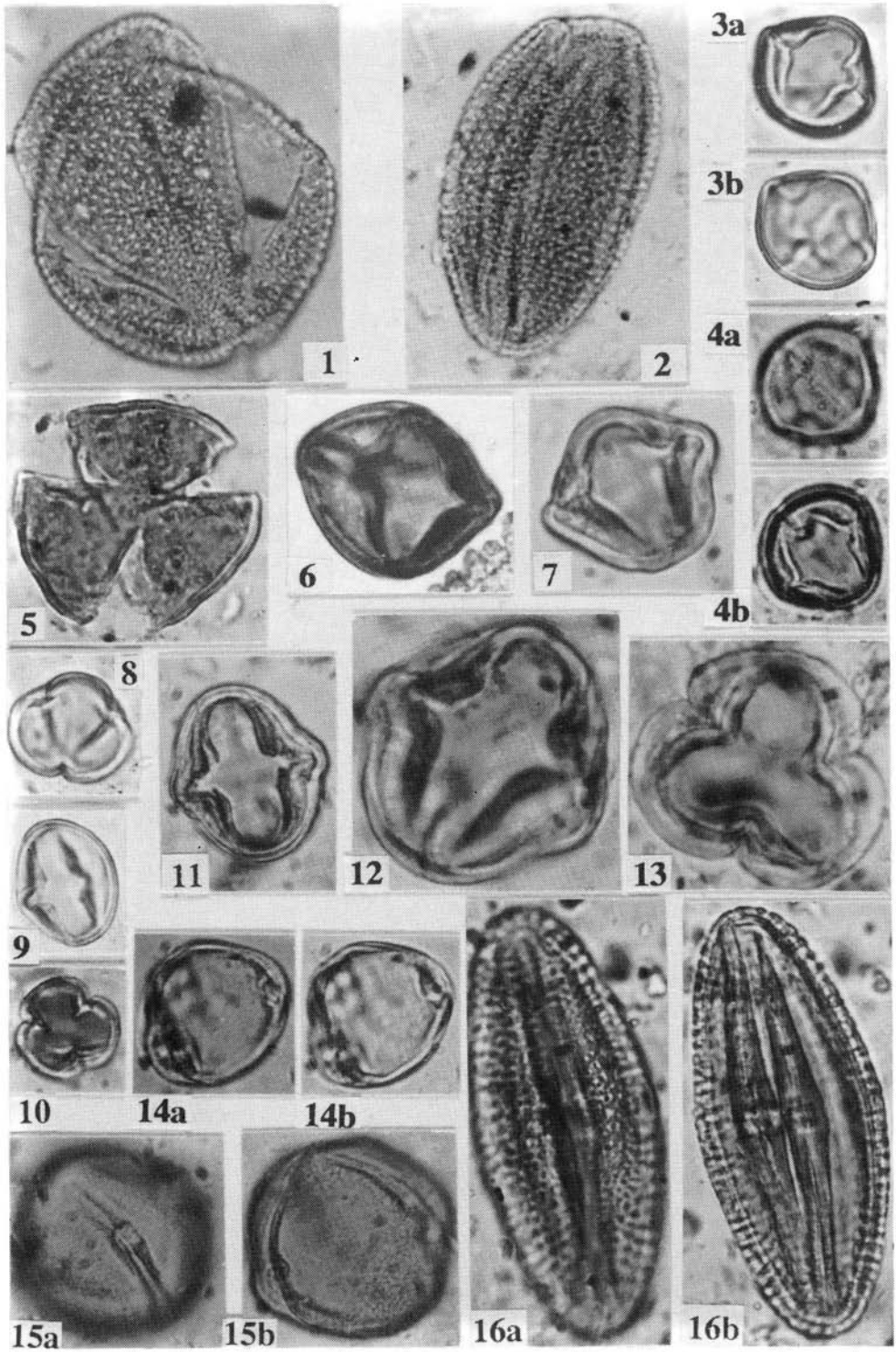

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Plate 29

× 1000

1a, b. *Tricolporopollenites marcodurensis* Pflug et Thomson 1953, (*Parthenocissus* Planch. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 32.75–32.85 m, sample No. 49

2a, b. *Tricolporopollenites marcodurensis* Pflug et Thomson 1953, (*Parthenocissus* Planch. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 51.5–52.0 m, sample No. 19

3a, b. *Tricolporopollenites marcodurensis* Pflug et Thomson 1953, f. *major* (*Leea manillensis* Walp.? *Parthenocissus* Planch?)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

4a, b. *Tricolporopollenites* cf. *marcodurensis* Pflug et Thomson 1953 (*Cyphostemma* (Planch.) Alston – *Cissus* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 34.5–35.0 m, sample No. 54

5a, b. *Tricolporopollenites* cf. *marcodurensis* Pflug et Thomson 1953 (*Cyphostemma* (Planch.) Alston – *Cissus* L. – type)
Middle Miocene (Mid-Polish Beds), Kosztowo, depth 80.4–81.0 m, sample No. 31

6a, b. *Araliaceoipollenites* sp. form B, Konzalova 1976 (*Aralia* chinensis var. *mandschurica* Rehd. – type)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.5–56.0 m, sample No. 11

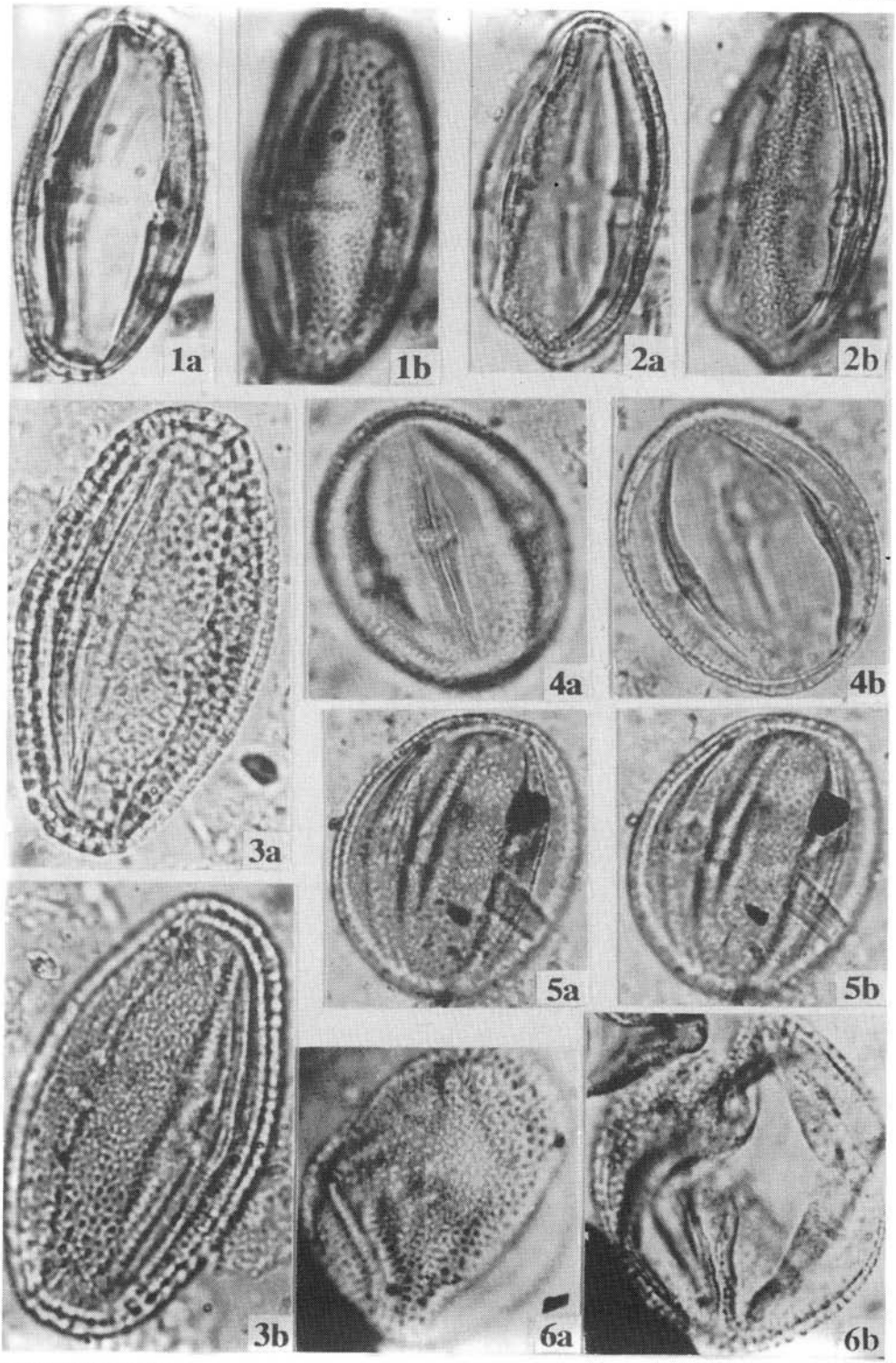

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Plate 30

× 1000

1a, b. *Araliaceoipollenites edmundi* (Potonié 1931) Potonié 1950 (*Araliaceae* – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.5–41.0 m, sample No. 49

2a, b & 3a, b. *Araliaceoipollenites edmundi* (Potonié 1931) Potonié 1950 (*Araliaceae* – type)
Middle Miocene (Adamów Beds), Kosztowo, depth 87.7–88.0 m, sample No. 43

4a, b. *Tricolporopollenites satzveyensis* Pflug 1953 (*Cornus* L. – type 1)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.5–51.0 m, sample No. 21

5a, b. *Ericipites* sp. 3 (*Rhododendron* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.5–48.0 m, sample No. 29

6a, b. *Araliaceoipollenites euphorii* (Potonié 1931) Potonié 1951 (*Aralia chinensis* L. – type)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

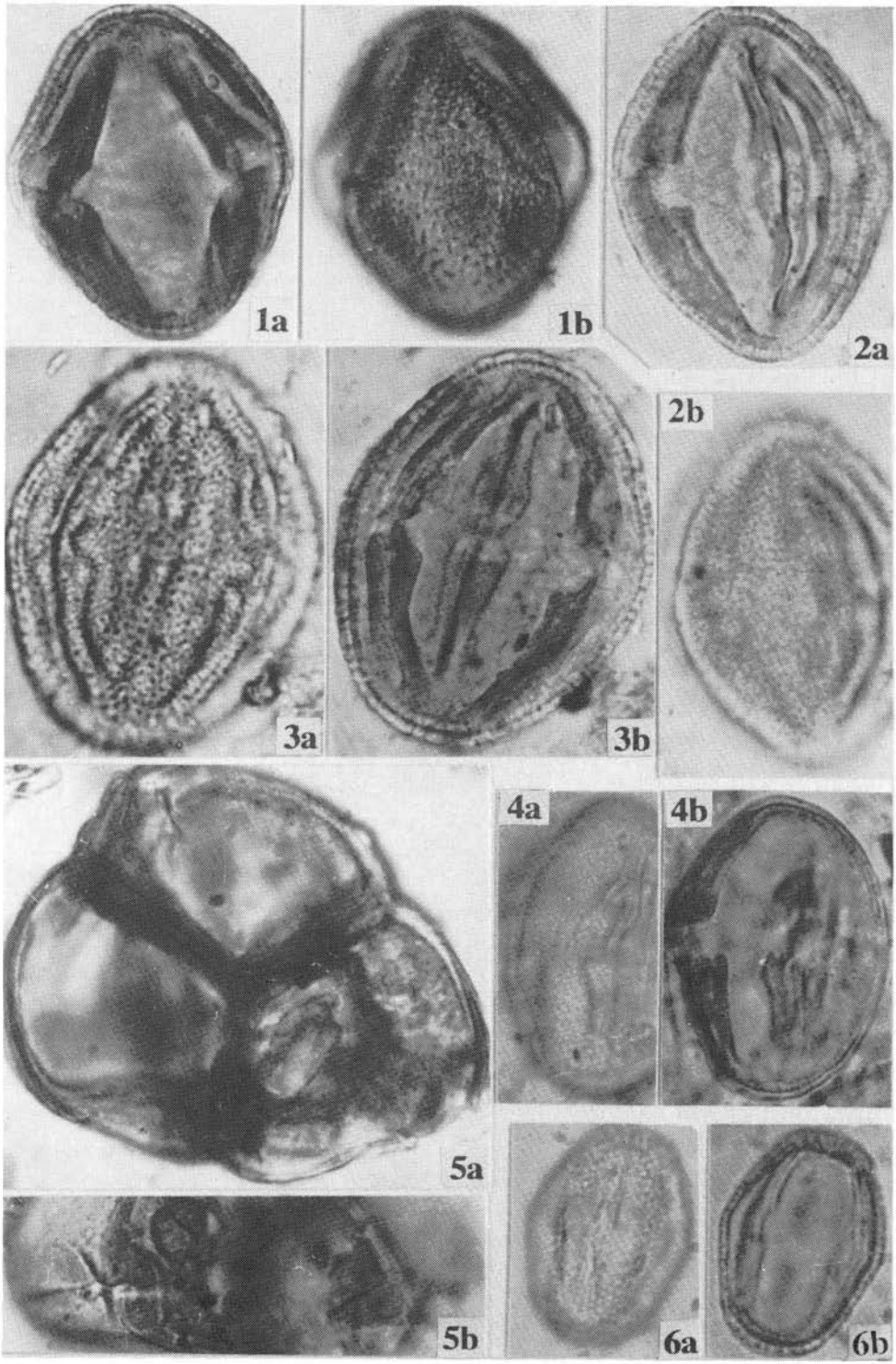
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Plate 31

× 1000

1a, b. *Tricolporopollenites pseudocingulum* (Potonié 1931) Thomson et Pflug 1953 (*Anacardiaceae*)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

2. *Cornus* L. – type 2
Lower Miocene (Ścinawa Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

3. *Ericipites baculatus* Nagy 1969 (cf. *Calluna vulgaris* (L.) Hull.)
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 53.5–54.0 m, sample No. 15

4. *Ericipites ericius* (Potonié 1931) Potonié 1960
Lower Miocene (Ścinawa Beds), Kosztowo, depth 101.0–101.8 m, sample No. 55

5. *Ericipites* sp. 1 (cf. *Erica arborea* L.)
Lower Miocene (Ścinawa Beds), Liszkowo, depth 98.2–98.6 m, sample No. 43

6. *Ericipites baculatus* Nagy 1969 (cf. *Calluna vulgaris* (L.) Hull.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 37.7–38.0 m, sample No. 58

7. *Ericipites* sp. 5
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

8. *Ericipites* sp. 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.5–47.0 m, sample No. 34

9. *Ericipites* sp. 4 (cf. *Pyrolaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

10. *Ericipites roboreus* (Potonié 1931) Krutzsch 1970 (cf. *Arbutus unedo* L.)
Middle Miocene (Adamów Beds), Kosztowo, depth 87.7–88.0 m, sample No. 43

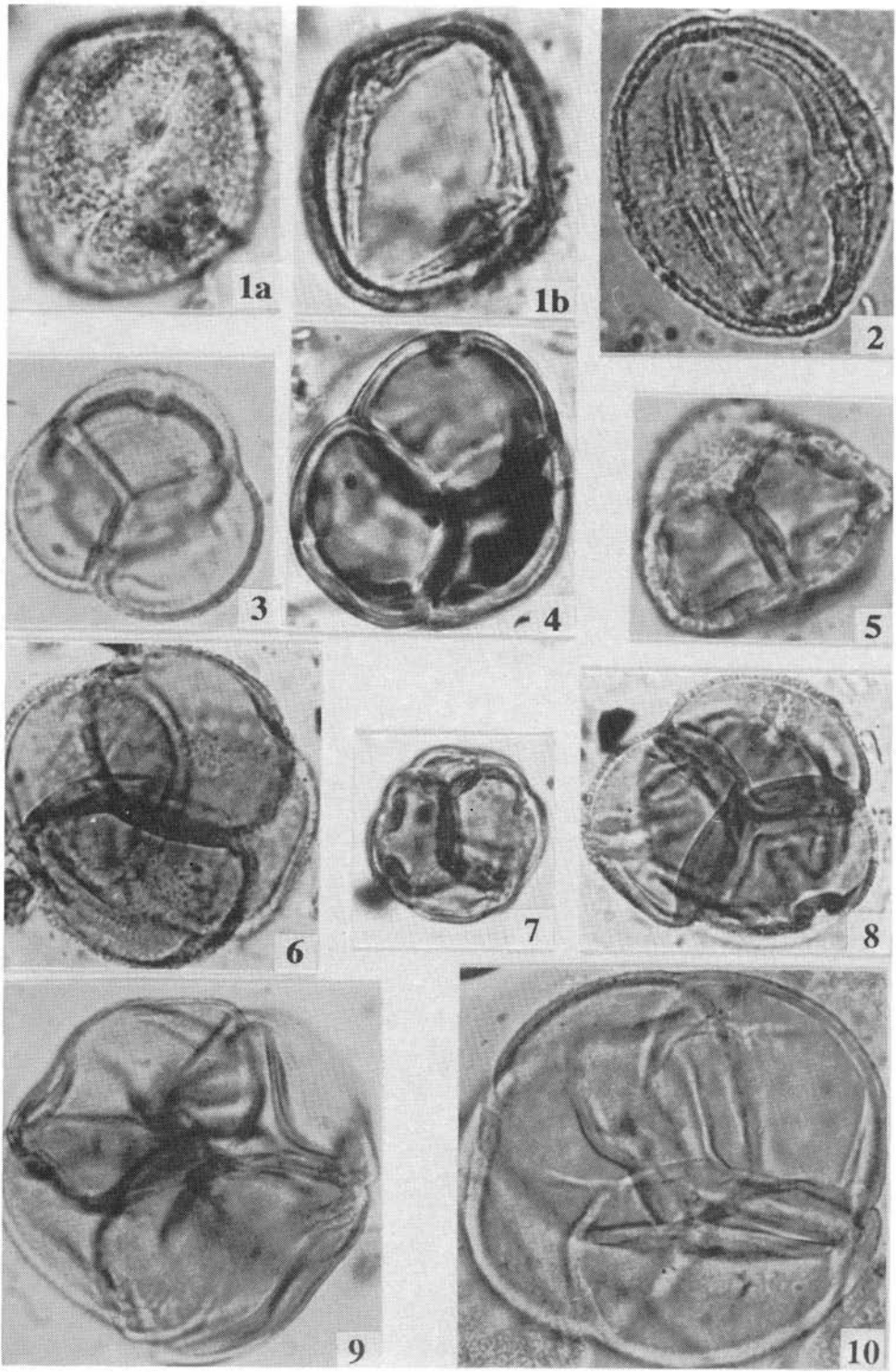

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Plate 32

× 1000

1. *Ligustrum* L. – type 1 (cf. *L. amurense* Carr.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

2a, b. *Fraxinus* L. – type 1 (cf. *F. ornus* L.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.5–42.0 m, sample No. 47

3a, b. *Fraxinus* L. – type 1 (cf. *F. mariesii* Hook.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 47.4–47.5 m, sample No. 30

4. *Labiatae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

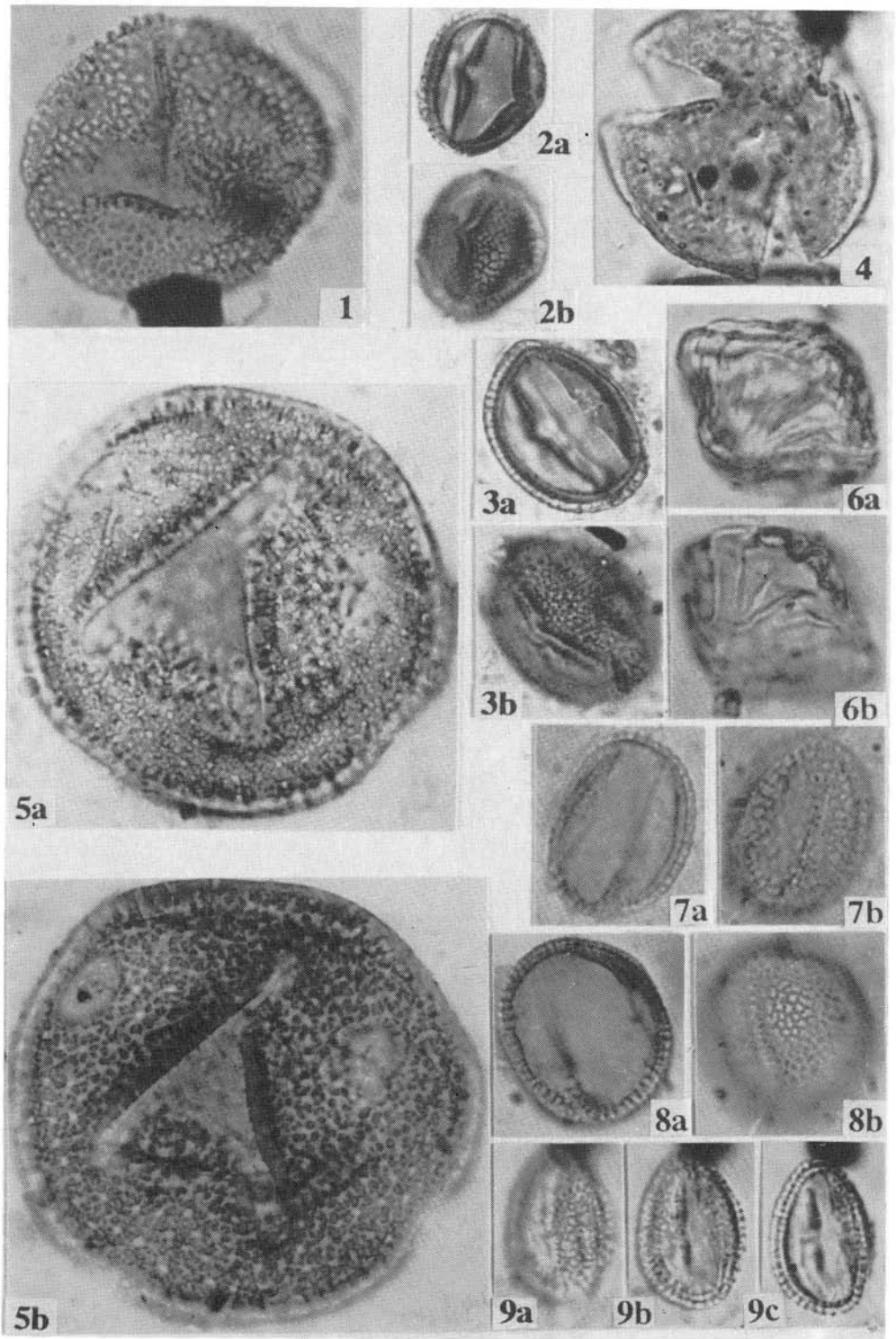
5a, b. *Calystegiapollis sarmaticus* Nagy 1969 (*Calystegia* R. Br. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.0–41.5 m, sample No. 48

6a, b. *Utriculariaepollenites elegans* Nagy 1969 (*Utricularia* L. – type)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.5–81.7 m, sample No. 28

7a, b. *Ligustrum* L. – type 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.3–31.4 m, sample No. 77

8a, b. *Oleaceae* – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 43.5–44.0 m, sample No. 40

9a, b, c. *Sambucus* L. – type (cf. *S. nigra* L., *S. canadensis* L.)
Lower Miocene (Ścinawa Beds), Kosztowo, depth 101.0–101.8 m, sample No. 55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7b
8a
8b
5b
9a
9b
9c

Plate 33

× 1000

1a, b. *Diervillapollenites megaspinosus* Doktorowicz-Hrebnicka 1956
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.6 m, sample No. 75

2a, b. *Manikinipollis tetradoides* Krutzsch 1970 (*Asclepiadaceae – Periplocoideae, Periploca* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

3a, b. *Tubulifloridites ambrosiinae* Nagy 1969 (cf. *Ambrosia maritima*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.5–42.0 m, sample No. 47

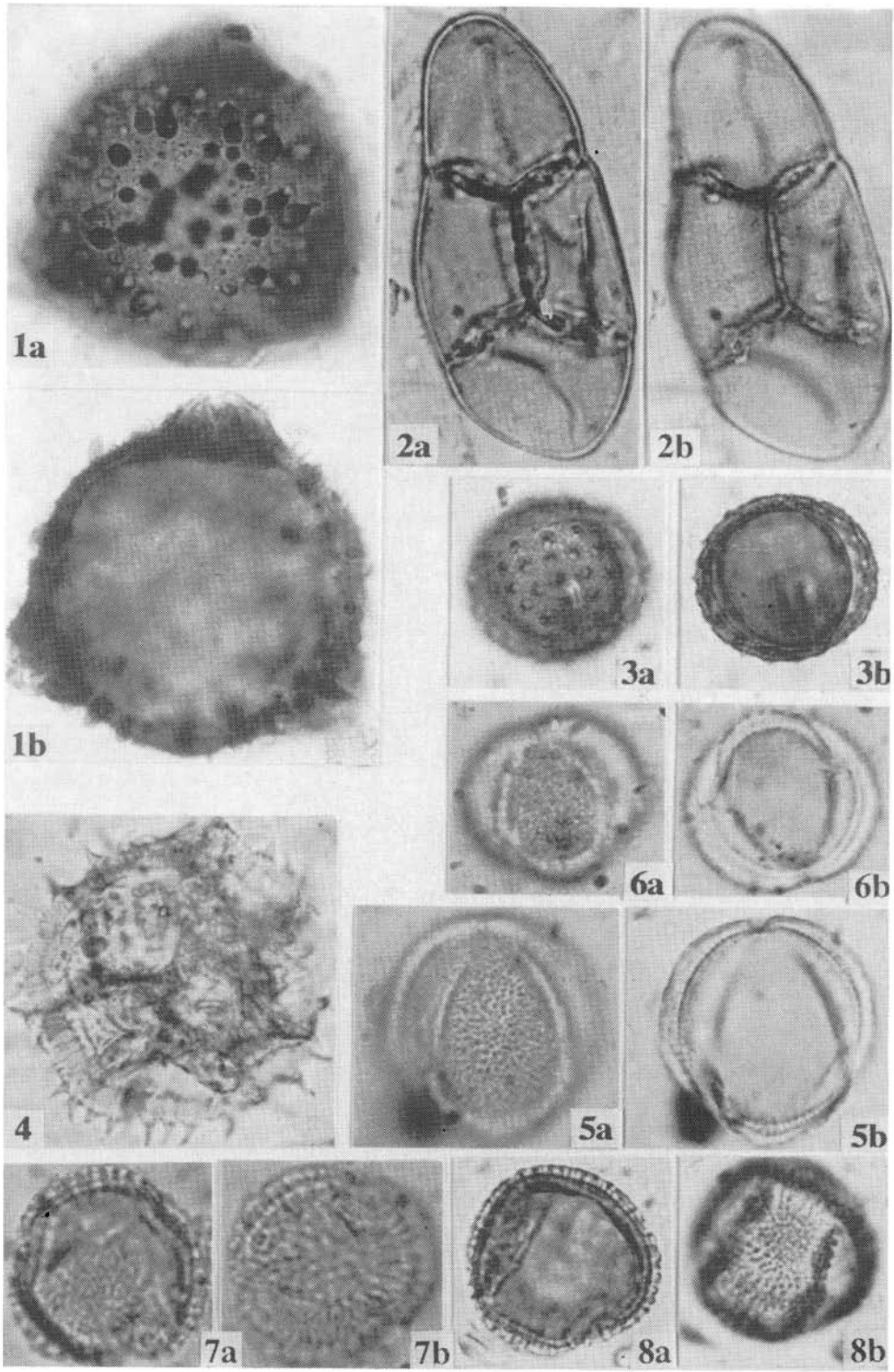
4. *Cichoreacidites gracilis* (Nagy 1969) Nagy 1985 (*Liguliflorae – Cichorieae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 4, depth 44.5–45.0 m, sample No. 81

5a, b. *Artemisiaepollenites sellularis* Nagy 1969
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.0–40.5 m, sample No. 50

6a, b. *Artemisiaepollenites sellularis* Nagy 1969
Lower Miocene (Rawicz Beds), Liszkowo, depth 115.0–117,0 m, sample No. 58

7a, b. *Viburnum* L. – type (cf. *V. carlesii* Hemsl., *V. lentago L.*)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 98.2–98.6 m, sample No. 43

8a, b. *Viburnum* L. – type (cf. *V. carlesii* Hemsl., *V. lentago L.*)
Lower Miocene (Rawicz Beds), Liszkowo, depth 103.0–105.0 m, sample No. 52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6b
7a
7b
8a
8b

Plate 34

× 1000

1. *Porocolpopollenites vestibulum* (Potonié 1931), Thomson et Pflug 1953 (*Symplocos* Jacq. – type 1)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

2. *Porocolpopollenites* sp. (*Symplocos* Jacq. – type 2)
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 62.2–63.4 m, sample No. 3

3a, b, c. *Sparganiaceaepollenites magnoides* Krutzsch 1970 (*Sparganium* L. – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 40.5–41.0 m, sample No. 49

4. *Sparganiaceaepollenites sparganioides* (Meyer 1956) Krutzsch 1970, (*Typha* L. – type, cf. *T. angustifolia*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

5. *Sparganiaceaepollenites sparganioides* (Meyer 1956) Krutzsch 1970, (*Typha* L. – type, cf. *T. angustifolia* L.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 46.0–46.5 m, sample No. 35

6. *Sparganiaceaepollenites polygonalis* Thiergart 1937 (*Typha* L. – type, cf. *T. minima* L.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.6 m, sample No. 75

7. *Sparganiaceaepollenites polygonalis* Thiergart 1937 (*Typha* L. – type, cf. *T. minima* L.)
Lower Miocene (Rawicz Beds), Kosztowo, depth 105.5–106.0 m, sample No. 64

8. *Potamogeton* L. – type
Lower Miocene (Rawicz Beds), Kosztowo, depth 105.0–105.5 m, sample No. 63

9. *Cyperaceaepollis piriformis* Thiele-Pfeiffer 1980
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

10. *Cyperaceaepollis piriformis* Thiele-Pfeiffer 1980
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.2–42.5 m, sample No. 45b

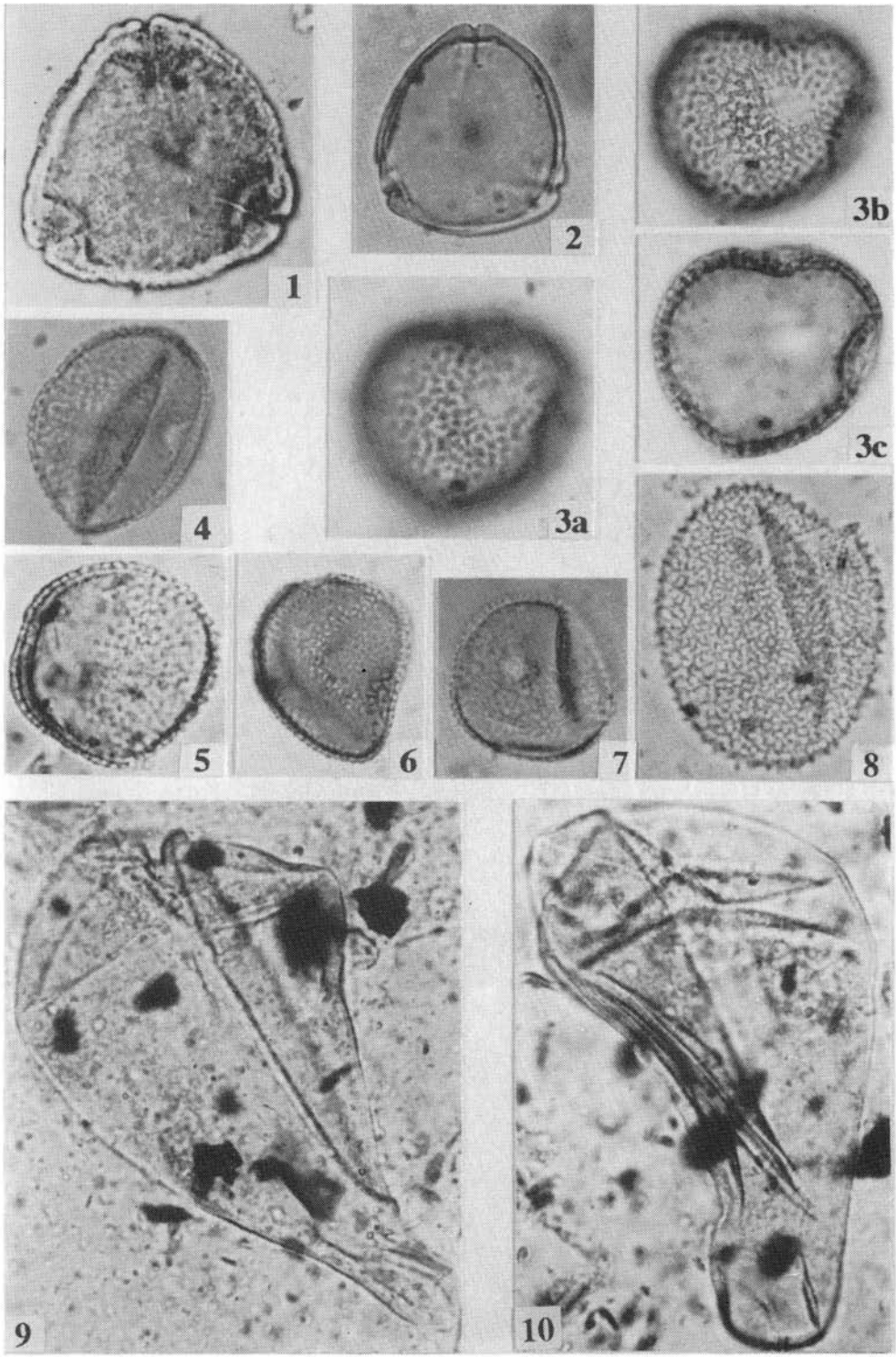
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Plate 35

× 1000

1. *Graminidites pseudogramineus* Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

2. *Graminidites* cf. sp. B. Krutzsch 1970
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

3. *Cyperaceaepollis piriformis* Thiele-Pfeiffer 1980
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

4a, b. *Arecipites* cf. *longicolpatus* Krutzsch 1970 (*Sabal adamsonii* Guerns.? – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.5–42.0 m, sample No. 47

5. *Arecipites* cf. *longicolpatus* Krutzsch 1970 (*Sabal adamsonii* Guerns.? – type)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 37.7–38.0 m, sample No. 58

6a, b. *Arecipites* cf. *pseudoconvexus* Krutzsch 1970 (cf. *Trachycarpus excelsa* Mak. var. *typica* Mak.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 41.0–41.5 m, sample No. 48

7. *Cyperaceaepollis* sp. 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

8. *Cyperaceaepollis* sp. 1
Lower Miocene (Rawicz Beds), Kosztowo, depth 104.5–105.0 m, sample No. 62

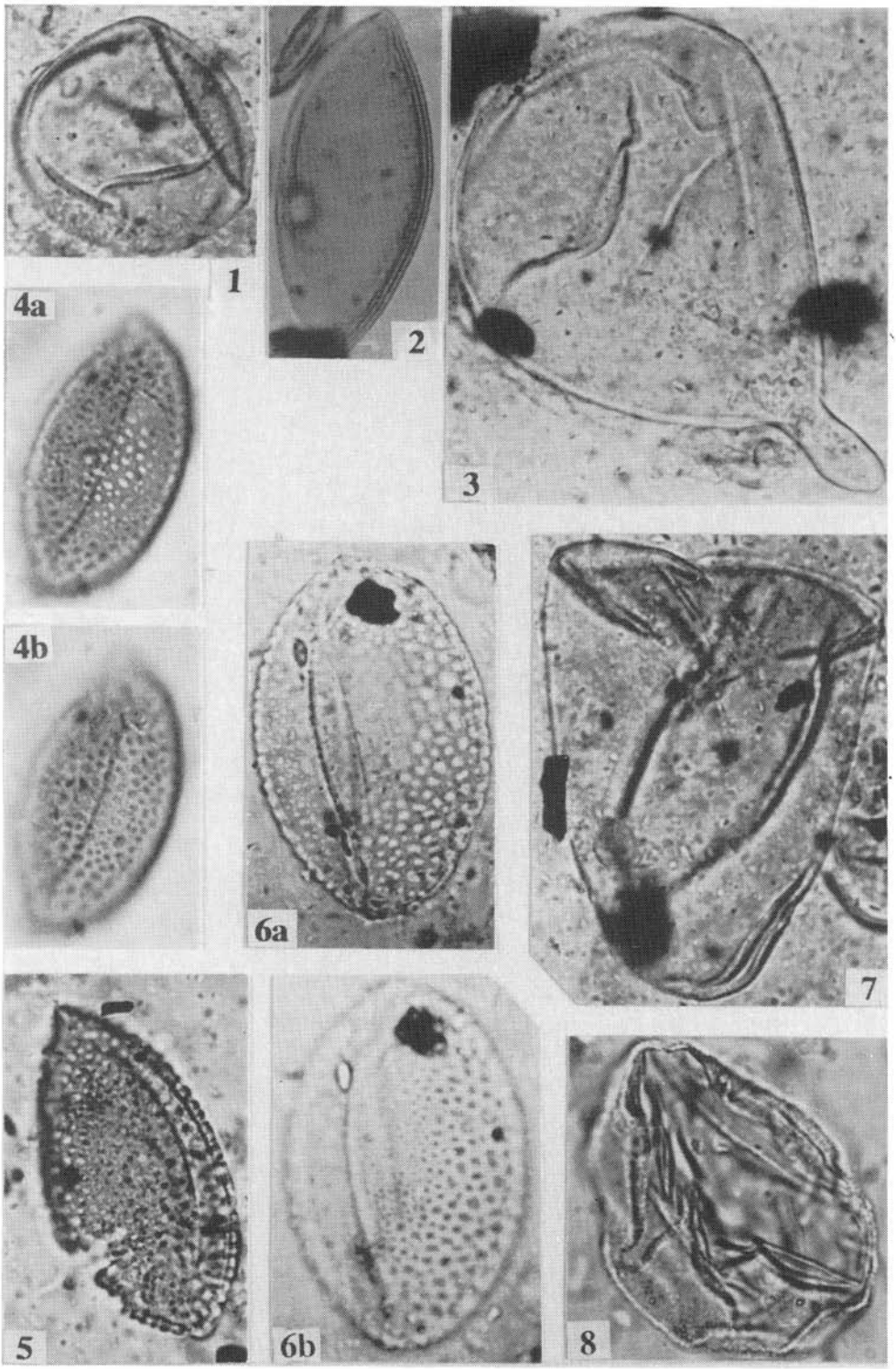
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Plate 36

× 1000

1a, b. *Arecipites lusaticus* Krutzsch 1970 (cf. *Trachycarpus fortunei* Wendl.)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 33.7–33.8 m, sample No. 69

2. *Arecipites butomus butomoides* Krutzsch 1970 (cf. *Butomus umbellatus*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 50.0–50.5 m, sample No. 22

3a, b. *Palmae* – type 5
Lower Miocene (Ścinawa Beds), Liszkowo, depth 115.0–117.8 m, sample No. 58

4a, b. *Arecipites butomoides semilaevigatus* Krutzsch 1970
Lower Miocene (Ścinawa Beds), Kosztowo, depth 89.5–91.5 m, sample No. 46

5. *Palmae* – type 3
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 81.0–81.5 m, sample No. 27

6. *Palmae* – type 4
Middle Miocene (Adamów Beds), Karolewo-Dąbki, 3, depth 55.0–55.5 m, sample No. 12

7a, b. *Corypha* L. – type
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 38.1–38.2 m, sample No. 56

8. *Palmae*? – type 6
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.2–42.5 m, sample No. 45b

9. *Palmae*? – type 6
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

10a, b. *Palmae*? – type 6
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 37.7–38.0 m, sample No. 58

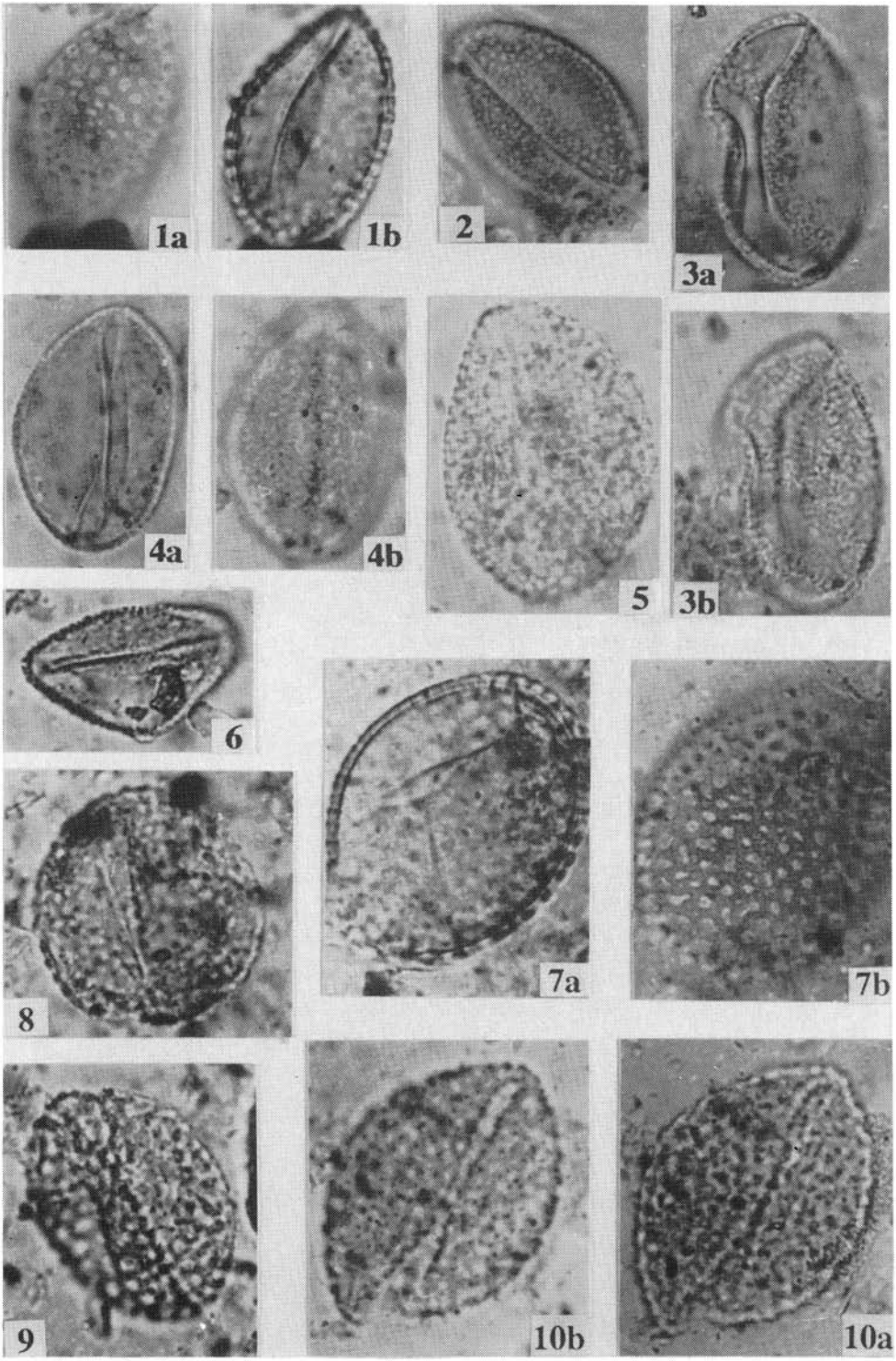
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Plate 37

× 1000

1a, b. *Palmae* – type 1
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 75.0–75.4 m, sample No. 17

2. *Liliaceae – Iridaceae* – type 2
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 49.5–50.0 m, sample No. 23

3. *Liliaceae – Iridaceae* – type 1
Middle Miocene (Adamów Beds), Kosztowo, depth 89.5–91.5 m, sample No. 46

4a, b. *Palmae* – type 2
Lower Miocene (Ścinawa Beds), Kosztowo, depth 102.7–103.0 m, sample No. 58

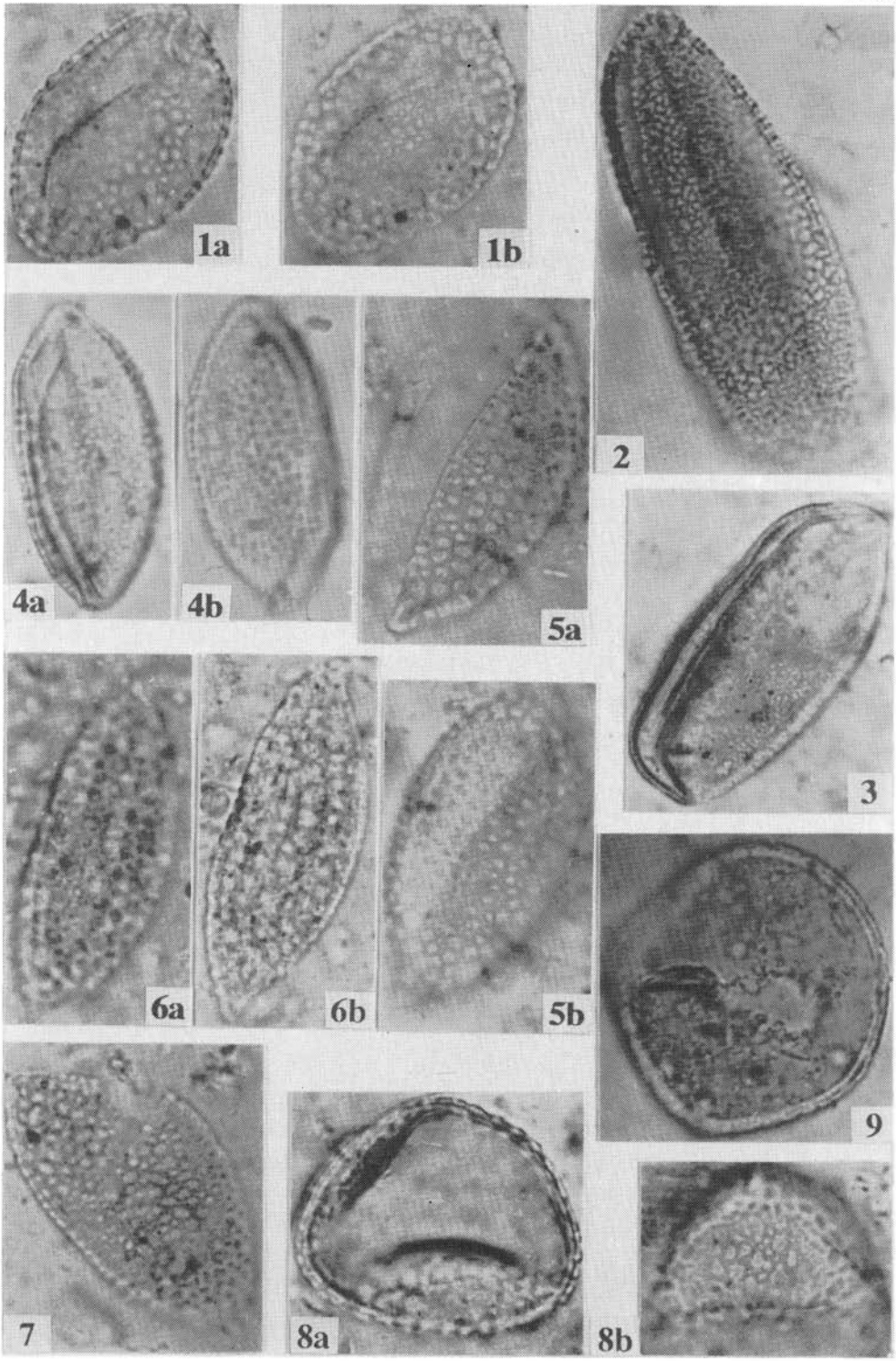
5a, b. *Amaryllidaceae* – type 1
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.5–31.7 m, sample No. 80

6a, b. *Amaryllidaceae*? – type 3
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 30.9–31.0 m, sample No. 81

7. *Amaryllidaceae*? – type 3
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 31.2–31.3 m, sample No. 78

8a, b. *Amaryllidaceae* – type 2
Middle Miocene (Mid-Polish Beds), Liszkowo, depth 79.7–80.4 m, sample No. 25

9. *Milfordia incerta* (Thomson et Pflug 1953) Krutzsch 1961 (*Restionaceae*)
Middle Miocene (Mid-Polish Beds), Karolewo-Dąbki, 3, depth 42.6–42.8 m, sample No. 43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